PROGRAM and ABSTRACTS

Northeast Aquaculture Conference & Exposition

and the

43rd Milford Aquaculture Seminar

Celebrating 25 Years of the NACE

Northeast Aquaculture
• CONFERENCE & EXPOSITION •

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

January 10-12, 2024
Omni Providence Hotel
Providence, Rhode Island

The 2024 NACE-MAS at a Glance

Northeast Aquaculture Conference & Exposition
& Milford Aquaculture Seminar 2024
Omni Providence Hotel, Providence, Rhode Island

	Wednesday, January 10 2024					
8:30 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 PM	***Who's got your back?* Get up and move with FishAbility (third floor hallway)**					
7:00 PM	**Opening reception in the Narragansset Ballroom (Trade show opens)**					
	Thursday, January 11 2024					
7:00 AM	**Registration outside the Narragansset Lobby**					
7:00 AM	***Who's got your back?* Get up and move with FishAbility (Morning movement in the 3rd floor hallway)**					
7:00 AM	**Continental breakfast in the Narragansset Ballroom**					
8:30 AM	**Plenary Session in the Narragansset Ballroom**					
10:00 AM	**Break in the foyer outside the Narragansset Ballroom**					
	Providence II/III	**Providence I/IV**	**Bristol/Kent**	**Newport/Washington**	**South County**	**Blackstone**
10:30 AM	**Sea Vegetable Aquaculture I** Chair: Anoushka Concepcion	**Ocean Acidification in the Northeast** Chair: Natalie Lord	**The Northeast Bivalve Hatchery Health Consortium** Chairs: Rob Hudson & Marta Gomez-Chiarri	**The Solar System** Chairs: Dana Morse & Carissa Maurin	**Transition of an Oyster Farm: Succession Planning & Selling the Farm** Chairs: Seth Garfield & Charmaine Gahan	**Tools for Planning & Growing Your Growing Business** Chairs: Nick Branchina
12:00 PM	**Lunch in the Narragansset Ballroom**					
1:30 PM	**Sea Vegetable Aquaculture II** Chair: Anoushka Concepcion	**Clam Aquaculture** Chair: Molly Roberts	**Tribal Aquaculture** Chair: Ellen Keane	**Oyster Farming Meets Restoration I** Chairs: Steve Kirk & Boze Hancock	**Working with the USDA – Agency Insights and Producer Experiences** Chair: Emily Cole	**Engaging Youth in Aquaculture Education I** Chairs: Carla Scocchi & Melissa Malmstedt
3:00 PM	**Break in the Narragansset Ballroom**					
3:30 PM	**Sea Vegetable Aquaculture III** Chair: Anoushka Concepcion	**Mussel Aquaculture** Chair: Mark Dixon	**Promoting a Diverse, Equitable, Inclusive & Accessible Aquaculture Industry** Chairs: Emily Whitmore & Maya Pelletier	**Oyster Farming Meets Restoration II** Chairs: Katie McFarland	**The Intersection Between Angel Investment, Bluetech, and Environmentally Responsible Aquaculture** Chair: Matt Thompson & Luke Sawitsky	**Engaging Youth in Aquaculture Education II** Chair: Kristen Jabanoski
4:30 PM	**Celebrating Diversity, Equity, & Inclusion in Aquaculture: Happy Hour in the Narragansset Ballroom**					
5:30 PM	**Poster Session & Trade Show: Happy Hour in the Narragansset Ballroom**					
6:30 PM	**ECSGA Annual Meeting (Bristol/Kent Room)**					
6:30 PM	**Dinner out on the town**					
	Friday, January 12 2024					
7:00 AM	**Registration in the Lobby**					
7:00 AM	***Who's got your back?* Get up and move with FishAbility (Morning movement in the 3rd floor hallway)**					
7:00 AM	**Continental breakfast in the Narragansset Ballroom**					
	Providence II/III	**Providence I/IV**	**Bristol/Kent**	**Newport/Washington**	**South County**	**Blackstone**
8:00 AM	**General Aquaculture I** Chair: Gillian Phillips	**Emerging Species** Chairs: Coleen Suckling & Dana Morse	**Shellfish Breeding & Genetics** Chairs: Jessica Small	**Scallop Health in Hatcheries** Chair: Sue Ishaq	**Social License to Operate for Aquaculture** Chairs: Emily Whitmore & Bailey Moritz	**Impacts of the Maine Aquaculture Hub: Research, Innovation & Workforce Development** Chair: Annie Fagan
10:00 AM	**Break in the Narragansset Ballroom**					
10:30 AM	**General Aquaculture II** Chair: Zach Gordon	**Solutions at Work: Pathways to Plastic Free Aquaculture** Chairs: Dana Morse & Sue van Hook	**Shellfish Aquaculture I** Chair: Dylan Redman	**NOAA Aquaculture Strategy: A Listening Session** Chair: Danielle Blacklock	**Creating a Road Map for Advancing Social License to Operate for Aquaculture in the Northeast** Chairs: Emily Whitmore & Bailey Moritz	**Salty Talks Live! Bridging Research and Industry at UMaine's ARI** Chairs: Deborah Bouchard & Corinne Noufi
12:00 PM	**Lunch in the Narragansset Ballroom**					
1:30 PM	**Seaweed Farmers Forum** Chairs: Jaclyn Robidoux & Liz McDonald	**Ecosystem Services I** Chairs: Julie Rose, Daphne Munroe & Carrie Byron	**Shellfish Aquaculture II** Chair: Shannon Meseck	**Coastal Systems & Scallops** Chairs: Sue Ishaq & Phoebe Jekielek	**From Regulations to Recipes: Partnering to Enhance Aquaculture Communications** Chairs: Christopher Schillaci & Brianna Shaughnessy	**Workforce Development** Chairs: Carissa Maurin & Christian Brayden
3:00 PM	**Break in the Foyer Outside Narragansset Ballroom**					
3:30 PM	**Practical Resources for Seaweed Farms and Businesses** Chair: Jaclyn Robidoux	**Ecosystem Services II** Chairs: Julie Rose, Daphne Munroe, & Carrie Byron	**Shellfish Aquaculture III** Chair: Katy Shoemaker	**Initial Assessment of Mussel & Seaweed Supply Chain Carbon Emissions for Maine Aquaculture** Chair: Sam Belknap	**Stories & Lessons Learned from Farmer to Farmer Exchanges** Chair: Chris Davis	**Lumpfish: Cleanerfish Production to Mitigate Sea Lice in Salmonid Farms** Chairs: Elizabeth Fairchild & Mike Pietrak
5:00 PM	**Closing Remarks & Sendoff Toasts in the Foyer Outside Narragansset Ballroom**					

Welcome

The NACE – MAS Planning Committee welcomes you to this joint meeting of our organizations. We hope that by bringing together industry producers, resource managers, researchers and students in an informal setting, all can share each other's knowledge on aquaculture in the northeast region.

This year's event promises to deliver a quality program with forty two sessions on finfish, sea vegetables and shellfish farming, five informative workshops, four field trips to area aquafarms, research facilities and a tradeshow including major aquaculture vendors from across North America. We hope that you enjoy the meeting.

NACE-MAS Organizing Committee

Chris Davis – Maine Aquaculture Innovation Center
Anne Langston Noll – Maine Aquaculture Innovation Center
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 & **Sylvia Feeney** - NOAA National Marine Fisheries Service Milford Laboratory
Maya Pelletier, Sydney Avena & Emily Whitmore – Maine Aquaculture Innovation Center

Thank you to our sponsors!

Gold Sponsors

Maine Aquaculture Innovation Center
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USDA/NIFA Northeastern Regional Aquaculture Center
Maine Technology Institute
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Thanks to Our Exhibitors

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Program for Wednesday & Thursday Morning

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8:30 AM	**Plenary Session in the Narragansset Ballroom** NOAA welcome address by Danielle Blacklock Rapid fire industry updates of issues facing the northeastern states					
10:00 AM	**Break in the foyer outside the Narragansset Ballroom**					
	Providence II/III	**Providence I/IV**	**Bristol/Kent**	**Newport/Washington**	**South County**	**Blackstone**
	Sea Vegetable Aquaculture I *Chair: Anoushka Concepcion*	**Ocean Acidification in the Northeast** *Chair: Natalie Lord*	**The Northeast Bivalve Hatchery Health Consortium** *Chairs: Marta Gomez-Chiarri & Rob Hudson*	**The Solar System** *Chair: Dana Morse & Carissa Maurin*	**Transistions of an Oyster Farm: Succession Planning & Selling the Farm** *Chairs: Seth Garfield & Charmaine Gahan*	**Tools for Planning & Growing Your Business** *Chair: Nick Branchina*
10:30 AM	State of the States: Status of Seaweed Aquaculture in the U.S. *Jaclyn Robidoux*	WORKSHOP Ocean and coastal acidification pose a substantial threat to marine ecosystems, and especially to calcifying organisms such as shellfish. We will discuss the latest research findings from the region, including field observations and laboratory experiments, that shed light on how varying levels of ocean acidification affect the growth, survival, and reproductive success of shellfish species. This workshop will also provide an update on the Northeast Coastal Acidification Network's monitoring and research priorities. Participants will have the opportunity to share their challenges and concerns regarding ocean acidification and provide feedback that will be a part of a national stakeholder needs assessment for the NOAA Ocean Acidification Program (OAP).	WORKSHOP The "Northeast Bivalve Hatchery Health Consortium (NEBHHC): Managing Larval Mortalities in Northeast Hatcheries" aims to support the growth of the bivalve shellfish industry in the Northeast USA by providing access to diagnostic tools that help hatcheries ensure reliable production of bivalve seed. The objectives for this consortium are to: (1) identify the causes of bivalve hatchery larval mortalities and crashes in the Northeast US through an integrated, collaborative, and proactive approach to sample collection and analysis; and (2) develop strategies and protocols to manage and minimize larval crashes in hatcheries. Members of the NEBHHC coordinating team, including pathologists, ecologists, hatchery managers, and extension specialists, will answer questions and gather feedback from stakeholders on how to address this critical issue of larval crashes.	Solar-powered seafood *Abigail Barrows*	WORKSHOP Oyster Farm Exit Strategy: Don't Get Shucked! If you are curious about selling your farm or are looking into an alternative exit strategy, join Seth Garfield and Charmaine Gahan for this important workshop. Hear about the fundamentals of succession planning and exit strategies, the factors that are considered during a valuation as well as all the other pieces puzzle such as permits, finances, legal aspects, and last but not least transacting "The Deal"	PANEL SESSION Join Nick Branchina from Coastal Enterprise Inc for this panel discussion focusing 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.
10:45 AM	Exploring techniques for gametophyte based husbandry, alternative settlement substrates, and accelerated sporophyte development for nursery optimization and resiliency in kelp aquaculture *Adam St Gelais*			Solar System for an off-grid, near-shore, oyster processing float *Maxwell Burtis*		
11:00 AM	Identifying and breeding heat-tolerant strains of Sugar Kelp *Sara Gonzalez*			3-Dimensional Cultivation of Oysters Automated with Solar Tumbling *Luke Saindon*		
11:15 AM	Effects of different seed strings on germination and early development of gametophytes in *Pyropia yezoensis* *Jang Kyun Kim*			Electrifying aquaculture *Nick Planson*		
11:30 AM	Evaluation of six superior sugar kelp (*Saccharina latissima*) crosses on three farms in three northeastern states *Yaoguang Li*			Solar FLUPSYs: a survey of powering floating upwellers with photovoltaics. *Dale Leavitt*		
11:45 AM	Building reliable kelp seed supply chains using gametophyte cultures *Toby Sheppard Bloch*			Discussion		
12:00 PM	**Lunch in the Narragansset Ballroom**					

Program for Thursday Afternoon

12:00 PM	**Lunch in the Narragansset Ballroom**					
	Providence II/III	**Providence I/IV**	**Bristol/Kent**	**Newport/Washington**	**South County**	**Blackstone**
	Sea Vegetable Aquaculture II *Chair: Anoushka Concepcion*	**Clam Aquaculture** *Chair: Molly Roberts*	**Tribal Aquaculture** *Chair: Ellen Keane*	**Oyster Farming Meets Restoration I** *Chairs: Steve Kirk & Boze Hancock*	**Working with the USDA - Agency Insights & Producer Experiences** *Chair: Emily Cole*	**Engaging Youth in Aquaculture Education I** *Chairs: Carla Scocchi & Melissa Malmstedt*
1:30 PM	Modeling to inform seaweed farm design for optimizing growth, production, and advancement of the U. S. marine aquaculture industry *Andrea Angera*	Inter-tidal field-based nurseries for cultured soft-shell clam juveniles: experimental results from three Maine communities *Brian Beal*	PANEL SESSION: Join representatives of Tribal Nations from across the Northeast. Learn more about aquaculture projects aligned with Tribal wisdom and goals for the future, and find out about resources available for Tribal aquaculture projects.	Program considerations for the Natural Resources Conservation Service oyster restoration initative in RI *Brunilda Velez Diaz*	Federal crop insurance programs for aquaculture *Alexander Sereno*	WORKSHOP Dive into an immersive aquaculture learning experience with Carla from UMaine Cooperative Extension 4-H and Melissa from UMaine Center for Cooperative Aquaculture Research. Explore hands-on curriculum from the nationally-recognized 4-H Aquaponics Project, an innovative workforce development program designed to harness youth interests in fish and horticulture to cultivate real-world skills applicable to the aquaculture industry. In this dynamic workshop, participants will engage in hands-on activities to construct a mini-aquaponics system and take a virtual field trip through UMaine's Center for Cooperative Aquaculture Research using state-of-the-art virtual reality tools. Walk away from the session equipped with lesson plans and innovative ideas for integrating aquaculture into your teaching and learning setting. Participants will also have the chance to win an aquaculture-themed prize!
1:45 PM	Maine Seaweed Exchange & Green Urchin Cultivation on Seaweed and Oyster Farms *Andrea Angera*	Establishment and Evaluation of Regionally Crossbred Hard Clam *Mercenaria mercenaria* *Paul Coyne*		NRCS Coastal Innovation Grant for Farmer-Supported Restoration in Massachusetts *Amanda Cutler*	Farm service agency programs and resources for aquaculture producers *Sherry Hamel*	
2:00 PM	Following the snail trail: detecting and predicting the arrival and settlement of the marine snail *Lacuna vincta* on kelp farms in Maine *Cara Blaine*	Site-specific growth rates of Atlantic surfclams (*Spisula solidissima*) collected from nearshore locations in Cape Cod, MA. *Matthew Poach*		A farmer's perspective: Implementing oyster restoration through the NRCS Environmental Quality Incentives program *Matthew Griffin*	Implementation of the natural resources conservation service oyster restoration program in Rhode Island *Melissa Hayden*	
2:15 PM	Low cost sensor to ensure integrity of seaweed aquaculture operations *Andrea Angera*	The effects of site and shell hash on Atlantic Surfclams (*Spisula solidissima*) growth and feeding rate in Cape Cod, MA *Emily Roberts*		Leveraging aquaculture for restoration: An overview of the Supporting Oyster Aquaculture and Restoration (SOAR) program *Boze Hancock*	Working with the USDA - Producer experiences *Robert Rheault*	
2:30 PM	Microbial assessment of dried sea vegetables for safety and quality *Stephen Eddy*	Growth, physiology, and survival of the Atlantic Surfclam, (*Spisula solidissima*): Off-shore aquaculture and multi-stressor laboratory experiments *Laura Steeves*		A Growing Partnership Between Aquaculture and Restoration in the Great Bay Estuary, NH *Brian Gennaco*	PANEL DISCUSSION USDA & ECSGA representatives and shellfish producers from New England will share first-hand experiences of working with USDA agencies.	
2:45 PM	'Kelp' us learn! Expanding Maine's place-based elementary school curriculum using seaweed aquaculture *Maya Pelletier*	Arctic surfclam, *Mactromeris polynyma*, culture in Eastern Maine: A comparative field experiment to assess growth and survival *Brian Beal*		Achieving oyster restoration goals and supporting the aquaculture industry on Martha's Vineyard *Emma Green-Beach*		
3:00 PM	**Break in the Narragansset Ballroom**					
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	Sea Vegetable Aquaculture III *Chair: Anoushka Concepcion*	**Mussel Aquaculture** *Chair: Mark Dixon*	**Promoting a Diverse, Equitable, Inclusive, & Accessible Aquaculture Industry** *Chairs: Emily Whitmore & Maya Pelletier*	**Oyster Farming Meets Restoration II** *Chairs: Steve Kirk & Boze Hancock*	**The Intersection Between Angel Investment, Blue Tech, & Environmentally Responsible Aquaculture** *Chairs: Matt Thompson & Luke Sawitsky*	**Engaging Youth in Aquaculture Education II** *Chair: Kristen Jabanoski*
3:30 PM	Business and economic planning for seaweed aquaculture systems in the United States *Tammy Warner*	Ribbed mussel (*Geukensia demissa*) cultivation: Progress and challenges *Barry Udelson*	A Rising Tide? The role of alternative social networks for women oyster farmers in Maine and New Hampshire *Natalie Lord*	Oyster health and restoration in Long Island Sound Part I. LIS oyster populations *Isaiah Mayo*	PANEL SESSION Join this session to find out more about the UpSwell program as well as the findings of its aquaculture whitepapers. We will also hear from industry leaders as they provide their views on the challenge-opportunity space and provide recommendations for future startups. This session will benefit investors, entrepreneurs, innovators, and industry looking for opportunities in scaling responsible aquaculture.	Re-building a marine science community education toolkit to enhance local lifelong learning *Nina Ferry Montanile*
3:45 PM	Into the deep: Can daily depth cycling enhance growth and increase resilience in climate change in tropical seawed? *Loretta Roberson*	Consumer perspectives on a value-added, marinated mussel product *Denise Skonberg*	Aquaculture in Shared Waters 2024: A Skill-Building Series for Maine Women and Nonbinary Aquaculturists *Annie Fagan*	Oyster health and restoration in Long Island Sound Part II. Trends in diseases of unmanaged oyster populations *Mariah L Kachmar*		Building the workforce of tomorrow: Expanding awareness of aquaculture as a viable STEM career for Maine's youth *Carissa Maurin*
4:00 PM	Moving kelp farming offshore to explore vertical culture methods *Michael Chambers*	Development of environmental conditions for engineering design of a continuous mussel farm in New England offshore waters *David Fredriksson*	Minorities in Aquaculture: Promoting Aquaculture Workforce Development with DEI Approaches *Imani Black*	Oyster health and restoration in Long Island Sound Part III. Observations of changing water chemistry *Genevieve Bernatchez*		Exploring the Science of Seaweed Farming: An In-School Experiential Program *Pauline Dion*
4:15 PM	Using novel seaweed products to assess consumer preferences *Christian Brayden*	Estimating the probability of failure of mussel farm's components in New England offshore waters using numerical modeling *Longhuan Zhu*	Aquaculture Needs Assessment at Minority Serving Institutions *Kaitlyn Theberge*	Biophysical modeling and genomic recruitment estimates to map larval connectivity for oyster restoration planning in the Hudson River *Matthew Hare*		Developing an aquaculture pathway in Connecticut to increase aquaculture workforce development *Alysa Mullen*
4:30 PM	**Celebrating Diversity, Equity, & Inclusion in Aquaculture: Happy Hour in the Narragansset Ballroom**					
5:30 PM	**Poster Session & Trade Show: Happy Hour in the Narragansset Ballroom**					
6:30 PM	**ECSGA Annual Meeting**					
6:30 PM	**Dinner on your own out on the town**					

Program for Friday Morning

	Friday, January 12					
7:00AM	**Registration outside the Narragansset Lobby**					
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8:00 AM	Evaluating the feasibility and sustainability of an integrated multi-trophic recirculating aquaculture system using Striped Bass (*Morone saxatilis*), sand worms (*Alitta virens*), and sea beans (*Salicornia bigelovii*) *Michael Acquafredda*	Blame it on Tom Marcotti: Planting juvenile softshell clams (*Mya arenaria*) in containment *Dana Morse*	Founder population selection for an oyster selective breeding program *Thomas Delomas*	Bacterial community trends associated with sea scallop, *Placopecten magellanicus*, larvae in a hatchery system. *Sue Ishaq*		A Highly Efficient Oyster Farming Model: Modified for a Maine Family Farm *Keith Butterfield*
8:15 AM	Seasonal patterns of distribution and abundance of waterbirds in relation to oyster aquaculture in coastal Rhode Island: implications for disease risk *Martina Muller*	Expanding Northeastern US green sea urchin aquaculture production and their potential to reduce biofouling of shellfish. *Coleen Suckling*	Early stages of implementation of genomic slection in the Eastern oyster, *Crassostrea virginica* *Jessica Small*	Investigating the activity of bacteria isolated from tank biofilms in a hatchery system for sea scallop, *Placopecten magellanicus*, larvae *Ayodeji Olaniyi*		Testing the efficiency of biofouling removal in the Maine scallop aquaculture industry *Cait Cleaver*
8:30 AM	Microbial source tracking to mitigate bacterial contamination in aquaculture waters - a promising public health tool *Sarah Esenther*	Assessing bottlenecks preventing successful Green Sea Urchin production *Tara Plee*	Genetic improvement of the Eastern oyster and prospects of genomic selection *Ximing Guo*	Identification of bacterial communities and their association with larval mortality in Atlantic sea scallops (*Placopecten magellanicus*) hatchery system *Adwoa Dankwa*		Highlighting Maine Fishermen as Leaders in Sustainable Aquaculture *Liz MacDonald*
8:45 AM	Microplastics as vectors for bacterial contamination of finfish *Lyle Massoia*	Opportunities and challenges for building resilience of the aquaculture industry in Rhode Island *Nikol Damato*	Performance of triploid Eastern oysters across the Northeast: Assessment of growth, survival, and disease *Christopher Brianik*	The use of probiotics to mitigate atlantic sea scallop (*Placopecten magellanicus*) mortality following challenge with pathogenic vibrio species *Kyle Brennan*		Maine to Mountain: A seafood pipeline to the West *John Herrigel*
9:00 AM	Liopsome-containing complex particles (LCP): A novel microdiet for delivery of water-soluble nutrients to marine fish larvae *Kara Chuang*	A systems-approach for integrated multitrophic aquaculture production for coastal New Hampshire *David Fredriksson*	Triploidy enhances tolerance to *Perkinsus marinus* in Eastern oysters *Christopher Brianik*	Isolation, screening, and selection of potential pathogenic and probiotic bacteria from bivalve shellfishes *Jaypee Samson*		Advancing scallop aquaculture through innovative hatchery techniques *Brea Salter*
9:15 AM	Performance of Striped Bass Reared at Mid-Atlantic and Gulf Coast Photothermal Regimes *Linas Kenter*	Maine's Scallop Farming Industry Emerges, as a Direct Outcome of Japan/US Technology Transfer *Dana Morse*	Updates from the East coast hard clam selective breeding collaborative *Bassem Allam*	"Cracking the shell": Lessons learned from a collaborative approach to developing hatchery production of the Atlantic sea scallop, *Placopecten magellanicus* *Sydney Avena*		Mussel Aquaculture Feasibility Trials in Eastern Maine *Bob Wood*
9:30 AM	Distinct effects site exposure on the cost of seaweeed and shellfish farm structures *Tobias Dewhurst*	Discussion	Survival of the fittest: Genomic investigations of the bay scallop reveal a shift in population structure through a summer mortality event *Bassem Allam*	Saving the seed: Nantucket Bay Scallop seed management of 2023 *Tara Riley*		Gender equity on Maine's working Waterfront: Diversifying the Aquaculture In Shared Waters training program *Jess Veo*
9:45 AM	Coral reef loss: What can be done? *Walter Blogoslawski*		Genomic and phenotypic variation in wild and selectively bred oysters *Angel Carrasquillo*	Discussion		Aquaculture in shared waters: 10-year impacts of an entrepreneurial training program *Jaclyn Robidoux*
10:00 AM	**Break in the Narragansset Ballroom**					
	Providence II/III	**Providence I/IV**	**Bristol/Kent**	**Newport/Washington**	**South County**	**Blackstone**
	General Aquaculture II *Chair: Zach Gordon*	**Solutions at Work: Pathways to Plastic Free Aquaculture** *Chairs: Dana Morse & Sue van Hook*	**Shellfish Aquaculture I** *Chair: Dylan Redman*	**NOAA Aquaculture Strategy: A Listening Session** *Chair: Danielle Blacklock*	**Creating a Roadmap for Advancing Social License to Operate f or Aquaculture in the Northeast** *Chairs: Emily Whitmore & Bailey Moritz*	**Salty Talks Live! Bridging Research and Industry at UMaine's ARI** *Chairs: Deborah Bouchard & Corinne Noufi*
10:30 AM	Great Lakes aquaculture decision-maker day: An event bringing state legislators to meet with aquaculture farmers and tour a farm *Barry Udelson*	Global Policy changes to support reduction of plastic pollution in the ocean *Sue van Hook*	Taking the 'guesswork' out of seed collection: Developing novel environmental RNA (eRNA) tools for blue mussel aquaculture *David A Ernst*	WORKSHOP NOAA Fisheries is developing a Program Plan that will outline how the agency would be able to implement the NOAA Aquaculture mission and vision under various funding scenarios. In this listening session, The Director of the Office of Aquaculture, the Northeast Fisheries Science Center Director, and the Regional Administrator for the Greater Atlantic Regional Office will review the Goals and Objectives outlined in the NOAA Aquaculture Program Strategic Plan and engage participants in prioritization discussions around the future of NOAA's aquaculture mission.	WORKSHOP In this workshop, participants will take a deep dive into social license challenges and solutions through a series of small group activities. The end goal of the workshop is to outline concrete social license actions for both farmers (who have the most influence over social license) and supporting actors (trade associations, eNGOs, municipalities, chefs & more) that are specific to the Northeast. Groups will tackle a range of stakeholder groups, and the resulting notes will be compiled into a Northeast Social License Roadmap.	PANEL SESSION Join us for a 90-minute session with six panelists from the Aquaculture Research Institute (ARI) at the University of Maine, where they will illuminate the intersection of research and industry application in sustainable aquaculture. This session will broadly cover topics like aquatic animal health, the cultivation and uses of kelp, and shellfish aquaculture, showcasing how these areas are pivotal to Maine's aquaculture industry. The discussion will also touch on the role of ARI's research in addressing challenges posed by climate change and in driving innovations that enhance both environmental sustainability and economic resilience in coastal communities. Whether you're an industry professional, a researcher, or simply someone keen on sustainable practices, this session will offer valuable insights into the practical applications of ARI's research.
10:45 AM	Who's Who in Maine Aquaculture? Understanding the landscape of aquaculture actors and priorities *Molly Miller*	Coalition Building to Address Derelict Fishing Gear *Dana Morse & James Rutter*	A user-friendly, rapid eDNA tool to identify pathogens responsible for disease in oyster aquaculture *Robin Sleith*			
11:00 AM	NECAN - The Northeast Coastal Acidification Network *Austin Pugh*	Reimagining Plastic-Based Aquaculture: an investigation into viable materials *Abigail Barrows*	Flow cytometric analysis of hemocyte immune functions in the Pacific oyster (*Crassostrea gigas*) in response to *in vitro* exposure to bacterial probiotic strain OY15 *Diane Kapareiko*			
11:15 AM	ELAP: opportunities and challenges from a national perspective *Charlie Culpepper*	Marine Gear from Seaweed *Katie Weiler*	History and future of monitoring oyster diseases in Connecticut *Lydia Bienlien*			
11:30 AM	Making a splash: Creating excellent publications for aquaculture and aquacultural engineering *Steven Hall*	Solutions for Sustainability on Shellfish Farms *Willy Leathers*	Getting Back to Basics: Hatchery Cleaning Protocols *Chris Edwards*			
11:45 AM	Discussion	Discussion	Feeding regimes for post-set bivalves – new relevance arising from the Regional Shellfish Seed Biosecurity Program *Gary Wikfors*			
12:00 PM	**Lunch in the Narragansset Ballroom**					

Program for Friday Afternoon

12:00 PM	**Lunch in the Narragansset Ballroom**					
	Providence II/III	**Providence I/IV**	**Bristol/Kent**	**Newport/Washington**	**South County**	**Blackstone**
	Seaweed Farmers Forum *Chairs: Jaclyn Robidoux & Liz MacDonald*	**Ecosystem Services I** *Chairs: Julie Rose, Daphne Munro & Carrie Byron*	**Shellfish Aquaculture II** *Chair: Shannon Meseck*	**Coastal Systems & Scallops** *Chairs: Sue Ishaq & Phoebe Jekielek*	**From Regulations to Recipes: Partnering to Enhance Aquaculture Communications** *Chairs: Christopher Schillaci & Brianna Shaughnessy*	**Workforce Development** *Chairs: Carissa Maurin & Christian Brayden*
1:30 PM	PANEL SESSION Join this farmer-focused panel session to hear from seaweed farmers from across the Northeast about the ways in which they are responding, innovating, and building new opportunities in the rapidly developing seaweed sector. From Maine to New York, the seaweed industry in each state is unique, and panelists will represent different states and scales of operation. We'll learn from the folks on the water about their state and regional industries, supply chains, and needs, as well as discuss shared experiences, resources, and opportunities for the Northeast	Shellfish ecosystem services (nitrogen removal and filtration) as case study for the Reykjavik Protocol Environmental Credit Generation Architecture *Daniel Codiga*	The influence of vessel shape on bottle upweller performance. *Dale Leavitt*	Developmental mismatch of pCO2 levels in a second generation of northern bay scallops *Samuel Gurr*	Making your message count: Research, resources, and funding to enhance public understanding of aquaculture *Brianna Shaugnessy*	Blending aquaculture education into a fisheries crew training program in Rhode Island *Azure Cygler*
1:45 PM		Eastern oyster aquaculture nitrogen and phosphorus reduction in Chesapeake Bay: low variation across season, ploidy, and farm location *Ryan Morse*	Shellfish Wet Storage Containment Systems *Mark Crandall*	Comparing growth of ear hung and lantern net cultured sea scallops, *Placopecten magellanicus*, over a complete grow-out cycle to determine optimal harvest timing *Christopher Noren*	Window to an underwater world: sharing the habitat value of shellfish farms with a broad audience *Kristen Jabanoski*	Connecticut aquaculture workforce development study: Phase I *Tessa Getchis*
2:00 PM		Oyster Aquaculture Larval Subsidy Drives Emerging Wild Oyster Populations In Maine, USA *Sarah Risley*	Ropeless Submersible Autonomous Aquaculture Platform *Tim Matuszewski*	A comparative study of sea scallop (*Placopecten magellanicus*) energy investment strategies in farmed and wild environments *Phoebe Jekielek*	Delivering for your Buyers: Using appropriate technologies to simplify operations and deliver safe seafood with a story *Chip Terry*	An update of the Suffolk Project in Aquaculture Training (SPAT) *Kim Tetrault*
2:15 PM		Ecosystem services of bivalves in urban estuaries *Allyson Kido*	Oysters on trees - A look back at the Poquonnock method *Timothy Visel*	Understanding wild sea scallop (*Placopecten magellanicus*) larval spatial and temporal distribution in Maine to support culture and capture fisheries *Caitlin Cleaver*	Fishermen or Scientists? How ideology shapes who the public trusts for information on aquaculture. *Emily Whitmore*	Aquaculture Workforce Development: Engaging Audiences Through Place-Based Education *Madison Maier*
2:30 PM		Utlizing Flowcam to enhance understanding of oyster and green crab larvae in Great Bat Estuary, New Hampshire *Kelsey Meyer*	Quantifying oyster aquaculture lease acceptance: a case study on repurposed Maine lobster pounds *Ruby Krasnow*	Predicting larval dispersal and population connectivity of Sea Scallops, *Placopecten magellanicus*, in Downeast Maine. *Paul Rawson*	Communicating beneficial services provided by shellfish aquaculture within the aquaculture permitting and review process *Christopher Schillaci*	Voices of Maine's Aquaculture Apprenticeship *Trixie Betz*
2:45 PM		Would you like biodiversity with that? Investing in oysters for food and habitat *Hugh Forehead*	Developing Oyster aquaculture best management practices (BMPs) in Maine *Christian Brayden*	Review of Nantucket Island's Bay Scallop Spat Bag Program *Griffin Harkins*	Discussion	Maine shellfish & seaweed apprenticeship: A partnership between industry and the community college system *Carissa Maurin*
3:00 PM	**Break in the Foyer Outside Narragansset Ballroom**					
	Providence II/III	**Providence I/IV**	**Bristol/Kent**	**Newport/Washington**	**South County**	**Blackstone**
	Practical Resources for Seaweed Farms and Businesses *Chair: Jaclyn Robidoux*	**Ecosystem Services II** *Chairs: Julie Rose, Daphne Munro & Carrie Byron*	**Shellfish Aquaculture III** *Chair: Katy Shoemaker*	**Initial Assessment of Mussel & Seaweed Supply Chain Carbon Emissions for Maine Aquaculture** *Chair: Sam Belknap*	**Stories & Lessons Learned from Farmer to Farmer Exchanges** *Chair: Chris Davis*	**Lumpfish: Cleanerfish Production to Mitigate Sea Lice in Salmonid Farms** *Chairs: Elizabeth Fairchild & Mike Pietrak*
3:30 PM	PANEL SESSION Resources, reports, toolkits, and more! Over the past few years, a number of new resources and valuable tools have become available for seaweed farms and businesses as the sector has developed and expanded. Helpful to seaweed farmers, decision makers, and the seaweed curious alike, these "seed to sale" resources include business planning and management guides, production and benchmarking reports, and marketing and outreach toolkits. In this session, we'll cover the highlights and findings of these resources and explore how businesses and organizations can best utilize this new information. Panelists include: Michael Ciarmella: Creating standards for harvesting seaweed as food in New York Christian Brayden: Can I make money growing seaweed? using financial benchmarks to assess seaweed aquaculture profitability in Maine Jaclyn Robidoux: The seaweed marketing toolkit Anne Langston Noll: The sea vegetable consumer dashboard	Development of an eastern oyster harvest nutrient calculator for the Northeast Region *Julie Rose*	Building a Benchmarking Program for Market Oysters *Bill Walton*	PANEL SESSION Aquaculture is often portrayed as a more environmentally and climate friendly opportunity for food production that produces less greenhouse gas (GHG) equivalent emissions than other terrestrial food production methods. Lifecycle and GHG analyses are increasingly being used to demonstrate this in a quantitative manner. This panel will discuss the initial result of the full supply chain analysis of two species currently being farmed in Maine: *Mytilus edulis* (blue mussel) and *Saccharina angustissima* (skinny kelp).	PANEL SESSION Maine Aquaculture Innovation Center has piloted a Farmer to Farmer Exchange program. The program has funded 9 Maine businesses for visits to out of state domestic and international farms, where they can learn about new processes, techniques, technology, and networks to improve their business. Join this session to hear about the exchanges, lessons learned, and what comes next!	The development and use of cleanerfish in Newfoundland and Labrador *Darrell Green*
3:45 PM		Integrating information on beneficial services provided by shellfish aquaculture into the aquaculture permitting and review process *Christopher Schillaci*	Real-time water quality monitoring in shellfish growing areas; Lessons learned *Rachel Hutchinson*			Lumpfish production for use as cleanerfish: An overview with an emphasis on research in New Hampshire *Elizabeth Fairchild*
4:00 PM		Fish production and use of oyster aquaculture gear in comparison to natural habitats north and south of Cape Cod *Kelsey Schultz*	Picture this: 25 years of flow imaging microscopy (FLOWCAM) in shellfish aquaculture *Savannah Judge*			Cooke Aquaculture Lumpfish Hatchery *Jen Ford*
4:15 PM		Oyster aquaculture cages as habitat for Black Sea Bass *Renee Mercaldo-Allen*	Comparing growth and survival of juvenile oysters at five sites across a gradient of water quality conditions in a Cape Cod estuary *Josh Reitsma*			Development of a lumpfish breeding program for Maine industry *Steve Eddy*
4:30 PM		Using artificial intelligence to identify fish from cameras on aquaculture gear *Gillian Phillips*	Got the fuzz? A conversation about the effect of stalked ciliates on oyster nursery culture *Samantha Glover*			Progress towards a Gulf of Maine captive reared lumpfish (*Cyclopterus lumpus*) broodstock population *Mike Pietrak*
4:45 PM		A year-long eDNA survey of fishes in Long Island Sound - Does aquaculture gear matter? *Yuan Liu*	Testing mitigation strategies for a changing world: co-culturing blue mussels and sugar kelp *Brittney Honisch*			Endocrine dynamics during the reproductive cycle of Lumpfish (*Cyclopterus lumpus*) *Erin Legacki*
5:00 PM	**Closing Remarks & Sendoff Toasts in the Foyer Outside Narragansset Ballroom**					

Poster Presentations
Thursday 5:30 – 6:30

Hisham	Abdelrahm	Diploid and Triploid Eastern Oysters (*Crassostrea virginica*): Contrasting Tolerance and Responses to thermal Stress in the Northern Gulf of Mexico
Richa	Arya	Impact Of Brining On The Survival Of Shiga Toxigenic *Escherichia Coli*, *Vibrio* Spp. *Salmonella* Spp. And *Listeria Monocytogenes* On Inoculted Sugar Kelp (*Saccharina Latissima*) During Refrigerated And Ambient Storage
Linda	Auker	Design and Application of Biofouling Dashboards for Use in Aquaculture
Jessie	Batchelder	Exploring the Viability of Intertidal Quahog Aquaculture in Maine
Nichole	Blackmer	Atlantic Sea Scallop (*Placopecten magellanicus*) Immune Ontogeny And Its Relevance To Hatchery Survival Rates
Christopher	Brianik	The Effect Of Ploidy On The Formation And Antimicrobial Efficacy Of Extracellular Traps In The Eastern Oyster
Grace	Cajski	Behavior of scup associated with an oyster farm and rock reef in Long Island Sound
Ling	Ding	Immune Gene Expression As Markers For Early Development Of The Immune System In Yellowtail Kingfish (*Seriola Lalandi*)
Johnathan	Evanilla	Co-Designing Forecasts For Aquaculture
Rob	Holmberg	Softshell Clam *Mya arenaria S*urvival, Shell Morphometrics, and Susceptibility to Predation in Response to Simulated Ocean Acidification and Warming
Kristen	Jabonowski	Rebooting NOAA fisheries Milford Lab's annual open house after a global pandemic
Christopher	Jenkins	Assessing the Potential of Purple Sea Urchins for Biofouling Control on RI Oyster Farms
Zoe	Kendall	Impacts of Lab-Induced Acidification and Changes in Ambient Ecosystem Conditions on Growth and Survival of *Mytilus edulis*
Anne	Langston-Noll	Developing a world class, industry-relevant, community-college based training program to prepare the next generation of Maine's aquaculture workforce
Abby	Lucas	Baseline Aquatic Biodiversity and Water Quality Data from Seyðisfjörður, an East Iceland Fjord, Before the Proposed Installation of Fish Farms
Aidan	Lurigo	Establishing the Seasonal Baseline Levels of Vibrio parahaemolyticus in Three Locations in Maine
Alley	McConnell	Using Shellfish Aquaculture Equipment To Propagate Eelgrass For Restoration
Gary	Moline	Can a Biofouling Settlement Period be Predicted in the Damariscotta River Using Environmental DNA
D Nathaniel	Mulcahy	The true chicken of the sea. What we can learn from the rise, boom, collapse and return of an adriatic shellfish industry
Christopher	Noren	Bioeconomic Model Framework Application Developed for Sea Scallop Growers
Mariah	Pearson	Extraction and detection of geosmin and 2-methylisoborneol in water and fish as a service to farmers or researchers in need of low cost testing
Maya	Pelletier	MAI-Ed: Creating an aquaculture learning hub to support a diverse and innovative workforce in Maine's farmed seafood sector
Gabriella	Peluso	Immune Gene Expression as an Indicator of Immunocompetence in Lumpfish, *Cyclopterus lumpus*
Jesús	Pineda	"Unwanted Marine Life Growing On Oyster Farms": A Survey Of Massachusetts Oyster Farmers
Isaac	Reeves VII	Technicians' Update on the Northeast Oyster Breeding Center at the Milford Lab
Marta P.	Sanderson	Are Your Oyster Larvae Starving? Symptoms And Possible Causes For An Emerging Oyster Larval Disease Syndrome.
Katyanne	Shoemaker	Population adaptation of Atlantic surfclams, *Spisula solidissima solidissima*, to ocean acidification and phytoplankton availability
Sheila	Stiles	Perspectives On Biodiversity And Genetic Diversity For Adaptation In Shellfish Aquaculture
Sophia	Tearman	Novel Cultivation Technique for a Common Species: *Ulva lactuca*
Benjamin	Wasson	Exploring the Dynamics of *Vibrio parahaemolyticus* Association with Hatchery Oysters in the NH Great Bay Estuary.
Jane	Weinstock	Timing of barnacle biofouling on Cape Cod Oyster Farms
Jennifer	Zhu	Dermo Presence In Eastern Oysters Restored To The New York Harbor

ABSTRACTS OF ORAL PRESENTATIONS AND POSTERS

EVALUATING THE FEASIBILITY AND SUSTAINABILITY OF AN INTEGRATED MULTI-TROPHIC RECIRCULATING AQUACULTURE SYSTEM USING STRIPED BASS (*MORONE SAXATILIS*), SAND WORMS (*ALITTA VIRENS*), AND SEA BEANS (*SALICORNIA BIGELOVII*)

***Michael Acquafredda*[1,2], Christopher Spino[2], John Rosendale[2], Beth Phelan[2]**
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In many ways, striped bass (*Morone saxatilis*) aquaculture production using recirculating aquaculture systems (RAS) is commercially ready in the United States. However, as with other forms of finfish aquaculture, waste management is a major challenge constraining its expansion. The objective of this project was to investigate whether integrated multi-trophic aquaculture (IMTA) is a suitable strategy for mitigating the wastes produced by RAS-reared striped bass. Specifically, we tested the capacity of sand worms (*Alitta virens = Nereis virens*) and sea beans (*Salicornia bigelovii*) to utilize solid and dissolved wastes, respectively. In this experiment, two nearly identical RAS were established: one system was designed for striped bass monoculture and the other was designed for bass–worm–sea bean IMTA. Over the course of the five-month experiment, we measured and assessed the growth of the focal organisms, waste accumulation and reduction, and striped bass and system-wide feed conversion ratios (FCR). We found that the monoculture and IMTA-reared striped bass grew at statistically similar rates. Approximately 45% of the total solid waste collected from the IMTA system was recycled as worm feed, and total worm biomass increased by ~114%. Dissolved waste mitigation was also observed in the IMTA system. Compared to the monoculture, the IMTA system exhibited significant reductions in nitrate and phosphate concentrations and a significant increase in pH. More than 24.5 kg of sea beans were also produced during the study. Finally, while the striped bass of both systems exhibited a similar FCR (~1.2), the IMTA system-wide FCR was ~64% lower than the monoculture system-wide FCR. Taken together, this project demonstrates that striped bass, sand worms, and sea beans can be successfully co-cultured in RAS. Future studies should investigate the economic costs (e.g., added labor and utility costs) and benefits (e.g., diversification and new sources of income) of this IMTA system.

SURVIVAL OF THE FITTEST: GENOMIC INVESTIGATIONS OF THE BAY SCALLOP REVEAL A SHIFT IN POPULATION STRUCTURE THROUGH A SUMMER MORTALITY EVENT

***Bassem Allam*[1], Denis Grouzdev[1], Sarah Farhat[1,2], Isabelle Boutet[3], Arnaud Tanguy[3], Stephen Tettelbach[4], Harrison Tobi[4], Emmanuelle Pales Espinosa[1]**
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The bay scallop *Argopecten irradians* is a commercially and recreationally important shellfish species found in estuarine and coastal environments from New England to the Gulf of Mexico. In New York, adult bay scallop populations have been decimated every summer since 2019, causing the collapse of the fishery. These mortality events were associated with annual outbreaks of an undescribed apicomplexan parasite recently dubbed Bay Scallop Marosporida (BSM). This presentation summarizes some of our genetic and genomic investigations on bay scallop in New York. First, a chromosome-level assembly of the bay scallop

genome was generated and used as a reference for exploring host-pathogen interactions and evaluation of population structure. Data from RNA-Seq, RAD-Seq, and mitochondrial DNA sequencing have been used to identify the population structure of New York bay scallops. Results allowed the characterization of wild and aquacultured scallops used for stock enhancement in NY and enabled the assessment of changes in population structure throughout a mortality outbreak. Specifically, results enabled the identification of what appears to be a more resilient scallop lineage that seems to better survive the mortality outbreak. While a better understanding of scallop population structure in New York and along the east coast of the United States is highly needed, these results are important for understanding the evolutionary history of bay scallops and for identifying populations with unique genetic makeups that could be important for conservation and restoration efforts.

UPDATES FROM THE EAST COAST HARD CLAM SELECTIVE BREEDING COLLABORATIVE

***Bassem Allam*[1], Denis Grouzdev[1], Emmanuelle Pales Espinosa[1], Arnaud Tanguy[2], Kimberly Reece[3], Huiping Yang[4], Gregg Rivara[5], Joshua Reitsma[6], Antoinette Clemetson[7], Ximing Guo[8]**
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The hard clam, *Mercenaria mercenaria*, is a major marine resource along the east coast of the United States. The species is extensively aquacultured from Massachusetts to Florida. Maintenance and growth of this aquaculture industry relies on hatchery production of seed, and billions of seed clams are produced annually to fulfill aquaculture and restoration needs. In this context, the production of quality seed able to survive under harsh biological and environmental conditions represents a major priority for the aquaculture community. This collaborative project builds on partnerships between Sea Grant programs, scientists and extension teams in five Atlantic states to develop hard clam selective breeding programs using state of the art genomic tools. In this framework, the team produced a chromosome-level assembly of the clam genome and used that resource as a reference for the characterization of the species genetic diversity across its range. Through a series of stringent selection criteria, single nucleotide polymorphisms (SNPs) identified in *M. mercenaria* were filtered and a subset of 66,644 SNPs was used to produce SNP arrays for high-throughput genotyping of a total of 3,456 clams. Produced arrays showed high efficiency and robustness in differentiating clams from different geographic origins and for contrasting the genotypes of clams resistant or susceptible to QPX (*Mucochytrium quahogii*) disease. Genomic selection using this tool is ongoing to identify clam stocks that are resistant to QPX disease and heat stress.

MAINE SEAWEED EXCHANGE & GREEN URCHIN CULTIVATION ON SEAWEED AND OYSTER FARMS

Andrea “Trey” Angera
Maine Seaweed Exchange, 14 Factory Rd, Gouldsboro ME 04607

The Maine Seaweed Exchange is a 501(c)(3) non-profit corporation with a mission to support the development of an organic, sustainable, and restorative seaweed aquaculture industry. The organization

works to support the seaweed aquaculture industry through seaweed farming education and training, research on seaweed farming, aquaculture diversification, and products, developing markets and distribution channels, assistance with branding and marketing opportunities, including organic certification, by creating and supporting innovation, and by facilitating key networks for the industry. The MSE hosts events and workshops, which have included the Maine Seaweed Fair, a day long free family event that showcases Maine wild and farmed seaweeds, and the Practical Seaweed Farmer's Conference, which provided educational, networking, and exchange of ideas among existing and potential seaweed farmers, potential buyers and investors, regulators and researchers, and others involved or interested in the seaweed aquaculture industry. We offer a wide range of seaweed farming courses and training opportunities that cover all aspects of seaweed farming in order to promote responsible, informed farmers for a more professional industry. Recently, we have launched the Organic Kelp Collaborative, where we work to train, support, and connect new organically certified seaweed farmers and processors in order to develop a network of organic producers that will be able to aggregate products and sell into larger markets.

Report on SARE funded project researching the cultivation of green urchins on seaweed and oyster farms.

MODELING TO INFORM SEAWEED FARM DESIGN FOR OPTIMIZING GROWTH, PRODUCTION, AND ADVANCEMENT OF THE U.S. MARINE AQUACULTURE INDUSTRY

Andrea "Trey" Angera
Springtide Seaweed LLC, 14 Factory Rd, Gouldsboro ME 04607

Report on the results from MIT Sea Grant funded project that developed a set of "rules" to guide future seaweed and other aquaculture farm development. It analyzed flow patterns and nutrient transmission patterns that guide current and future aquaculture farm designs. It also created a table of load values that will be essential in designing the gear that locates and constitutes the structure of aquaculture farms. This project was the first of its kind to quantify seaweed farm design with the objective of maximizing yield and quality by optimizing nutrient flow and light.

LOW COST SENSOR TO ENSURE INTEGRITY OF SEAWEED AQUACULTURE OPERATIONS

Andrea "Trey" Angera
Springtide Seaweed LLC, 14 Factory Rd, Gouldsboro ME 04607

Report on the ASMFC funded project that created a patented low-cost automated sensor that can detect when there is stress on a seaweed farm indicating undue stress, as that would occur during system failure or a large animal entanglement.

IMPACT OF BRINING ON THE SURVIVAL OF SHIGA TOXIGENIC *ESCHERICHIA COLI*, *VIBRIO* SPP. *SALMONELLA* SPP. AND *LISTERIA MONOCYTOGENES* ON INOCULTED SUGAR KELP (*SACCHARINA LATISSIMA*) DURING REFRIGERATED AND AMBIENT STORAGE

Richa Arya, Denise Skonberg, Jennifer Perry
School of Food and Agriculture, University of Maine, ME 04469 USA

The seaweed industry has several challenges including limited harvesting time and the short shelf life of fresh seaweed. One preservative method to extend the shelf life of sugar kelp is brining (40% weight/volume). However, studies on the impact of brining on pathogen survival in seaweed are limited. Therefore, the aim of this study is to investigate the survival of pathogens inoculated on brined sugar kelp as compared to un-brined kelp (control), which were subjected to different temperatures during storage. Fresh sugar kelp was inoculated (6.0 log CFU/g) separately with a cocktail of two strains of *E. coli* and *L. monocytogenes*, and two species and serovars of *Vibrio* and *Salmonella*, respectively. Samples were stored at 4°C and 22°C for 12 weeks. Microbiological analyses were performed weekly to evaluate the effects of brining and storage temperature on pathogen survival. A Multi-way ANOVA ($p<0.05$) was used to assess the effects on pathogens' population during storage. Pathogen populations decreased under all storage conditions, irrespective of the temperatures, with lower pathogen populations recorded on brined sugar kelp as compared to control. *Escherichia coli* was not detectable after week 7 on brined kelp, likewise *L. monocytogenes* and *Salmonella* after week 10 of storage. Survival was greatest for *Vibrio* exhibiting 1.5 log CFU/g at the end of storage. Although temperatures did not have a significant impact on survival, only *Vibrio* was detectable in brined sugar kelp at the end of storage, suggesting that brining may have a positive impact on pathogens' reduction in sugar kelp.

DESIGN AND APPLICATION OF BIOFOULING DASHBOARDS FOR USE IN AQUACULTURE

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Biofouling species, such as sponges, tunicates, bryozoans, and other colonizing organisms, can create problems by overgrowing cultured shellfish, as well as gear. To visualize and measure the presence of biofouling in marine habitats across spatial and temporal scales, it is useful to engage citizen science data, reported observations from the literature, and anecdotal presence into one readily accessible tool. This work will describe the design and possible uses for such a biofouling dashboard built using R, Shiny, and ArcGIS Pro with data from a number of sources to share biofouling species presence, abundance, and seasonal recruitment in a public user-friendly experience. The aim of this dashboard tool is to provide general information for all stakeholders who are interested in the distribution, biology, and identification of common biofouling species in the Northeastern United States from Long Island to Maine. Attendees will be encouraged to not only try out the dashboard, but will also be invited to submit ideas through a survey of how such a tool could be useful for their own experiences in the aquaculture industry.

"CRACKING THE SHELL": LESSONS LEARNED FROM A COLLABORATIVE APPROACH TO DEVELOPING HATCHERY PRODUCTION OF THE ATLANTIC SEA SCALLOP, *PLACOPECTEN MAGELLANICUS*

***Sydney Avena*[1,5], Christopher Davis[1], Anne Langston Noll[1], Meredith White[2], Cody Jourdet[2], Brian Beal[2,4], Brea Salter[4], Tessa Houston[4], Sarah Zuidema[4], Kyle Pepperman[4], Damian Brady[5], Timothy Bowden[6], Jennifer Perry[6], Sue Ishaq[6], Erin Grey[7], Kyle Brennan[6], Nichole Blackmer[6], Mark Dixon[8], Gary Wikfors[8]**
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The Atlantic sea scallop, *Placopecten magellanicus*, is becoming a valuable, commercially-farmed product in Maine's aquaculture industry. Although most successful aquaculture industries throughout the world are supported by commercial hatcheries, solving problems inherent with husbandry methods during the hatchery phase for sea scallop larvae is a major challenge to overcome. The sea scallop's lengthy larval phase has proved to be a challenge, especially when coupled with larval sensitivity to environmental conditions and hatchery expenses. Although there have been research-scale successes with Atlantic sea scallop hatchery production, repeatable, large-scale seed production has remained elusive and unreliable. This project focuses on early-stage sea scallop culture to improve survival and growth, thereby developing guidelines for husbandry that can be replicated reliably to help grow the sea scallop aquaculture industry in Maine. Three hatcheries are engaged in this effort: Mook Sea Farm, the University of Maine's Darling Marine Center, and the Downeast Institute. Here, we describe findings and lessons learned from three years of this collaborative effort. Completed hatchery experiments that will be discussed include conditioning and spawning trials, larval culture in static versus flowthrough systems, effects of buffered seawater on larval growth and survival, and effects of temperature on larval growth and survival. To date, Mook Sea Farm has produced successful cohorts three years in a row, with post-settlement nursery culture occurring at the Darling Marine Center. Future plans for hatchery-produced spat include engaging established sea scallop farmers in Maine to estimate growth and performance of these animals in open-water farm sites.

REIMAGINING PLASTIC-BASED AQUACULTURE: AN INVESTIGATION INTO VIABLE MATERIALS

Abigail Barrows
Long Cove Sea Farm, 10 Tidal Cove Lane, Stonington, Maine 04681

Aquaculture, specifically shellfish and seaweed aquaculture, is often celebrated as among the most sustainable food production systems in the marine world. Oyster and seaweed aquaculture techniques do tread lightly on the environment and are beneficial to ocean health in many ways—but the fact remains that a reliance on plastics in every step of cultivation has an enormous negative environmental impact. Aquaculture contributes to more than half of the seafood consumed globally, and is only projected to increase and with it, industries dependency on plastic. In order to have a truly sustainable aquaculture industry, every step of production needs to be examined and improved. Currently, aquaculturists rely on almost 100% plastic materials to cultivate and grow food. Long Cove Sea Farm strives to change this, through re-thinking the materials we put in the water to grow seafood and sea vegetables. Over the past three years, we have aimed to identify durable, competitive, viable, and ecologically friendly materials for aquaculture systems, with a focus on oyster surface cultivation. At the most basic level, our goal has been to figure out which materials are the best for building grow-out bags — in performance, supply, scalability—and that meet our ecological goals.

SOLAR-POWERED SEAFOOD

Abigail Barrows
Long Cove Sea Farm, 10 Tidal Cove Lane, Stonington, Maine 04681

Many small, surface-culture oyster farms either do not have access to shore power or are situated at an inefficient distance from power. Farms that tumble or wash oysters *in situ* usually rely on gas- or diesel-powered motors for power. Not only do these motors rely on fossil fuels, contributing to carbon emissions,

ultimately impacting the ocean, they also directly pollute the local environment in which a farmer is relying on to cultivate food. Additionally, they create noise pollution and are unpleasant to work next to for farm employees. At Long Cove Sea Farm, we strive to scrutinize every aspect of our business, with the aim of not just doing no harm to the environment but actively doing good. Through grant support, we built a floating tumbler and rigged a washdown pump reliant on solar power on our lease in Deer Isle, Maine. Solar-powering the farm was a relatively affordable and straight-forward process which is easily adaptable for any size lease- with either floating or land-based equipment.

EXPLORING THE VIABILITY OF INTERTIDAL QUAHOG AQUACULTURE IN MAINE

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The Gulf of Maine is warming faster than 99% of the world's oceans, threatening the livelihoods of thousands of Mainers who make a living from the sea. Marine resource diversification is essential for adapting to this rapid change and ultimately promoting economic resilience for Maine's coastal communities. Quahogs, or hard-shell clams, present an opportunity for diversification within both aquaculture and wild shellfish industries as waters have warmed and conditions have become more hospitable to quahog growth and survival. Determining viable pathways for culturing quahogs in the intertidal zone will benefit existing and potential new shellfish farmers looking to diversify their crops, as well as shellfish harvesters who are increasingly dependent on the wild quahog resource. We aim to test a new method of intertidal quahog aquaculture that could be an opportunity for sea farmers to expand their operations and diversify their crops, as well as a method for supporting municipal shellfish wild stock enhancement activities. We will present results from the first year of experimentation using bags to grow quahogs in the intertidal for aquaculture crop diversification and as wild stock enhancement.

ADVANCING SCALLOP AQUACULTURE THROUGH INNOVATIVE HATCHERY TECHNIQUES

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The Atlantic sea scallop, *Placopecten magellanicus*, is becoming a valuable, commercially-farmed product in Maine's aquaculture industry. The development of a sustainable sea scallop aquaculture industry faces a significant obstacle: the lack of a consistent source of scallop seed (spat). Currently, farmers who wish to culture scallops must rely on collecting wild juveniles, a process prone to variability and uncertainty. This study, part of a collaboration with the Scallop Research Consortium, aimed to address this challenge by optimizing husbandry protocols to increase larval survival and growth, thereby paving the way for the establishment of a source for hatchery-reared sea scallop spat. Sea scallops have been reared in research hatcheries, including the Downeast Institute (DEI), but commercial-scale production has yet to be achieved. The limited success with hatchery production of sea scallops is due primarily to their lengthy larval life stage (40-45 days), during which they are susceptible to disease and sensitive to environmental changes. The study compared the efficacy of flow-through vs. static culture systems with the expectation that flow-through seawater systems would enhance scallop larval development, as it has for other larval bivalve species. Surprisingly, results demonstrated that static culturing methods may be preferable for rearing scallop larvae. Hatcheries participating in the Scallop Research Consortium are leveraging this information

to refine their production techniques of sea scallop larvae with the overarching goal of establishing a more dependable source of seed stock.

ARCTIC SURFCLAM, *MACTROMERIS POLYNYMA*, CULTURE IN EASTERN MAINE: A COMPARATIVE FIELD EXPERIMENT TO ASSESS GROWTH AND SURVIVAL

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We are investigating the efficacy of culturing Arctic surfclams, *Mactromeris polynyma*, in eastern Maine to diversify shellfish species for harvesters, shellfish buyers, and the public as direct and indirect effects of warming waters have pushed stocks of wild, commercial bivalve species such as soft-shell clams, sea scallops, and blue mussels to historic low levels. A fishery for Arctic surfclams in offshore waters of Atlantic Canada is worth >$100 million annually; however, no Gulf of Maine fishery exists although surfclams are found there. After successfully working out early life-history culture techniques, we are now examining the fate of cultured juveniles in the field. A 415-day trial was initiated at two low intertidal sites in Gouldsboro (Timber Cove: 44º27'48.99"N;68º00'01.26"W) and Beals, (Mud Hole Cove: 44º29'08.32"N; 67º35'15.93"W) from mid-June 2022 to August 2023. Surfclams (small: 9.6 ± 0.4 mm SL; large: 12.4 ± 0.4 mm) at three densities unique to clam size were added to two sizes of protected experimental units (EU:2 ft^2; 4 ft^2) in a completely factorial design at both locations (N = 60). Samples from January 2023 (~220 days) revealed live surfclams in only 45% (Gouldsboro) vs. 100% (Beals) of EU, due primarily to differences in crab densities between locations (crabs were removed from boxes in January). Surfclam growth varied with initial size at both sites, but larger clams of both sizes were recovered at Beals where maximum seawater temperature was 15.6ºC vs. 18.5ºC at Gouldsboro. August 2023 samples revealed < 5% survival in Gouldsboro vs. 38% in Beals.

INTERTIDAL FIELD-BASED NURSERIES FOR CULTURED SOFT-SHELL CLAM JUVENILES: EXPERIMENTAL RESULTS FROM THREE MAINE COMMUNITIES

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Soft-shell clam, *Mya arenaria* L., juveniles have been cultured annually for public stock enhancement in Maine – first at the Beals Island Regional Shellfish Hatchery (1987-2002) and, since 2003, at the Downeast Institute. Juveniles (2.5-3 mm SL) are moved to a field-based nursery in eastern Maine residing in floating trays from mid-May to November reaching 10-15 mm SL. In November, clams are removed from trays and stored in high-density, flow-through bags (2-3 kg/bag) receiving ambient seawater until the following spring when they are planted in coastal towns. These post-hatchery activities, designed to produce the largest clams possible for enhancement efforts, are necessary because most participating communities have no access to field-based nurseries or land-based upwellers; however, they increase seed cost and risk incurred in maintaining millions juvenile clams held over the winter. During 2022, we tested the concept of using the mid intertidal at three intertidal locations in Freeport, Maine where cultured seed (1.9-2.5 mm SL) were added to nursery units over five densities (range = 1,667-33,333/m^2). Results demonstrated no significant density effect on survival (P = 0.61), and overall mean of 36.1 ± 7.8 (n = 15). Final mean SL varied inversely with increasing density (P < 0.001; $SL_{1,667}$ = 26.1 ± 0.9 mm vs. SL33,333 = 17.1 ± 0.9 mm). These results were used to inform additional tests during 2023 at three intertidal locations across the

Maine coast from Sipayik (east), Gouldsboro (midcoast), and Freeport (south) where clams were deployed on four dates (early June to mid-July).

INITIAL ASSESSMENTS OF MUSSEL AND SEAWEED SUPPLY CHAIN CARBON EMISSIONS FOR MAINE AQUACULTURE

Sam Belknap[1], Sam Feldman[1], Cora Kerber[2], Kate Winneback[2], Matt Moretti[3], Bri Warner[4]
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Increasing attention is being paid to the environmental and climate impact of food systems. Aquaculture is often portrayed as a more environmentally and climate friendly opportunity for food production that produces less greenhouse gas (GHG) equivalent emissions than other terrestrial food production methods. Lifecycle and GHG analyses are increasingly being used to demonstrate this in a quantitative manner. This panel will discuss the initial result of the full supply chain analysis of two species currently being farmed in Maine: *Mytilus edulis* (blue mussel) and *Saccharina angustissima* (skinny kelp). These reports focus on two companies with integrated supply chains, Bangs Island Mussels and Atlantic Sea Farms. Results for each species is illustrative of broader production but not necessarily representative of the industries writ large. These reports captured the emissions associated with the supply chains of each species and identified 'hot spots' within the supply chain to guide future investments in clean energy solutions. These recommendations for further reductions are transferable to other companies and supply chains in New England and beyond.

OYSTER HEALTH AND RESTORATION IN LONG ISLAND SOUND - PART III. OBSERVATIONS OF CHANGING WATER CHEMISTRY

***Genevieve Bernatchez*, Isaiah Mayo, Mariah Kachmar, Samuel Gurr, Shannon Meseck, Mark Dixon, Tyler Houck, Meghana Parikh, Katherine McFarland**
NOAA Fisheries, Northeast Fisheries Science Center, Milford Laboratory, 212 Rogers Ave, Milford, CT 06460

This third presentation in the series, "Oyster health and restoration in Long Island Sound", will provide a historical and current perspective on water chemistry in the near-shore coastal waters of the region. It is well understood that water chemistry such as changes in temperature, salinity, dissolved oxygen, chlorophyll a, and pH have direct effects on shellfish growth and survival. It can affect their shell-building capabilities and make them more brittle and susceptible to predation and biofouling damage. In Long Island Sound (LIS), seasonal lows in pH frequently occur in the summer months, coinciding with seasonal highs in temperature and hypoxia events which can amplify the effects of acidification on bivalves, particularly early life stages present during this critical growth period.

Here we present recent trends in water chemistry from the four oyster bed study locations, as well as Milford Harbor which provides the source water for the Northeast Fisheries Science Center Milford Lab. Historically, the Milford Harbor pH was closer to open ocean values averaging 8.1, where now on average the pH is 7.7. Using long term water quality monitoring and continuous water quality measurements, we try to better understand what the organisms are currently experiencing and consider how projected environmental changes in the region may affect shellfish population dynamics. This synthesis, paired with laboratory data in the literature, aims to inform adaptive management to ensure the success of both restoration initiatives and aquaculture production.

VOICES OF MAINE'S AQUACULTURE APPRENTICESHIP

Trixie Betz
Maine Aquaculture Association, 339 Water St., Gardiner, ME 04345

In 2023, the Maine Aquaculture Association and Gulf of Maine Research Institute launched the nation's first aquaculture apprenticeship program, in partnership with Educate Maine and Southern Maine Community College. Six apprentices are currently working full-time on shellfish and seaweed farms across the state. This presentation will expound upon "Maine's Aquaculture Apprenticeship Program -Assessing Its Formation, Launch, And Future" by demonstrating the importance of communications and visual storytelling to the success of the apprenticeship program. It will begin with the screening of a series of short-form videos each profiling the individual apprentices, their experiences, and their day-to-day responsibilities. The presentation will feature an analysis of the videos' performance metrics, emphasizing the influential role of dynamic video content in aquaculture workforce development. Additionally, we will explore how meaningful storytelling through social media can motivate viewers to actively support and want to participate in valuable programs like this one.

HISTORY AND FUTURE OF MONITORING OYSTER DISEASES IN CONNECTICUT

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Connecticut hosts a valuable shellfish industry, both commercially and recreationally, with more than 70,000 acres of shellfish farms under cultivation in Connecticut coastal waters and harvests exceeding 200,000 bushels of oysters annually. Like any food production system, disease management is an important part of protecting this natural resource. The Bureau of Aquaculture in the Department of Agriculture is tasked with this in the state of Connecticut and has a robust oyster disease monitoring program that dates from the late 1990s. *Haplosporidium nelsoni* (MSX) was monitored using histology from 1997 to 2016 and then using qPCR from 2019-2023, along with a co-occurring parasite *Haplosporidium costale* (SSO). *Perkinsus marinus* (Dermo) was monitored using RFTM with histology from 1997 to 2016 and then using qPCR from 2019-2023. Nuances of annual prevalence and intensity varied by year, location, and sampling technique. While *H. nelsoni* has had a declining impact on local oyster populations since 1998 and *P. marinus* has never reached epizootic proportions in Connecticut waters, it is important to continue to monitor the health of oyster populations. Moving forward, the Bureau will restore its histology-based surveillance program and plans to expand by adding qPCR capabilities. It is important to stay vigilant and be resilient to fluctuations in this dynamic system that is impacted by a myriad of things including environmental changes, range expansions, and emerging diseases.

MINORITIES IN AQUACULTURE: PROMOTING AQUACULTURE WORKFORCE DEVELOPMENT WITH DEI APPROACHES

Imani Black
Minorities in Aquaculture, https://www.mianpo.org/

Aquaculture has become interconnected into our global seafood resource. This industry has helped many coastal and inland communities supply food resources, and while the United States imports a large proportion of its seafood resources, it's important that we effectively communicate the importance of aquaculture. Aquaculture has the power to help the world in its goal to sustainability, and in order for this to happen, we must allow people to understand, support and advocate for sustainable seafood in their own

communities. Since its founding in 2020, Minorities In Aquaculture has understood the impact and importance of aquaculture locally and globally. Through MIA's programs, responsive minority engagement, and their goal to empower underrepresented communities to become more involved in aquaculture, are all combined approaches to accomplish MIA's efforts for the future of the industry's workforce development.

NOAA AQUACULTURE STRATEGY: A LISTENING SESSION

Danielle Blacklock
NOAA Fisheries, Office of Aquaculture, 1315 East-West Highway, 12th Floor, Silver Spring MD 20910

NOAA Fisheries is developing a Program Plan that will outline how the agency would be able to implement the NOAA Aquaculture mission and vision under various funding scenarios. The scenarios include static funding (decreasing services) and both 5-year and 10-year growth scenarios. Communicating with our stakeholders through the Program Plan development process is critical. The prioritization of activities will be informed by stakeholder input, including listening sessions at meetings and conferences around the nation. In this listening session, The Director of the Office of Aquaculture, the Northeast Fisheries Science Center Director, and the Regional Administrator for the Greater Atlantic Regional Office will review the Goals and Objectives outlined in the NOAA Aquaculture Program Strategic Plan and engage participants in prioritization discussions around the future of NOAA's aquaculture mission. The Program Plan, once finalized, will better communicate our vision for the future and what constraints may stop us from achieving our goals.

ATLANTIC SEA SCALLOP IMMUNE ONTOGENY AND ITS RELEVANCE TO HATCHERY SURVIVAL RATES

Nichole Blackmer[1], Jennifer Perry[1], Sue Ishaq[1], Kyle Brennan[1], Brian Beal[2,3], Brea Salter[3], Tessa Houston[3], Sarah Zuidema[3], Kyle Pepperman[3], Anne Langston Noll[4], Christopher Davis[4], Sydney Avena[4,6], Meredith White[5], Cody Jourdet[5], Damian Brady[6], Erin Grey[7], Mark Dixon[8], Gary Wikfors[8], Timothy Bowden[1]
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Over the last several years, Maine hatcheries have attempted to produce a consistent spat supply of sea scallops (*Placopecten magellanicus*), but they continue to experience sudden mass mortalities of larval scallops with unconfirmed causes of mortality. There is currently a lack of knowledge about the immune system and its development during the vulnerable larval stages of the sea scallop. Further research on sea scallop immune ontogeny and immunocompetence can provide insight into underlying reasons behind the mass moralities and what types of immune functions are available to protect the larvae. This project seeks to understand the immune ontogeny and immunocompetence of sea scallop larvae through gene expression analysis of immune markers and its relevance to larvae survival in hatchery hatcheries. Several immune-related genes of interest have been identified and amplified in the sea scallop using RT-PCR. These genes will be used to analyze immune development of larval sequences provided by hatcheries. Methodologies for analyzing the gene expression in larval sea scallops including identification of target genes, primer design, optimization of the RT-PCR protocols for the chosen housekeeping and immune genes of interest,

and optimization of RNA extraction protocols will be discussed. Goals for using these methodologies to develop better husbandry techniques and major complications encountered will also be highlighted. This study and methodologies contribute to the information on the basic biology and immune ontogeny of the sea scallop.

FOLLOWING THE SNAIL TRAIL: DETECTING AND PREDICTING THE ARRIVAL AND SETTLEMENT OF THE MARINE SNAIL *LACUNA VINCTA* ON KELP FARMS IN MAINE

***Cara Blaine*[1], Thew Suskiewicz[2], Markus Frederich[1], Emily Lancaster[1,3], Carrie J. Byron[1]**
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As the cultivation of macroalgae increases in Maine, farmers face mounting challenges from invertebrate biofouling of farmed biomass. The generalist mesograzer *Lacuna vincta* is a small snail whose ability to migrate in the ocean creates opportunity to encounter the blades of kelp suspended from farms. *L. vincta* eggs are difficult to remove from kelp blades post-harvest and can lead to losses of income for farmers, who must either harvest early or redirect harvested kelp into lower-value products. Firstly, we conducted two laboratory experiments to determine if there were differences in *L. vincta* preference between 1) nutrient-fed "healthy" and nitrate-deprived "stressed" cultivated sugar kelp and 2) cultivated sugar kelp and skinny kelp. Secondly, we used a novel PCR primer for *L. vincta* to develop an assay for detection of the snail in environmental DNA (eDNA) samples. Our preference experiments showed that snails prefer to graze and reside upon "healthy" kelp in the first experiment, and skinny kelp in the second experiment. Our eDNA assay successfully detected *L. vincta* both in laboratory settings and in the ocean at kelp farms, interannually and at multiple locations. Furthermore, we were able to link the presence of snails during visual assessments of farms with presence of *L. vincta* DNA in environmental samples. This research has the potential to inform best management strategies for kelp farmers in Maine dealing with snail biofouling, and to serve as a model for eDNA assays for additional biofouling species that are detrimental to both farmers and processors.

CORAL REEF LOSS: WHAT CAN BE DONE?

Walter J. Blogoslawski
PO Box 167, Milford, CT 06460

This brief review came about because of my 40 years of personal experience diving on, studying, and enjoying coral reefs in the Florida Keys and in the US Virgin Islands and now, sadly noting their decline. The reasons why coral reefs are valuable and in need of protection are noted as are the principal threats to the reefs: the climate crisis causing ocean acidification and raised temperatures leading to bleaching of corals, declining water quality, introduced coral disease, overfishing, predators, and natural disasters such as hurricanes. Efforts to educate the public to sensitize them to the critical need for protection and management measures, monitoring and assessment surveys performed by both scientists and the public, legislation that is already on the books, and coral restoration are addressed. These measures to save and bring back coral reefs provide hope that once again we shall be able to enjoy the benefits and beauty of these vital living natural treasures.

“SALTY TALKS LIVE!" BRIDGING RESEARCH AND INDUSTRY AT UMAINE'S ARI

Deborah Bouchard, Corinne Noufi
Aquaculture Research Institute, 17 Godfrey Drive, University of Maine, Orono, ME 0449

Join us for a 90-minute session with six panelists from the Aquaculture Research Institute (ARI) at the University of Maine, where they will illuminate the intersection of research and industry application in sustainable aquaculture. This session will broadly cover topics like aquatic animal health, the cultivation and uses of kelp, and shellfish aquaculture, showcasing how these areas are pivotal to Maine's aquaculture industry. The discussion will also touch on the role of ARI's research in addressing challenges posed by climate change and in driving innovations that enhance both environmental sustainability and economic resilience in coastal communities. Additionally, the panelists will highlight ARI's contributions to workforce development and strategic communications within the aquaculture sector. This session isn't just an insightful exchange of ideas; it's also a live recording for our 'Salty Talks' podcast, providing listeners with an in-depth look at the latest trends and developments in sustainable aquaculture. Whether you're an industry professional, a researcher, or simply someone keen on sustainable practices, this session will offer valuable insights into the practical applications of ARI's research.

DIPLOID AND TRIPLOID EASTERN OYSTERS (*Crassostrea virginica*): CONTRASTING TOLERANCE AND RESPONSES TO THERMAL STRESS IN THE NORTHERN GULF OF MEXICO

Kayla Boyd[1], *Hisham Abdelrahman*[2], Scott Rikard[1], Andrea Tarnecki[1], Jim Stoeckel[1]
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Over the last decade, the oyster industry in the northern Gulf of Mexico (nGOM) has seen a renaissance. Most eastern oysters (*Crassostrea virginica*) harvested from aquaculture production for the half-shell market are triploid, single set oysters. Triploid eastern oysters are becoming the preferred choice for growers in nGOM areas due to their faster growth rates and better meat quality during the summer spawning season compared to diploid oysters. However, triploid oysters are experiencing higher mortality rates in various nGOM areas compared to diploids. The primary reasons behind the increased mortality of triploid oysters remain unclear but are suspected to be related to a lower tolerance to environmental stressors. To investigate links to temperature, we conducted experiments comparing physiological and behavioral responses of diploid and triploid oysters to acute thermal stress, their ability to recover from sublethal stress, and their upper thermal limits.

The experiments involved gradually raising temperatures from 25°C at 2°C/h and monitoring physiological responses through respirometry and behavioral reactions like gaping, closing, and mantle retraction. We found minimal differences between diploid and triploid oysters in metabolic peak temperature and onset of behavioral reactions, except for slightly higher metabolic demand in diploid oysters at the peak. In summary, our study indicates little variation in behavioral and metabolic reactions to acute thermal stress between diploid and triploid eastern oysters. While thermal stress may play a role, it is unlikely the sole factor contributing to the observed mortality differences between these oyster types in the nGOM.

TOOLS FOR PLANNING AND FUNDING YOUR GROWING BUSINESS

Nick Branchina
Coastal Enterprises, Inc., 2 Portland Fish Pier Suite 201, Portland, ME 04101

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 Host: Nick Branchina, Director of Fisheries & Aquaculture, Coastal Enterprises Inc. (CEI)
Speaker: Christian Brayden, Project Manager, Maine Aquaculture Association (MAA)
Speaker 2: Peter Piconi, Certified Business Advisor, Small Business Development Centers (SBDC)
Speaker 3: Chris Laughton, Director of Knowledge Exchange, Farm Credit East
Speaker 4: Laurie McKenna, Loan Specialist, Northeast Financial Services Branch, NOAA Fisheries

CAN I MAKE MONEY GROWING SEAWEED? USING FINANCIAL BENCHMARKS TO ASSESS SEAWEED AQUACULTURE PROFITABILITY IN MAINE

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Seaweed farming has experienced more than 20-fold growth over the last six years in Maine. While it is assumed that at least *some* of those farming seaweed are turning a profit, up until now there has not been any empirical evidence to support the claim. This report provides an assessment of the current state of the sector. It presents financial benchmarks (cost, labor hours, profitability, etc.) for the 2022 growing season in Maine, and highlights what has changed since 2017. Overall, it finds that farming seaweed *can* be profitable, but is not for everyone. The analysis found economics of scale, meaning that larger farms tended to have the highest likelihood of achieving profitability. Other factors, such as labor efficiency, also tended to increase with profitability. The report underscores the previously held belief – seaweed farming can be a profitable, secondary source of income for those who already work on the water.

USING NOVEL SEAWEED PRODUCTS TO ASSESS CONSUMER PREFERENCES

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While seaweed farming is growing in Maine and other states in the U.S., some are left wondering – where will it go? Who will eat it? *What* will they eat? This work builds on the consumer preferences report by the Maine Aquaculture Innovation Center, which provides data on the typical seaweed consumer and their preferences. This survey was formed with input from seaweed farmers to include specific seaweed products, and to gauge which of them are the most likely to be purchased by consumers. Furthermore, the analysis explores why consumers prefer certain products over one another. This presentation will provide an overview of the findings from this survey.

DEVELOPING OYSTER AQUACULTURE BEST MANAGEMENT PRACTICES (BMPS) IN MAINE

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As oyster farming continues to grow in Maine, it is of increasing importance that farmers site and operate their farms to the highest of standards. Farmers face increasing risk from social acceptance of new farm locations, and economic risk from any subquality product that enters the marketplace. These best management practices are based on former MAA best management practices, and will be crafted working with the oyster sector. They will include all aspects of farming – from siting to final sale. The BMPs will highlight best practices of the most successful farmers, and be presented in a format that all can follow. Lessons learned will be included as well. While there have been strong BMPs written previously, these BMPs will provide an update for farmers with the latest gear, concerns, and regulations. Input is welcome from any oyster farmers who would like to share their insight.

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

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The Atlantic sea scallop supports one of the most economically important fisheries in the northeastern U.S. As demand for sea scallop meat increases, wild harvest efforts must be supplemented with aquaculture. Scallop farmers rely on spat acquisition to continue production, yet wild spat collection is inconsistent. Hatcheries in the state of Maine could produce spat year-round but struggle with mortality events, presumably from pathogenic *Vibrio* species. Probiotics have decreased mortality amongst infected bivalve larvae in other fisheries, and could be implemented to decrease larval sea scallop mortality. Eight probiotics and two pathogenic bacteria have been identified from similar industries and cultured. Bacterial competition assays were used to examine inhibition of selected pathogens by probiotic candidates. To test effectiveness of applied probiotics, challenge trials with larval sea scallops are being conducted. The impacts of promising probiotic treatments on the growth and development of larval sea scallops will be monitored in small scale trials. One probiotic candidate has shown success in inhibiting pathogens *in vitro*. Probiotic physiology and methods of inhibition are being identified. Inhibition of pathogenic bacteria by probiotic candidates has been displayed *in vitro*, and some candidates display increased sea scallop larvae survival when challenged with scallop pathogens. Impacts of promising probiotics on development and incorporation into feed is in progress. This study should examine probiotic-pathogen interactions in Atlantic sea scallop hatcheries and may identify probiotic pretreatments to decrease larval sea scallop mortality.

THE EFFECT OF PLOIDY ON THE FORMATION AND ANTIMICROBIAL EFFICACY OF EXTRACELLULAR TRAPS IN THE EASTERN OYSTER

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DNA-derived extracellular traps (ETs) represent a highly conserved component of the innate immune system, recently discovered and observed in all metazoan life. When encountering pathogens, cellular DNA is decondensed and released, forming net-like meshes that can capture and neutralize viruses, bacteria, fungi and parasites. Consequently, the greater DNA content observed in triploid oysters may improve the effectiveness of ETs in combating pathogens.

Numerous stimuli were assessed for their efficacy in generating ETs in the eastern oyster and, once identified, were used to compare the capacity of half-sibling triploid and diploid oysters to generate ETs. We evaluated ET formation and efficacy through a combination of fluorescence microscopy and bacterial neutralization assays, along with corresponding DNAse controls. Our findings demonstrated that inducing a puncture wound in oysters significantly increased the rate of ET formation, which was able to neutralize >60% of introduced bacteria. Additionally, ET efficacy was correlated with the proportion of agranulocytes in hemolymph and the production of reactive oxygen species (ROS) in these cells, suggesting agranulocytes as potent immune effector cells. ImageJ analysis further revealed that triploid oysters produced more ETs compared to their diploid counterparts, displaying a higher frequency of ET-producing cells and larger ETs, although there was no significant disparity in bacterial neutralization between diploid and triploid hemocytes.

In summary, this study describes a reliable method for inducing ETs in oysters and identifies crucial host factors influencing ET formation, paving the way for further exploration of this conserved immune mechanism.

PERFORMANCE OF TRIPLOID EASTERN OYSTERS ACROSS THE NORTHEAST: ASSESSMENT OF GROWTH, SURVIVAL, AND DISEASE

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Triploid oysters now constitute the predominant farm-raised oyster product in numerous regions primarily due to their notable growth advantages and more consistent meat quality. Despite triploid popularity, there is a surprising lack of information regarding triploid performance in the Northeast, with anecdotal reports claiming triploids grown here are “frail” or “ugly”. The reasons for such reports are unclear, likely stemming from unideal environmental-genetic pairings of selected triploid lines. To address this, three diploid and three half-sibling triploid lines were produced in April 2021. At the larvae and juvenile stages, a subset of oysters from these lines were exposed to bacterial pathogens and monitored for mortality. The remaining spat from these lines were then deployed in NJ, NY, MD, and RI to evaluate if ploidy significantly impacts growth, survivorship, and disease at these locations. Results from these experiments showed that triploids

experience significantly more mortality during larval stages though these trends significantly decreased over time as adult diploid and triploid oysters displayed equivalent survivorship at all grow-out locations. Furthermore, ploidy had no influence on the prevalence and intensity of dermo or MSX in adult oysters, with location being the primary determinant of disease burden. Location also influenced growth significantly, although triploids showed superior growth metrics at all locations, being on average 35% larger than diploids. The results of this study suggest that triploids should be beneficial for northeastern aquaculture purposes, though they may be at increased risk of mortality events during early developmental stages.

TRIPLOIDY ENHANCES TOLERANCE TO *PERKINSUS MARINUS* IN EASTERN OYSTERS

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Disease tolerance represents a host defense strategy that prioritizes minimizing the fitness costs of infection over pathogen elimination (host resistance). Previous research has indicated that triploid and diploid oysters generally exhibit similar levels of resistance, both being equally susceptible to infection, however, some data suggest that triploids may exhibit greater disease tolerance. Utilizing a laboratory-based approach, this study investigated oyster tolerance to the parasite *Perkinsus marinus* (Dermo) in adult half-sibling diploid and triploid oysters while accounting for energetics and immunological capacities. To accomplish this, 240 oysters were collected in April 2022 with a subset of these oysters immediately sacrificed to assess their immunological status, energy reserves, and Dermo prevalence. The remaining oysters were then subjected to either a Dermo injection or saline water (control group) and maintained in a semi-stressful common garden setup. Oysters were monitored daily and upon death, immediately removed and Dermo body burdens were evaluated. Eight weeks into the experiment, a subset of the remaining oysters was censored and used to examine immunological, energetic, and parasitic changes. The experiment lasted 171 days with triploids observed to survive ~26 days longer on average, despite triploids and diploids having similarities in parasite body burden, most energetic reserves, and most immunological features. These findings suggest that parasite tolerance in triploid oysters is higher, leading to prolonged survivorship which could aid aquaculture efforts. This research contributes to our understanding of disease tolerance and may offer valuable insights for future disease management strategies.

SOLAR SYSTEM FOR AN OFF-GRID, NEAR-SHORE OYSTER PROCESSING FLOAT

Maxwell Burtis
Ferda Farms LLC, 9 Pinefields Ln, Brunswick, ME 04011 USA

Using solar power for oyster processing compliments the inherent sustainability of the farming practice. I have been experimenting with solar-powered oyster processing for the past four summers on my farm on the New Meadows River in Maine (Ferda Farms). Currently, we are powering our DIY oyster tumbler and washdown pump using a 1 kW solar array and battery bank. The two 12’x24’ work floats are connected together and are located in a mooring field near the farm. The decision to use exclusively solar power has had the advantages of being quiet for our neighbors, environmentally friendly, and logistically simple. However, the disadvantage is the upfront cost of the system. We considered the pros and cons of lithium and lead acid batteries, as well as DC, AC single-phase, and AC three-phase motors. We are planning the expansion of our solar system to accommodate a larger, more commercial tumbler and washdown pump. The expansion will include the addition of an inverter, a phase converter, and ~1 kW more solar power.

A HIGHLY EFFICIENT OYSTER FARMING MODEL: MODIFIED FOR A MAINE FAMILY FARM

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Efficient oyster farming can lead to farm profitability and industry growth. In Maine, oyster farms have traditionally relied upon hazardous, hard labor to produce quality oysters. High labor costs can quickly erode profitability. By contrast, in New Zealand, large oyster farms, utilizing automation and a new farming system technology enable a profitable industry. In 2019, this project began adapting the FlipFarm System for use on a small Maine oyster farm for field testing and design feedback to the manufacturer. Challenges in implementation included a mussel infestation arising from over-weight and subsequently damaged baskets, retro-fitting gear with upgraded components, and pandemic supply chain issues. Learnings from these challenges were documented along with best practices in farm set up, assembly, deployment and anchoring; engineering and re-design of flotation; and maximizing the efficiency of farm crews of various sizes when using this technology. Upcoming FlipFarm technology upgrades have incorporated feedback from this project to address the key challenges, ultimately striving for risk reduction, labor management and product consistency resulting in higher profit and industry growth.

BEHAVIOR OF SCUP ASSOCIATED WITH AN OYSTER FARM AND ROCK REEF IN LONG ISLAND SOUND

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Aquaculture gear may enhance seafloor habitat by providing structure to ecologically and economically important finfish, especially rock-dwelling species like scup (*Stenotomus chrysops*). Observations of fish behavior near shellfish farms and natural reefs can provide insights into fish habitat preferences on manmade and natural structures.

Underwater cameras were used to assess fish activity on eastern oyster (*Crassostrea virginica*) shelf and bag aquaculture cages, recording fish activity on the cage top and sides. In collaboration with the region's shellfish growers, cameras were mounted on four study cages at a dense oyster farm with 40+ commercial cages and on four single cages interspersed at low density on flat seafloor. Cameras were similarly mounted on the top and sides of four boulders on a natural reef. All study sites were located in a small embayment in Milford, Connecticut. Video was recorded in eight-minute segments hourly, from 7am to 7pm, over a complete tidal cycle, weekly from May-September 2018. Scup behavior was visually identified and documented using Observer XT. Scup life history and abundance were noted.

Foraging, shelter, and grouping behaviors were observed on both cages and boulders. Territorial and escape behaviors were observed on cages only. Behavior quantification across treatments is ongoing. Preliminary results indicate that multi-tiered oyster aquaculture cages, at high and low cage density, add structure to seafloor environments, providing habitat for wild fish similar to natural boulder reefs. These results can inform aquaculture policymaking and regulation with positive benefits of growing shellfish.

GENOMIC AND PHENOTYPIC VARIATION IN WILD AND SELECTIVELY BRED OYSTERS

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Selective breeding on native New England oysters has been proposed as an alternative to commercially bred lines from the Mid-Atlantic that don't perform as well in the Northeast. Investigating the impact of genetic diversity is important for understanding factors that can affect oyster yield. The goal of this project is to compare genetic diversity of oysters before spawning and the performance of the hatchery reared offspring. Oysters from two populations in Rhode Island (GH and NR), one population in Connecticut (CT) and one population in Martha's Vineyard (MV) were collected, genotyped and spawned, along with two commonly used commercial oyster lines (CL1 and CL2). The progeny of these oysters were grown at a site in Rhode Island over a 19 month growing period. Growth and survival were measured (55 oysters x 3 bags per stock) from July 2021 to October 2022 and then processed for disease testing and genotyping. Different oyster stocks had significant differences in percent mortality ranging from 7.9% for CT to 81.9% for NR. These stocks also had significantly different harvest sizes with an average oyster size of 48 mm for NR and an average oyster size of 79 mm for CL2. Disease intensity also varied between lines with an average dermo intensity of 1.5 for CL2 and an average dermo intensity of 3.9 for CL1. The data used here will be used to inform the creation of a breeding program for New England farmers.

MOVING KELP FARMING OFFSHORE TO EXPLORE VERTICAL CULTURE MEHTODS

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Nearshore, protected culture sites for kelp farming in New England is limited. As you move further offshore, there's potential concern for Northern Right Whale entanglement. The University of New Hampshire and the Center for Sustainable Seafood Systems is focused on developing aquaculture gear that reduces the risk of marine mammal entanglement. Recently, they acquired an offshore aquaculture farm located 4.4 km offshore Rye Harbor, NH in 35 m water depth. This site is exposed to Northeast storms with seas over 10 m in height and currents up to 0.6 m/sec. Working in concert with WHOI, new innovative techniques were deployed at the site to utilize the vertical water column to culture different family strains of sugar kelp from the Gulf of Maine. Growth and survival of the vertical kelp lines will be monitored during the winter and spring of 2024 and shared at the session. In addition, research space at the offshore farm will be shared with fellow researchers, industry partners and entrepreneurs that have interest in farming the ocean.

LIPOSOME-CONTAINING COMPLEX PARTICLES (LCP): A NOVEL MICRODIET TYPE FOR DELIVERY OF WATER-SOLUBLE NUTRIENTS TO MARINE FISH LARVAE

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Production of farm-raised marine finfish is limited, in-part, by inadequate nutrition during the larval stage. Existing larval microdiets are prone to high leaching of their water-soluble nutrients when suspended in water, reducing the nutritional quality of the feed when ingested. Additionally, they have high sinking rates in the water column, which can lead to poor feed uptake rates. This uneaten feed may accumulate in the tank, leading to degraded water quality. Ultimately, insufficient nutrition combined with stressors from poor tank conditions may result in poor larval growth, low rates of survival, increased malformations, and disease. Recent studies have shown liposomes containing water-soluble core materials to be an effective way to enrich live feeds with water-soluble nutrients and deliver them to marine finfish larvae. Alternatively, these liposomes can be incorporated into larger alginate-based particles to create liposome-containing complex particles (LCP). These particles have shown lower rates of nutrient leaching in comparison to existing liquid and commercial-type diets and can be directly ingested by fish larvae. Our research objectives to: 1) optimize buoyancy of LCP to increase rates of feed capture by fish larvae; 2) determine particle efficiencies of core materials and assess against other diet types; 3) compare feed uptake rates, digestibility, and acceptability of LCP with other commercial-type microdiets; and 4) evaluate viability of these diets for a commercial species. If successful, liposome-containing complex particles have the potential to efficiently deliver key water-soluble compounds directly to larvae and revolutionize the way marine finfish larvae are fed in commercial hatcheries.

CREATING STANDARDS FOR HARVESTING SEAWEED AS FOOD IN NEW YORK

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Interest in local seaweed production is increasing across the US, and New York recently permitted its first commercial seaweed farm. Despite the increased interest, there is little seaweed specific guidance on best practices for harvesting, handling, and assessing source/harvest related food safety hazards. As this emerging industry continues to grow, it is important to provide food safety resources and guidance to ensure safe production and harvest of domestic products.

While some controls are already in place to reduce the risk of biological hazards, there is a lack of data on chemical hazards associated with seaweed species grown in different regions. Through review of available resources and known contaminants of concern in New York waters, New York Sea Grant has developed guidelines for the industry to assist in controlling potential chemical contaminants of concern.

For contaminants that did not have existing domestic or international standards, thresholds were calculated to recommend initial conservative standards for such contaminants. The calculations were based on published tolerable weekly or monthly intake values or minimal risk levels. Calculations were designed to limit exposure to ¼ the published harmful levels assuming a single serving was consumed daily.

While this resource is a start to guide New York production, continued discussions around best practices for harvesting food-grade seaweed are important as the emerging industry continues to grow. This is especially important for the evaluation and determination of contaminant thresholds to ensure current and future recommendations are effective and ensure safe products make it to market.

TESTING THE EFFICIENCY OF BIOFOULING REMOVAL IN THE MAINE SCALLOP AQUACULTURE INDUSTRY

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Biofouling, a common issue in aquaculture, poses economic and biological challenges, including increased remediation and/or removal costs and growth rate reduction and higher mortality rates for the farmed species. Maine scallop farmers currently employ labor-intensive methods like pressure washing and hot tank treatment to combat biofouling throughout the growing season. To enhance efficiency, farmers acquired a mechanized lantern net washer through funding from the Maine Aquaculture Hub. We conducted an on-farm study from June to October 2023 to compare the net washer's effectiveness with the traditional pressure washing method. We quantified biofouling biomass removal, lantern net weight changes, and scallop shell height and tissue condition by treatment (control, net washer, or pressure washer). We will discuss the process of purchasing the net washer, provide insights into the seasonal nature of the biofouling issue within the scallop aquaculture industry, and report on the trade-offs in cost, labor, and efficiency associated with different methods. This research not only offers practical solutions to biofouling challenges for aquaculture farmers but also contributes valuable insights to the scientific understanding of biofouling management. Ultimately, the successful implementation of more efficient methods stands to benefit both the aquaculture industry and the broader region by promoting sustainability and economic viability.

WHO'S WHO IN MAINE AQUACULTURE? UNDERSTANDING THE LANDSCAPE OF AQUACULTURE ACTORS AND PRIORITIES

Caitlin Cleaver[1], Robin Fail[2], *Molly Miller*[3], Emily Farr[4], Jessica Batchelder[4], Maeve Staab[4], Marissa McMahan[4]
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The Maine aquaculture sector has been rapidly evolving in the last 15 years and is looked to as an area of economic development potential for the state. While there are many actors engaged in aquaculture development, there is less clarity around whose priorities are shaping the direction of the sector, how those priorities have evolved over time, and who benefits. Our study sought to answer the following question: Who has shaped aquaculture development priorities in Maine, and how? Through the analysis of public testimony submitted in response to aquaculture-related bills before the Maine legislature between 2017 and 2023 and aquaculture grant funding received by Maine organizations since 2017, we categorized the role of different actors and priorities shaping aquaculture development in Maine.

Our analysis of testimony submitted for aquaculture-related bills found consistent participation by a handful of actors (state agencies, advocacy groups, and NGOs) commenting on multiple pieces of legislation. Our analysis of funding found that the largest number of grants were awarded to aquaculture farmers (43%) and academic or research institutions (29%), but the greatest proportion of funding went to institutions (68%) while farmers received only 15% of these total funds. This analysis provided one lens to understand the funding landscape but was limited by publicly available information. This study offers insight into whose priorities are included as aquaculture in Maine develops and the implications for equity and inclusion in the Maine aquaculture sector.

SHELLFISH ECOSYSTEM SERVICES (NITROGEN REMOVAL AND FILTRATION) AS CASE STUDY FOR THE REYKJAVIK PROTOCOL ENVIRONMENTAL CREDIT GENERATION ARCHITECTURE

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In September 2023, more than 40 organizations from around the world published and committed to implementation of a novel architecture for environmental credit generation. The Reykjavik Protocol (https://www.reykjavik-protocol.com/), named based mainly on where it was signed, is intended to advance the development of credible large-scale credit markets by providing best practices for credit suppliers in the form of nine core principles. Highlights include scientific review, independent auditing, and data transparency. Though mainly focused on credits for nature-based carbon removal, the protocol is broad and applicable to other environmental credits. As a case study that may inform future Protocol applications, we examine methods for systematically quantifying ecosystem services provided by shellfish, with a focus on nitrogen assimilation and water filtration. We treat a season-long period for two idealized examples: 1) one million Eastern oysters bottom-planted under a coastal restoration context and 2) one million surf clams grown in an upweller in an aquaculture context. We present a method for estimating season-cumulative nitrogen removal and water filtration based on assumptions supported by results from published studies. We evaluate uncertainties, consider site-specific measurements required for ground truthing, and compare results to methods used in established shellfish credit markets. Compared to nitrogen assimilation, methods for quantifying and verifying filtration are more challenging. The approach can be generalized to other species of shellfish and other settings, and could be relevant to helping establish new, science-based credit markets for shellfish ecosystem services.

PANEL DISCUSSION: WORKING WITH THE USDA

Emily Cole
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The USDA Farm Service Agency (FSA), Natural Resources Conservation Service (NRCS), Risk Management Agency (RMA), Rural Development (RD), and the East Coast Shellfish Growers Association (ECSGA) representatives as well as shellfish producers from the New England region will participate in a moderated panel discussion focused on both sharing first-hand experiences working with these USDA agencies, as well as ways USDA programs can be improved to better meet the needs of Northeast Shellfish growers. The panel will be moderated by Dr. Emily Cole who will also facilitate a question-and-answer session for panelists and attendees.

GOT THE FUZZ?: A CONVERSATION ABOUT THE EFFECT OF STALKED CILIATES ON OYSTER NURSERY CULTURE

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Oyster Seed Holdings, Inc (OSH) is an independent, commercial oyster hatchery specializing in providing high quality seed to growers. In recent years, OSH has struggled with periodic infestations of stalked ciliate epibionts. Stalked ciliates disturb the feeding process in small oyster seed effectively by causing a steric

hindrance to the feeding process and therefore slowing growth. At first, infestations were limited to bottle nursery systems, but have now been observed in upwellers, not only at OSH, but at a number of locations. Through Virginia Sea Grant Fisheries Resource Grant funding, OSH led a sampling program to identify these epibiont pests to the genus level during the 2022 hatchery season, in collaboration with Dr. Richard Snyder from Virginia Institute of Marine Science (VIMS). Results showed that suctorians in the genus *Acineta* were the dominant epibiont pest in the bottle nursery system. In upweller nursery systems, peretrichs in the genus *Zoothamnium* were the dominant pest. During 2023, OSH began exploring methods for controlling infestations of these epibionts on oyster seed of varying sizes. There is still much to be learned about the severity of stalked ciliate infestations at other facilities along the coast. In collaboration with VIMS, we are creating a coast-wide survey to determine the extent of infestations in east coast facilities, seasonality of infestations, and efficient mitigation strategies.

ESTABLISHMENT AND EVALUATION OF REGIONALLY CROSSBRED HARD CLAM *MERCENARIA MERCENARIA*

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Hard clam (*Mercenaria mercenaria*) aquaculture is currently impacted by mass-mortality events caused by QPX (quahog-parasite unknown). The growth of cultured clams is slow and needs to be improved. To determine if the performance in QPX resistance and growth can be improved by interstrain hybridization, we produced the following four hybrid and pure crosses of hard clams in summer 2023: a NY hatchery (NYH) stock selected for QPX resistance, a wild stock from Barnegat and Great Bays of New Jersey (NJW), a hybrid cross (HYB) between NYH and NJW, and a hatchery stock from New Jersey (NJH). The four groups were produced by mass spawn of 12 – 23 parental clams with 4-5 replicates per group. No difference was observed in larval size among the groups from day 1 and day 14. Survival to D-stage at Day 1 was significantly lower ($p < 0.05$) in the hybrid cross than other crosses. Larval survival from D1 to Day 7 and Day 14, however, was significantly higher ($p < 0.05$) in the hybrid cross. After metamorphosis, the number of juveniles survived to 3-5 mm was 51,780 for HYB, 24,500 for NJW, 2,450 for NJH and 1,788 for NYH. While preliminary, results of this study suggest that the hybrid cross has higher larval survival after D1, which may be attributable to increased genetic diversity. Juveniles from the four groups are being maintained in the nursery for field deployment and evaluation.

SHELLFISH WET STORAGE CONTAINMENT SYSTEMS

Mark Crandall
Sæplast Americas Inc., 100 Industrial Drive, Saint John, New Brunswick E2R 1A5 Canada

Constructed from double-walled food-grade polyethylene and filled with polyurethane, the Sæplast multi-purpose containers are ideal for the storage and purification of live oysters, clams & mussels.

An even flow of water is maintained resulting in the perfect oxygenation of each individual shellfish. This new concept is multi-functional and is a complete system that includes specific features that have been designed with the North American market in mind.

This Saeplast solution offers lifting handles on a 48” x 48” footprint polyethylene container that allows for the container to be used for harvesting on the water, transporting to the plant and within the plant for purging – all in one container system.

The container is ergonomically designed for maximum strength, ease of handling, stacking, and optimum hygiene. They are designed so that they stack perfectly together with or without lids. They come with a host of built-in features, including integrated water channels and easy release plugs for rapid emptying and, as the container operates without the need for any external pipe or drain connections, they are equally at home in both closed and open-looped systems.

DEVELOPING AN AQUACULTURE PATHWAY IN CONNECTICUT TO INCREASE AQUACULTURE WORKFORCE DEVELOPMENT

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In the state of Connecticut, the aquaculture industry has been growing for the past several decades and has become very diverse. The industry includes cultivation of seaweed, shellfish, and finfish for food consumption, the production of ornamentals, salmonid hatcheries for recreational stock enhancement, as well as mitigation strategies to help combat climate change. In order to help support this growing industry, workers who have post-secondary training and specialized skill sets are needed. The state of Connecticut’s Vocational Agricultural High School Programs are deeply invested in career and technical education as well as preparing students for competitiveness in post-secondary education. Those students who follow the aquaculture strand have the opportunity to learn hands-on aquaculture education in fully functioning fish production laboratories. Despite the state having these impressive programs, there is a lack of post-secondary education pathways offered and in turn students with this training are leaving to seek established pathways in other states.

As part of a CT SeaGrant award, we discuss an aquaculture pathway being developed at Southern Connecticut State University (SCSU). This includes the state’s first Early College Experience (ECE) courses in aquaculture that are currently being collaboratively developed by The Sound School and SCSU. The goal of this aquaculture pathway is to increase recruitment of highly skilled students from Connecticut’s Vocational Agricultural High School Programs at a CT higher education institution to further prepare the next generation for the aquaculture workforce.

ELAP: OPPORTUNITIES AND CHALLENGES FROM A NATIONAL PERSPECTIVE

Charlie Culpepper
National Aquaculture Association (USA), PO Box 12759 Tallahassee, FL 32317

An overview of USDA Farm Service Agency's Emergency Assistance for Livestock, Honeybees and Farm Raised Fish Program (ELAP). The presentation will focus on aquaculture eligibility and the ELAP claims process, recent changes that expanded aquaculture commodity access, challenges from aquaculture farmers around the nation, and the National Aquaculture Association’s ongoing efforts improve ELAP efficacy for U.S. aquaculture.

NRCS COASTAL INNOVATION GRANT FOR FARMER-SUPPORTED RESTORATION IN MASSACHUSETTS

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The Nature Conservancy (TNC) is working to permit additional oyster reef restoration sites in Massachusetts and expand oyster reef restoration as a nature-based solution addressing coastal environmental challenges. TNC implemented the Supporting Oyster Aquaculture and Restoration (SOAR) project in seven states including Massachusetts at the start of the pandemic to purchase excess oysters from growers and plant them on restoration sites. One of the barriers to more widespread industry participation in SOAR, particularly in MA, along with biosecurity concerns, was the lack of restoration sites. A natural next step to institutionalizing this farmer-supported restoration model is to establish more restoration sites. The process of permitting additional sites has involved meeting with town natural resource specialists and shellfish constables, growers, and project partners to determine which areas have the most suitable conditions for restoration. Some of the conditions that are assessed are sediment type, salinity and freshwater influence, dynamics of the location, potential for recruitment, enforcement feasibility, and public outreach value, along with number of growers, water classification designations, and management capacity. The Natural Resources Conservation Service (NRCS) has been a committed partner in working to expand this model and is funding TNC, and partners including the MA Aquaculture Association, through a Conservation Innovation Grant (CIG) to identify and permit sites in locations where restoration would benefit oyster farmers and the environment the most.

BLENDING AQUACULTURE EDUCATION INTO A FISHERIES CREW TRAINING PROGRAM IN RHODE ISLAND

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Rhode Island's seafood sector faces many concerns that are reflected across our nations coasts, including greying of the fleet, recruitment and retainment, and pipeline to ownership/captain. However, RI has been proactive and dedicated to shaping training programs for young fishermen, shellfishermen, and even aquaculturists for the past several years. One example is the Commercial Fisherman Apprenticeship Program (CFAP), started in 2017, led by the Commercial Fisheries Center of RI and supported by federal funds which has since offered hands-on classroom training to individuals interested in working in commercial fishing, either on vessels or shoreside. The four-week program has trained XX people and placed individuals in employment aboard XX vessels and shoreside support firms. Through partnership with Coastal Resources Center/Rhode Island Sea Grant and NOAA funding, the project team worked to integrate additional aquaculture education and training in 2022 and 2023 into the successful, in-person crew training program, providing additional career pathways for participants. The team also revised the learning curriculum, shaped and is facilitating a mentorship program for trainees, and has expanded recruitment across the nation. We will share some highlights from the 2023 training, success stories, challenges, and next steps.

OPPORTUNITIES AND CHALLENGES FOR BUILDING RESILIENCE OF THE AQUACULTURE INDUSTRY IN RHODE ISLAND

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The aquaculture industry in Rhode Island has experienced substantial growth in recent years, with oyster production valued at ~$7.5 million in 2022. However, the industry currently faces numerous social, regulatory, and environmental challenges that may limit its continued expansion and longevity. This study used semi-structured interviews with stakeholders in the Rhode Island aquaculture industry, including growers, distributors, regulators, economists, research scientists, and nonprofit organizations, to investigate the challenges and opportunities facing the aquaculture industry in the state. The goal of the study was to understand whether and how the industry can take actions to become more resilient, such as by incorporating new production practices into their farms. Preliminary findings suggest farms may become more resilient to challenges such as crop loss from disease and changing ocean conditions by producing new species including sugar kelp, bay scallops, and sea urchins. However, industry stakeholders face barriers to adopting new production practices, including organized and well-funded resistance to aquaculture lease applications, space limitations and use conflicts between growers and coastal homeowners and the fishing industry, and a lack of infrastructure for species production and distribution. Adopting new practices is also time-, labor-, and resource-intensive, so growers are seeking additional support and access to grants to fund new opportunities and to share market risk throughout the industry. Results of this study will commence efforts toward developing a collaborative aquaculture network in Rhode Island to support stakeholders as they pursue opportunities to increase the resilience of the industry.

IDENTIFICATION OF BACTERIAL COMMUNITIES AND THEIR ASSOCIATION WITH LARVAL MORTALITY IN ATLANTIC SEA SCALLOPS, *PLACOPECTEN MAGELLANICUS*, HATCHERY SYSTEM

***Adwoa Dankwa*, Ayodeji Olaniyi, Sue Ishaq, Jennifer Perry**
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Atlantic sea scallops, *Placopecten magellanicus,* are economically important in the northeastern coast of North America. Hatcheries rely on wild-caught adults and juvenile spat for production. Increased larval mortality rate has rendered production unprofitable. Research in closely related scallops and other marine bivalves have revealed that larval mortality may be related to bacterial infection with *Vibrio* spp. identified as major contributors to fatality. Currently, there are no known causes of larval mortality in Atlantic sea scallops. There is, therefore, the need to determine the bacterial communities found in hatcheries and their relationship with sea scallop larvae mortality.

Veliger, wild larval, hatchery larval, biofilm, and clean tank samples were obtained from 3 sea scallop hatchery facilities. 134 morphologically distinct colonies were subjected to DNA extraction, quantification and PCR amplification using 27F/1492R primers. Amplified products were EXOsap cleaned and Sanger sequenced using three primers (27F, 515F and 1492R). Sequence data were combined into a contiguous sequence to span the full 16S rDNA gene which aided in reliable bacterial identification using Flench TV, blenching and NCBI Blastx platform for analysis.

Preliminary data identified *Bacillus* and *Vibrio* spp. in hatcheries. *Vibrio syngnathi, V. atlanticus, V. splendidus, V. alginolyticus* with percent identity >93% were confirmed. These are confirmed to cause vibriosis, a high rate of mortality in aquaculture turbot, scallops, clams, and oysters. These results, along with future work, will inform hatcheries on the potential causes of larval mortality and advise accordingly on strategies to incorporate to increase larval survival in these facilities.

STORIES AND LESSONS LEARNED FROM FARMER TO FARMER EXCHANGES

Christopher Davis **and Anne Langston Noll.** Maine Aquaculture Innovation Center, 193 Clarks Cove Road, Walpole, ME 04573

Small aquaculture businesses tend to operate using locally-derived processes and technologies, often without regard to practices conducted elsewhere. The Maine Aquaculture Innovation Center (MAIC) is currently piloting an aquaculture-specific farmer-to-farmer exchange program that is playing a major role in connecting and funding exchange visits for Maine farmers to identify proven production practices, farm management methodologies or tools for improving farm efficiencies, reducing bottlenecks, and increasing business success. Selected farmer exchanges have all travel costs covered through the program. Participant personnel costs are in-kind contributions from the applicant farm. Upon return from exchange visits, funded farmers are expected to assist the MAIC in dissemination of key findings.

In September 2022, MAIC initiated an online, rolling application process with decisions generally made within one week of each monthly application deadline. To date, over twenty-five farmers from ten Maine companies in the shellfish and seaweed sub-sectors have conducted site visits to Louisiana, Alaska, Washington, North Carolina, Mexico, Faroe Islands, Norway, Denmark, Australia and Japan. This session will feature stories and lessons learned from selected farmer to farmer exchanges.

ASSESSMENT OF U.S. CONSUMER ATTITUDES AND PREFERENCES FOR DOMESTIC FARM-RAISED SEAWEED

Christopher Davis[1], *Anne Langston Noll*[1], Qiujie Zheng[2], Raymond Bernier[3], & Randy Labbe[3]
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Edible seaweed can provide income diversification for aquaculture operators and for fishermen. However, little consumer research has been conducted on seaweed, leaving seaweed farmers in need of insights data on which to base market-driven decision making, as opposed to supply-driven business decision making and planning.

A nationwide consumer insights survey on edible seaweed and value-added products was carried out. Survey data was used to develop an interactive data dashboard that can be utilized by seaweed farmers, distributors, wholesalers, aquaculture researchers, and Extension professionals.

The data dashboard provides searchable, clearly understandable data on which good business planning can be based. Businesses can realize a significant competitive advantage by practicing market-driven, that will result in increased revenues and higher profitability for seaweed farmers and value-added producers. Ultimately, the results of this project inform seaweed farmers about consumer attitudes and preferences,

allowing them to produce the products and volumes that consumer's want and to communicate that information to their wholesalers and resellers.

FOUNDER POPULATION SELECTION FOR AN OYSTER SELECTIVE BREEDING PROGRAM

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Genetic diversity benefits selective breeding programs by providing the variation necessary for improvement and preventing long-term inbreeding. However, inclusion of genetically diverse broodstock that are maladapted to the target environment can decrease performance. Founders of a breeding program must therefore be selected to balance the need for genetic diversity and minimize inclusion of maladapted individuals. In order to start an eastern oyster selective breeding program serving producers in the northeastern United States, we surveyed 46 oyster populations from New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, and Maine. By restricting the populations considered to only those in the target area, we aimed to exclude individuals maladapted to the region. Individuals from each population (total of 1,591) were genotyped for over 60,000 single nucleotide polymorphisms to assess genetic diversity within and between populations. These genotypes were then analyzed with a neural network to select a subset with close to the maximum possible genetic diversity. Individuals from this subset of populations will be used as founders of the breeding program.

DISTINCT EFFECTS SITE EXPOSURE ON THE COST OF SEAWEEED AND SHELLFISH FARM STRUCTURES

***Tobias Dewhurst*, Samuel Rickerich, William Ntsoane, Michael MacNicoll, Nathaniel Baker, Zach Moscicki**
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The influence of site exposure on the economics of seaweed and shellfish farm structures was investigated. By differentiating between "distance from shore" and "exposure energy," the research aims to facilitate precise risk and cost assessments in offshore aquaculture. Analyzing the German Bight in the North Sea as a case study, the research underscores that nearshore, exposed sites often exhibit higher exposure energies, challenging conventional offshore assumptions.

The economic analysis centers on a specific site off the coast of Maine, chosen for its potential wind installation synergies. Rigorous design parameters, including extreme scenarios (5, 10, and 50-year storms), form the foundation. The study particularly emphasizes the trade-offs between biomass maximization and mooring costs in deep-water locations. Advanced simulations contribute to accurate force estimates on structural components, directly impacting cost projections.

To ensure model accuracy, empirical data from exposed locations validate the study's findings. The comprehensive economic model encompasses permitting, surveillance, financial considerations, and more, enabling the calculation of the cost per dry metric ton at the farm gate. This provides valuable insights into the economic dynamics of seaweed farming, including its potential for carbon credit applications.

The study emphasizes the need to enhance cost efficiency and economic viability through optimized hatchery processes, reduced labor expenses, and refined farm designs. The combination of techno-economic modeling and engineering expertise offers promising avenues for achieving economic sustainability in offshore aquaculture.

BUILDING THE WORKFORCE OF TOMORROW: EXPANDING AWARENESS OF AQUACULTURE AS A VIABLE STEM CAREER FOR MAINE'S YOUTH

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Maine's aquaculture industry represents an adaptive response to climate-induced changes to the Gulf of Maine. Total economic impact has nearly tripled since 2007, and growth in the overall workforce is expected to increase by 33% by 2030. Despite these advances, growth of the industry also presents recruiting challenges as the field becomes increasingly technology and data-driven, requiring the development of a skilled workforce with knowledge of how changing ecological conditions strongly impact marine natural resource industries, and the economic reasoning to make operational decisions based on those changing conditions. In this talk, we share technology products and insight from a multi-year NSF funded research project aimed at increasing awareness and knowledge of Maine's aquaculture industry among Maine's elementary students. Among the technology products we will share is a virtual aquaculture game in which students build and manage a virtual farm across several years of production. This tool was designed to make visible the costs and benefits of variable production and selling decisions on the financial stability of the farm with the ultimate goal of developing multiple areas of skill and knowledge in students that can be flexibly deployed across their entire academic career and across evolving future work environments. Long term impacts of this project include (1) providing a model for local school districts to connect participating youth with local farmers, (2) diversifying the aquaculture workforce and broadening participation in aquaculture career pathways, and (3) providing Maine students with the knowledge, capacity and interest to pursue a career in aquaculture.

IMMUNE GENE EXPRESSION AS MARKERS FOR EARLY DEVELOPMENT OF THE IMMUNE SYSTEM IN YELLOWTAIL KINGFISH (*SERIOLA LALANDI*)

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Yellowtail kingfish is an ideal aquaculture candidate species currently being developed for commercial production and production facilities are being developed in the Northeastern United States. However, the aquaculture of yellowtail kingfish faces difficulty dealing with the high mortality problem during larval rearing stages in hatcheries. The bottleneck may, in part, be due to the larvae's undeveloped immune system. Therefore, we want to investigate the species-specific larval immune function development to optimize the hatchery management strategy and improve the larval survival rate. Lymphoid organs and both T and B cells have been used to study the ontogeny of the fish immune system in various fish species. Recombination-activating gene 1 (RAG-1) and immunoglobulin M (IgM) have been considered very useful markers of immunological maturation, which determine the appropriate time of vaccination. This project aims to investigate the larval immune development of yellowtail kingfish and build an immunological

development timeline. Larvae samples at different developmental time points were collected to investigate different immune genes and create a timeline for the functional immunity of fish larvae. qPCR will be utilized to probe the larval tissue of yellowtail kingfish for expression of immune genes such as RAG-1, IgM, C3, lysozyme, and C-reactive protein. The potential outcome of this project is gaining the knowledge of when the yellowtail kingfish will become immunologically competent, which helps create better vaccination schedules to improve production.

EXPLORING THE SCIENCE OF SEAWEED FARMING: AN IN-SCHOOL EXPERIENTIAL PROGRAM

Pauline Dion
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The marine environment is facing severe challenges due to climate change, pollution, ocean acidification, human development, and invasive species affecting the ocean as a food source. This in-school program stimulates investigation exploring these issues, challenges students to think critically about future problems and possible solutions supporting a deeper understanding of where they live and stronger sense of place. A school-based effort in its 7th year has expanded its reach from 3 schools in Lincoln County (2013) to 15 schools in 7 Maine Counties. Impacting 1,000+ students each schoolyear it engages Maine aquaculturists Down East to Gouldsboro and South to Biddeford. This collaborative program promotes a better understanding of innovative aquaculture techniques and a better understanding of "sustainability" and "entrepreneurial opportunities". It raises ecological awareness and responsible use of renewable resources building environmental ethics and practices while developing ocean literacy and a sense of leadership to steward the environment. With scientist and aquaculturists students explore if Saccharina latissima and Alaria esculenta are impacted by their growing environments. Early fall, equipment, filtered seawater, and "manmade ocean" are brought to the classroom where seaweed seedlings grow for 6 weeks before planted on farms on vertical drop lines in December. Winter months are spent reviewing data collected in the fall and developing hypotheses. Late April seaweed is harvested, real-time scientific data collected and recorded, and findings shared at a "community presentation". This program opens doors to career paths in aquaculture and encourages ownership of research that stimulates a passion to learn and do more.

DEVELOPMENT OF A LUMPFISH BREEDING PROGRAM FOR MAINE INDUSTRY

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Lumpfish (*Cyclopterus lumpus*) were first utilized in Norway as cleaner fish beginning about 2014 and later in several other countries, including Canada. Cooke Aquaculture is eager to deploy lumpfish at its Maine salmon sites, but the lack of a commercial-scale lumpfish hatchery and domestic broodstock population in Maine has so far stymied progress. In 2019, researchers from the University of New Hampshire, University of Maine, and the USDA National Cold Water Marine Aquaculture Center formed the US Lumpfish Consortium in collaboration with Cooke Aquaculture to spur progress, and in 2022 Cooke Aquaculture began construction on the first commercial US lumpfish hatchery, in Eastport, Maine. The University of Maine's Center for Cooperative Aquaculture Research (CCAR) has been supporting these efforts by

capturing young-of-the-year lumpfish and 2nd year juveniles from the Gulf of Maine to establish a domestic broodstock population. The collection program was started in 2018 and with funding from NOAA Sea Grant will continue through at least 2025. A pilot lumpfish hatchery is also being established at the CCAR under the program. Several cohorts of lumpfish have been captured, domesticated, and conditioned to spawn at the CCAR, and reproductive fish and fertilized eggs have been shared with Consortium partners. Data on collection effort, size ranges, and surface seawater temperatures at time of capture will help inform future efforts. In 2023, lumpfish were captured for the first time under the program from Cobscook Bay and Portsmouth Harbor, providing additional useful information on lumpfish distribution in the Gulf of Maine.

MICROBIAL ASSESSMENT OF DRIED SEA VEGETABLES FOR SAFETY AND QUALITY

Stephen Eddy
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Maine Coast Sea Vegetables (MCSV) sells several species of macroalgae (sea vegetables) harvested from the Gulf of Maine and Iceland and dried as ready-to-eat (RTE) foods or as ingredients for food products and nutritional supplements. Dried sea vegetables are routinely screened by MCSV for *Salmonella spp., Staphylococcus aureus,* mold and yeast, total coliforms, *Escherichia coli,* and total aerobic count using FDA or USP approved methods. These microbial screens are widely accepted in the food and supplement industries as reliable indicators of product safety and quality. An analysis of 367 test results dating from 2007 to 2023 offers lessons for Maine's emerging seaweed aquaculture sector as it navigates issues of regulatory compliance and product safety. The nine macroalgae species/products included in the analysis varied in total aerobic counts and yeast & mold counts, but there was zero incidence of *Salmonella spp.* and *S. aureus.*, two leading causes of food-borne illness. Coliform bacteria were detected in 45 samples but at levels ($<3 \times 10^3$ CFU/g) falling below food safety or quality concern. However, testing dried sea vegetables for *E. coli* poses special challenges. Thirty-six samples returned findings of presumptive positive *E. coli* using a selective agar USP method and thus required follow-up testing to confirm species identification, with just seven confirmed positive *E. coli* findings. Additional testing to rule out Shiga-toxin producing *E. coli* (STEC) strains showed no such strains were present. Overall, the results support findings that show consumption of dried macroalgae as a RTE food presents low microbial risk.

GETTING BACK TO BASICS: HATCHERY CLEANING PROTOCOLS

***Chris Edwards*, Emma Green-Beach, Rick Karney, Alley McConnell, Nina Ferry Montanile**
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The Martha's Vineyard Shellfish Group (MVSG) provides the Vineyard with millions of quahog, oyster and bay scallop seed annually. MVSG operates three facilities, and all are feet away from the shoreline. In aquaculture, we boast the importance of shellfish for water quality, but we also need to be thoughtful of what hatcheries discharge. Clean equipment is essential for growing healthy shellfish and there are many products and methods to accomplish this. Sodium hypochlorite (bleach) is most commonly used to sterilize algal culture media, but it is also used as a topical solution for cleaning tanks and other hatchery equipment. Bleach can be very toxic to aquatic organisms and can irritate skin and eyes depending on concentration. MVSG uses alternative topical solutions, such as Povidone-iodine and an oxalic acid-based cleanser, to reduce the amount of bleach used. The alternative cleaning agents are overall less caustic and gentler to the environment as well as the people who are applying them. In combination with our regular cleaning protocols, we find these products to be effective and efficient for cleaning in the hatchery setting.

TAKING THE 'GUESSWORK' OUT OF SEED COLLECTION: DEVELOPING NOVEL ENVIRONMENTAL RNA (eRNA) TOOLS FOR BLUE MUSSEL AQUACULTURE

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Blue mussel aquaculture in the U.S. is steadily growing, yet the industry's dependence on wild-caught seed presents significant challenges for farmers; recent and frequent seed recruitment failures have caused financial and production losses. To better understand the rising unpredictability associated with seed collection and increase the probability of successful young-of-year recruitment, reliable methods to quantify and map the spatiotemporal dynamics of mussel larvae are urgently needed. Molecular tools that take advantage of environmental nucleic acids within the water column, such as environmental DNA (eDNA) and RNA (eRNA), are particularly well suited to address this need. Unlike current eDNA-based tools, eRNA tools leverage differences in gene expression and are capable of: (1) discriminating fine-scale organismal characteristics, such as developmental stage and condition, (2) detecting living organisms, and (3) superior spatiotemporal resolution due to RNA's rapid degradation rate. Here, we describe the development of sensitive biomonitoring tools that exploit the eRNA in seawater samples to detect, quantify, and monitor wild blue mussel larvae. Ultimately, we aim to incorporate these novel eRNA technologies into user-friendly and field-ready toolkits that will transform mussel farmers' ability to quickly and accurately monitor seed in the water column around their seed collection sites. Not only will these tools allow for near-real-time monitoring capabilities of seed quantity and quality, but they will also permit farmers to better understand the changing phenology of mussel larval supply. Moreover, these tools can be adapted for other shellfisheries reliant on wild seed.

MICROBIAL SOURCE TRACKING TO MITIGATE BACTERIAL CONTAMINATION IN AQUACULTURE WATERS - A PROMISING PUBLIC HEALTH TOOL

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Shellfish bed closures are currently determined by a simple fecal indicator bacteria threshold. Water samples exceeding the threshold - or in some jurisdictions, precipitation levels statistically likely to correlate with exceedant bacteria levels - initiate closure of a shellfish bed without providing information about the root cause of the contamination. While this simplifies routine administration procedures, it may be insufficient to provide identifying information necessary to understand patterns of fecal contamination and to direct mitigation efforts in waters with chronically poor water quality. We here provide an example of the use of microbial source tracking (MST) to identify the species source of fecal indicator bacteria from outfalls in Branford, Connecticut entering the Long Island Sound near shellfish beds and kelp farms. Contrary to the assumption that leaky sewage disposal systems in the town were responsible for the high levels of contamination, preliminary results indicate that dog and avian bacteria enter the waters in high concentrations at these outfalls. These findings have initiated efforts, in collaboration with the Civic Association of Short Beach, to add water-tight trash cans for canine waste at local beaches and to improve

education of proper waste disposal among residents. As the magnitude and frequency of extreme precipitation events is anticipated to increase with climate change, shellfish beds will likely face increasing bacterial contamination from precipitation-induced runoff in coming years. Use of MST and other technologies will likely become increasingly important to understand our aquaculture systems and protect their viability in a changing climate.

CO-DESIGNING FORECASTS FOR AQUACULTURE

Johnathan Evanilla, Nicholas R Record, Benjamin Tupper
Bigelow Laboratory for Ocean Sciences, East Boothbay, ME

Emerging predictive modelling methods along with new data streams available has given rise to new and improved forecasts across many domains. The Tandy Center for Ocean Forecasting was formed in 2021 at Bigelow Laboratory for Ocean Sciences with a goal of developing ocean forecasting tools in collaboration with their intended end users. One area of focus has been placed on the shellfish aquaculture industry in the northeast US, and we focus here on three example projects. The first is an early warning system for paralytic shellfish poison (PSP) levels along the Maine coast. In just a few years, an industry-conceived concept was transformed into an experimental forecast tool that was made available for public use in the spring of 2022, then transferred to Maine Department of Marine Resources to operate during the 2023 PSP season. A second early warning system was investigated through a pilot study aiming to predict blooms of *Margalefidinium polykrikoides*, also known as rust tide, for shellfish growers in Rhode Island. The most recent attempt to co-design a forecast for aquaculture changes directions from giving warning of events that could damage a grower's ability to sell product to predicting opportunities to collect blue mussel (*Mytilus edulis*) seed for their farms. All three of these examples have featured engagement by growers and managers throughout the projects, and as early as during the proposal phase. Each project will be summarized, with a specific focus towards lessons learned and effective cooperative research.

AQUACULTURE IN SHARED WATERS 2024: A SKILL-BUILDING SERIES FOR MAINE WOMEN AND NONBINARY AQUACULTURISTS

***Annie Fagan*[1], Annie Langston-Noll[2], Jaclyn Robidoux[3], Sebastian Belle[4], Nick Branchina[5], Hugh Cowperthwaite[5], Chris Davis[2], Teresa Johnson[6], Dana Morse[1], Jessica Veo[6], Gayle Zydlewski[7]**
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Since its inception in 2013, the Aquaculture in Shared Waters program has provided entrepreneurial support, technical training, community-building opportunities and networking connections for hundreds of prospective Maine aquaculturists. In recent years, shifting student demographics alongside emerging needs in diversity, equity, inclusion and accessibility within the aquaculture industry led to the initiation of a needs assessment through the Maine Aquaculture Hub to better understand opportunities for specialized affinity training and programming for underrepresented groups. The curriculum and format for this year's workshops are drawn directly from the research findings of that needs assessment. In 2024, the training

series will include both virtual and in-person components and feature women as topical experts covering a range of maritime, business and safety topics identified as being of particular interest to women and nonbinary aquaculturists. Priority will be given to those who can attend most or all workshops in order to encourage cohort-building and facilitate new connections and mentorship amongst participants.

LUMPFISH PRODUCTION FOR USE AS CLEANERFISH: AN OVERVIEW WITH AN EMPHASIS ON RESEARCH IN NEW HAMPSHIRE

Elizabeth Fairchild
Department of Biological Sciences, University of New Hampshire, Durham, NH 03824

Lumpfish, *Cyclopterus lumpus,* a species endemic to the northern Atlantic Ocean, has become the focus of the salmonid cleanerfish industry. Commercial or large-scale research production of lumpfish now occurs in Europe and Canada. Aquaculture researchers in Maine and New Hampshire are making steady progress in transferring lumpfish rearing technology from their international counterparts to their own facilities to catalyze the use of cleanerfish for Atlantic salmon and steelhead trout ocean farms in New England. The first in a series of lumpfish talks, an overview of lumpfish use and ongoing lumpfish research in the US will be covered, with an emphasis on five years of NH-based studies. These studies include a variety of small-scale projects focused on lumpfish hatchery needs, using lumpfish in salmonid farms, and wild lumpfish population dynamics. Collectively, this body of research addresses some of the barriers that limit cleanerfish use, in general, and, if employed in the US, could help to increase domestic salmonid production.

COOKE AQUACULTURE LUMPFISH HATCHERY

Jen Ford
Cooke Aquaculture USA Lumpfish Hatchery, 40 Barron Rd., Eastport, ME 04631 USA

Cooke Aquaculture is currently building the first commercial lumpfish hatchery in the USA, to support its Atlantic Salmon farms in Maine. The lumpfish will be deployed in Cooke's salmonid net pens along the coast of Maine as a "biological delouser", part of an integrated pest management program to mitigate sea lice. We'll give an overview of the facility along with future plans and projections.

WOULD YOU LIKE BIODIVERSITY WITH THAT? INVESTING IN OYSTERS FOR FOOD AND HABITAT

Hugh Forehead
University of Wollongong, SMART Infrastructure Facility, Northifields Ave, Wollongong, NSW, 2522, Australia

The case for restoring the lost 88% of biomass of oyster reefs is well established. These systems support biodiversity while filtering, cleaning, and removing nutrients from the water. The rich habitat offered by oyster aquaculture gear and reefs on abandoned leases provides similar benefits. Farmers are already supporting biodiversity as a by-product of producing food and could do more if funded. The United Nations Sustainable Development Goals are driving investment in biodiversity and institutional investors are ready to fund enterprises that can deliver benefits. Robust evidence will be key to ensuring trust in a funding system, if we are to avoid the loss of confidence caused by unscrupulous operations in carbon markets. The size of the biodiversity benefit will vary according to the where farms are located and the methods and gear

used. The Oceanfarmr App is an excellent platform for collecting this evidence. Farmers use their phones to harvest geolocated and timestamped data, including video and water quality metrics. Our study tests an affordable method for quantifying fish populations around different habitats on an oyster farm on the Clyde River, Australia. We are collecting water quality data and underwater video and analysing it with artificial intelligence. We aim to quantify differences in the species and biomass associated with four types of habitat: intertidal and floating oyster gear, bare sediment and restored reefs. We aim to give oyster farmers a pathway to rewards for their stewardship of our coasts and waterways.

A SYSTEMS-APPROACH FOR INTEGRATED MULTITROPHIC AQUACULTURE PRODUCTION FOR COASTAL NEW HAMPSHIRE

***David Fredriksson*, Michael Chambers, Michael Coogan, Michael Doherty, Longhuan Zhu, Erich Berghahn**
Center for Sustainable Seafood Systems, School of Marine Science and Ocean Engineering,
University of New Hampshire, Durham, NH 03824

The University of New Hampshire is conducting research to develop a systems-approach for a community-based, integrated multitrophic aquaculture (IMTA) production. This presentation will describe our approach to include (1) growing both fed and extractive seafood, (2) at a scale consistent with fishing community infrastructure, (3) quantifying ecosystem interactions, and (4) powered with renewable energy.

The IMTA system design is to offset dissolved and particulate nutrients from the fed species with extractive species. We are stocking the system with 2000 steelhead trout, along with extractive species including 72 m of blue mussel droppers, 48 m of sugar kelp cultivation line, 300 green sea urchins, and 2000 sea scallops. The size is intended to be manageable with lobster fishing infrastructure with boat sizes less than 12 m and hauling capacity of 2-3 tons. In addition, the species chosen are cultured throughout the winter, opposite of when most lobsters are fished.

To quantify ecosystem interactions, water samples will be analyzed for nitrogen, plankton, and eDNA. Sediment samples will also be collected. Two instrumentation packages are incorporated in the IMTA approach to obtain temperature, salinity, dissolved oxygen, chlorophyl-a, pH, nitrate, fluorescent dissolved organic matter, and current velocities. One sensor suite will be mounted within the fish containment structure with the other at a far field location, transmitting to shore with cell phone communication. A power system is designed to be mounted on the IMTA structure, consisting of batteries charged with solar panels, but expandable to include wave energy converters or tidal turbines.

TRANSISTIONS OF AN OYSTER FARM: SUCCESSION PLANNING & SELLING THE FARM

Seth Garfield, Charmaine Gahan
Cuttyhunk Shellfish Farms, Inc.

If you are curious about selling your farm or are looking into an alternative exit strategy, join Seth Garfield and Charmaine Gahan for this important workshop. Hear about the fundamentals of succession planning and exit strategies, the factors that are considered during a valuation as well as all the other pieces puzzle such as permits, finances, legal aspects, and last but not least transacting "The Deal".

A GROWING PARTNERSHIP BETWEEN AQUACULTURE AND RESTORATION IN THE GREAT BAY ESTUARY, NH

***Brian Gennaco*[1], Brianna Group[2]**
[1]Virgin Oyster Company, LLC, 19 Tuttle Lane, Dover, NH 03820; [2]The Nature Conservancy, 22 Bridge St, Concord, NH 03301

Oyster aquaculture is currently the fastest growing seafood industry in NH, providing not only revenue and jobs, but also positive ecosystem services to NH's coastal waters. Virgin Oyster Co LLC owned by Brian Gennaco, one of 12 actively harvesting oyster farms in NH since 2014 and part of the NH Shellfish Farmers Initiative, has been heavily involved with oyster reef restoration through partnerships with TNC (The Nature Conservancy), the SOAR (Supporting Oyster Aquaculture and Restoration) program, and NRCS (Natural Resources Conservation Service) since 2019. Over the past 4 years Brian's farm has contributed many oysters to reef restoration in the Great Bay Estuary, NH.

Participation in restoration programs like SOAR and NRCS not only help Virgin Oyster Co. show our community we are dedicated to protecting our local ecosystems, they also add some financial stability to an industry that experiences challenges as all agriculture does. During this presentation Brian will discuss his experiences participating in both SOAR and the NRCS purchase program and the growing intersection between the oyster aquaculture industry and restoration.

CONNECTICUT AQUACULTURE WORKFORCE DEVELOPMENT STUDY: PHASE 1

***Tessa L. Getchis*[1], Zachary Gordon[1], Michael Gilman[1], Martyn Haines[2], Andrew Parker[2], David Carey[3], Alissa Dragan[3], Michael Zuber[3], Harold Mackin[4], Ivette Ruiz[5], Alysa Mullen[6], Pete Solomon[6], Holly Turner-Moore[7], Eric Litvinoff[8], Michael Guyot[8], Matthew Smith[9], Jaunice Edwards-Hassan[10], Leanne Golembeski[11], Emma Cross[12], Patrick Heidkamp[12], Elizabeth Kendall[13], Anoushka Concepcion[1], Nancy Balcom[1]**
[1]Connecticut Sea Grant, University of Connecticut, Groton, CT USA; [2]Pisces Learning Innovations Limited, UK, Scotland; [3]Connecticut Department of Agriculture, Bureau of Aquaculture, Milford, CT USA; [4]CT Department of Education, Hartford, CT USA; [5]Healing by Growing Farms, East Haven, CT USA; [6]The Sound School, New Haven, CT USA; [7]Bridgeport Regional Aquaculture Science & Technology Education Center, Bridgeport, CT USDA; [8]Marine Science Magnet High School, Groton, CT USA; [9]Ledyard Vo-Ag Program, Ledyard High School, Ledyard, CT USA; [10]Bloomfield Vo-Ag Center, Bloomfield, CT USA; [11]Ellis Clark Regional Agriscience & Technology Program, Woodbury, CT USA; [12]Southern Connecticut State University, New Haven, CT USA; [13]Manchester Community College, Manchester, CT USA

A decades-long effort initiated in the 1970s involving farmers, educators, business and political leaders aimed to support aquaculture workforce development resulted in a network of innovative Agriscience, Aquascience and Technical Education and Career System programs in secondary schools across Connecticut.

In addition to high school training, other organizations involved in aquaculture development include the NOAA Milford Aquaculture Laboratory, the Connecticut Sea Grant program, and a non-profit organization called GreenWave. State fish hatcheries also offer experiential learning for students of all ages and have relationships with public and private schools. Connecticut state colleges and universities offer coursework, albeit limited, in aquaculture science.

As aquaculture has grown and diversified over the last several decades so has demand for workers who have post-secondary training and specialized skill sets in the trades. Despite Connecticut's renowned high school education and training programs, the state lacks clear and accessible pathways for post-secondary education and training.

The goal of this initiative is to better prepare the next generation of aquaculture farmers and supporting sectors by establishing more transparent, comprehensive, and accessible pathways for post-secondary aquaculture education and training and developing a process to evaluate future investments. The first step in the process is to understand more about the opportunities and constraints to developing a strong aquaculture workforce. Structured interviews will be conducted to gain insight from both industry members and aquaculture educators across the state.

IDENTIFYING AND BREEDING HEAT-TOLERANT STRAINS OF SUGAR KELP

***Sara Gonzalez*[1], David Bailey[1], Margaret Aydlett[1,2], Hadley Kerr[1], Nora Sauers[3], Charles Yarish[1,2], Scott Lindell[1]**
[1]Woods Hole Oceanographic Institution, 266 Woods Hole Rd., Woods Hole, MA, 02543 USA; [2]GreenWave, 315 Front Street, New Haven, CT 06513 USA; [3]North Carolina State University, Raleigh, NC 27606 USA

Warming sea temperatures are threatening sugar kelp populations; the Gulf of Maine waters are some of the most quickly warming on the planet. For the future of kelp aquaculture and restoration, we need to identify individuals with natural adaptations to cope with heat. Heat tolerance can be determined directly at the adult stage, but if heat tolerance of adult kelp can be predicted by assessment at the early-life gametophyte stage (prior to fertilization), we can accelerate breeding of heat tolerant strains and identification of the genes involved. We conducted two experiments, one focused on gametophytes and one on adult sporophytes, to assess physiological stress under heat and generate predictions of heat-tolerant strains. Gametophyte heat tolerance was assessed for 93 distinct genotypes by exposing them to temperatures representing current (12°C) and future (24°C) average annual temperatures in the Gulf of Maine, U.S.A., and measuring their photosynthetic performance (as chlorophyll a fluorescence). Individual tolerance to heat, which was determined by compared post-heat to baseline fluorescence values, ranged from 4% to 100%. A preliminary genome-wide association study indicated potential candidate loci related to heat tolerance. Sporophyte heat tolerance was assessed for farm-grown sporophytes representing 30 unique strains by measuring their photosynthetic efficiency (Fv/Fm), growth, and survival in a gradually warming outdoor flow-through tank up to 24°C. We identified three pairs of gametophytes that, when crossed, yielded sporophytes with high survival, growth, and photosynthetic efficiency. Our current work evaluates whether these gametophytes can yield heat-tolerant sporophytes consistently, or only when mated in specific combinations.

THE DEVELOPMENT AND USE OF CLEANERFISH IN NEWFOUNDLAND AND LABRADOR

***Darrell Green*[1], Danny Boyce[2], Sheldon George[3], Candice Way[4], Cathy Follett[5]**
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Despites a high level of technological sophistication the salmon farming industry has had significant challenges with the management of sea lice. Historically, approved veterinary therapeutants have been the main elements in Integrated Pest Management schemes, but the use biological sea lice control, employing wrasse and other cleanerfish species, is increasing. In Newfoundland and Labrador development efforts have concentrated on the use of wild-caught cunners and cultured lumpfish.

Since 2010, the Department of Ocean Sciences of Memorial University has worked directly with salmon farming companies and the Newfoundland Aquaculture Industry Association (NAIA) to drive the development of the cleanerfish aquaculture sub-sector. Research and development efforts have focused on topics such as broodstock selection and husbandry, hatchery production, juvenile rearing, juvenile diets, fish transport, fish welfare in cages, supplemental cage diets, regulatory requirements for use and vaccine development.

To date, our experience using these two species in salmon cages across Atlantic Canada have shown encouraging results, but cleanerfish production in Atlantic Canada needs to be scaled up over the coming years. It is estimated that about five million lumpfish juveniles will be needed per year to supply the growing salmon farming industry and commercial cleanerfish production is the next step in the development cycle.

ACHIEVING OYSTER RESTORATION GOALS AND SUPPORTING THE AQUACULTURE INDUSTRY ON MARTHA'S VINEYARD

***Emma Green-Beach*[1], Stephen Kirk[2], Boze Hancock[2], Alley McConnell[1], Chris Edwards[1], Nina Ferry Montanile[1]**
[1]Martha's Vineyard Shellfish Group, Inc. 220 Weaver Lane, Vineyard Haven MA 02568; [2] The Nature Conservancy, 20 Ashburton Place, Floor 4, Boston, MA 02108

The Martha's Vineyard Shellfish Group (MVSG) has worked with the local shellfish departments to support, enhance, and restore the naturally occurring oyster populations of Martha's Vineyard for over 40 years. The oyster stocks are constantly challenged by dermo disease, eutrophication-driven environmental degradation, and fishing pressure. Since 2021, MVSG is partnered with the Nature Conservancy to implement the SOAR (Supporting Oyster Aquaculture and Restoration) model on Martha's Vineyard. With the help of TNC, local oyster growers and the Edgartown Shellfish Department, hundreds of thousands of cultured oysters, not worthy of the half shell market, have been planted within a town-designated oyster sanctuary area. Several restoration benchmarks have been reached, including wild sets of oyster spat which have not occurred in several years. We will share the wide-reaching benefits of these partnerships and how they have impacted the aquaculture community on Martha's Vineyard. We will also discuss the monitoring methods employed to continuously evaluate the efficacy of SOAR and other restoration efforts.

A FARMER'S PROSPECTIVE – IMPLIMENTING OYSTER RESTORATION THROUGH THE NRCS ENVIRONMENTAL QUALITY INCENTIVES PROGRAM

***Matthew Griffin*, Tobias Adams-Cook, Cassandra Ramirez**
Saltbox Sea Farm, 218 Lindley Ave, North Kingstown, RI 02852 USA

The USDA Natural Resource Conservation Service has been partnering with commercial shellfish farmers and state resource agencies to implement oyster restoration via the Environmental Quality Incentives Program (EQIP) in Rhode Island since 2008, resulting in ten geographically distinct restoration sites. This program is unique, as it leverages farmers' experience and efficiencies in growing shellfish by providing dedicated revenue streams for participating farms. It also incorporates annual monitoring of reefs to aid in

resource management. Proper implementation of EQIP adds new layers of logistics for farms including cultch acquisition/storage, remote setting, reef building, record keeping in accordance with NRCS standards and requires the utilization of a considerable amount of grow-out gear. While this program offers farms a new revenue stream, understanding the financial risks along with time and gear commitments are important elements for farmers to consider. Saltbox Sea Farm has participated in both aspects of EQIP, monitoring and reef implementation since 2011. We will discuss logistical aspects of participating in the program from an on-farm perspective.

UNDERSTANDING WILD SEA SCALLOP (*P. magellanicus*) LARVAL SPATIAL AND TEMPORAL DISTRIBUTION IN MAINE TO SUPPORT CULTURE AND CAPTURE FISHERIES

Carla Guenther[1], *Caitlin Cleaver*[2], Phoebe Jekielek[3], Madison Maier[3], Lucy Williams[3]
[1]Maine Center for Coastal Fisheries, 13 Atlantic Ave, Stonington, ME 04681; [2]Colby College, 4000 Mayflower Hill Dr, Waterville, ME 04901; [3]Hurricane Island Center for Science and Leadership, 19 Commercial Street, Rockland, ME 04841

The sustainability of wild capture fisheries is uncertain and entry into Maine's inshore sea scallop fishery is only possible via an annual lottery and a 3:1 exit to entry ratio. Scallops 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. 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. We partnered with scallop fishermen and farmers to design, deploy, retrieve, and quantify spatial and temporal variability in spat abundance along the Maine coast. We deployed transects of paired lines from inshore to offshore in four bays along the coast from October of 2022 to January of 2023 (Fall set) and again from January to May 2023 (Winter set). In each timeframe we enumerated the larval abundance of each line. In this pilot deployment we found higher larval numbers at offshore sites compared to inshore sites, higher numbers in the eastern sites compared to western sites, and substantially larger abundance in the Fall set as compared to the Winter set. We secured funding for an additional two years of data collection and collaboration, making this project the longest standardized data set assessing scallop larval distribution and abundance.

GENETIC IMPROVEMENT OF THE EASTERN OYSTER AND PROSPECTS OF GENOMIC SELECTION

***Ximing Guo*, Samuel Ratcliff, Zhenwei Wang, Jillian Jamieson, Ming Liu, Noah Chriss, Iris Burt, David Bushek**
Haskin Shellfish Research Laboratory, Department of Marine and Coastal Sciences, Rutgers University, 6959 Miller Avenue, Port Norris, NJ 08349.

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 selectively bred eastern oysters since 1960 and produced strains that have shown 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. 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.

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, each represented by several sublines and maintained by progressive rotational crossing. Both strains show improved growth and survival compared with unselected controls. 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. Genomic selection was recently implemented to improve dermo resistance and field survival. For both traits, survivors and fatalities were classified as resistant (live) and susceptible (dead) phenotypes and genotyped with a 66K SNP array to predict genomic estimated breeding values (GEBVs) in the breeding population. Genomic selection utilizes whole genome information and is expected to enhance selection efficiency for traits such as dermo resistance.

DEVELOPMENTAL MISMATCH OF PCO2 LEVELS IN A SECOND GENERATION OF NORTHERN BAY SCALLOPS

***Samuel J. Gurr*, Shannon Meseck, Meghana Parikh, Lisa Guy, Genevieve Bernatchez, Gabriella Panayotakis, Chen Walker, Chris Pierce, Gary H. Wikfors, Dianna K. Padilla, Katherine M. McFarland**
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Cellular-molecular underpinnings of resilience to environmental changes, especially coastal acidification, remain poorly understood. It has a basis in cell physiology that is influenced by both historical conditions experienced by the population and conditions under which an individual develops. A developmental "mismatch", *sensu* Gluckman (2019), is a contrast between the phenotype of an individual and that which otherwise confers optimal responses (fitness) under a different environment post-development. We leveraged a rare multigenerational experiment that produced adult northern bay scallops, *Argopecten irradians*, grown under three pCO_2 histories: one grown for two generations in low pCO_2, one with two generations in moderately-elevated pCO_2, and a third where scallops were initially raised under low pCO_2 followed by a second generation under severe acidification (high-pCO_2). Each lineage was then exposed to matched and mismatched pCO_2 and hemocytes were extracted at 24 hours and 14 days for flow-cytometric analyses. Independent of exposure, scallops that historically experienced severely-elevated pCO_2 had greater hemocyte mitochondrial superoxide (mtROS), whereas scallops with a moderately-elevated-pCO_2 history had greater hemocyte mitochondrial membrane potential ($\Delta\Psi m$) and cell viability. In contrast, two weeks of pCO_2 mismatch increased $\Delta\Psi m$ and decreased cell viability in scallops with low-pCO_2 history, suggesting a linkage between mitochondrial function and resilience to elevated pCO_2. Analyses of gill tissues for ATP, oxidative damage, and gene frontloading will further describe cellular mechanisms of rapid acclimation to coastal acidification.

MAKING A SPLASH: CREATING EXCELLENT PUBLICATIONS FOR AQUACULTURE AND AQUACULTURAL ENGINEERING

Steven Hall
Marine Aquaculture Research Center; Biological and Agricultural Engineering, North Carolina State University, Raleigh NC 27695 USA

Aquaculture is a fast growing sector of aquatic protein and bioresource production. Aquacultural Engineers focus on solving problems to enable improved production and sustainability in recirculating, flow through, fresh and marine systems, as well as in adjacent fields with relevant links to both aquaculture and engineering expertise. The results of projects and studies can be shared with the field via peer reviewed

publications in relevant journals. The author is co-editor in chief of Aquacultural Engineering, an Elsevier Journal with link here: https://www.sciencedirect.com/journal/aquacultural-engineering.

Preparing clear, novel, and significant publications and understanding how to move through the publication process effectively can be immensely helpful for producing excellent publications. This brief presentation will highlight good design of experiments, understanding how to find a good match between a project and journal and preparation of the manuscript to match publication standards. Understanding the publication process can help authors move through this process more effectively, resulting in quicker and better publications in relevant journals with interested audiences. I will also share critical areas to consider in preparation of manuscripts and some key suggestions that can help make not just acceptable but excellent publications that serve the field while bringing your relevant work to light, ultimately helping move this fast growing and important field forward. Come learn how you can make a splash as you create excellent publications for aquaculture and aquacultural engineering.

FARM SERVICE AGENCY PROGRAMS AND RESOURCES FOR AQUACULTURE PRODUCERS

Sherry Hamel
USDA Farm Service Agency, 967 Illinois Ave. Suite 2, Bangor, ME 04401

Maine FSA State Executive Director Sherry Hamel will present information on FSA programs and resources that are available to aquaculture producers. These programs include financial assistance, disaster programs, crop insurance and risk mitigation. Participants will learn the basic eligibility requirements and how to obtain additional information and assistance. In addition, our producer panel will share their experiences utilizing FSA programs and resources.

LEVERAGING AQUACULTURE FOR RESTORATION: AN OVERVIEW OF THE SUPPORTING OYSTER AQUACULTURE AND RESTORATION PROGRAM

***Boze Hancock*[1], Robert Jones[2], Zachary Greenberg[3], Rebekah Borgert[2]**
[1]The Nature Conservancy, C/O URI Grad. School of Oceanography, 215 South Ferry Rd., Narragansett, RI, 02882; [2]The Nature Conservancy, Worldwide Office, 4245 N. Fairfax Dr., Arlington, VA, 22203; [3]The Pew Charitable Trusts, 901 E Street NW, Washington, DC, 20004-2008

In response to the Covid-19 impact on the shellfish industry, The Pew Charitable Trusts and The Nature Conservancy formed a partnership to map opportunities for linking growers with excess oysters, to restoration sites, on a national scale. In October 2020, the Supporting Oyster Aquaculture & Restoration (SOAR) program was launched in partnership with growers, industry associations, state regulatory agencies, universities, NGO's, the National Oceanic and Atmospheric Administration and United States Department of Agriculture Natural Resources Conservation Service. The program featured two components, an oyster purchase for restoration and a Shellfish Growers Resiliency Fund. The program has generated enormous cooperation and support from all participants, primarily growers, regulators, and the restoration community. As a result, SOAR 2.0, was launched in early 2023 with additional funding support, to demonstrate the effectiveness of the program and to secure long-term support through the USDA. Program successes and challenges will be described, as well as an overview of SOAR 2.0.

BIOPHYSICAL MODELING AND GENOMIC DISPERSAL ESTIMATES TO MAP LARVAL CONNECTIVITY FOR OYSTER RESTORATION PLANNING

***Matthew P. Hare*[1], Sean Kramer[2], Henry Hua[1], Harmony Borchardt-Wier[1]**
[1]Natural Resources and the Environment, Cornell University; [2]Mathematics Department, Norwich University

Sustainable restoration of oysters to restore 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 also strategically placed restored habitat to rebuild a source-sink larval dispersal network. To inform oyster restoration planning in New York City (NYC), we report on multiyear recruitment mapping to measure the existing recruitment pattern from a remnant wild population of eastern oysters in the Hudson River. The remnant breeding population is north of NYC, near Tarrytown. The spatial distribution of oyster juvenile (spat) recruitment is consistently skewed with highest abundances near the breeding population at low salinity and rapidly decreasing recruitment toward moderate salinities near NYC. This gradient in recruitment may be due to a pollution gradient elevating larval mortality, hydrodynamic retention of planktonic larvae in the north, or both. To test the hydrodynamic retention hypothesis we employed the New York Hydrodynamic Observing and Predicting System modeling platform coupled with a particle tracking submodel. We report on sensitivity of simulated larval dispersal patterns to environmental heterogeneity and agreement with recruitment observations. In addition, the model predicts low self-recruitment for a restoration site in Hudson River Park, Manhattan, and we test this prediction using genomics to assign individual spat to their parental source population. Genomic results largely validate the model and indicate that hydrodynamic forces can severely limit relative recruitment numbers at certain locations while amplifying it at others. Spatial restoration planning should account for these connectivity patterns.

REVIEW OF NANTUCKET ISLAND'S BAY SCALLOP SPAT BAG PROGRAM

***Griffin Harkins*, Joseph Minella, Tara Riley, David Berry**
Town of Nantucket, Department of Natural Resources, Brant Point Shellfish Hatchery, 131 Pleasant St. Nantucket, MA 02554

Nantucket Island, Massachusetts boasts one of the last remaining sustainable harvests of wild bay scallops (*Argopecten irradians*), with supplementation for the wild fishery coming from an intensive hatchery operating through the Town of Nantucket's Natural Resources Department (NRD). The use of "spat bags" by the hatchery has proved to be a valuable component of NRD's research, restoration, and stock enhancement. With multiple locations within Nantucket's two productive harbors, spat lines are deployed seasonally at two-week increments throughout the active spawning season. Over the past decade, the use of spat bags has shifted from primarily monitoring recruitment from wild spawns to include the assessment of hatchery produced larval releases, juvenile grow-out, and for collecting large amount of spat for stock enhancement. The implementation of a "swirl-separator" that leverages the morphological features of the bay scallop spat and water physics has greatly improved spat bag processing efficiency, allowing for the diversified use of spat bags at the hatchery. NRD's results suggest that spat bags are not just a research tool, but also a valuable method for stock enhancement and restorative aquaculture of bay scallops.

IMPLEMENTATION OF THE NATURAL RESOURCES CONSERVATION SERVICE OYSTER RESTORATION PROGRAM IN RHODE ISLAND

Melissa Hayden
USDA Natural Resources Conservation Service, 60 Quaker Lane, Warwick, RI 02886 USA

The USDA Natural Resources Conservation Service (NRCS), through the Environmental Quality Incentives Program (EQIP), began working with oyster growers on an oyster restoration initiative in 2008. Since 2008, the program has undergone modifications to expand program access, improve program outcomes, incorporate adaptive management, include monitoring as a required element, and expand partnerships. Currently, through EQIP, RI NRCS offers financial and technical assistance to oyster growers to build oyster restoration reefs in identified areas that are closed to shellfish harvesting. The goal is to enhance aquatic wildlife habitat, improve water quality, and increase natural spatfall to area waters. We have expanded our partnership with the Division of Marine Fisheries at the RI Department of Environmental Management in order to continue to grow the program and to continue to provide opportunities for RI oyster growers to participate in this program. Some considerations for program participation include grower eligibility, willingness of growers to take on expanded documentation requirements, availability of funding, and availability of restoration sites. RI NRCS has also provided training and guidance to NRCS staff in several other states who are considering implementing similar programs, and ease of transferability of RI program elements to other states is an important consideration.

MAINE TO MOUNTAIN: A SEAFOOD PIPELINE TO THE WEST

***John Herrigel*[1], Annie Fagan[2]**
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The collective development of a shared Maine seafood brand along with new distribution channels out West, both consumer & wholesale, for Maine oysters, shellfish & seafood created for the long term strategic growth & security of the Maine seafood industry. Phase 1 involves building the brand & growing the relationships with restaurant & resort groups in select cities/towns including Denver, Boulder, Kansas City, Aspen, Telluride & Jackson Hole. This is actively being achieved through collaborative events in the cities/towns that involve “on site” Maine aquaculture farmers & producers sharing & engaging with the consumers whilst also gathering quantitative data through digital survey. Phase 1 (2023-25) will transition into Phase 2 “Dock to Dine: The Maine Seafood Pipeline”; the collective transport of a cornucopia of Maine seafood products to the network of restaurants & resorts created in Phase 1. The ultimate goal of Maine to Mountain is to establish a consistent higher price per unit to the farmer/producer through efficiencies of scale & value boosted products resulting from the personal & direct relationships formed in Phase 1 & fostered throughout Phase 2 whilst increasing industry collaboration, innovation & community along the way.

SOFTSHELL CLAM *MYA ARENARIA* SURVIVAL, SHELL MORPHOMETRICS, AND SUSCEPTIBILITY TO PREDATION IN RESPONSE TO SIMULATED OCEAN ACIDIFICATION AND WARMING

Robert J. Holmberg[1], Rachael Smith, Hannah Zuklie, Kassandra Root, Reena John, Maylee Sun, Brian Beal[2,3]
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Ocean acidification (OA) is experimentally demonstrated to impact bivalve survival, growth, and other sublethal endpoints, with the earliest life stages expected to be most sensitive. The softshell clam, *Mya arenaria*, is already under intense pressure from predation by the invasive European green crab, and OA may be another stressor challenging clam populations as climate change progresses. A pair of experiments were conducted to investigate the responses of *Mya* to anticipated future OA and warming scenarios. The first experiment analyzed *Mya* survival and shell morphometrics in response to 3 pH treatment levels (7.80, 7.50, 7.20) and 2 temperature treatment levels (18°C, 20°C) following exposure between 48 hours post-fertilization and settlement (14 days). The second experiment repeated that analysis with revised pH (7.80, 7.30) and temperature (18°C, 21.5°C) treatment levels, and subsamples of experimental clams were settled under experimental conditions, transferred to floating trays, and further reared under experimental conditions for an additional 2 months until they were large enough to transplant into recruitment boxes on a tidal mudflat in Beals, Maine. Experimental clams were then subjected to a monthlong field trial consisting of pre-deployment pH and temperature treatment levels and a 2-level predator deterrent netting treatment (netting, no netting). At the end of the field trial, experimental clams were analyzed for post-deployment survival and growth. The results of both experiments hint at how early-life stage *Mya* may fare in the future ocean, including fitness in response to a real-world ecological interaction.

TESTING MITIGATION STRATEGIES FOR A CHANGING WORLD: CO-CULTURING BLUE MUSSELS AND SUGAR KELP

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Without mitigation, ocean acidification lessens U.S. shellfisheries profitability by weakening shells and byssal threads and disrupting larval development. Cultivated seaweed can raise seawater pH in the immediate vicinity of a sheltered coastal seafarm, but this capacity in a warmer and more acidic ocean is unclear. We performed a two-factorial tank experiment with contemporary conditions (~12±2 °C, 400±100 µatm pCO_2) and projected conditions (+4°C, +600 µatm pCO_2) for the Gulf of Maine. Within these treatments, blue mussels were grown with (~150g) and without (0 g) sugar kelp, *Saccharina latissima* for 50 days (n=6 tanks). Custom 35L flow-through tanks (1.5L/min) each housed 10 juvenile mussels (~2-4 cm shell length) and ~100 spat (0.5 cm). Reported are resultant seawater carbonate chemistry conditions (e.g., total alkalinity and dissolved inorganic carbon), mussel fitness (growth, shell morphometrics, meat mass, gut contents) and kelp growth (surface area, wet weight, dry weight). Shell thickness for juvenile mussels increased 1.62 to 5.84% when co-cultivated with kelp in both ambient and future conditions and meat mass increased 6.47% in future conditions. Only meat mass of spat increased 14.72% with kelp, and only in future conditions. Gut contents are currently being analyzed with recently developed qPCR primers

(COI gene) to quantify gene copy numbers of *S. latissima* therein to identify mechanisms of kelp influence on mussel productivity, be they a result of phytoremediation of CO_2-driven acidification or kelp detritus feed subsidies. Either way, kelp-mussel co-cultivation may improve mussel fitness now, and in the future, with variable impacts across mussel size classes.

NORTHEAST BIVALVE HATCHERY HEALTH CONSORTIUM

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The goal of the "Northeast Bivalve Hatchery Health Consortium (NEBHHC): Managing Larval Mortalities in Northeast Hatcheries" is to support the growth of the bivalve shellfish industry in the USA by providing access to diagnostic tools helping hatcheries ensure reliable production of bivalve seed. The objectives for this consortium are to: (1) identify the causes of bivalve hatchery larval mortalities and crashes in the Northeast US through an integrated, collaborative, and proactive approach to sample collection and analysis; and (2) develop strategies and protocols to manage and minimize larval crashes in hatcheries. During the 2024 and 2025 hatchery seasons, we will be working with commercial and public/research hatcheries wishing to participate in the project to collect algae, water, and larvae from a variety of larval runs, including "good" (successful performance) and "bad" (lower performance or crashes). Hatcheries will also provide data relevant to larval performance. All individual hatchery information collected will remain confidential. We will provide all supplies for the sample collections, cover shipping fees, and cover the cost of disease diagnosis. The goal of this collaborative workshop is to strengthen our experimental plan and enlist hatcheries and other stakeholders (e.g., researchers, extension specialists) to participate in the NEBHHC. Members of the NEBHHC coordinating team, including pathologists, ecologists, hatchery managers, and extension specialists, will answer questions and gather feedback from stakeholders on how to address this critical issue of larval crashes.

REAL-TIME WATER QUALITY MONITORING IN SHELLFISH GROWING AREAS, LESSONS LEARNED

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Cape Cod and South-Eastern Massachusetts is home to a thriving shellfish aquaculture industry. These aquaculture farmers, as well as regulators and wild harvesters, rely on water quality conditions to operate, and accurate data can help to properly operate their business. Changes in water temperature, chlorophyll concentration or dissolved oxygen are important as farmers make decisions to manage their farms and harvest the product. Having access to real time information specific to the growing area, as well as long term data is valuable for both farmers and regulators to track seasonal trends as well as changes over time.

Cape Cod Cooperative Extension has been maintaining long term monitoring at sites across the region for up to 20 years at some locations. This data is utilized by various agencies in their decision-making processes. To make the information available in real-time, water quality instruments were connected to telemetry devices to provide information to the public. This equipment can often be cost prohibitive and providing this equipment across an array of sites can become expensive. Working with In-Situ products Cape Cod Cooperative Extension has been able to purchase more cost-effective options to bringing telemetry to all 6 of its locations. These devices work in conjunction with water quality sondes and can upload to an In-Situ or 3rd party website. These newer products have not been without trials and tribulations, these will be discussed along with some of the other lessons learned from the data. Ultimately providing real time location specific data for growers, regulators and researchers will increase their ability to understand the environmental conditions around them.

BACTERIAL COMMUNITY TRENDS ASSOCIATED WITH SEA SCALLOP, *PLACOPECTEN MAGELLANICUS*, LARVAE IN A HATCHERY SYSTEM

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Knowledge on the microbial communities which associate with Atlantic sea scallops, *Placopecten magellanicus,* is limited. We identified bacterial communities in veliger-stage wild larvae, hatchery larvae, and tank biofilms, using the V3-V4 region of the 16S rDNA gene, via Illumina MiSeq sequencing. Hatchery larvae had lower bacterial richness (number of bacteria taxa present) than the wild larvae and tank biofilms, and hatchery larvae had a similar bacterial community (which taxa were present) to both wild larvae and tank biofilms. Bacterial richness was not significantly different between tanks which had been occupied by larvae for 48 hours, and those which had just been drained, scrubbed clean, and refilled with filtered seawater. Static-water-flow compared to continuous-water-flow (flow-through) did not generate different levels of bacterial richness overall, and only an equivocal difference when accounting for time as a smoothing feature in the model. Bacterial richness and community similarity between tank samples fluctuated over the trial in repeated patterns of rise and fall, which showed some correlation to lunar cycle where richness is high when the moon is about 50% and richness is low during new and full moon phases. This may be a proxy for the effects of spring tides and trends in seawater bacteria and phages which are propagated into hatchery tanks. The number of days since the full moon was significantly correlated with bacterial community richness in tanks: low during the full moon, peaking ~ 21 days after the full moon, and decreasing again at the next full moon.

REBOOTING NOAA FISHERIES MILFORD LAB'S ANNUAL OPEN HOUSE AFTER A GLOBAL PANDEMIC

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The NOAA Fisheries Milford Lab's annual open house, a 25-year tradition, paused for 3 years during the recent global pandemic. The lab has typically hosted local school group tours and the public during the 2-day event. We used this pause as an opportunity to refresh the event and brainstorm new ideas, forming an open house planning committee. During its first post-pandemic public open house held on September 30, 2023, the Milford Lab hosted more than 600 community members, a recent attendance record. We brought back many popular activities and successfully implemented new features suggested by our committee, including: seaweed pressing, stamp "passports" for kids, and informational signage throughout the lab's corridors. We moved from many individual stations to a more cohesive model to present the shellfish aquaculture research conducted at the lab. We also present the results of an informal survey asking visitors what they learned during the event. The lab plans to pilot a new open house format for school groups in spring 2024. It aims to offer a more hands-on, authentic science experience for a smaller group of students, and we will solicit feedback from students and teachers.

WINDOW TO AN UNDERWATER WORLD: SHARING THE HABITAT VALUE OF SHELLFISH FARMS WITH A BROAD AUDIENCE

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The NOAA Milford Lab first set out with GoPro cameras in 2017 to investigate reports from oyster growers that they were seeing wild fish and other animals in and around their gear. In the six years since, "Team GoPro" has collected more than 1,600 hours of underwater footage from farms and naturally-structured comparison habitats in Long Island Sound from Norwalk to Noank, Connecticut. The project has documented 21 fish species associated with the cages, including commercially and recreationally important species, as well as a wide variety of fish behaviors associated with habitat use. The project has resulted in considerable evidence that fish use oyster gear in a similar way as they use natural structured habitat.

The underwater videos collected throughout this project are a powerful and compelling outreach tool, in addition to data. They can demonstrate to coastal residents and regulators who make decisions concerning aquaculture that local farms are providing fish habitat. They are also useful to engage K-12 students and the public in discussions about local marine ecosystems, aquaculture, and science.

Analytics demonstrate the popularity of the videos on the project's website. The team worked with a production company to make a short video about the project called "Home Sweet Oyster Cage". Partnering with the non-profit Science Journal for Kids, the team developed a STEM education activity targeted toward middle-school aged students. The project and videos have also been highlighted by two ArcGIS StoryMaps, NOAA Fisheries feature stories, social media posts, and media coverage. This presentation will share what the team has learned about how different outreach products reach different audiences, as well as the value of underwater video to demonstrate the ecosystem services provided by aquaculture.

A COMPARATIVE STUDY OF SEA SCALLOP (*PLACOPECTEN MAGELLANICUS*) ENERGY INVESTMENT STRATEGIES IN FARMED AND WILD ENVIRONMENTS

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The Atlantic sea scallop (*Placopecten magellanicus*) fishery ranks among the most economically valuable marine fisheries in the United States (~$530M). Recent declines in catch and projections indicating that demand for sea scallops may surpass the supply from traditional fisheries, the scallop aquaculture industry has been on the rise. However, the ecological consequences of raising sea scallops in aquaculture remain largely unexplored. Here, we aim to assess biological and ecological impacts of sea scallop aquaculture by comparing the morphometrics of farm-raised sea scallops to those of wild scallop populations in Penobscot Bay, Maine. In 2020-2022, we sampled farm-raised scallops from lantern nets at three aquaculture sites in Penobscot Bay, Maine, and collected wild scallops via SCUBA from beds adjacent to each farm. During each sampling event we collected shell height (mm) and adductor, gonad, total viscera and shell masses (g). Our findings indicate that farmed scallops have larger adductor, gonad, and viscera masses compared to their wild counterparts within size classes 80 - 110mm ($p < 0.01$). Conversely, wild scallops have larger shell masses ($p < 0.01$). Larger meat yields from aquaculture-raised scallops offer a significant return on investment for scallop growers. Additionally, larger gonads in aquaculture-raised scallops suggest an increased potential for reproductive output, which has ecological ramifications for both aquaculture and wild harvest industries. These results shed light on the complex interplay between aquaculture and the natural environment, highlighting the need for further investigation into the ecological consequences of sea scallop cultivation.

ASSESSING THE POTENTIAL OF PURPLE SEA URCHINS FOR BIOFOULING CONTROL ON RI OYSTER FARMS

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Biofouling is a persistent problem for oyster farmers that incurs significant operational costs. This study aims to measure the potential for reducing biofouling when oysters are co-cultured with sea urchins local to RI, the purple sea urchin (*Arbacia punctulata)*. A pilot project was started in collaboration with a local oyster farm located in southern RI. Sea urchins were obtained from the same locality as the farm with the required permissions. The sea urchins were placed in oyster bags alongside adult eastern oysters *Crassostrea virginica*. Data pertaining to biofouling metrics, oyster and sea urchin growth, and site-specific information was collected at deployment and at experiment end after a period of approximately 8 weeks. The results will be used to quantify the potential impact on oyster production and quality.

PICTURE THIS: 25 YEARS OF FLOW IMAGING MICROSCOPY (FLOWCAM) IN SHELLFISH AQUACULTURE

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FlowCam—the first flow imaging microscope—was invented for imaging phytoplankton in the same year NACE was founded. This year, NACE and FlowCam turn 25! In honor of these birthdays, we will go on a journey to see how FlowCam has grown in that time to help aquaculture researchers to image, measure, and count a variety of organisms across the shellfish and finfish industry including (but not limited to): shellfish gametes & larvae, harmful algae, invasive crabs, and salmon lice. Our journey begins with an overview of how flow imaging microscopy is applied in each of these areas through the eyes of users in the Northeast like the Downeast Institute, Milford Lab, and University of New Hampshire. An overview of basic operating principles will be provided so that all attendees leave with a greater understanding of flow imaging microscopy technology. In addition, key considerations will be discussed when applying this technique to aquaculture research and monitoring. Tips and tricks will also be included for more seasoned users.

OYSTER HEALTH AND RESTORATION IN LONG ISLAND SOUND - PART II. TRENDS IN DISEASES OF UNMANAGED OYSTER POPULATIONS

***Mariah L. Kachmar*, Genevieve Bernatchez, Isaiah Mayo, Mark Dixon, LTJG Tyler Houck, Katherine McFarland, Meghana Parikh**
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The second presentation in this series introduces the project activities addressing the objective to ascertain a quantitative understanding of the seasonal dynamics of disease and reproductive success in unmanaged oyster populations. 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.

We will describe the diagnostic methods being used to assess oyster health 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. Preliminary results of monthly monitoring from four study sites will be presented. The study sites represent unique environments and population sizes with both intertidal and subtidal reefs, and both well-established and newly restored beds being monitored. We will discuss initial observations of biotic and abiotic factors that may currently drive health and disease at these sites, such as biofouling, population demographics, and environmental conditions.

FLOW CYTOMETRIC ANALYSIS OF HEMOCYTE IMMUNE FUNCTIONS IN THE PACIFIC OYSTER (*CRASSOSTREA GIGAS*) IN RESPONSE TO *IN VITRO* EXPOSURE TO BACTERIAL PROBIOTIC STRAIN OY15

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In 2020, United States aquaculture production of seafood was valued at $1.5 billion (www.Fisheries.NOAA.gov), with oysters being the most important commercial aquaculture product on

both the east and west coasts. Eastern and Pacific oysters comprise the largest percentage of seafood production in the United States (40 and 38% respectively). The NOAA Fisheries Milford Laboratory has completed the discovery, laboratory and hatchery-scale *in vivo* evaluation 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 (20-35% improvement) and settlement of Eastern oyster larvae when supplemented with probiotic strain OY15. OY15 protects larvae from bacteriosis by stimulating hemocyte immune defense functions. With support from the NOAA Aquaculture office (FY21 ICAF), the Milford Laboratory advanced efforts to determine OY15's effectiveness in Pacific oyster (*Crassostrea gigas*) larvae. Collaboration with two U.S. oyster hatcheries (Hawaiian Shellfish and Pacific Hybreed) and Cartron Point Oyster Hatchery in Ireland have shown promising results that OY15 improves larval survival, fitness and settlement for this species of oyster. With support from the NOAA Aquaculture office (FY23 ICAF), this new study using flow cytometry, will examine the effects of OY15 on the immune functions in Pacific oysters, and may confirm OY15's beneficial probiotic effects for another economically relevant species of oyster. Results from this study could indicate that the benefits of OY15 may be widely generalizable, thus benefiting the aquaculture industry for two oyster species and greatly increasing the market for probiotic strain OY15.

TRIBAL AQUACULTURE

Ellen Keane
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Representatives of Tribal Nations and their partners from across the Northeast come together to share thoughts and experiences on tribal aquaculture. Learn more about aquaculture projects aligned with Tribal wisdom, goals for the future, and the importance of food sovereignty. Federal representatives will tell us more about resources available for Tribal aquaculture projects.Last but not least a panel of Tribal Nations, and sector-supporting organizations will share expertise and respond to questions about how the broader aquaculture sector can support Tribal aquaculture projects.

IMPACTS OF LAB-INDUCED ACIDIFICATION AND CHANGES IN AMBIENT ECOSYSTEM CONDITIONS ON GROWTH AND SURVIVAL OF *MYTILUS EDULIS*

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Ocean acidification is an increasingly significant stress for bivalves. Decreased pH limits carbonate availability, thus inhibiting the formation and growth of their calcium carbonate-based shells and decreasing defenses against predation and disease. *Mytilus edulis* were housed in aquaria supplied with seawater from the Gulf of Maine seawater at ambient pH, and at moderately and more highly acidified conditions (0.25 pH and 0.5 pH below ambient) for three months. The impacts of pH, aragonite saturation (Ω), and the length of exposure time on lengthwise growth and mortality were examined in the summer of 2022 and summer to fall of 2023. Average lengthwise growth rates for mussels were highest at ambient pH and lowest in the -0.5 pH treatments. Mussel mortalities increased with exposure time under increasingly more acidic conditions during 2022 but remained relatively low and constant throughout 2023. Acidification also

lowered mussel shell resistance to crushing force, thus potentially increasing their susceptibility to predation by crabs and other damage. The impacts of different ambient conditions (salinity, pH, temperature) within and between years are also being assessed as indicators of overall mussel health in the two years of study.

PERFORMANCE OF STRIPED BASS REARED AT MID-ATLANTIC AND GULF COAST PHOTOTHERMAL REGIMES

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Striped Bass *Morone saxatilis* have been well studied and are currently cultured in freshwater ponds as food and gamefish. Recent industry expansion has generated an interest in strain-specific broodstock development for marine net pen culture. In this effort, Atlantic (Delaware, DE; Virginia, VA; Maryland, MD) and Gulf coast (Florida, FL; Texas, TX) Striped Bass strains were cultured in recirculating aquaculture systems (RAS) simulating a full production cycle to early market size in each respective region's photothermal environment. Atlantic and Gulf strains were initially maintained in RAS "nurseries" until 400 and 160 days post spawn (dps) respectively, when offshore conditions (temperature) were conducive for stocking juvenile fish. Individuals from all strains were implanted with PIT tags and stocked ("common garden design") into a pair of identical recirculating systems (three x 5000 L tanks/system). One system received 48 Atlantic fish/tank (16 fish/strain; DE, VA, MD) and the second system received 48 Gulf fish/tank (24 fish/strain; FL, TX). Salinity was maintained at 30 ppt and photothermal regimes corresponded with ambient ocean conditions at selected locations off the mid-Atlantic and Gulf coasts. Studies were conducted for up to two years and production parameters (feed conversion, absolute growth rate, survival) were compared. Final weights of ungraded fish in both simulated locations averaged approximately 900 g by 600 dps and early market size (~1.3 kg) by 800 dps. Growth rates differed by strain in both nursery and grow out phases, but results indicate high potential for production of Striped Bass in US coastal waters.

ECOSYSTEM SERVICES OF BIVALVES IN URBAN ESTUARIES

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Bivalve aquaculture contributes to improvement of local water quality and habitat in estuaries. Urban estuaries are in dire need of water quality improvements, but stressful conditions and microbial contamination make these waters unsuitable for culture of many bivalves, such as the eastern oyster. However, it is possible to identify naturally occurring bivalve species to perform these ecosystem services. Baltimore Harbor has long been plagued by excess nutrients that leads to algae blooms. While the oysters can grow and survive in Baltimore Harbor, there is no natural recruitment, and deep-water hypoxia makes bottom culture impossible. The dark false mussel, *Mytilopsis leucophaeata*, is a small mussel that occurs in high abundance on piers and boats in Baltimore Harbor. This mussel is an attractive species to provide enhanced ecosystem services, as it avidly recruits to artificial substrates such as nylon straps suspended in water. Our research aims to quantify the capacity of *M. leucophaeata* to remove phytoplankton using lab-grown and wild algae blooms. We examined the clearance rate of these mussels at different temperatures and salinities. Our results show that the mussels can reduce algae levels of both the lab-grown and wild algae blooms, and how they respond to relevant environmental conditions in Baltimore Harbor. These

findings will support the development of a best management practice for phytoplankton removal by dark false mussels in urban estuaries.

EFFECTS OF DIFFERENT SEEDSTRINGS ON GERMINATION AND EARLY DEVELOPMENT OF GAMETOPHYTES IN *PYROPIA YEZOENSIS*

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Seedstring cultivation is a fundamental method for *Pyropia yezoensis* aquaculture, as it provides an artificial substrate for the attachment of *P. yezoensis* conchospores and growth of the macroscopic blade gametophytes. This method has been widely used in the *P. yezoensis* aquaculture in Asia due to its convenience for *Pyropia* management and harvest. However, the composition and types of seedstrings vary in different countries. Little is known about the effect of different seedstrings in terms of spore attachment and early development of the gametophytes in *P. yezoensis*. In this study, four types of commercially available seedstrings from Korea (KR), China (CN) and Japan (JP1 and 2) and three new seedstring types developed by W.L. Gore & Associates Inc. (Gore A, B and C) were compared. The comparisons were conducted in three aspects: seeding density, growth rate and biomass yield. Our results show that, for both conchospore and archeospore seeding, the Gore C seedstring had the highest seeding density and yield among all seedstrings while the Gore B had the lowest. For conchospore seeding, the Gore A and B seedstrings had the highest growth rate at the early stages of gametophytes too. In the case of archeospore seeding, the difference between Gore A and other seedstrings was not significant. The CN and KR seedstring showed lower growth rates than the other seedstring types in the case of conchospore seeding. A comprehensive evaluation shows that the Gore C seedstring type, had the best performance among all seven seedstrings under laboratory conditions. Future studies are needed to test the performance of the seedstrings on *Pyropia* farms.

QUANTIFYING OYSTER AQUACULTURE LEASE ACCEPTANCE: A CASE STUDY ON REPURPOSED MAINE LOBSTER POUNDS

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Oyster aquaculture holds tremendous potential to diversify coastal economies and increase resilience to climate change, but conflicts with other marine resource users present an ongoing challenge to the growth of aquaculture worldwide. However, these conflicts are difficult to characterize quantitatively. We developed an analytical framework to analyze the difficulty of obtaining an aquaculture lease through publicly available application decisions in Maine, USA. We then applied this novel quantitative framework to a case study examining the potential of using existing fishery infrastructure as aquaculture leases as a means of diversifying working waterfronts. Recently, repurposing tidal impoundments historically used to store American lobsters (lobster pounds) for oyster aquaculture has been proposed as an innovative and actionable method of overcoming obstacles to aquaculture development in coastal Maine. While the environmental suitability of lobster pounds as oyster aquaculture habitat has been established, there has been minimal exploration of potential regulatory or socioeconomic benefits. We assessed the relative

difficulty of obtaining a lease for an aquaculture site within a lobster pound compared to a traditional open-water site. Our analysis demonstrated that the enclosed and privately-owned nature of a lobster pound eliminated many issues that commonly arise during oyster farm site selection, including conflict with riparian landowners, impeded navigation, and interference with commercial fishing or other existing water uses. These results provide the first empirical evidence that repurposing vacant lobster pounds for oyster aquaculture can minimize social, institutional, financial, and logistical barriers to marine aquaculture development.

SOLUTIONS FOR SUSTAINABILITY ON SHELLFISH FARMS

Willy Leathers
Ocean Farm Supply, Brunswick, ME

Through an internal audit of their own farm, Maine Ocean Farms, the founders of Ocean Farm Supply, recognized a point in their harvest and distribution stream where they could provide a plastic free mesh. Shellfish farms in the United States produce significant plastic waste each year and it is difficult to reconcile the environmental benefits of shellfish with the environmental impact of growing practices that generate plastic waste. It is through exploration of these growing practices and the life cycle of aquaculture gear that we can identify where plastic waste can be reduced or eliminated. bag solution. Ocean Farm Supply launched in Spring of 2021 with the Ocean Harvest Bag™**,** a 100% biodegradable and 100% home compostable netting woven from beechwood cellulose fiber. This talk will cover the current trends in aquaculture gear life cycles, identify significant points of waste, and offer solutions that are currently on the market that can work to help farmers, distributors, and retailers increase their sustainability.

SOLAR FLUPSYS: A SURVEY OF POWERING FLOATING UPWELLERS WITH PHOTOVOLTAICS

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Floating upweller systems (FLUPSYs) have become an important technology for the nursery culture of bivalves. Often, the placement of a FLUPSY is dictated by the availability of shore power to operate the pump required for water flow through the system. Multiple successful attempts have been made to integrate solar panels and battery systems into FLUPSYs providing 24/7 power to operate the pump and ancillary electrical power needs. This presentation will survey our current state of knowledge on powering FLUPSYs with photovoltaics with examples of existing solar FLUPSYs in recent operation.

THE INFLUENCE OF VESSEL SHAPE ON BOTTLE UPWELLER PERFORMANCE

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The bottle upweller system (BUPSY) has become an important transitional step in shellfish hatchery operations between the setting downweller and the nursery upweller. While it is growing in popularity, there has been little research to optimize the operation of the BUPSY, leading to a variety of BUPSY designs. To improve upon BUPSY performance, four different BUPSY vessels were evaluated, including a hipped

bottle (HC), an inverted cone (IC), an inverted pyramid (IP) and a straight cylinder (SC) shape. For each of the four trials completed, each shape was seeded with an equivalent volume of uniformly sized oyster seed between 1 and 4mm in length and monitored for oyster growth, flow rate, and bed expansion over time intervals of 1 to 3 weeks. Flow was adjusted to maintain a bed expansion of 20-30%. Flow required to allow for target bed expansion was highest for the SC followed by HC, IC and IP. Growth was closely aligned with flow through the vessel and highest growth was observed in SC followed by IC, IP and HC. Based on the results of this study, it is recommended that the straight cylinder vessel shape allows for higher growth due to enhanced flow (i.e. food flux) through the vessel while minimizing the risk of small seed being lost in the overflow. A fifth vessel shape was tested during the fourth trial run and also shows promise as a simpler design to the straight cylinder shape.

ENDOCRINE DYNAMICS DURING THE REPRODUCTIVE CYCLE OF LUMPFISH (*CYCLOPTERUS LUMPUS*)

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Lumpfish are the most important cleaner fish species in Atlantic salmon farming. Currently, the majority of lumpfish broodstocks are wild caught but farmed lumpfish are preferrable due to better biosecurity, control of stocking sizes and year-round stocking times. Successful production of lumpfish is dependent on a stable supply of viable eggs, and this requires good broodstock management routines. Understanding the endocrine pathways that regulate gamete production, sexual maturation and spawning is necessary for controlled reproduction and year-round supply of juveniles. The use of liquid chromatography mass spectrometry (LC-MS/MS) has enabled a complete picture of the complex endocrine pathways which control reproductive stages. Plasma was collected monthly from adult female lumpfish from February 2022 through November 2022, stored at -80°C and analyzed by LC-MS/MS. The LC-MS/MS method developed was able to measure steroid hormones from all classes (pregnanes, glucocorticoids, estrogens, and androgens). To our knowledge this is the first time 5α reduced pregnanes and androgens have been measured in lumpfish reproductive cycles. This data will be used to synchronize spawning and improve gamete yield needed for future aquaculture production of lumpfish.

EVALUATION OF SIX SUPERIOR SUGAR KELP (*Saccharina latissima*) CROSSES ON THREE FARMS IN THREE NORTHEASTERN STATES

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Sugar kelp (*Saccharina latissima*), a brown macroalgae, is cultivated on both the East and West coasts and plays a vital role in the burgeoning seaweed aquaculture industry in the United States. As seaweed farms expand, the traditional practice of collecting wild sporophytes for generating nursery seedlings is becoming inconsistent, untimely, insufficient, and risky for meeting the growing and exacting demands of the market.

Developing and delivering new kelp cultivars and hatchery technologies that fit multiple farm conditions are necessary. Our MARINER breeding project selected six predicted high-yield sugar kelp crosses for simultaneous growth trials in New Hampshire, Massachusetts, and New York in 2022/2023 to address this challenge. These crosses exhibited varying performances and compositions, yet their yield trends remained consistent among all three farms. The Moriches Bay farm yielded the most compared to the Duxbury and UNH farms. Furthermore, significant genotype by environment was observed, emphasizing the influence of specific environmental conditions on kelp performance. These findings support future sugar kelp breeding and facilitate the adoption of cultivar development that contributes to sustainable economic growth in diverse kelp farm conditions in the United States.

A YEARLONG eDNA SURVEY OF FISHES IN LONG ISLAND SOUND – DOES AQUACULTURE GEAR MATTER?

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Environmental DNA (eDNA) water sampling was conducted in Long Island Sound (LIS), biweekly from mid-May to mid-September 2018 and monthly from November 2018 to April 2019. eDNA sampling from May to September 2018 was concurrent with underwater camera deployment at a high-density oyster aquaculture cage farm, low density cage site, and a reference site with boulders on a natural rock reef. While video footage provided an opportunity to study fish abundance and behavior in relation to oyster cages and natural structured habitat, eDNA metabarcoding captured a more complete list of species present at the study sites. The combination of eDNA and underwater video, therefore, helped us gain a better understanding of the ecosystem as a whole, and shed light on the pros and cons of each method if used alone. The extended eDNA sampling from November 2018 to April 2019 was conducted to track fish assemblages in LIS during colder months when aquaculture gear was used less actively. Data on temporal variation in fish community composition, variation across habitat types and by location will be presented, as well as insights on the potential spatial resolution of eDNA metabarcoding.

A RISING TIDE? THE ROLE OF ALTERNATIVE SOCIAL NETWORKS FOR WOMEN OYSTER FARMERS IN MAINE AND NEW HAMPSHIRE

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New England is a leader in sustainable aquaculture practices and, in comparison with other parts of the United States, has high numbers of woman-operated leases for shellfish cultivation. Integrating gender analysis in aquaculture development is critical to ensure equal access and opportunity for women to a viable business, a social support system, and the ability to produce food with positive impacts on ecosystem biodiversity, water quality, and a small or neutral carbon footprint. However, data on gender are not currently collected, for example as part of the aquaculture permitting process. We surveyed a subset of oyster farmers in Maine and New Hampshire to allow for a gendered analysis of barriers and opportunities, for example in funding opportunities, training programs, social networks, and gear. We also implemented a photovoice case study, a participatory action research methodology, with four women oyster farmers to

share stories about their experiences as oyster producers in the aquaculture sector and to understand the role of social networks in how women start and build businesses on the water. Our findings provide a baseline of data shedding light on the role of gender in oyster farming in Maine and New Hampshire to foster equal economic opportunities for working on the water and growing local, sustainable seafood. More broadly, our findings contribute to emerging research applying gender and social-ecological systems analyses to understand how gender dynamics impact barriers and opportunities for aquaculture producers in the United States.

OCEAN ACIDIFICATION IN THE NORTHEAST: RESEARCH UPDATE AND NEEDS ASSESSMENT

Natalie Lord
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Ocean and coastal acidification pose a substantial threat to marine ecosystems, and especially to calcifying organisms such as shellfish. The Northeast is particularly at risk for acidified conditions due to the low buffering capacity of the cold water in the Gulf of Maine, allowing for more variation in pH. We will discuss the latest research findings from the region, including field observations and laboratory experiments, that shed light on how varying levels of ocean acidification affect the growth, survival, and reproductive success of shellfish species. Special emphasis will be placed on key shellfish species such as oysters, scallops, clams, and mussels, which hold significant economic and ecological value in coastal regions of the Northeast. The presentation will also provide an update on the Northeast Coastal Acidification Network's monitoring and research priorities.

In addition, participants will have the opportunity to share their challenges and concerns regarding ocean acidification and provide feedback that will be a part of a national stakeholder needs assessment for the NOAA Ocean Acidification Program (OAP). As our knowledge about our changing oceans has advanced, so has the needs of audiences around the nation. The NOAA OAP is assessing nationwide stakeholder needs to identify gaps, priorities, and the ways in which we can support people impacted by ocean and coastal acidification. Help us understand your priorities and technical assistance needs so we can learn how to best support you.

BASELINE AQUATIC BIODIVERSITY AND WATER QUALITY DATA FROM SEYÐISFJÖRÐUR, AN EAST ICELAND FJORD, BEFORE THE PROPOSED INSTALLATION OF FISH FARMS

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With consumption increase of Atlantic salmon grown in pristine waters, fish farming is expanding from West to East Iceland. Introducing fish farms to pristine fjords could cause habitat alteration or introduce pathogens, potentially impacting water quality and biodiversity. Aquatic environmental monitoring does not typically occur before disturbances such as installing fish farms. Here, we discuss baseline biodiversity data from East Iceland fjords via collecting eDNA, GoPro footage, and plankton tows as well as water quality data before proposed fish farm installation. Samples were collected in two fjords in Eastern Iceland in June 2022, July 2022, June 2023, July 2023, and September 2023. Sampling was conducted at four proposed fish farm sites in Seyðisfjörður and one reference site, Loðmundarffjörðuras. At each site, water samples were collected at 2 m, 7 m, and 20 m to measure biodiversity and water quality just below the surface, in the middle and below a typical fish farm. Vertical plankton tows from 20 m were also collected

at each site. Preliminary biodiversity data analysis revealed potential seasonal and spatial differences in zooplankton and larger trophic organism diversity. Preliminary water quality data revealed no spatial differences. GoPro video footage and microscope zooplankton images will complement our eDNA metabarcoding data to provide a more comprehensive understanding of fjord biodiversity. Due to the increased ability for humans to exploit the warming waters of the Arctic, environmental monitoring in these regions is crucial. This long-term monitoring research will inform aquaculture management practices about the ever-expanding human exploitation activities.

ESTABLISHING THE SEASONAL BASELINE LEVELS OF *VIBRIO PARAHAEMOLYTICUS* IN THREE LOCATIONS IN MAINE

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Vibrio parahaemolyticus is a naturally occurring bacteria found in marine waters and is one of the leading seafood borne pathogens in the world. *V. parahaemolyticus* is associated with filter feeders such as oysters which feed by filtering particles from the surrounding water, including bacteria. There are both pathogenic and nonpathogenic strains of *V. parahaemolyticus.* One of the most distinctive differences between pathogenic strains, is the presence of the TDH and TLH genes. As this bacteria increases with warming waters, it bioaccumulates in the tissues of oysters and can cause vibriosis illnesses in the population that consumes them. The reported CDC vibrio illness cases have increased in Maine each year. To help understand this public health concern as the Gulf of Maine warms, this research aims to determine the baseline levels of pathogenic and nonpathogenic strains of *V. parahaemolyticus* from three different locations in Maine. From May 2023-November 2023, oysters were harvested from the Scarborough River, Maquiot Bay, and the Damariscotta River along with temperature and salinity readings. For each sample, a three-tube MPN method was performed, and the samples were run through a 7500 fast PCR machine looking for the presence of the TLH gene that is seen in all strains of *V. parahaemolyticus,* and the TLH/TRH genes found in pathogenic strains. This research will allow for a better understanding of the amount of *Vibrio parahaemolyticus* in our waters and help inform harvesters and policy makers on better vibrio control to protect public health.

HIGHLIGHTING MAINE FISHERMEN AS LEADERS IN SUSTAINABLE AQUACULTURE

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Ocean Approved, Inc (DBA Atlantic Sea Farms, ASF), was founded as the first commercial seaweed farm in the United States. Since 2018, under new leadership, ASF has been laser focused on building opportunities for fishermen along Maine's coast. Maine is facing a tremendous challenge: the Gulf of Maine is warming faster than 98% of the oceans in the world and our rural coastal economies are dependent almost exclusively on lobster. Equally as compelling is our unique opportunity to create profitable, sustainable, climate change mitigation and adaptation strategies that can allow coastal fishermen to add aquaculture to making a living on the water.

Through a grant funded project from the Maine Aquaculture Hub: Supporting Innovation & Outreach in the aquaculture sector, ASF has been able to put a spotlight on Maine fishermen's positive and activist

involvement in aquaculture, which promotes the Maine seafood brand, helps educate and break down coastal opposition to aquaculture within fishing communities, and inspires more fishermen to participate in the industry.

The Meet the Sea Farmers, a short documentary style film highlighting 3 farmers' experiences and motivations for getting involved in farming from a commercial fishing background was produced. Additionally, a series of impactful portrait style photos of fishermen turned kelp farmers were created with a local photographer. These photos have been incorporated into our new branded website & product packaging, social media, and in our advocacy work. We plan to show both the video (~3min) at the presentation along with the photos and their applied impact in 2023.

AQUACULTURE WORKFORCE DEVELOPMENT: ENGAGING AUDIENCES THROUGH PLACE-BASED EDUCATION

***Madison Maier*[1], John Van Dis[1,2], Micah Conkling[1], Chlöe Finger[1], Kyle Amergian[1], Claire Gabel[1], Phoebe Jekielek[1], Anya M. Hopple[1]**
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As the shifting marine ecology in the Gulf of Maine creates changes in local and regional ocean fisheries, there has been a growing demand for information and resources related to aquaculture workforce development in Maine. Recognizing this need, from May through August, 2023, the Hurricane Island Center for Science and Leadership offered single-day aquaculture workforce-development training sessions for adults and multi-day aquaculture workshops for high school students. Funding for these initiatives was secured through SEAMaine, enabling Hurricane Island to serve 95 adults and 6 high school students; an additional 13 high school students were able to participate thanks to generous funding from the Maine Department of Education. We delivered a total of 10-day workshops, strategically designed to cater to diverse audiences. Six of these workshops were part of the 'Developing Aquaculture Skills' series, targeting existing aquaculturists. These sessions featured collaborations with prominent industry experts, enriching the learning experience. The remaining four workshops were part of the 'Introducing Aquaculture' series, designed to engage various audiences broadly interested in aquaculture. Additionally, we delivered two specialized, multi-day workshops for high school students, focusing on the cultivation of shellfish and macro-algae. These workshops placed significant emphasis on water quality and life history, and participants left with a Level 2 Youth Aquaculture Microbadge awarded by the University of Maine. Post-attendance surveys clearly indicated that these workshops effectively enhanced aquaculture literacy in participants, with a majority expressing interest in continuing their engagement with aquaculture education in the future.

MICROPLASTICS AS VECTORS FOR BACTERIAL CONTAMINATION OF FINFISH

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Microplastics are ubiquitous pollutants of marine environments and can be ingested by aquatic organisms including important aquaculture species consumed by humans. Microbes attach to marine microplastics, and therefore microplastics may raise the risk of pathogens entering aquatic organisms and the human food supply. No studies to date have examined whether microplastics can transport pathogens into edible finfish,

and as a result, microbe-associated microplastics may pose a heretofore neglected hazard to human health. To investigate the role of microplastics in mediating bacterial entry and retention in fish, we compared bacterial and microfiber uptake and tissue dissemination when zebrafish, a laboratory model for finfish, were exposed to *Vibrio alginolyticus* or *Escherichia coli* in either free-floating form, or in association with fluorescent plastic microfibers or fluorescent wool microfibers (a natural particle control). At 48, 72 and 96 h post-exposure, zebrafish gills, gut, liver, and muscle tissue were dissected, and bacteria and microfiber load were measured in each tissue via microbiological plating and spectrofluorometry, respectively. Additionally, whole fish from each tissue were preserved and subjected to histological sectioning and microscopy to assess the impact of treatments on gut morphology and bacterial or microplastic dissemination to tissues. Preliminary findings demonstrate greater translocation of plastic versus wool microfibers to fish tissues. Additionally, we observed treatment and time-dependent differences in tissue bacterial load. These findings will enhance our understanding of the role of microplastics in microbial contamination of seafood, which will aid in future strategies to protect microbiological safety of marine foods.

MAINE SHELLFISH AND SEAWEED AQUACULTURE APPRENTICESHIP: A PARTNERSHIP BETWEEN INDUSTRY AND THE COMMUNITY COLLEGE SYSTEM

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Workforce shortage in Maine's aquaculture industry has been an obstacle to growth for many businesses and could stunt the industry's tremendous growth potential. To address this, the Gulf of Maine Research Institute (GMRI), The Maine Aquaculture Association (MAA), and Educate Maine partnered on The Maine Aquaculture Workforce Development Strategy- a forward thinking strategic roadmap for Maine to achieve a cohesive and comprehensive workforce training pipeline that meets the needs of today's industry and anticipates future workforce needs as the industry evolves. Considerable progress has been made towards implementing the Strategy since it was published in 2020. The first-generation Maine Aquaculture Occupational Standards were created by MAA in partnership with GMRI and Educate Maine to help standardize workforce training programs. Using the Occupation Standards as building blocks and with funding from USDA NIFA, the first Shellfish and Seaweed Aquaculture Apprenticeship was registered with the Maine Department of Labor. This program includes 2,000 hours On-the-Job Training (OJT) as well as 144 hours Related Technical Instruction (RTI). Apprentices receive their OJT hours while employed for an aquaculture business and their RTI hours are provided by Southern Maine Community College (SMCC). All training provided by SMCC was reviewed and approved by an industry steering committee. This program is still in its pilot year and currently has 6 apprentices at 5 aquaculture farms (4 oyster farms, 1 mussel/kelp farm). Overall feedback has been very positive from both the apprentices and the aquaculture businesses. During this session we'll talk about the process of creating the program and what we've we hope the future of this program will be.

OYSTER HEALTH AND RESTORATION IN LONG ISLAND SOUND - PART I. LIS OYSTER POPULATIONS

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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 fully realize these potential contributions, increasing shellfish production from aquaculture, recreation, and restoration has been identified as an ecosystem target by the LIS Study, a national estuary program dedicated to restoring and protecting the Sound's waters and watershed.

In this first of three presentations, we will provide an overview of a newly established oyster health monitoring program funded by the LIS Study that monitors the population health of four natural and restored oyster beds in the region. The primary objectives of this program are to 1) ascertain a quantitative understanding of the seasonal dynamics of disease and reproductive success in unmanaged oyster populations; 2) identify the key water quality and physical oyster bed characteristics that best relate to the population burden of disease; and 3) establish a standard methodology for incorporating disease burden in oyster population health assessments for future evaluation of restoration projects. Using this comprehensive approach, which considers disease progression in the context of the environment and overall population health, we aim to fill critical information gaps needed to guide restoration planning in a way that promotes the success of natural, restored, and cultivated oysters and in turns supports healthy, resilient ecosystems and coastal communities.

A USER-FRIENDLY, RAPID eDNA TOOL TO IDENTIFY PATHOGENS RESPONSIBLE FOR DISEASES IN OYSTER AQUACULTURE

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The bacterial agents responsible for oyster hatchery and aquaculture diseases are currently identified via quantitative polymerase chain reaction (qPCR); however, this diagnostic method requires a lab setting and expensive equipment, limiting accessibility for smaller operations, and the turnaround time is often long enough that an outbreak cannot be stopped after identification. Our research proposed utilizing an eDNA tool: colorimetric loop-mediated isothermal amplification (LAMP) assays as a rapid, on-site diagnostic tool for *Aliiroseovarius crassostreae* and six species of *Vibrio*, each of which have the potential to cause die-offs of oysters in New England. Pathogenicity genes were identified by reviewing literature, and the genomes of 2,373 strains of related bacterial species were analyzed to identify species-specific target regions. The LAMP primer sets for each species were created using LAMPDesigner, and these assays were then validated against pathogenic cell cultures. Environmental samples from a die-off with a known causative agent, collected from juvenile oyster extracts and filtered seawater, were subsequently tested in the NextMug self-heating coffee cup, with results confirmed via fluorescent LAMP and qPCR. Identification of die-off causative agents was achieved using a crude cell lysate from filtered seawater collected at the hatchery during a die off, with the colorimetric reaction successfully occurring in 30 minutes in an affordable self-heating coffee mug. These results indicate LAMP assays have the potential to serve as cost-effective diagnostic tools to be used on-site at oyster operations by individuals without extensive scientific background, and the rapid delivery of results would allow operations to respond rapidly to an outbreak.

USING SHELLFISH AQUACULTURE EQUIPMENT TO PROPAGATE EELGRASS FOR RESTORATION

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The Martha's Vineyard Shellfish Group (MVSG) is a 501(c)(3) nonprofit organization that has been growing quahog, oyster and bay scallop seed for its six island towns for almost 50 years later. MVSG produces millions of shellfish, every year, to support municipal propagation, habitat restoration, and to provide ecosystem services. Expanding climate change issues and increasing eutrophication concerns in island salt ponds has prompted MVSG to pilot propagation and restoration of eelgrass for juvenile bay scallop habitat. By utilizing flotsam vegetative materials that would otherwise dissipate and go to waste, MVSG has found innovative ways to restore eelgrass using aquaculture equipment that is already available to us. Eelgrass propagation in the hatchery began in 2018 with rehabilitating rescued shoots using indoor flow-through tanks, as well as replanting shoots in suspended sand rafts. Progress has been made with germinating eelgrass from seed indoors, building up a small seagrass nursery in the hatchery, and participating in collaborative research with others on Martha's Vineyard and along the east coast. As of 2023, MVSG's most notable eelgrass-related success has been producing seed-germinated flowering shoots in the hatchery within eelgrass clumps. As we continue to grow and learn more from our increasing efforts each year, we have begun to find answers, ask more questions, and identify new colleagues to collaborate and learn with.

OYSTER AQUACULTURE CAGES AS HABITAT FOR BLACK SEA BASS

***Renee Mercaldo-Allen*[1], Pete Auster[2], Paul Clark[1], Mark Dixon[1], Erick Estela[3], Yuan Liu[1,4], Lisa Milke[1], Gillian Phillips[1,4], Dylan Redman[1], Chris Schillaci[5], Barry Smith[1], Alison Verkade[6], Julie Rose[1]**
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Five years of underwater video were collected, documenting fish activity on oyster aquaculture cages at shellfish farms in Long Island Sound. Black sea bass (*Centropristis striata*) were of particular interest as an ecologically important, federally managed, economically valuable species that supports commercial and recreational fisheries. Existing essential fish habitat definitions for this species include natural and artificial habitats.

Black sea bass occurred on shellfish farms from early summer through fall across all years. Results from 2018 and 2019 found fish in high abundance at all farms and in greater abundance on farms relative to natural structured seafloor. Black sea bass of multiple sizes and life stages were associated with cages. Nearly all black sea bass observed were juvenile or young-of-the year, suggesting gear may provide nursery habitat. Numbers of fish corresponded closely to seasonal changes in temperature, increasing from spring through late summer and declining by early winter. Black sea bass demonstrated foraging, shelter, territoriality, escape, and grouping behaviors. Preliminary analysis indicates no difference in foraging and

territoriality between cages and natural structured habitat, and more instances of escape, grouping, and shelter on cages vs. natural habitat.

Use of oyster cages by black sea bass, across five study years, at multiple life stages, in high abundance, and exhibiting behaviors associated with habitat use, suggests that aquaculture gear is providing structured habitat. For this reason, regulators may consider whether existing essential fish habitat designations should include aquaculture gear among the artificial structures providing habitat for this species.

UTILIZING FLOWCAM TO ENHANCE UNDERSTANDING OF OYSTER AND GREEN CRAB LARVAE IN GREAT BAY ESTUARY, NEW HAMPSHIRE

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Due to their role in water filtration and habitat creation, the Eastern oyster, *Crassostrea virginica*, is an important ecological driver in many bodies of water like Great Bay Estuary (GBE) in New Hampshire. In response to multiple negative impacts such as disease, habitat modification, and invasive species, oysters are declining in many locations, including GBE. The invasive yet naturalized European green crab (*Carcinus maenas*) is one such species. They can adapt easily to their surroundings, disrupt habitat, and their planktonic larvae coincide at times with oyster larvae, so it is possible that increasing numbers of green crabs have negative consequences for the GBE oyster population. A useful tool for studying larval populations is the FlowCam™, a flow-imaging microscope that promotes tracking these species in GBE waters. Analyzing water samples using FlowCam™ enabled the collection of abundance data for both oyster and crab larvae providing a better understanding of when they first appear, abundances of each organism in the water column, and when they co-occur. Observations based on FlowCam™ allowed selection of individual crab larvae that were tested using oyster-target PCR, which gives insight into whether crab larvae might be a significant predator on oyster larvae.

CAN A BIOFOULING SETTLEMENT PERIOD BE PREDICTED IN THE DAMARISCOTTA RIVER USING ENVIRONMENTAL DNA?

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Biofouling of suspended aquaculture gear impacts both farmer and organism negatively by adding to labor requirements to maintain the gear and potentially decreasing growth rate of the organism being grown. We are trying to predict the settlement period for the hard-fouling species *Mytilus edulis* and *Semibalanus balanoides* in the Damariscotta River by using environmental DNA (eDNA) sampling and analysis methods. Our sampling site on the Damariscotta River is situated just offshore from the Darling Marine Center (University of Maine Branch, Walpole, ME) at the mouth of Lowes Cove. During the summer months, typically when biofouling settlement increases significantly, there is a large influx of settlement that occurs on the offshore longline, making it a desirable location for eDNA sampling. For these samplings, three different types will be taken, a water sample, a sample swabbed from a scallop shell, and a sample collected from fuzzy rope. The variability in these sample types is to observe which collection method is the most effective in with-holding the highest concentration of hard-fouling eDNA. By being able to predict

potential biofouling settlement periods, farmers would be able to prepare their gear and desiccate the new settlement before it becomes labor intensive for the farmer.

RE-BUILDING A MARINE SCIENCE COMMUNITY EDUCATION TOOLKIT TO ENHANCE LOCAL LIFELONG LEARNING

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Historically rich fishing communities around the United States struggle to instill the importance of ocean resources for commerce, tradition and ecology in today's students, young adults, and newer community members. The Martha's Vineyard Shellfish Group, founded in 1976, has traditionally focused on enhancing inshore resources by running multiple small shellfish hatcheries to support the needs of the six island towns. In 2022, the Shellfish Group identified education and outreach as an integral piece of maintaining both the industry and culture of shellfish harvesting. With the help of a local grant from the Edey Foundation, a full-time educator and outreach position was added to the small year-round staff to curate a number of field-based activity kits and establish consistent collaboration with schools, libraries and other like-minded science and conservation organizations. During the first year of the program, multiple community-based instructional programs took place and two afterschool clubs were started, one of them affiliated with 4-H. Examples and lessons learned from the grant project will be shared, as well as a compiled list of resources to support education and outreach in your own community.

MAINE'S SCALLOP FARMING INDUSTRY EMERGES, AS A DIRECT OUTCOME OF JAPAN/US TECHNOLOGY TRANSFER

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Landings of farm-raised Atlantic scallops (*Placopecten magellanicus*) exceeded $100,000 in 2022 (Maine Dept. of Marine Resources, Landings Division); an encouraging indication of advancement towards enterprise profitability (Fig. 1) . Markets for whole/live and shucked products have been strong, commanding prices above wild-harvested product. Producers have attracted private and traditional capital - including Coastal Enterprises, Inc. - further indicating that financial reviews of scallop farms are positive enough for such investments. The present view is that scallop farming in Maine is emerging as a real sector of the industry, and one which can entertain future growth.

Much of the work has focused on concrete operational issues: spat collection techniques and equipment, lantern and pearl net production, ear hanging techniques and machinery, biofouling management, etc. The authors have imported a variety of equipment from Mutsu-Kaden Tokki Co of Aomori City in Aomori Prefecture, Japan; one producer has purchased equipment from the HAMADE Company of Towa Denki Seisakusho, Inc, of Hakodate, Hokkaido, Japan. Pearl and lantern nets have come from the Jin Fishing Net Company, also of Aomori City, Japan.

Other positive signs of growth for scallop farming in Maine:

- -A market analysis of farmed Atlantic sea scallops showing promise
- A Farmed Scallop Recipe Cookbook to help consumers, chefs and wholesaler dealers understand product formats and options

- Significant investment in shared equipment to give multiple growers opportunity to grow scallops
- Increasing numbers of shellfish dealers carrying whole scallops
- Increasing number of producers selling live product.
- Improved data describing PSP and ASP levels in scallop tissues, and at different sites; critical for risk management, farm siting, and proper regulation.
- A strong bioeconomic model for scallop production, already in use by industry.
- Decades of relationship building and collaboration between industry in Maine and Japan
- risks from phycotoxins, to gather relevant data, and to minimize the spread of pests, predators and pathogens during the entire scallop cultivation process.

COALITION BUILDING TO ADDRESS DERELICT FISHING GEAR

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The Maine Marine Debris Community Action Coalition will consist of four primary partners and eight current collaborating organizations from the education, research, industry, and community sectors, with additional members to be recruited through the proposed project activities. The coalition's proposed objectives are: 1) to identify and develop improved methods and technological designs for processing and reusing or refabricating marine debris, such as ghost lobster traps and derelict aquaculture farming gear, into products; 2) to develop new educational programs and opportunities for high school students and professionals to develop the knowledge and skills necessary to recover, process, and fabricate marine debris materials; and 3) to create a robust and connected community with information exchange, professional development, and networking opportunities to collaborate and work together to leverage existing resources and efforts within the network. Through a series of projects and events, this project will help to advance methods, technological design and collaboration and advance Maine's marine debris recovery efforts, and increase awareness among the community and professionals about the existing problem and solutions to address ghost gear in the Gulf of Maine.

BLAME IT ON TOM MARCOTTI: PLANTING JUVENILE SOFTSHELL CLAMS (Mya arenaria) IN CONTAINMENT

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Softshell clams (*Mya arenaria*) are a valuable species harvested in Maine, but populations have been strongly reduced through predation, mostly by green crabs (*Carcinas maenas*) and milky ribbon worms (*Cerebratulus lacteus*). Protection of seeded clams with screening only has been largely unsuccessful despite many well-implemented and thorough trials; crabs can make it through the meshes of the screens or can exploit tears or gaps in the protection, and ribbon worms burrow through the mud and attack clams laterally or from below.

Tom Marcotti, a retired Shellfish Biologist working in the town of Barnstable, MA, observed many years ago that softshell clams of market size had survived in remarkable numbers, in a broken-off piece of PVC pipe. Given this observation, the intense problems from local predators, and the approach taken by west

coast geoduck (*Panopea generosa*) farmers, we set out to explore the possibilities of growing seed clams in pipes.

Results of our small trials are thus far encouraging, with high survival and good growth. This segment will review materials and methods, results to date, further questions of interest, and upcoming work.

EASTERN OYSTER AQUACULTURE NITROGEN AND PHOSPHORUS REDUCTION IN CHESAPEAKE BAY: LOW VARIATION ACROSS SEASON, PLOIDY, AND FARM LOCATION

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Eastern oyster aquaculture has been approved as a best management practice for nutrient removal in Chesapeake Bay, and there is substantial interest in incorporating oyster farms into nutrient management programs across Maryland and Virginia. This study addressed BMP-identified data gaps involving variation in nutrient content related to ploidy, effects of seasonal reproductive development, and a paucity of phosphorus content data. Diploid and triploid oysters were collected from farms in Maryland and Virginia between February and October, spanning the typical local reproductive cycle. Morphometric measurements, tissue and shell dry weight, and tissue nitrogen and phosphorus content were obtained for all collected oysters. Shell nitrogen and phosphorus content were determined for a subsample of individuals. Nitrogen and phosphorus content of oyster tissue was within previously-reported ranges with only minor variation among sampling dates, both within Chesapeake Bay and across the Northeast region. Differences in nutrient content between diploid and triploid oysters were also minor. Both of these results indicate that no modification of existing calculations of tissue nutrient content by management programs is needed, and the phosphorus data greatly strengthens the existing science supporting inclusion of oyster aquaculture in phosphorus management. Interestingly, we did not observe differences in tissue dry weight between diploid and triploid oysters at either farm location, which contrasts with current nitrogen reduction crediting practices. These results suggest separate crediting for diploids and triploids may need further investigation and potential future re-evaluation.

THE TRUE CHICKEN OF THE SEA. WHAT WE CAN LEARN FROM THE RISE, BOOM, COLLAPSE AND RETURN OF AN ADRIATIC SHELLFISH INDUSTRY

D Nathaniel Mulcahy

Chamelea gallina or vongole lupino are small shellfish native to the eastern Atlantic, Mediterranean, and Adriatic. This short presentation is focused primarily on the industry built around it located in the central Adriatic. Climate change, pollution, poor regulation, and overfishing brought the industry surrounding it to a boom and catastrophic collapse. Current innovative efforts have allowed for a cautious return of the industry and can provide insights that may be useful to other shellfish industries.

SEASONAL PATTERNS OF DISTRIBUTION AND ABUNDANCE OF WATERBIRDS IN RELATION TO OYSTER AQUACULTURE IN COASTAL RHODE ISLAND: IMPLICATIONS FOR DISEASE RISK

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The spatial distribution of waterbirds is typically seasonally dynamic, yet few detailed studies have investigated how seasonal variation in waterbird distribution and abundance relates to shellfish aquaculture operations. We conducted weekly land-based surveys in Rhode Island from Dec 2020 to April 2023 to assess seasonal variation in the distribution patterns of birds in nearshore waters and coastal ponds with and without certain types of oyster aquaculture gear (e.g., submerged vs. floating). The most abundant waterbird species in coastal Rhode Island changed seasonally: the species present in the highest densities in the winter months were waterfowl (ducks and geese) plus grebes and loons, whereas in summer, gulls, terns and cormorants predominated. The density of gulls, terns and cormorants was highest on floating cages associated with oyster aquaculture during late-summer and early-fall, and much higher than in waters over submerged aquaculture or in surrounding waters with no active aquaculture. The peak bird use of floating gear during late summer coincides with when harmful bacteria may proliferate; thus, late-summer provides the window of opportunity for most effective use of deterrents at floating gear operations. Evaluation of levels of bacteria of human health concern in water, bird feces, and oysters at six farms in Rhode Island and Massachusetts in August - September 2023 showed absence (for *Campylobacter* spp.) or levels below regulatory action level (fecal coliforms). We continue to assess the extent to which bird abundance on floating aquaculture gear is related to disease-risk in Rhode Island and Massachusetts.

DEVELOPING A WORLD CLASS, INDUSTRY-RELEVANT, COMMUNITY-COLLEGE BASED TRAINING PROGRAM TO PREPARE THE NEXT GENERATION OF MAINE'S AQUACULTURE WORKFORCE

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The Maine Aquaculture Innovation Center and Washington County Community College have partnered to create and pilot a workforce training program for aquaculture. The need for the program was identified in a report written by The Gulf of Maine Research Institute. This community college aquaculture program enables students to graduate with either a 1-year Workforce Training Certificate or a 2-year Associate Degree. Associate Degree graduates are able to choose from two concentrations: fin-fish aquaculture and shellfish and macroalgae aquaculture. Badging and micro-credentials enable students to demonstrate competency in specific, industry-relevant skills to prospective employers. Innovative teaching delivery solutions promote hands-on yet remote learning opportunities for students across Maine. The content of the programming meets the need for entry-level skill sets for Maine's 4 key aquaculture sub-sectors: recirculating aquaculture, fin-fish aquaculture, shellfish aquaculture, and macroalgae.

Aligned with the aquaculture programs being developed at Washington County Community College and Southern Maine Community College, internship and apprenticeship programs are also under development.

COMPARING GROWTH OF EAR HUNG AND LANTERN NET CULTURED SEA SCALLOPS, *PLACOPECTEN MAGELLANICUS*, OVER A COMPLETE GROW-OUT CYCLE TO DETERMINE OPTIMAL HARVEST TIMING

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Scallop aquaculture represents the fastest growing global shellfish industry, however the Atlantic sea scallop aquaculture industry has shown stagnated growth despite research interests starting in the 1970's. Uncertainty in long term growth history and grow-out methodology has created a potential hurdle for new growers, in particular previous studies have focused on a whole scallop market with grow-out to 90 mm instead of the established commercial adductor market at >100 mm requiring a two year grow-out. Quarterly shell height measurements were collected for two-year classes of scallops grown in ear hanging and lantern net suspended culture over a two year grow-out period, adductor weight was tracked for the final year of grow-out when a potential shucked scallop product would be viable. Following model selection, reconstructed growth metrics for adductor weight were compared against theoretical quarterly mortality regimes to determine biological harvest timing. Results indicated that while shell height differences between ear hung and lantern net cultures were only 1.19%-4.22% depending on month, synergistic interactions between shell height and exponential adductor growth resulted in a 10.86% increased adductor growth for ear hung scallops harvested in August after one year in grow-out culture although this difference diminished in the second year of grow out due to reduced growth as size increased. Biological harvest timing assessment under different quarterly mortality regimes determined that quarterly mortality as low as 2.5% offset adductor growth between November and February resulting in a negative return if harvested during that time period.

BIOECONOMIC MODEL FRAMEWORK APPLICATION DEVELOPED FOR SEA SCALLOP GROWERS

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Concerted research efforts have been ongoing since the 1970's to facilitate the commercial culture of the Atlantic Sea Scallop (*Placopecten magellanicus*) in the Northwest Atlantic Ocean. Currently, a dizzying array of literature exists spanning several decades discussing husbandry, different grow-out techniques, stocking density, site selection, end market products, and hatchery rearing of spat. However, while this data is available in several manuals, it can be daunting for growers to make informed decisions with the multitude of options available. Following the longest available growth study of grow-out over a three-year period using lantern net and ear hanging suspended culture, we have created an application to allow growers to quickly and easily assess potential farm opportunities for these grow-out methods. The application runs in a hierarchical setup with a simplified primary system, growers can select their business model, labor requirements, husbandry method, harvest season, and product type (whole scallop/adductor meat) to

determine an ideal commercial operation for their needs. Further secondary inputs in the application related to gear type, labor requirements, capital expenditure purchases, and maintenance/fuel costs allow growers to refine their desired husbandry to create a versatile and customized scallop farm setup. Publication materials used this model, validated with inputs from established commercial grower, to test the impacts of grow-out type (ear hanging vs lantern net), product type (adductor vs whole scallop), and harvest season (Summer, Fall, Spring, and Winter) on average scallop price to offset annual operating costs and offset of total 10-year debt.

INVESTIGATING THE ACTIVITY OF BACTERIA ISOLATED FROM TANK BIOFILMS IN A HATCHERY SYSTEM FOR SEA SCALLOP, *PLACOPECTEN MAGELLANICUS*, LARVAE

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We looked at how the bacteria in tank biofilms in scallop hatcheries might affect the health of the larvae. DEI, Mook Sea Farm, and Darling Marine Center provided biofilm samples for tests in genomics and microbiology. Every 48 hours, larvae are fine-filtered from all tanks, drained and cleaned, and larvae are put into a fresh tank of filtered seawater. Three bottom biofilm swabs were taken before cleaning and refilling after draining. Swabs of the tank biofilms were used to hatcheries grow certain bacteria on thiosulfate-citrate-bile salts-sucrose (TCBS) agar to check for pathogenic Vibrio spp. Plates were transferred to UMaine for gram and endospore staining, testing the bacteria's capacity to utilize sugar and the isolates' resistance to other antibiotics.

Static tanks hosted more yellow (54%) than green (47%) isolates, indicating different Vibrio species, while flow-through tanks hosted nearly identical, at 47% yellow and 50% green. Clean tanks had more yellow (51%) than green (41%) isolates. Dirty static and flow-through tanks had higher colony growth rates and a higher prevalence of yellow isolates. Specifically, there are 55% yellow isolates and 30% green isolates in static and dirty tanks, whereas there are 47% yellow isolates and 47% green isolates in flow-through and dirty tanks.

Like other aquaculture species, scallops are occasionally infected with bacteria, which can lower their productivity and quality. Antibiotics like ampicillin, streptomycin, penicillin, and oxytetracycline were given to the isolates to avoid bacterial infections. Streptomycin outperformed all other antibiotics against isolates from various tanks.

EXTRACTION AND DETECTION OF GEOSMIN AND 2-METHYLISOBORNEOL IN WATER AND FISH AS A SERVICE TO FARMERS OR RESEARCHERS IN NEED OF LOW COST TESTING

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Geosmin and 2-methylisoborneol are volatile organic compounds of microbial origin that frequently occur in recirculating aquaculture systems and cause unpleasant odors and flavors to the fish therein even at extremely low concentrations. Existing analytical methods struggle to achieve enough sample throughput

and are oftentimes not automated, requiring extensive hands-on preparation. We have developed methods for the analysis of geosmin and 2-methylisoborneol from water and fish tissues respectively, using a robust metal probe bearing a high-capacity sorptive extraction phase (HiSorb). We achieved robust and quantitative detection from both water and fish tissues, with minimum detection limits of 1.2 ng/L for geosmin and 1.1 ng/L for 2-methylisoborneol from water, and 25 ng/kg and 25 ng/kg respectively from fish. These concentrations are well below human odor thresholds, hence our methods are able to detect geosmin and 2-methylisoborneol before they become perceptible to humans. We suggest that this method is suitable for monitoring in all water quality applications as well as applications for the detection of off-flavor in farm-raised fish. Detection of these compounds are done at the University of Maine's Aquaculture Research Institute (ARI) as a service to farmers or researchers in need of low-cost testing.

'KELP' US LEARN! EXPANDING MAINE'S PLACE-BASED ELEMENTARY SCHOOL CURRICULUM USING SEAWEED AQUACULTURE

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Seaweed aquaculture is a relatively new addition to the American working waterfront but has rapidly become one of the fastest growing maritime industries in the United States. Maine plays an important role in this growing sector; it is home to both the first commercial seaweed farm in the country as well as over half the national production of edible farmed seaweed. Maine's long standing working waterfront is facing many challenges yet is embracing the growth of the seaweed industry. Seaweed aquaculture provides an opportunity for the future of working waterfronts but remains largely novel to young Mainers at the elementary and middle school levels. Teaching about aquaculture in elementary and middle school classrooms can simultaneously provide students with a sense of place through hands-on opportunities to grow socially and environmentally sustainable careers while meeting educational standards set by the state.

The purpose of this project was to develop and distribute a seaweed curriculum to Maine elementary and middle school classrooms using the book *With a Little Kelp From our Friends* as the backbone. The curriculum was designed to provide educators with easily accessible activities that fit within fifth grade learning standards. To organize and execute this project, the Maine Aquaculture Innovation Center brought together and led a cross-organizational coordinating team of partners 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 seaweed curriculum, our strategy for connecting with educators across the state, and the process of bringing seaweed education resources to Maine students.

MAI-Ed: CREATING AN AQUACULTURE LEARNING HUB TO SUPPORT A DIVERSE AND INNOVATIVE WORKFORCE IN MAINE'S FARMED SEAFOOD SECTOR

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With over 3,000 miles of coastline and a rapidly growing aquaculture industry, Maine has the potential to reap considerable economic benefits from aquaculture expansion in the United States. Maine is also well-equipped to direct future environmental and social sustainability of the American aquaculture industry due to the state's existing collaborative partnerships between industry, research, and conservation. A key element in supporting the growth of economically, environmentally, and socially responsive aquaculture is ensuring the presence of a diverse, eager, and informed workforce. To achieve this goal, it is important to provide accessible, inclusive, informative, and up-to-date workforce training resources to potential aquaculturists. Creating an aquaculture learning hub with freely available education materials that include topic-specific modules will provide opportunities for consistent, organized, and independent learning. Through these modules, learners will be able to gain insight into the economic, environmental, and social intricacies of Maine aquaculture and aquaculture at large.

The purpose of this project is to create 12+ learning modules that cover the process of aquaculture in Maine from site selection and lease application through harvest and product marketing. These modules include but are not limited to: farm set-up, farmed species biology, and best husbandry practices. They are designed to exist on a web-based learning management platform which will enable free and easy access across the state while providing content creators with analytical information about module use. Development of these modules is focused on updating, revising, and transferring existing aquaculture learning resources (currently housed as iBooks published in 2019) to a new, WordPress-based learning management system called LearnDash. A key focus in this project is incorporating learner accessibility into every aspect of course design to develop engaging, informative, and easy-to-use content that serves to support a diverse and innovative workforce in Maine's growing aquaculture sector.

IMMUNE GENE EXPRESSION AS AN INDICATOR OF IMMUNOCOMPETENCE IN LUMPFISH, CYCLOPTERUS LUMPUS

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Sea lice are a major threat to the financial and biological success of farmed Atlantic salmon and are one of the top contributors to economic losses in the industry. The use of lumpfish, *Cyclopterus lumpus* L., as cleaner fish in salmon net pens has increased recently in Europe and Atlantic Canada, due to their demonstrated efficacy as a measure of sea lice control. To mitigate associated threats to fish welfare and biosecurity, aquaculture operations producing lumpfish must closely monitor the fishes' health and vaccinate them against harmful pathogens. An optimal vaccination regime has yet to be determined, as the understanding of lumpfish immune system development and adaptive immune response is still in its infancy. This project aims to identify and investigate the expression of genes directly related to the development of the lumpfish immune system and adaptive immune response, to establish when during development lumpfish become immunocompetent. Methodology will include an in-depth literature review of lumpfish development and immune responses to identify 6-8 genes of interest, qPCR analysis of gene expression, and agarose gel electrophoresis to verify gene presence. The intended outcome of this project is to inform lumpfish aquaculture operations of the developmental time point at which lumpfish are able to distinguish between "self" and "non-self" to ensure successful vaccination, avoid oral tolerance when fish are vaccinated, and minimize mortality caused by pathogens.

USING ARTIFICIAL INTELLIGENCE TO IDENTIFY FISH FROM CAMERAS ON AQUACULTURE GEAR

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Artificial intelligence (AI) is a quickly growing field within the social and natural sciences. Identification of fish in underwater video by human scorers is both challenging and time consuming. Use of machine learning models may potentially enhance accuracy and efficiency of video analysis. Milford Laboratory's GoPro Aquaculture Habitat Project has collected video on shellfish farms and on boulders at a natural rock reef in Long Island Sound. Over 1650 hours of video have been scored for fish abundance and community composition. A subset of these previously scored videos shared with a number of institutions provided an opportunity to train machine-learning models. Preliminary models yielded low and inaccurate results due to varying levels of visibility, fouling organisms and low light conditions. A recent partnership with the National Research Council (NRC) of Canada set out to create a model derived directly from our videos and an existing framework. The preliminary success of this model is the basis of a growing partnership. We hope that ongoing efforts to collaborate with external partners will advance the viability AI technology in the future.

PROGRESS TOWARDS A GULF OF MAINE CAPTIVE REARED LUMPFISH (*Cyclopterus lumpus*) BROODSTOCK POPULATION

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Lumpfish represent one of the first fish native to the western Atlantic to be utilized as cleaner fish to help control sea lice infestations on Atlantic salmon. Sea lice are the most economically damaging pest or pathogen faced by the domestic salmon farming industry. The USDA National Cold Water Marine Aquaculture Center (NCWMAC) in collaboration with various partners from the US Lumpfish Consortium have been focused on developing and optimizing hatchery culture techniques for lumpfish. The University of New Hampshire and USDA recently published a Lumpfish Hatchery Handbook to help promote lumpfish culture in the US. The current focus of efforts at the USDA is the development of a captive reared, Gulf of Maine broodstock population that can be used to support future domestic commercial rearing operations and further research into improved rearing and utilization of lumpfish to help manage sea lice infestations in the domestic salmon farming industry. Successful spawns at the USDA in the spring of 2023 from Gulf of Maine lumpfish captured by the University of Maine as young of the year and reared to adults have resulted in the establishment of 15 families of captive reared broodfish. It is anticipated that these fish will spawn in the spring of 2024. Work is on-going to create a second year class of broodstock to spawn in alternating 2-year cycles.

“UNWANTED MARINE LIFE GROWING ON OYSTER FARMS”: A SURVEY OF MASSACHUSETTS OYSTER FARMERS

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We conducted an online survey of Massachusetts oyster growers in spring 2023 to assess the current and potential impact of unwanted marine life (algae, mussels, barnacles, sea grapes, etc.), or “biofouling”. Biofouling is the growth of unwanted organisms on aquaculture gear, docks, and boat hulls, and can add to the costs of shellfish aquaculture through increased gear weight, restricted water flow to farmed oysters, and damage to the appearance of commercial products. Survey questions included biofouler types, intensity of biofouling, mitigation strategies, gear for culturing oysters, and location of farms in Massachusetts coastal areas, and there were 39 responses. This survey was conducted as part of a larger project on barnacle biofouling, which also included measuring barnacle set through the year and identifying nuisance species using DNA barcoding (see the presentation by Weinstock et al.). The survey results are evaluated in the context of field measurements of barnacle set in Buzzards Bay and Cape Cod Bay addressing the magnitude and timing of the barnacle set. The overall goal of this project is to help the industry mitigate the growth of biofouling on gear and oysters and to avoid subsequent losses in productivity.

ELECTRIFYING AQUACULTURE

Nick Planson
The Boat Yard, LLC, and Shred Electric

The Boat Yard, LLC, in partnership with Shred Electric, is developing clean sea farming technology. We work closely with sea farmers of all stages and sizes, primarily across the US and Canada. USDA SARE funds the project to study current mariculture operations, document the equipment farmers use, measure duty cycles, and gather input on challenges and opportunities for improvement. The result will be sea farm battery kits pre-configured to run all on-farm equipment, eliminate gasoline generators and pumps, and last for years. These kits will include solar canopies, swappable lithium batteries for some applications, stationary lead-acid batteries for others, remote charge-state monitoring, and will allow for interconnection of micro wind-turbines and other renewable sources.

ASSESSING BOTTLENECKS PREVENTING SUCCESSFUL GREEN SEA URCHIN PRODUCTION

***Tara Plee*, Coleen Suckling**
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The aquaculture production process of green sea urchins (*Strongylocentrotus droebachiensis*) involves several key stages, each requiring optimization to ensure the industry's success. Production begins with the spawning of broodstock collected from wild populations, leading to the emergence of planktonic larvae. Larvae are reared in a controlled environment until they are competent to settle, and in the presence of the appropriate environmental cues, undergo metamorphosis into benthic juveniles. Once the juveniles reach a seed size of 10-15mm, they become viable for sale and can be grown to marketable sizes on bottom leases or integrated with other aquaculture species. This study focuses on enhancing three major production milestones for green sea urchins in the Gulf of Maine (GoM). The first two milestones relate to seed supply

where low settlement success and post-settlement survival rates result in low seed numbers, consequently increasing seed production costs. To address these issues, experiments were conducted to assess the potential of specific chemical and biological cues to enhance larval settlement and certain post-settlement food sources to improve survival and growth. The third milestone pertains to the possible adverse effects of marine heatwaves on seed grow out in certain locations in the GoM. Given the increasing frequency and duration of heatwaves due to anthropogonic climate change, an experiment was conducted to evaluate how *S. droebachiensis* responds to recurring thermal stress and explores whether stress priming can mitigate the negative impacts of heatwaves on seed. We will discuss our findings and provide suggestions for optimizing cultivation and grow out for this species.

SITE-SPECIFIC GROWTH RATES OF ATLANTIC SURFCLAMS (*SPISULA SOLIDISSIMA*) COLLECTED FROM NEARSHORE LOCATIONS IN CAPE COD, MA.

***Matthew Poach*[1], Emily Roberts[1], Martin Gonzalez[2], Genevieve Bernatchez[1], Daniel Hennen[1], Barry Smith[1], Shannon Meseck[1]**
[1]National Marine Fisheries Services (NMFS), Northeast Fisheries Science Center (NEFSC)
National Oceanic and Atmospheric Administration (NOAA); [2]University of California, Santa Cruz

Surfclams (*Spisula solidissima*) represent an important fishery in the Northeastern US that has been identified as highly vulnerable to climate change. Previous studies have shown that increases in temperature and decreases in pH reduced surfclam growth. The current study was conducted to assess if environmental conditions and surfclam growth rates differ among five nearshore sites around Cape Cod, MA: Barnstable Harbor, Chatham, Dennis, East Falmouth, and Provincetown. During monthly spring low tides, bottom waters were sampled and adult surfclams were collected. Dissolved inorganic carbon, pH, and alkalinity of water samples were either determined in the field or at the Milford lab by standard methods. Water samples were also filtered for total suspended material determination as a proxy for food availability. Surfclam lengths were measured and their age was determined by counting growth bands on the bisected and polished chondrophore under magnification. Size-at-age relationships were then analyzed through a specialized von Bertalanffy growth function. Surfclams from sites that bordered Cape Cod Bay attained older ages and grew to a larger terminal size than surfclams from sites along the Southern shore of Cape Cod. These differences are not surprising as previous research indicated that the surfclams at the south coast locations were the *similis* variety of surfclams. Patterns in environment conditions, carbonate chemistry, and food availability provide insight into site specific growth rates.

NECAN- THE NORTHEAST COASTAL ACIDIFICATION NETWORK- IN ACTION

Austin Pugh
NERACOOS, NECAN, Portsmouth, NH 03801

The Northeast Coastal Acidification Network (NECAN) is the leading group in the region for the synthesis and dissemination of ocean and coastal acidification information. Established under the Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) in 2013, NECAN is a partnership among government agencies, industry members, and the scientific community. NECAN helps to make available OCA information, resources and data products tailored to and informed by the interests of regional stakeholders and decision-makers. Since NECAN's inception the group's efforts have continued to diversify and expand, and we currently have four working groups for Science, Policy, Education and Outreach, and Industry. We also host a yearly webinar series to highlight new results relevant to the region, and convene topical workshops on OCA issues in collaboration with other partners. We will provide a brief history of NECAN and the current and future activities of this regional collaboration, with a focus on the

Regional OA monitoring plan currently under development. We welcome discussion and input on desired NECAN activities and how to align efforts within the broader regional and national OCA communities. In doing so, the region can better address the impacts of OCA in the Northeast.

TECHNICIANS' UPDATE ON THE NORTHEAST OYSTER BREEDING CENTER AT THE MILFORD LAB

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The Northeast Oyster Breeding Center (NOBC) is an ongoing collaborative project between the NOAA NEFSC and the USDA ARS with the goal of utilizing modern aquaculture technology and genome-assisted, family-based breeding to create genetically selected Eastern oyster, *Crassostrea virginica* lines for commercial growers across the Northeast. While the bulk of the physical infrastructure of the Center is located within the Milford NEFSC Lab, a team of USDA ARS geneticists and aquaculturists with the University of Rhode Island work directly with colleagues in Milford to formulate genetic plans with the goal of 100 family crosses per year.

The integration of modern aquaculture systems such as two Industrial Plankton photobioreactors, separate recirculating upweller and downweller systems, and the new Cawthron Ultra-Density Larval System (CUDLS) for rearing larvae families in flow-through bottles to ensure the specially selected genetic families remain separated, will allow the NOBC to meet the high-capacity demands needed for the production of sufficient volumes of oysters- roughly 1 000 000 per year. After the larvae have grown to 4 mm, the resulting oyster seed will be distributed to commercial grower partners across the Northeast to be raised into adulthood for an overall genetic evaluation by the NOBC geneticist. Since being brought onto the project, the three A.I.S. Inc. oyster hatchery research technicians at the Milford Lab have been hard at work troubleshooting the newly created systems in anticipation of holding, conditioning, spawning, and rearing broodstock and seed in 2024.

WORKING WITH THE USDA – PRODUCER EXPERIENCES

Robert Rheault
East Coast Shellfish Growers Association, 1623 Whitesville Rd., Toms River, NJ 08755

This presentation will cover some of the feedback we have gotten from shellfish growers on the East Coast and the pros and cons of various FSA and RMA programs available for shellfish farmers. Disaster Assistance programs such as the Emergency Livestock Assistance Program (ELAP) have recently become available for shellfish farmers and for those counties where the Farm Service Agency has established the necessary data required to reimburse growers for weather-related losses the program has proven to be a fantastic farm saving tool. For those counties still working out the details we will explain how growers can get involved and ensure future losses are properly addressed.

COMPARING GROWTH AND SURVIVAL OF JUVENILE OYSTERS AT FIVE SITES ACROSS A GRADIENT OF WATER QUALITY CONDITIONS IN A CAPE COD ESTUARY

Jennie Rheuban[1], *Josh Reitsma*[1,2], Abigail Archer[1,2], Harriet Booth[1,2]
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Numerous studies have shown that acidification (OCA) has the potential to cause negative impacts on bivalve shellfish in the laboratory. Many coastal communities in Massachusetts rely on shellfish aquaculture. A better understanding of how ocean acidification may impact commercially-important species will help communities prepare for potential future changes. Most studies of the impacts of OCA on mollusks have looked at stressors in controlled laboratory settings where experiments are often limited to one or two factors. However, under field conditions in coastal environments, acidification is often linked to other biogeochemical changes such as hypoxia, increased nutrient and organic matter concentrations, and large changes in these stressors over the course of diel and tidal cycles.

In this field-based study, 2-3mm hatchery reared oyster seed were deployed in cages at five different areas across a natural gradient in water quality in an estuarine system at several times over the course of two years. On a biweekly basis during the growing season, oysters were assessed for growth and survival. To help estimate the degree of coastal acidification experienced under grow out conditions, discrete water quality samples were collected biweekly for a water quality suite (dissolved inorganic nitrogen, dissolved organic nitrogen, particulate organic nitrogen and carbon, and chlorophyll a), and carbonate chemistry (dissolved inorganic carbon and total alkalinity). In addition, multi-parameter sondes were deployed at each of the sites to follow water quality conditions every fifteen minutes. Results will be discussed in the context of measured water parameters and variability in growth.

SAVING THE SEED: NANTUCKET BAY SCALLOP SEED MANAGEMENT OF 2023

***Tara A. Riley*, Joseph Minella, Griffin Harkins, David Berry, Morgan Nelson**
Town of Nantucket, Department of Natural Resources, Brant Point Shellfish Hatchery, 131 Pleasant St. Nantucket, MA 02554

The waters around Nantucket, Massachusetts are home to the world's largest commercial bay scallop (*Argopecten irradians*) fishery that historically fueled the island's winter economy through fishery-related jobs, abundant seafood supply, recreational activities, and provides a continuance of history and culture dating back to the late 1800's. As harvests declined over time, Nantucket Island has seen a shift in fishery participation as scallopers find more dependable work on shore. During the summer of 2023, an astronomical set of bay scallops recruited within the shallows in Nantucket Harbor with densities surveyed as high as 500 m^2.

The Town of Nantucket Brant Point Shellfish Hatchery runs a municipal shellfish stock enhancement program. Bay Scallop Larval Releases have been the primary stock enhancement strategy utilized to buffer and rebuild the natural population. Data is under analysis to determine if this recruitment was the result of a hatchery released larval set, a natural population recruitment set, or a combination of both. Given the vulnerability of these seed to stranding, shellfish resource managers, scallopers, and industry experts have come together to manage this valuable resource. Over thirteen million seed have been rescued and relocated to deeper areas of the harbor to prevent additional strandings, decrease population densities, and provide spawn potential for the next season in hopes of moving towards a more sustainable population.

OYSTER AQUACULTURE LARVAL SUBSIDY DRIVES EMERGING WILD OYSTER POPULATIONS IN MAINE, USA

***Sarah C. Risley*[1,2,3], Heather M. Leslie[1,2,3]**
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Maine's wild oyster populations have been functionally extinct for hundreds of years, restricted to relict populations in warmer, upper estuary habitats. Recently, however, estuaries with high concentrations of oyster aquaculture farms – like the Damariscotta River estuary in midcoast Maine – are experiencing an interesting phenomenon: the expansion of 'wild' Eastern oyster (*Crassostrea virginica*) populations that have resulted in a new wild oyster fishery. It is believed that these populations are the result of larval spillover from farmed oyster populations. To investigate this hypothesis, we placed larval collectors along the Damariscotta River estuary in three zones: (1) Areas with high density of aquaculture farms, predicted to have high larval density, (2) Areas with medium density of farms, predicted to have medium larval density, and (3) Areas with minimal to no farming activity, predicted to have low larval density. Results indicate that larvae are indeed recruiting to the intertidal and are correlated with aquaculture farm density. These results offer insights into the interactions between aquaculture and wild shellfish populations, and the benefits aquaculture may provide in terms of shared economic benefits with wild fisheries, ecosystem services, and shellfish restoration.

INTO THE DEEP: CAN DAILY DEPTH CYCLING ENHANCE GROWTH AND INCREASE RESILIENCE TO CLIMATE CHANGE IN TROPICAL SEAWEED?

***Loretta M. Roberson*[1], Mayra Sánchez-García[1], Olivia Tran[1], Zeran Fei[2]**
[1]Marine Biological Laboratory, Woods Hole, MA, USA; [2]University of Chicago, IL, USA

Seaweed farm production has increased globally to nearly 36 million tonnes annually, with most of the production in southeast Asia and China. There is a growing interest in the U.S. to increase production for not only food and feed, but for sustainable products that can help reduce greenhouse gases (e.g., bioplastics, soil conditioners) and provide valuable ecosystem services (e.g., sequester nitrogen). There is growing concern, however, that warming oceans will limit productivity, decrease the diversity of seedstock, and increase the prevalence of disease. Here we explore cycling seaweed from warm surface waters, down to deep water that is cooler and nutrient-rich to reduce thermal stress and increase productivity, particularly for nutrient-poor tropical seas. We used the tropical red seaweed *Gracilaria mammillaris* as a model and simulated depth-cycling by exposing samples overnight to three conditions: (1) high nutrients, (2) low nutrients, and (3) high nutrients and low temperature. Samples were kept at 25-29°C in culture media with low sea-surface nutrient concentrations (<0.1 µM Nitrogen) during the day and overnight were exposed to a 15-hour nutrient pulse (25 or 5 µM N), with the cool treatment at 21°C. Controls were maintained at 25°C and constantly kept in the low nutrient condition. We found significant differences in growth rates and tissue nitrogen content between treatments, with the highest growth and %N per dry weight of tissue in the high nutrient treatment. Depth cycling may therefore be a useful tool for protecting seedstock from global warming.

THE EFFECTS OF SITE AND SHELL HASH ON ATLANTIC SURFCLAMS (*SPISULA SOLIDISSIMA*) GROWTH AND FEEDING RATE IN CAPE COD, MA

***Emily Roberts*, Shannon Meseck, Genevieve Bernatchez, Barry Smith, Katherine McFarland, Daniel Hennen, Katyanne Shoemaker, Renee Mercaldo-Allen, Matthew Poach**
National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Milford Laboratory, 212 Rogers Avenue, Milford CT 06460 USA

Understanding the role of sediment porewater chemistry in ocean acidification (OA) and ocean warming on individual species is a major challenge in marine ecology. Atlantic surfclams *(Spisula solidissima)* are a large fishery across the Northeast U.S. and an emerging aquaculture species marketed as butter clams. Lab experiments and lab-based growth models suggest that surfclams are sensitive to OA. Coupled environmental and biological measurements are needed to test if there is an effect of carbonate chemistry on growth in situ. We compared growth across multiple sites with known differences in seawater chemistry and temperatures, and tested the effect of adding crushed shell to sediment on seawater chemistry and growth. We hypothesized that growth would be limited by high temperatures and low aragonite saturation state (Ω_{ar}) in bottom water and sediment porewater. In summer 2022, seawater temperatures differed by site, and Ω_{ar} was variable. Survival was low at the South site, but growth did not significantly differ between the South and North sites. In fall 2022 to spring 2023, seawater temperatures were similar but Ω_{ar} was lower at the South site. Growth was lower at the South site. In both experiments, shell hash increased Ω_{ar} of sediment porewater at the North site, but there was no evidence of a positive effect of shell hash treatment on growth. These patterns of growth are consistent with a negative effect of seawater Ω_{ar} on surfclam growth. We discuss the use of a lab-based growth model in evaluating the effect of environmental variables on growth.

AQUACULTURE IN SHARED WATERS: 10-YEAR IMPACTS OF AN ENTREPRENEURIAL TRAINING PROGRAM

***Jaclyn Robidoux*[1], Sebastian Belle[2], Nick Branchina[3], Hugh Cowperthwaite[3], Chris Davis[4], Annie Fagan[5], Teresa Johnson[6], Annie Langston Noll[4], Dana Morse[5], Jess Veo[6], Gayle Zydlewski[7]**
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Aquaculture in Shared Waters (AQSW) originated in 2013 as a community-based training program to help Maine fishermen develop aquaculture businesses as a means of diversifying their income on the water. Ten years later, the program has offered 13 total courses and served several hundred fishermen, working waterfront professionals, and aquaculture entrepreneurs. Developments of this training program have paralleled the growth of the aquaculture industry in the state of Maine, and AQSW has earned national recognition as a leading aquaculture training model. Stewarded by several collaborating organizations, AQSW has expanded to include new audiences, formats, curriculum, and technology to address emerging needs. Meanwhile, ten years of associated social science research gives insight into the changing demographics of the aquaculture industry and current needs in aquaculture workforce training and business development. This presentation will dive into the history of this long-standing program, chronicle its impacts, and offer reflections on the program that will help inform and advance future aquaculture training efforts.

SEAWEED FARMER FORUM

Jaclyn Robidoux[2], Liz MacDonald[1], Robbie Hudson[3]
[1] Atlantic Sea Farms, Biddeford, ME, [2] Maine Sea Grant, University of Maine, Orono, ME and
[3] Rhode Island Sea Grant, University of Rhode Island, Narragansett, RI

Join this farmer-focused session to hear from seaweed farmers from across the Northeast about their direct experience on the water and the ways in which they are navigating and building new opportunities in the developing seaweed sector. This session will feature three targeted 20-minute discussions on seaweed farm design, on-farm operations and production, post-harvest markets, with additional time for questions from the audience.

PANEL 1: Seaweed Farm Design: Seaweed farmers find success when farm design efficiency & productivity meet
Facilitator: Liz MacDonald[1]

Of all the aquaculture species currently farmed in Maine, seaweed farming has proven to be the easiest transition for fisherman, more specifically lobstermen, as it is cultivated in the lobster off-season, uses much of the same equipment as lobstering, and requires the same skill set. Atlantic Sea Farms partner farmers currently represent around 85% of the US cultivated kelp from Maine and more than 75% of the U.S. total production. In 4 years, ASF has recruited, provided technical assistance, free seed, and a buy-back guarantee to 34 partner farmers between Maine and Rhode Island. Of these farmers, no farm site or design is exactly the same. Farmers have been innovating their farm design to hit two key elements: efficiency & productivity. Since the seaweed farming fleet in New England follows the owner operated model of small boat family farmers, the equipment needs to be manageable for a 1 - 2 person crew to deploy, maintain and recover season to season while producing high quality crops. This requires access to gear that is off the shelf or better yet repurposed from other fisheries. This reduces the barriers of entry in cost, access to supplies especially for remote island communities, and familiarity and comfort with working the equipment. Long lines and grid systems are the two primary designs farmers have adopted for 4-8 acre farm plots on the East coast. Hearing the direct experiences from profitable, seasoned seaweed farmers should help inform others interested in expanding or starting their farming journey.

PANEL 2: Seaweed Farmer Forum: On-Farm Operations
Facilitators: Jaclyn Robidoux[1], Robbie Hudson[2], Liz MacDonald[3]

As a part of the seaweed farmer-focused panel, we'll talk with farmers from across the Northeast about their on-farm operations. From Maine to New York, the seaweed industry in each state is unique and significant differences in operations, scale, and production exist. As they say, if you've seen one seaweed farm… you've seen one seaweed farm. We'll learn from the folks on the water about their regional industries and what this means for each farm operation. As new tools and resources help us understand the state of seaweed production in the Northeast, we'll discuss with farmers how they navigate: seasonal workflow, vessels, labor, husbandry, and harvest.

PANEL 3: Seaweed Farmer Forum: Post-Harvest Markets
Facilitators: Jaclyn Robidoux[1], Robbie Hudson[2], Liz MacDonald[3]

In the final topic of the seaweed farmer panel, we'll discuss post-harvest markets with seaweed farmers from across the Northeast. Farmers are seeing their crops in a range of different products from high end dinner plates, pet and animal feeds, to cosmetics and bioplastics. We'll discuss with farmers about the ways in which they're getting their crop to buyers and end consumers in order to be profitable. This is a critical

link in the domestic seaweed supply chain where first-hand farmer experiences can benefit existing and prospective farmers to expand opportunities for the Northeast.

PRACTICAL RESOURCES FOR SEAWEED FARMS AND BUSINESSES

Jaclyn Robidoux
Maine Sea Grant, University of Maine, Orono, ME

Resources, reports, toolkits, and more! Over the past few years, a number of new resources and valuable tools have become available for seaweed farms and businesses as the sector has developed and expanded. Helpful to seaweed farmers, decision makers, and the seaweed curious alike, these "seed to sale" resources include business planning and management guides, production and benchmarking reports, and marketing and outreach toolkits. In this session, we'll cover the highlights and findings of these resources and explore how businesses and organizations can best utilize this new information.

STATE OF THE STATES: STATUS OF SEAWEED AQUACULTURE IN THE U.S.

***Jaclyn Robidoux*[1], Gabriela Bradt[2], Meg Chadsey[3], Mike Ciaramella[4], Anoushka Concepcion[5], Angee Doerr[6], Kai Fox[7], Melissa Good[8], Robbie Hudson[9], Joshua Reitsma[10], Theresa Talley[11], Barry Udelson[4]**
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Within the past decade, the U.S. has seen significant developments in seaweed production, with seaweed farming becoming the country's fastest-growing aquaculture sector (NOAA Fisheries). Across the U.S. and in the Northeast, there have been a growing number of farms, significant developments in supply chains and markets, and increases in landings, investments, and infrastructure. However, the seaweed industry in each state is unique, and considering these state and regional factors is critical to evaluating the potential of seaweed farming in the U.S. The State of the States is a state-by-state report of seaweed production in the U.S., compiled by Sea Grant extension specialists and updated annually. This resource includes baseline information like the number of farms, landings, post-harvest markets, and permitting for eleven active seaweed producing states including Alaska, California, Connecticut, Hawai'i, Maine, Massachusetts, New Hampshire, New York, Oregon, Rhode Island, and Washington.

THE SEAWEED MARKETING TOOLKIT: COLLABORATIVE MARKETING AND ACCESSIBLE TOOLS TO TALK SEAWEED WITH THE PUBLIC

***Jaclyn Robidoux*[1], Gabriela Bradt[2]**
[1]Maine Sea Grant, University of Maine, Orono, Maine; [2]New Hampshire Sea Grant, University of New Hampshire, Durham, New Hampshire

The Seaweed Marketing Toolkit provides seaweed farms, businesses, and supporters with digital tools and free resources to effectively market U.S. seaweed across platforms and audiences. The toolkit organizes public-facing, seaweed-specific marketing language into current primary marketing areas of focus (culinary, nutrition, environment, economy) and provides downloadable print and digital assets, like posters, social media images, seaweed photos and graphic elements, that seaweed businesses and support organizations can utilize and adapt to their marketing needs. The toolkit's marketing campaign, "Let Seaweed Surprise You", aims to inspire curiosity about seaweed from the public and to provide unified and consistent messaging for those working to build public awareness for seaweed and seaweed products. The toolkit is the result of the work of the Seaweed Hub Market Opportunities Workgroup, a national collaborative effort that has worked since 2020 to capture and organize current information about seaweed market challenges and opportunities across the U.S.

DEVELOPMENT OF AN EASTERN OYSTER HARVEST NUTRIENT CALCULATOR FOR THE NORTHEAST REGION

***Julie M. Rose*[1], Ryan Morse[2,3], Christopher Schillaci[4]**
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Shellfish aquaculture can provide a variety of ecosystem services beyond food production. Shellfish assimilate nutrients into their tissue and shell, and these nutrients are removed from a waterbody when animals are harvested. In some coastal environments where excess nutrients are causing water quality problems, this service provided by shellfish farms has been formally incorporated into nutrient management programs, and in a few cases farmers have even received payments for nutrient removal services.

Resource managers and industry members have indicated a need for a simple tool, backed by robust science, to predict nutrient removal by harvest of cultivated shellfish. We have synthesized available literature for eastern oyster farms across the Northeast region (North Carolina to Maine), and applied methodology used by the Chesapeake Bay Program to calculate nutrient removal at harvest. Variability in oyster tissue and shell nutrient content was low, and an assessment of farm location, ploidy, and cultivation practice (with vs. without gear) suggested that a single average value could reasonably be applied across all farms. Evaluation of variation in animal size and weight across these same factors is ongoing and will determine the number of farm input factors needed in the final tool. The harvest nutrient calculator tool will be freely available online, and a preview of the tool will be provided in this presentation. Data gaps will be identified, and data needs for the creation of similar tools for other species and other regions will be discussed.

3-DIMENSIONAL CULTIVATION OF OYSTERS AUTOMATED WITH SOLAR TUMBLING

***Luke Saindon*[1], Aaron Waldman[2]**
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TWIYO (The World Is Your Oyster, Wiscasset, ME and Brooklyn, NY) has been developing a threedimensional oyster cultivation raft that incorporates automated, solar-powered cleaning and tumbling of American Oyster (Crassostrea virginica). TWIYO is referring to this approach as 3D-COAST (3-Dimensional Cultivation of Oysters Automated with Solar Tumbling). Oyster baskets are hung on vertical, rotating, conveyor belt-like mechanisms that cycle the baskets through the water column and into the air. A

solar panel system runs this mechanism which, through the cyclic movement, provides gentle tumbling action to improve oyster shape and quality, and cages are exposed to the sun for several hours each day at the top of the cycle to help reduce bio-fouling. 3D-COAST is a modular raft system that will be scalable and easy to use for new and established aquaculture operations. The system has been allowing TWIYO to work toward farm profitability sooner and with greater margin by increasing growing density and reducing costs per oyster. The system is currently in early stages of development with a preliminary prototype first deployed during the summer of 2023. Design information, fabrication processes, troubleshooting, images, lessons learned, and projected production specifications for this prototype will be shared during the presentation as a form of progress report on the development process. By openly sharing our experiences with the technology as well as the design itself, TWIYO hopes to enable new and established farms alike to experiment with this new approach.

ISOLATION, SCREENING, AND SELECTION OF POTENTIAL PATHOGENIC AND PROBIOTIC BACTERIA FROM BIVALVE SHELLFISHES

***Jaypee S. Samson*[1,2], Katrina Kulesh[1], David C. Rowley[3], David Nelson[4], Marta Gomez-Chiarri[1]**
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Disease management is essential for successful hatchery production of bivalve shellfish. Bacterial infections, particularly those caused by strains belonging to the genera *Vibrio* and *Aeromonas*, cause rapid mortality of larvae, with disastrous repercussions for both hatcheries and farmers who rely on them. In this study, we aimed to isolate and identify potential pathogenic and probiotic microorganisms in bivalve shellfish farms and hatcheries.
A total of 108 bacterial isolates were isolated from water, algae, and larval samples from different farms and hatcheries. The isolates were screened for their antimicrobial activity against two shellfish bacterial pathogens and 33 of them showed antagonistic activity against *Vibrio parahaemolyticus* PSU5579 while 30 against *Vibrio coralliilyticus* RE22. Their hemolytic activity was tested, and isolates were identified by 16S sequencing. There are 20 genera identified, and *Vibrio* is the most abundant (38 isolates) followed by *Pseudoalteromonas* (28 isolates) and *Alteromonas* (21 isolates).

The isolates that showed potential pathogenic and probiotic were selected; and five *Vibrio* spp. isolates tested in the hemocyte viability assay showed comparable LC50 (10^7 CFU/mL) to *V. coralliilyticus* RE22 while 11 isolates showed larval killing on the larval assay. This suggests that there might be a difference in the pathogenicity of the isolates. The lowest relative percentage survival was observed in larvae challenged by *Vibrio fortis* CH6 (0%), *Vibrio neptunius* DEN11 (0%), and *V. coralliilyticus* RE22 (0.88%). The selected isolates will be further analyzed for their pathogenic and probiotic activities.

ARE YOUR OYSTER LARVAE STARVING? SYMPTOMS AND POSSIBLE CAUSES FOR AN EMERGING OYSTER LARVAL DISEASE SYNDROME.

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Holdings, Inc., 425 Callis Wharf Road, Hudgins, VA 23076 USA; [5]Fishers Island Oyster Farm, Inc., P.O. Box 402, Fishers Island, NY 06390 USA

Successful hatchery production is the foundation of much of the shellfish aquaculture production of the North American East Coast. Understanding the cause of hatchery failures is critical to identify solutions and ensure that shellfish aquaculture is sustainable. In 2020, a troublesome new syndrome presented in young oyster larvae at a hatchery in Maine, resulting in production failures which decreased seed output. Delayed in development and often moribund, affected larvae displayed pale digestive glands suggesting failure of digestion despite a stomach full of microalgal food. The signs reappeared in 2021, demonstrating the syndrome's persistence. Similar signs were observed in hatcheries across a wide geography, with reports of larvae not digesting their food, and therefore not growing, at facilities in Maine, New York, and Virginia. Preliminary larval bioassays conducted at Mook Sea Farm in Maine, coupled with lipidomic analyses at UC Berkeley, California, demonstrated a link between the pathological signs and toxic phytoplankton byproducts (oxylipins) in hatchery water. Oxylipins are an oxidative byproduct of polyunsaturated fatty acids, which are produced by some phytoplankton in response to stress such as grazing. Current research including three East Coast hatcheries and experts in pathology and lipidomics is underway to help expand our knowledge of this new emerging oyster larval disease syndrome. Through partnerships between industry and academia, this research strives to understand this new but persistent disease, increase awareness along the East Coast, and identify mitigation technology to avoid or minimize symptoms with the overall goal of improving product yield.

COMMUNICATING BENEFICIAL SERVICES PROVIDED BY SHELLFISH AQUACULTURE WITHIN THE AQUACULTURE PERMITTING AND REVIEW PROCESS

***Christopher Schillaci*[1], Julie M. Rose[2], Zachary Gordon[2], Ryan Morse[3]**
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Shellfish aquaculture operations can provide a variety of beneficial environmental services. Cultured shellfish have been increasingly incorporated into nutrient management strategies due to their ability to assimilate nutrients into their tissue and shell. Shellfish aquaculture gear also creates complex structure, and a variety of recreationally and commercially important fish species have been observed exhibiting habitat-related behaviors such as foraging, shelter seeking, and reproduction around aquaculture gear. Other environmental, economic, and social benefits associated with shellfish aquaculture have also been documented.

We will discuss the results from initial outreach with resource managers to share information on growers can best relay information on the benefits associated with nutrient and habitat provisioning from shellfish aquaculture for inclusion in the shellfish aquaculture in the aquaculture permitting and review process.

INTEGRATING INFORMATION ON BENEFICIAL SERVICES PROVIDED BY SHELLFISH AQUACULTURE INTO THE AQUACULTURE PERMITTING AND REVIEW PROCESS

***Christopher Schillaci*[1], Julie M. Rose[2], Renee Mercaldo-Allen[2], Zachary Gordon[2], Paul Clark[2], Stephen Kirk[3], Lisa Milke[2], Ryan Morse[4]**
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Conservancy Massachusetts Chapter, 20 Ashburton Place, Suite 400. Boston, MA 02108; [4]CASE Consultants International, 1 Haywood St Suite 451, Asheville NC 28801

Shellfish aquaculture operations can provide a variety of beneficial environmental services. Cultured shellfish have been increasingly incorporated into nutrient management strategies due to their ability to assimilate nutrients into their tissue and shell. Shellfish aquaculture gear also creates complex structure, and a variety of recreationally and commercially important fish species have been observed exhibiting habitat-related behaviors such as foraging, shelter seeking, and reproduction around aquaculture gear. Other environmental, economic, and social benefits associated with shellfish aquaculture have also been documented.

Despite the growing body of evidence that aquaculture can consistently provide beneficial services, the current aquaculture permitting framework largely focuses on possible adverse effects to various environmental and socioeconomic factors. Engagement with resource managers suggests this is likely because adverse effects are often easier to quantify and document than beneficial effects, and variability in aquaculture production practices can limit managers ability to make defensible assumptions on the types and extent of beneficial effects a proposed operation may provide. In addition, not all aspects of the current aquaculture review/permitting framework allow for, or easily lend themselves to, a synergistic evaluation of adverse and beneficial effects during the aquaculture review/permitting process.

We will discuss the results from initial outreach with resource managers to share information on existing regionally-relevant research and literature related to nutrient and habitat provisioning from shellfish aquaculture and data gaps, and the existing regulatory mechanisms and the types of tools/end-products that may support greater consideration of beneficial services associated with shellfish aquaculture in the aquaculture permitting and review process.

FISH PRODUCTION AND USE OF OYSTER AQUACULTURE GEAR IN COMPARISON TO NATURAL HABITATS NORTH AND SOUTH OF CAPE COD

***Kelsey Schultz*[1], Randall Hughes[1], David Kimbro[1], Stephen Kirk[2], Julie M. Rose[3], Renee Mercaldo-Allen[3], Paul Clark[3], Gillian Phillips[3], Dylan Redman[3], Jonathan Grabowski[1]**
[1]Marine Science Center, Northeastern University, 430 Nahant Rd., Nahant, MA 01908; [2]The Nature Conservancy, 20 Ashburton Place, Boston, MA 02108; [3]NOAA Fisheries, Northeast Fisheries Science Center, Milford Laboratory, 212 Rogers Ave. Milford CT 06460

The degradation of natural oyster reefs has led to increased restoration over the past several decades aimed at recovering lost ecosystem services. Yet, oyster restoration can be expensive; moreover, with ~85% of oyster reefs lost globally, innovative strategies are needed to recover lost services. Recent studies have indicated that bivalve and seaweed aquaculture may provide similar ecosystem services, and thus can serve as a substitute for oyster reef restoration and help facilitate ecosystem recovery. The artificial structures used in bivalve aquaculture can lead to richer ecological communities, supporting numerous trophic levels not only on the aquaculture gear, but also in the surrounding area. To investigate the ecosystem services associated with oyster aquaculture and potentially help reduce barriers to expansion, we quantified fish and crustacean use of aquaculture gear in comparison to natural benthic habitats. These studies occurred at Cotuit Oyster Company, Cotuit, MA and Island Creek Oysters, Duxbury, MA from May-October of 2019-2021. Three different aquaculture gear types as well as two natural habitats were examined with the use of underwater cameras to determine if each gear type (1) augments nekton densities above unstructured habitat and (2) functions similar to oyster reefs and rocky intertidal habitat. Commercially and recreationally important species were observed at both sites. Aquaculture gear had higher fish and crustacean visitation rates than surrounding natural habitats, including several species of juvenile fish. These results suggest that

aquaculture gear may serve similar functions as essential fish habitat, which can help resource managers make more informed permitting decisions.

ENGAGING YOUTH IN AQUACULTURE EDUCATION

Carla Scocchi[1], Melissa Malmstedt[2]
[1]University of Maine Cooperative Extension– 4H, 491 College Avenue, Orono ME 04473; [2]University of Maine Center for Cooperative Aquaculture Research, 33 Salmon Farm Road, Franklin, ME 04634

Dive into an immersive aquaculture learning experience with Carla from UMaine Cooperative Extension 4-H and Melissa from UMaine Center for Cooperative Aquaculture Research. Explore hands-on curriculum from the nationally-recognized 4-H Aquaponics Project, an innovative workforce development program designed to harness youth interests in fish and horticulture to cultivate real-world skills applicable to the aquaculture industry. In this dynamic workshop, participants will engage in hands-on activities to construct a mini-aquaponics system and take a virtual field trip through UMaine's Center for Cooperative Aquaculture Research using state-of-the-art virtual reality tools. Walk away from the session equipped with lesson plans and innovative ideas for integrating aquaculture into your teaching and learning setting. Participants will also have the chance to win an aquaculture-themed prize!

FEDERAL CROP INSURANCE OPTIONS FOR AQUACULTURE

Alexander Sereno
USDA Risk Management Agency, 4405 Bland Road, Suite 160, Raleigh, NC 27609-6293

An overview on current Federal Crop Insurance programs for aquaculture and discussion on current efforts by the Risk Management Agency to provide more coverage for aquaculture.

MAKING YOUR MESSAGE COUNT: RESEARCH, RESOURCES, AND FUNDING TO ENHANCE PUBLIC UNDERSTANDING OF AQUACULTURE

Brianna Shaughnessy
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From the sustainability of products and industry processes, to food safety and security, the aquaculture industry is faced with many challenges in communicating complex topics to the communities they serve. Topics that require expertise from a variety of disciplines for more effective communication. Evaluations of content delivery mechanisms, public opinion surveys, and public comments, suggest that improving public understanding of aquaculture topics can increase consumer acceptance of industry expansion, as well as confidence in aquacultured products. Moreover, informed individuals are not only passive receivers of information, but also capable and influential participants in resource development and industry progress. In this talk we will take a tour of some of the overarching themes emerging out of recent communications and perceptions research, and discuss the value of connecting across sectors to develop and share accurate, up-to-date, and consistent aquaculture messaging toolkits. We will also share information about how to apply to the eeBLUE Aquaculture Literacy mini-grant funding opportunity, and the accomplishments of the inaugural cohort, who partnered across sectors to enhance public understanding of aquaculture in their communities. Altogether, this work suggests that facing aquaculture’s communication challenge will require a combination of more salient messaging strategies and engagement across sectors with trusted messengers of information.

BUILDING RELIABLE KELP SEED SUPPLY CHAINS USING GAMETOPHYTE CULTURES

***Toby Sheppard Bloch*, Michelle Stephens, Maggie Aydlett**
GreenWave, New Haven, CT USA

GreenWave, a 501c-3 nonprofit organization headquartered in south central Connecticut, has been producing sugar kelp seedstring in its New Haven facility since 2016. GreenWave's original seed production facility was based, in part, on the recommendations of the 2013 Kelp Farming Manual produced by Ocean Approved (Flavin, Flavin, and Flahive) and the seminal work of Dr. Charles Yarish and his lab at the University of Connecticut, Stamford. The Ocean Approved/Yarish technique was to collect wild sorus material, extract meiospores and inoculate seed string to initiate production. In 2022 GreenWave piloted the use of gametophyte cultures for commercial production of seed, generating 3,200 feet of seed string that were outplanted in the Long Island Sound and produced yields of up to 29 pounds a foot. In addition to industry leading yields, gametophyte production decouples seed from sourcing wild sorus, allowing kelp nurseries to align seed production with the optimal outplanting windows. In 2023 GreenWave scaled gametophyte production, produced seed with lower risk of contamination, and provided farmers with high quality seed earlier than is possible with meiospore methods. This presentation will share results from phase one and two of GreenWave's gametophyte culturing pilot.

POPULATION ADAPTATION OF ATLANTIC SURFCLAMS, *SPISULA SOLIDISSIMA SOLIDISSIMA*, TO OCEAN ACIDIFICATION AND PHYTOPLANKTON AVAILABILITY

Katyanne Shoemaker[1], Matthew Poach[1], Shannon Meseck[1], Daniel Hennen[1], Matthew Hare[2]
[1]NOAA Northeast Fisheries Science Center; [2]Cornell University

The US Atlantic surfclam (*Spisula solidissima solidissima*) fishery generates $20 to $30 million of revenue yearly and 1000s of jobs. Laboratory work has indicated that surfclams are susceptible to climate change; however, these studies focused on a single environmental driver changing – ocean acidification. Recent studies suggest that in a dynamic environment with constantly changing food availability, oxygen, and temperature, the role of ocean acidification is complex. Recently, two sympatric but genetically-distinct populations of the Atlantic surfclam have been identified in New York and Massachusetts. Preliminary data suggests that these subpopulations may be growing differently even when occupying the same habitat. Understanding how each subpopulation responds to ocean acidification and if adaptation/acclimation is occurring may be important to surfclam population dynamics and help maintain a viable Atlantic surfclam fishery. This new project will use a combination of laboratory and field methods to characterize how each subpopulation is responding to climate change by: 1) measuring carbonate chemistry and environmental differences (temperature, salinity, dissolved oxygen, and phytoplankton diet) at sites where each subpopulation is the dominant taxon, 2) assessing differences in the response of the subpopulations when exposed to OA-related stress conditions, and 3) determining survival and growth of larvae in-situ at field sites. Through the combined use of laboratory and field experiments working with larval, juvenile, and adult life stages, this project aims to better understand phenotypic plasticity in the context of cryptic subpopulation genotypic diversity.

CONSUMER PERSPECTIVES ON A VALUE-ADDED, MARINATED MUSSEL PRODUCT

***Denise Skonberg*, Sara Gundermann**
School of Food and Agriculture, University of Maine, Orono, ME 04469 USA

In New England, farm-raised mussels are commonly sold live in mesh bags. Product diversification at the retail level has the potential to expand markets and increase profitability for growers. The objectives of this study were to 1) understand consumer perspectives on a new product concept: marinated, refrigerated, heat-n-eat mussel meats, and 2) test the consumer acceptability of the marinated mussels reheated using different methods. The shucked mussel meats were cooked in the marinade by the sous-vide process, which reduces toughening and lipid oxidation, and helps to retain flavor of cooked muscle foods. Eighty-two participants provided feedback on the product concept and its sensory acceptability. Three different samples were presented to the participants, who used a 9-point hedonic scale (1= dislike intensely, 9 = like intensely) to rate appearance, aroma, flavor, texture, and overall liking. Panelists were also asked about their mussel consumption habits and their opinions about a product concept statement. Although 37% of participants indicated that they consume mussels six or more times per year, only 22% said they purchased mussels from the store with the same frequency. Thirty percent of participants reported that they do not purchase mussels from the store at all, which may be due to lack of familiarity with live product, however, specific reasons were not provided. Convenience with regard to home food preparation was rated as important by 66% of participants. There were no significant differences in hedonic scores among treatments, with reheated samples receiving overall liking scores of just under 7 (like moderately). Eighty-three percent responded that they would be "somewhat" or "extremely" likely to purchase this product, and the majority would reheat the product in a saucepan. Although there were some concerns about mussel texture, marinade flavor, and packaging, this proof-of-concept work suggests that consumers would be receptive to a convenient, heat-n-eat mussel product. Future work should investigate different sous-vide cooking conditions and marinade flavor preferences with a larger consumer panel. Research to understand the primary constraints to more frequent mussel consumption would also be useful for targeted development of sous-vide cooked and marinated farm-raised mussels at the retail level.

EARLY STAGES OF IMPLEMENTATION OF GENOMIC SELECTION IN THE EASTERN OYSTER, *CRASSOSTREA VIRGINICA*

***Jessica Small*[1], Klara Verbyla[2], Peter Kube[2], Stan Allen, Jr.[1]**
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Advances made through family breeding at ABC have yielded substantial gains in economically-important traits for *Crassostrea virginica.* Genetic gains are transferred to the commercial industry through production of two family-based broodstock lines derived from top families for improved performance in low salinity (LS), low disease-pressure environments (LILY line) and moderate salinity, high disease pressure environments (HNRY line). Pedigree-based breeding has limitations, however, utilizing estimated breeding values (EBV) calculated as an average value for the family as a whole, thereby possibly under- or over-estimating the breeding potential of individuals. It also relies on assumed genetic relationships based on believed coancestry. In contrast, genomic selection calculates more accurate breeding values and relationships through genotyping. Through combined efforts of the East Coast Oyster Breeding Consortium members, a 66K SNP array has been developed specifically for east coast oyster populations. ABC has utilized this tool to genotype over 4,700 oysters, (531 parents, 3073 progeny) from 4 years of family production and testing. In spring 2023, genomic selection was used for the first time to calculate genomic estimated breeding values on broodstock candidates, initially selected based on high EBV. The spread of GEBVs within families indicated a high degree of genetic gain is possible using genomic selection over pedigree-based approaches. To test this, spawns were executed to create 57 high salinity, 57 low salinity and 5 low-ranked GEBV families. Field trials of these families, to be assessed in fall 2024, will be the first step in validation of realized gains associated with genomic selection.

EXPLORING TECHNIQUES FOR GAMETOPHYTE BASED HUSBANDRY, ALTERNATIVE SETTLEMNT SUBSTRATES, AND ACCELERATED SPOROPHYTE DEVELOPMENT FOR NURSERY OPTIMIZATION AND RESILIENCY IN KELP AQUACULTURE

***Adam T. St. Gelais*[1], David S. Bailey[3,4], Scott Lindell[3], Maggie R. Aydlett[3,4], Tobias Dewhurst[5], Damian C. Brady[1,2]**

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Domestic seaweed aquaculture, specifically of kelp species, is growing in the United States with focal areas emerging in the states of Maine and Alaska, currently producing primarily Sugar Kelp (*Saccharina latissima*). While the structure, scale, and end uses of kelp produced in each of these regions are likely to differ, significant scaling is likely to occur in both regions. Recent baseline technoeconomic analyses of at-scale kelp farming in the Gulf of Maine suggest that a large portion of costs associated with production occur at the nursery stages using current approaches. These scale-driven costs constraints will likely apply to Maine, Alaska, and other developing production regions as well. Innovation and optimization of nursery production to decrease costs of operation as well as increase performance and predictability of seed is needed to ensure sustainability and resiliency in the sector. Acceleration and operationalization of Gametophyte-based husbandry could allow for decoupling current reliance of wild harvested sorus tissue, smoothing concerns of timing and availability, and increasing resilience of the industry. However, this technology has not been deployed on a commercial scale in the US seaweed farming industry. We take diversified approach towards nursery optimization including 1) Gametophyte-based (GPB) husbandry utilizing small volume replicated photobioreactors, 2) Exploration of alternative settlement substrates and 3) Acceleration of sporophyte development (decreasing time to deployment). Preliminary results, ongoing research, and future directions are discussed.

GROWTH, PHYSIOLOGY, AND SURVIVAL OF THE ATLANTIC SURFCLAM Spisula solidissima: OFF-SHORE AQUACULTURE AND MULTI-STRESSOR LABORATORY EXPERIMENTS

***Laura Steeves*[1], Molly Honecker[2], Sam Martin[3], Shannon Meseck[4], Daphne M. Munroe[1]**

[1]Haskin Shellfish Research Laboratory, Department of Marine and Coastal Sciences, Rutgers, The State University of New Jersey, New Jersey 08349; [2]Duke University, Marine Science & Conservation, Durham, North Carolina, 27708; [3]Atlantic Capes Fisheries, Cape May, New Jersey 08204; [4]NOAA Fisheries Service, Northeast Fisheries Science Center, Milford, CT 06460.

The Atlantic surfclam (*Spisula solidissima*) is an economically important species, being the most fished clam species by weight in the United States. Growing surfclams in aquaculture farms presents an opportunity to support surfclam production with a unique product that would not compete with fished surfclam (i.e., a steamer sized clam ~55mm). Although aquaculture farms are often established in protected coastal areas, farming in the open ocean presents an opportunity to farm shellfish where space is less competitive, water quality is often higher, and where species naturally occur. 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. This fall we deployed over 200,000 seed size surfclams (~15mm length) at five different stocking densities in four novel growout cages in federal waters off the coast of Atlantic city. This year, we will monitor the growth and survival of these clams while collecting a timeseries of environmental data within the cages (e.g., pH, temperature, salinity, oxygen). Further, to examine how changing ocean conditions in potential aquaculture areas may impact surfclam survival and growth rates,

we will use laboratory experiments to observe surfclam performance at ambient and stressful levels of temperature and carbonate chemistry (reflective of ocean acidification). This research will provide information about the potential to produce surfclams in offshore aquaculture farms, and the ability surfclam to survive and grow in changing oceanographic conditions.

PERSPECTIVES ON BIODIVERSITY AND GENETIC DIVERSITY FOR ADAPTATION IN SHELLFISH AQUACULTURE

Sheila Stiles
U.S. Department of Commerce, National Oceanic & Atmospheric Administration, National Marine Fisheries Service, Northeast Fisheries Science Center, Milford Laboratory, 212 Rogers Ave., Milford, CT.

Concepts of biodiversity and genetic diversity are relevant to understanding, addressing, and managing fisheries, including effects of factors, such as climate change, sea level rise, and ocean acidification. In addition, recent reports and articles have highlighted the roles of biodiversity and genetic diversity relative to fisheries, including adaptation in shellfish aquaculture. Aquaculture, which is valued at billions of dollars globally, has become increasingly significant as the wild fisheries that include economically and ecologically valuable shellfish have remained static. For example, some populations of oysters, clams, scallops and mussels, have declined or been inconsistent in abundance, while human consumption has increased. Biodiversity and genetic diversity measures, through sequencing, have been recommended to identify and assess the status of these stocks and populations, and to improve traits such as survival and growth through selective breeding for aquaculture. In this presentation, a sustained aquaculture genetics research effort on shellfish encompassing basic approaches to increase sustainability and resilience, will be described, reviewed and discussed with shellfish as model organisms. In addition to breeding and genomics, which are combined in marker-assisted selection (MAS) to improve performance of cultivated populations, a third component of this genetics effort involves collaborations with industry to test and supply seed and interactions with other stakeholders for different perspectives with consideration of underrepresented groups. These examples also are reviewed in another context of diversity, which is an overarching component of adaptation and survival that benefits populations and species.

EXPANDING NORTHEASTERN US GREEN SEA URCHIN AQUACULTURE PRODUCTION AND THEIR POTENTIAL TO REDUCE BIOFOULING OF SHELLFISH

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The green sea urchin (GSU), *Strongylocentrotus droebachiensis*, is an economically important species in the Northeastern US, with production primarily based in Maine. The fishery has dramatically declined since the 1990s, but the demand for GSUs has increased. GSUs can be grown in open water in a wide range of gear types either alone, in polyculture with shellfish or algae or as part of integrated multi trophic aquaculture systems. They are a high value luxury seafood product and global and national demand is unmet creating an opportunity for aquaculture. This talk will overview project efforts working towards expanding the emerging aquaculture industry. These include optimizing hatchery production methods, outreach to increase the awareness of seed availability, and facilitating uptake by providing new growers with seed and technical support for experimental growth to market. Sea urchins also offer a low trophic solution towards

reducing nuisance shellfish biofouling species through polyculture. Biofouling can prevent shellfish from reaching their full growth potential by >30% and sea urchins can reduce this fouling through grazing. This talk will include an overview of a new project partnering shellfish growers, hatchery producers and researchers on the use of GSUs for reducing biofouling on various shellfish species. This work is funded by the US Department of Agriculture's Northeast Sustainable Agriculture Research and Education, National Institute of Food Agriculture, and the Northeastern Regional Aquaculture Center.

DEVELOPMENT OF ENVIRONMENTAL CONDITIONS FOR ENGINEERING DESIGN OF A CONTINUOUS MUSSEL FARM IN NEW ENGLAND OFFSHORE WATERS

Richards C. Sunny[1], *David W. Fredriksson*[2], Longhuan Zhu[2], Igor Tsukrov[2], Michael Coogan[2], Michael Chambers[2]
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Sustainable aquaculture in nearshore waters faces formidable challenges, including stakeholder conflicts, coastal environmental pollution, and spatial constraints. As a potential solution, offshore aquaculture farms have emerged; however, their successful implementation hinges on robust engineering design to withstand extreme weather conditions. This study addresses the engineering aspects of offshore aquaculture farms by leveraging historical waves and current data from New England offshore waters, thereby providing valuable regarding feasibility and resilience. To assess the feasibility of offshore aquaculture in New England, we collected and analyzed historical wave and current datasets and employed advanced statistical techniques to establish return period statistics. The return period statistics formed the basis for a joint probability distribution of significant wave heights and current speed. Offering a comprehensive representation of the environmental conditions for offshore aquaculture farm engineering with the joint probability distribution function, the probability of failure for offshore aquaculture systems can be quantified, aiding in risk assessment and management. In summary, this study provides a comprehensive perspective on the engineering resilience of offshore aquaculture farms in New England offshore waters. By integrating historical data, advanced statistical methods, and finite element modeling, our research contributes to the development of sustainable aquaculture practices, ensuring their viability and success in the face of environmental challenges.

ESTIMATING THE PROBABILITY OF FAILURE OF MUSSEL FARM'S COMPONENTS IN NEW ENGLAND OFFSHORE WATERS USING NUMERICAL MODELING

Richards C. Sunny[1], David W. Fredriksson[2], *Longhuan Zhu*[2], Igor Tsukrov[2], Michael Coogan[2], Michael Chambers[2]
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Offshore aquaculture has been emerging as a potential solution for sustainable aquaculture, yet it necessitates intricate engineering analysis and driven design to withstand harsh offshore conditions, which include storm waves and currents. This study focuses on addressing mussel farm design challenges in New England offshore waters with numerical models to understand structural response and estimate component probability of failure. The approach includes developing return period statistics for waves and current for numerical model load cases. The numerical model simulations were performed at different growth stages

using a validated finite element software. The study includes results from three distinct mussel growth phases, with geometric and material properties of structural components obtained from literature and experimental sources. The hydrodynamic coefficients for the mussel droppers used in the simulations are derived from computational fluid dynamic modeling conducted in OpenFOAM. A statistical approach is proposed aimed at estimating the probability of failure for offshore mussel farm components within a specific time. This approach utilizes a joint probability density function with significant wave height and current speed and as key variables. Probability of failure for components, based on a given breaking strength and residual breaking strength, is determined by integrating the area within the joint probability density function where the interpolated breaking load of the components from the simulation exceeds the residual strength.

NOVEL CULTIVATION TECHNIQUE FOR A COMMON SPECIES: *ULVA LACTUCA*

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Sea lettuce (*Ulva lactuca*) is a transglobal species with a high protein content that is appealing for human consumption. To our knowledge, this species has never been commercially cultivated in North America. Novel nursery and ocean cultivation techniques for *Ulva lactuca* were developed at Atlantic Sea Farms. These techniques were developed within the natural life cycle pattern of spore release aligning with the lunar cycle. Across three lunar cycles, the largest sporophyte releases occurred at the new moon. In addition, new spore release methods were developed, including a slurry spore release where fragmented *Ulva* blades in a slurry were used to induce sporing, and also a deprived spore release was developed where *Ulva* blades were withheld from light, nutrients, and water movement to induce sporing. New line-seeding methods were also developed, including slurry seeding and mature *Ulva* seeding. Different regimes of light and nutrients were examined for the development of standards for ideal nursery conditions for sea lettuce, demonstrating that light was the most significant factor in *Ulva lactuca* growth. Growth substrate experiments yielded that the best nursery substrate for sea lettuce was a wider yellow nylon twine when compared to industry-standard twine, biodegradable string, and direct seeding onto rope. This research has the potential to inform the seaweed farming industry of the best nursery growth conditions in order to begin the cultivation of sea lettuce in the Gulf of Maine.

DELIVERING FOR YOUR BUYERS: USING APPROPRIATE TECHNOLOGIES TO SIMPLIFY OPERATIONS AND DELIVER SAFE SEAFOOD WITH A STORY

Chip Terry
BlueTrace, Castine, ME

All seafood operations face rising regulatory compliance challenges at the state, federal and global level. Although well intentioned, and in many cases well executed, these regulations place a paperwork burden on all stages of the seafood supply chain–tags and logs are just the tip of the iceberg. The alphabet soup of regulations is daunting: NSSP of the ISSC, FDA FSMA, SIMP, DFO, CFIA, Prop 65, SAFIS/Landing Reports, HACCP…The list could go on. See our primer below.

Your buyers simply want safe food delivered in a way that makes it easy for them to sell.

At the same time, oyster farmers have pioneered the Seafood-with-a-Story branding by bringing to consumers the often compelling stories of their farms, families and products. Consumers love to know where a product comes from and have proved willing to pay more for a product with a story.

There are a number of solutions out there to help growers meet these rising needs with modern technology like cell phones, QR codes, and cloud computing. Although BlueTrace offers one such solution, we are not the only one. This will be a review of the options and how to make an informed decision on what (if anything) you need.

AN UPDATE OF THE SUFFOLK PROJECT IN AQUACULTURE TRAINING (SPAT)

Kim Tetrault
Cornell Cooperative Extension of Suffolk, New York, 3690 Cedar Beach Road, Southold, NY 11971

The Suffolk Project in Aquaculture Training (SPAT) program is entering its 24th year and has a current membership of 350 families throughout Long Island, New York. The program maintains active shellfish hatchery, nursery and grow out systems and produced an excess of 2 million oysters each year. Year- round activities are available to SPAT members including weekly open workshops, a monthly lecture series and numerous events including Shellabration and the SPAT family picnic. SPAT is one of the few community gardening programs that allow members to grow 1000 oysters each year for their personal consumption (no selling allowed). The program has 3 community garden locations and allows for waterfront homeowners to grow shellfish at their docks in certified waters. SPAT has been instrumental in the inception of 17 local commercial oyster farms.

AQUACULTURE NEEDS ASSESSMENT AT MINORITY SERVING INSTITUTIONS

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Aquaculture is a rapidly growing sector in the US, which provides the opportunity to build inclusivity and diversity practices directly into its growth. To meet industry demand for a trained and educated workforce, it is necessary that development opportunities are supported in a way that benefits communities in the most productive fashion. To move towards this goal, a needs assessment of aquaculture and related education programs at Minority Serving Institutions (MSIs) was conducted to ascertain current capacity regarding aquaculture, goals for maintaining or expanding aquaculture, and what is needed to achieve those goals. Meetings were conducted with MSI faculty and staff to discuss these questions, and to ensure sufficient information was collected to inform future engagement efforts. Preliminary findings point to the importance of meeting student needs to learn about and participate in aquaculture education, supporting outreach about career and networking opportunities, and providing funding opportunities that use inclusive language to ensure a broad applicant pool. Another key piece of information that needs to be considered for those that wish to increase their engagement with MSIs is to not only understand the history of each MSI designation and what that means for students, but also to understand how each institution fits into society at large. Understanding this context is an important step in improving sustained engagement with MSIs.

THE INTERSECTION BETWEEN ANGEL INVESTMENT, BLUETECH, AND ENVIRONMENTALLY RESPONSIBLE AQUACULTURE

Matt Thompson[1], Luke Sawitsky[2]
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New England, particularly the Greater Boston area, is a hotbed of innovation in the blue technology space ("bluetech", which is novel technology that can support responsible ocean uses) and primed to address some of the most significant challenges to achieving responsible aquaculture both regionally and globally. Investment capital in this space, however, remains limited and maybe missing opportunities to scale startups with novel aquaculture solutions. SeaAhead and the New England Aquarium's EDA Capital Challenge funded UpSwell program aims to close this gap through a series of whitepapers and education tools for angel investors focused on specific challenge-opportunity areas, including those related to responsible aquafeed and AI in aquaculture. Panelists will introduce the UpSwell program and the findings of its aquaculture whitepapers, while industry leaders will provide their views on the challenge-opportunity space and provide recommendations for future startups. This session will benefit investors, entrepreneurs, innovators, and industry looking for opportunities in scaling responsible aquaculture.

GREAT LAKES AQUACULTURE DECISION-MAKER DAY: AN EVENT BRINGING STATE LEGISLATORS TO MEET WITH AQUACULTURE FARMERS & TOUR A FARM

Barry Udelson
New York Sea Grant, 500 Development Drive, Innovation & Discovery Center, Stony Brook University, Stony Brook, NY 11794

The aquaculture industry in New York stretches from the Great Lakes watershed to the marine waterbodies of Long Island. There is significant room for New York's industry to grow and expand, but it has been facing challenges and limitations that have restricted its growth, like issues in other states. Sea Grant's Great Lakes Aquaculture Collaborative (GLAC) has created an opportunity to bring legislators to aquaculture farms and highlight some of these industry issues. The events, known as "Great Lakes Aquaculture Decision-Maker Day", are individually organized by the Great Lakes Sea Grant programs. The objective is to invite legislators from districts with aquaculture farms or members of relevant legislative committees (*e.g.,* agriculture, economy, etc.) to the event. Additional farmers were invited to speak about their operations, the economic value their businesses have to the state and the challenges that they face.

New York's event was held at Local Coho, located in Auburn, which uses a recirculating aquaculture system (RAS) to raise coho salmon (*Oncorhynchus kisutch*). A total of 12 legislators and 10 farmers from other operations were invited to the event. The legislators were provided with a packet of information summarizing the industry, its ongoing needs they could assist with, and information from each farm highlighting the economic impacts and the challenges they face. Following the discussion with the farmers, legislators were given a tour of the farm, and then during an open networking session, refreshments were shared that contained fish raised at the farm where the tour was held.

RIBBED MUSSEL (*GEUKENSIA DEMISSA*) CULTIVATION: PROGRESS AND CHALLENGES

***Barry Udelson*[1], Matthew Sclafani, PhD.[2]**
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Shellfish aquaculture typically focuses on species for consumption and since ribbed mussel (*Geukensia demissa*), are considered non-edible, they were not of interest. For that reason, the consistent and reliable methods for culture were not thoroughly developed. The ribbed mussel is an important species for water quality and habitat restoration projects therefore it's critical to have a hatchery produced source. Traditional thermal cycling to induce spawning of the ribbed mussel was found to have minimal success but the "Bin-Silo Method" developed by Landau (2014) at Rutgers University AIC was successful. This technique thermally shocks the broodstock and lets them slowly cool overnight. Post spawn, ribbed mussel culture is similar to oyster and clam, but adjustments are needed due to their mobile behavior and byssal threads. They develop eyespots prior to transitioning into pediveligers. The downwelling stage is consistent with oyster and clam, however, at approximately 300-400µm, the juveniles become highly mobile and migrate up to the waterline. This behavior makes the remaining grow-out stages different from that of oyster and hard clam.

While independently working to develop consistent methods for producing ribbed mussel, several hatchery staff members from different organizations discussed their findings and decided to work together. The Ribbed Mussel Aquaculture Collaborative (RMAC) is a partnership developed to share methodology and collaborate to produce ribbed mussel for various projects in different regions. RMAC includes staff from New York Sea Grant, Cornell Cooperative Extension of Suffolk County, CUNY Baruch, Martha's Vineyard Shellfish Group, and the Aquaculture Innovation Center for Rutgers University.

GLOBAL POLICY CHANGES TO SUPPORT REDUCTION OF PLASTIC POLLUTION IN THE OCEAN

Sue Van Hook
MycoBuoys. Cambridge, NY

Since the early days of working with mushroom mycelium composite materials to replace plastic foams, I have been acutely aware of two policy changes that need to happen for us to transform current mariculture's reliance on plastic gear. We need EPR for plastic marine fishing and aquaculture gear and a shift of subsidies away from fossil fuels toward healthy agricultural products. The European Union's Single Use Plastics Directive (SUP) passed in 2019, obligates all EU member states to implement EPR for all fishing gear containing plastics by the end of 2024. The Ministry of Oceans and Fisheries in South Korea has banned all Styrofoam buoys by 2025 and has supplied 55 million non-plastic foam buoys to oyster growers. In addition, the South Korean government is subsidizing 70% of R&D to develop other sustainable alternative buoys. Other countries are ahead of the United States in rethinking plastic pollution and recovery. It is time to break the fossil fuel industry's lock on cheap plastic production in the United States and hold oil, gas and coal companies accountable for the greenhouses gases released during the chemical purification process and for the end life of their products. To do this, there need to be viable natural alternatives to replace the plastics in the aquaculture industry, and we need government subsidies to support the transition. We'll hear about addressing the derelict fishing gear problem in Maine waters and about three new non-plastic products.

PROGRAM CONSIDERATIONS FOR THE NATURAL RESOURCES CONSERVATION SERVICE OYSTER RESTORATION INITIATIVE IN RI

Brunilda Velez Diaz
USDA Natural Resources Conservation Service, 60 Quaker Lane, Warwick, RI 02886 USA

The USDA Natural Resources Conservation Service (NRCS) in RI offers voluntary technical and financial assistance through the Environmental Quality Incentives Program (EQIP) to oyster growers for construction and monitoring of oyster reef restoration. Growers with existing aquaculture operations can apply for funding to enter in a 5-year contract with NRCS to construct oyster reefs. NRCS utilizes practice scenarios to build contracts that can include marking the corners of the restoration plot, placement of clean cultch as a reef base, seeding, grow out, and placement of spat on shell at the restoration site, and monitoring of the restoration sites following deployment. During this session NRCS will discuss the considerations for implementing a restoration program, how they establish program eligibility, general program requirements and considerations for implementation.

GENDER EQUITY ON MAINE'S WORKING WATERFRONT: DIVERSIFYING THE AQUACULTURE IN SHARED WATERS TRAINING PROGRAM

***Jessica Veo*[1], Annie Fagan[2], Jaclyn Robidoux[2], Teresa R. Johnson[1]**
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Aquaculture in Shared Waters (AQSW) is a comprehensive, free aquaculture training course focused on shellfish and seaweed aquaculture that has been offered in Maine since 2013. The course has historically targeted commercial fishermen and recently expanded to serve a diverse audience in regard to experience and background. However, pre- and post-course surveys indicate that the course participants have mostly been white men. Prior research in the region has identified aquaculture as potentially more accessible to women than commercial fisheries, while identifying significant barriers that still exist for women wishing to participate in aquaculture. To better understand the barriers women face, we conducted 30 semi-structured interviews with women who have previously taken AQSW. Our goal was to learn more about their experiences as students and as women in aquaculture, as well as to identify pressing needs of women in aquaculture. In a preliminary analysis, we have identified the following needs: safe spaces for learning, networking opportunities, lessons to learn technical waterfront skills, and a diversity of gear types for a diversity of bodies. Connections to fishermen conferred advantages for women aquaculture farmers through access to social capital, technical skills, and gear. In addition, some participants perceived aquaculture to be more accessible to women than fisheries. We plan to use this information to inform future aquaculture training courses specifically targeted towards women. We hope to make aquaculture training more accessible to all Maine residents, thereby making Maine's aquaculture industry a leader in social, economic, and environmental sustainability.

OYSTERS ON TREES - A LOOK BACK AT THE POQUONNOCK METHOD

***Timothy Visel*[1], Michael Gilman[2]**
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The Poquonnock River in Groton, Connecticut was the site of off-bottom oyster culture - 1870 to 1881. Here in eastern Connecticut the collection of oyster spat on trees was referenced by Galtsoff (1930) and Ingersoll (1887) detailing placement of tree limbs into soft bottoms of the river. This river is described as drowned with a shallow exit channel (Patton, 2001.) At its mouth is an active barrier spit with a morphology impacted by storms (Sharp, 1929). These conditions created a larval trap over a thick, muddy bottom. For a decade, brush oyster culture thrived and catches recorded (Kimball, 1984). This presentation reviews climate factors of reduced flushing, growth of eelgrass and bacterial release of sulfide that combined to end this oyster culture method.

BUILDING A BENCHMARKING PROGRAM FOR MARKET OYSTERS

William C. Walton **and Jordan Lynch**
Virginia Institute of Marine Science, PO Box 1346, 1370 Greate Road, Gloucester Point, VA 23062

The increase in the variety of oysters in the marketplace has increased interest in product differentiation. With a greater understanding of how different culture methods can produce oysters with different attributes, some oyster growers are striving to produce oysters consistently with certain attributes (e.g., a deep cup). To assist growers with assessing how their product compares to others in the marketplace, a benchmarking program for market oysters is being built to provide a quantitative assessment of what is in the marketplace currently. This tool can also be used to measure the effects of any changes in production methods. Participating growers submit oyster samples to the program and receive reports of a variety of shell traits (e.g., dry shell weight, cup ratio, etc.) and meat characteristics (e.g., condition index, dry tissue weight, etc.) for the submitted product along with an anonymized benchmark for each attribute. As the database grows, the intent is to allow growers to make comparisons within subsets of the data (e.g., regionally, within certain production methods, etc.). With the benchmarking program in early development, results to date will be presented and feedback on currently collected attributes as well as alternative or additional attributes that should be included will be welcome.

PREDICTING LARVAL DISPERSAL AND POPULATION CONNECTIVITY OF SEA SCALLOPS, *PLACOPECTEN MAGELLANICUS*, IN DOWNEAST MAINE

Kelsey M. Ward[1], Huijie Xue[2], *Paul Rawson*[3]
[1]Department of Marine Sciences, University of Connecticut; [2]Xiamen University and School of Marine Science, University of Maine; [3]School of Marine Sciences, University of Maine

Our research combines computer modeling and population genomics approaches to explore the patterns of larval dispersal for the sea scallop (*Placopecten magellanicus*) along the Downeast coast of Maine. We seek to develop methods for predicting source and sink populations of sea scallop larvae. Such models will aid the nascent scallop aquaculture industry and managers of Maine's scallop fishery to reduce impacts on key spawning beds that support larval recruitment critical to both groups. To date, we have made modifications of an individual-based hydrodynamic computer model of the coastal currents in this region to include important aspects of larval development and behaviors such as growth and mortality rates, swimming speeds, and vertical migration patterns. Application of this model has provided three key observations. First, larvae originating from the Bay of Fundy typically did not reach the Gulf of Maine within the expected ~40-day larval duration. Second, larvae spawned along the Downeast coast typically are transported long distances downstream and offshore by the Eastern Maine Coastal Current with few of these larvae reaching inner bays, such as Blue Hill Bay, by the time they are competent to settle. Third, a significant proportion of larvae reaching the Jericho Bay area just west of Mount Desert Island may originate from the Penobscot Bay region further to the west due to circulation patterns within Penobscot Bay. These model predictions are currently being tested using genomic analyses and assignment tests to compare the degree of genetic similarity among predicted source sites and settlement sites.

BUSINESS AND ECONOMIC PLANNING FOR SEAWEED AQUACULTURE SYSTEMS IN THE UNITED STATES

***Tammy Warner*[1], Robert Pomeroy[2]**
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This presentation will share business planning and management tools developed as part of a project funded under the NOAA Sea Grant funding opportunity titled, "Addressing Economics and Market Needs of the U.S. Aquaculture Industry." Kelp, *Saccharina spp*. are the most common seaweed species cultivated in the United States. Kelp farming, as well as the farming of various other seaweeds, is a significant and growing industry in the US as seaweeds, especially kelp, can be used for food, medicinal products, additives and bioremediation. With any new industry, barriers to its development and expansion always emerge. One of the greatest barriers is the lack of economic/financial information on the cultivation of domestic kelp. There is a need to better understand the realistic economic and financial parameters associated with kelp aquaculture in order for farmers, investors and lenders to make more informed decisions regarding investment in this type of venture.

Project objectives include: (1) Develop business planning and management tools for kelp aquaculture systems, which improve the economic and financial viability of this industry; (2) Increase access to capital among existing and prospective seaweed farmers via an emphasis on improved industry knowledge for investors/financers/potential market entrants: (3) Conduct a comprehensive economic assessment of the ecosystem services provided by seaweed aquaculture; and (4) Develop outreach and education activities through SG extension for industry, regulators and financial institutions to support the development of a seaweed aquaculture industry.

EXPLORING THE DYNAMICS OF *VIBRIO PARAHAEMOLYTICUS* ASSOCIATION WITH HATCHERY OYSTERS IN THE NH GREAT BAY ESTUARY

Benjamin Wasson[1,2], Colby Griffin[1,2], Nadia Pavlik[1], Randi Foxall[1,2], Stephen H. Jones[1,2,3], Cheryl Whistler[1,2]
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Oyster aquaculture is a growing industry in New Hampshire that is threatened by the risk of introduction of invasive human pathogenic *Vibrio parahaemolyticus* (*Vp*) via oyster seed. *Vp* naturally colonizes oysters, but only some genetic variants can cause human gastroenteritis. To prevent introduction of pathogens, oyster importation is not permitted from locations with a history of disease. This limiting policy is controversial, as the actual risk associated with seed is undetermined. Therefore, establishing the extent that imported juvenile oysters maintain their *Vp* populations after transplantation would provide useful insight. We monitored the abundance of *Vp* in oysters from a permitted hatchery as they acclimated to Great Bay Estuary (GBE). Hatchery oysters, water, and algal feed were analyzed to determine if they were potential sources of *Vp* contamination, and while *Vp* was undetectable in water, both the oysters and some algae food harbored *Vp*. Once juveniles were transplanted into GBE, the *Vp* abundance patterns resembled those of local oysters, and the proportion of pathogenic isolates decreased with time matching background seasonal abundance patterns. This indicates that juvenile oysters can harbor *Vp* and are a potential source for introduction of human pathogens, but because levels mirror those in adults experiencing the same environmental conditions, practices that purge pathogens from adults may also do so in seed. Our ongoing work is examining how manipulation of salinity and temperature influence *Vp* abundance in oyster spat as a possible mitigation strategy to reduce risk associated with seed importation.

ROPELESS SUBMERSIBLE AUTONOMOUS AQUACULTURE PLATFORM

Christopher Webb, ***Tim Matuszewski***
AI Control Technologies

Ai Control Technologies (AiCT) is addressing the need to solve a variety of depth control challenges for small to large-scale aquaculture operations by using patented cost effective innovative underwater depth control technology. Our technology was developed to support North America aquaculture suppliers in gaining a competitive advantage in the global seafood marketplace and reduce their overall operational costs.

Our mission is to support aquaculture farmers (oysters, mussels and seaweed) in replacing certain labor-intensive repetitious tasks with automation to help maximize yield and growth, minimize go-to-market costs, reduce occupational injuries and maximize profitability. Our technology will enable US aquaculture farmers to eliminate the "seafood deficit" and become a major global competitor and secure a reputation for domestic supply of sustainable, healthy and providing local seafood. Our proprietary software compares rules with depth change movements in real-time using data from sensors and adjusts depth according to the application dynamic model required to optimize the growth conditions for shellfish. We provide a predictive control system where sensors across the platform/rig/cage/trap transmit readings in real-time to a master remote control unit. This allows the manual control and in future versions, to predictively generate actions autonomously or semi-autonomously according to the growers chosen dynamic model required for their business.

AiCT AUTODIVE® product is an aquaculture habitat structure (platform/cage options) to grow out seaweed, oysters, and mussels. We offer proprietary, patented air/water managed depth control technology, and consists of four parts: 1) Depth Control Engine, 2) Computer Sensors, 3) Computer and Software, & 4) Habitat Structure.

MARINE GEAR FROM SEAWEED

Katie Weiler
Viable Gear Co., Portland, ME

Viable Gear is a Maine company that is making material out of seaweed to provide ocean harvesters with an alternative non-plastic material for their harvesting gear. We are using seaweed because it is a renewable material that grows quickly, helps fight ocean acidification, and can be highly cultivated in the Gulf of Maine. By using seaweed, we are creating demand for more ocean farmers to grow seaweed and using essentially a zero-input growing zone since seaweed doesn't need large amounts of land, harmful fertilizers, and fresh water to grow. By replacing plastics that are made to go directly into our oceans, we are reducing plastic pollution called ghost gear, that is detrimental to marine species and ultimately breaks down into micro and nano-plastics that get into the food system of marine species and humans. Ingesting toxic plastics can lead to harmful health effects, so we are seeking to reduce that public health risk. We hope that providing this alternative material will help ocean harvesters reduce their dependency on plastics, but in order to do that we will need support from our government subsidies to accelerate transitioning to Viable Gear.

TIMING OF BARNACLE BIOFOULING ON CAPE COD OYSTER FARMS

Jane B. Weinstock[1,2], Jesús Pineda[2], Carolyn Tepolt[2]
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Shellfish aquaculture is a major industry in Massachusetts and on Cape Cod, but biofouling by barnacles can substantially undercut farm productivity. While growers have a variety of mitigation strategies already available, barnacle settlers are very abundant and often too small to see until they have grown beyond the point of negatively affecting shellfish stock and weighing down equipment. Here, we measured the timing and intensity of barnacle settlement (=barnacle biofouling) in Buzzards Bay and Cape Cod Bay, to identify times of year when mitigation will be easiest and most effective. To do this, we installed 10 PVC plates across each of 3 sites: an oyster farm in East Dennis, MA, consisting of intertidal racks; another farm in Fairhaven, MA, consisting of floating cages; and a rocky intertidal field site in Woods Hole, MA. Newly-settled barnacle larvae were counted, and a subsample were identified with DNA barcoding. Sampling was conducted weekly for 9.5 months (Fairhaven), 17 months (East Dennis), and 24 months (Woods Hole). Barnacle settlement was most intense at intertidal sites, particularly during Feb-Apr and Jun-Aug (Woods Hole) and Mar-May and Sep (East Dennis). Settlement times in Fairhaven were similar to Woods Hole, but intensity tended to be lower. Notably, in all sites, we observed substantial settlement by barnacle species that were not numerous as adults. Overall, we suggest that mitigation may be most effective during and directly after the winter-spring settlement pulses.

CREATING A ROADMAP FOR ADVANCING SOCIAL LICENSE TO OPERATE FOR AQUACULTURE IN THE NORTHEAST

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Social license to operate (SLO)—or community acceptance of a farm—is gaining importance in the aquaculture sector as public opposition has become a significant barrier to both business and sector development. In this workshop, participants will take a deep dive into social license challenges and solutions through a series of small group activities. The end goal of the workshop is to outline concrete social license actions for both farmers (who have the most influence over social license) and supporting actors (trade associations, eNGOs, municipalities, chefs & more) that are specific to the Northeast. Groups will tackle a range of stakeholder groups, and the resulting notes will be compiled into a Northeast Social License Roadmap. Participants will be invited to contribute to the development of this roadmap beyond the workshop, and the final roadmap will be published on the Maine Aquaculture Innovation Center website and distributed to all contributors. We encourage members of all aquaculture-related fields to attend and contribute.

SOCIAL LICENSE TO OPERATE FOR AQUACULTURE

***Emily Whitmore*, Anne Langston Noll, Chris Davis**
Maine Aquaculture Innovation Center, 193 Clark's Cove Rd., Walpole, ME 04573 USA

As the aquaculture industry in the US continues to expand, public opposition to sector development has become a significant barrier to growth. In response, farmers have been putting much effort into gaining social license to operate (SLO), or community support, from their network of stakeholders. Social license is centered around trust. Farmers are able to earn their community's trust through proactive and ongoing outreach and engagement, responsible farm practices, and by providing meaningful community benefits. Considering SLO is relational–existing between a farm and their network of stakeholders–much of the social license work rests on the farmers' shoulders. Farmers are the primary actor for navigating and developing SLO for their business. However, there is supporting work that can be done via secondary actors–supporting stakeholders that include trade associations, NGOs, municipalities, chefs and more. There are three ways that secondary SLO actors can assist in advancing SLO. First, they can generate SLO directly, often through advocating for a specific farm. Second, they can assist farmers in their SLO work, like by providing resources, funding, or engagement opportunities. And third, they can contribute to positive public perceptions more broadly, which can make it easier for farmers to generate SLO.

This session takes a deep dive into social license work for both primary and secondary SLO actors through two expert panels: First, we will feature a panel of primary actors– farmers–who will talk about their on-ground SLO work, how they create meaningful relationships, what resources are needed, and how SLO work can advance the broader industry. Second, we will feature a panel of secondary actors who will give insight into specific ways that they are working to influence SLO and dive into the real-world effects of this work and the meaningful changes they are seeing.

FISHERMEN OR SCIENTISTS? HOW IDEOLOGY SHAPES WHO THE PUBLIC TRUSTS FOR INFORMATION ON AQUACULTURE

***Emily Whitmore*[1], Anne Langston Noll[1], Chris Davis[1], Thomas Safford[2], Lawrence Hamilton[2]**
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It is well documented that the general public has limited knowledge of aquaculture, but when they want to know more, who do they turn to? This study expands on previous research exploring effective messaging (and messengers), by exploring what factors influence who Mainers trust for accurate information on aquaculture. While the most trusted messengers overall were scientists, stark differences were evident when broken down by political ideology. Respondents who identified as Democrats were significantly more trusting of scientists, government, and environmental organizations for accurate information on aquaculture compared to those who identified as independents or Republicans. However, Republicans were significantly more trusting of fishermen compared to Democrats. Trust also varied by respondents' views of what was most important for Maine's coastal communities. Those who valued preserving the traditional character of coastal communities by protecting traditional marine industries were more likely to trust fishermen, while those who valued sustaining Maine's coastal communities by encouraging new marine industries were more likely to trust aquaculture farmers, scientists, and government for accurate information on aquaculture. These findings have important implications for creating messaging campaigns that reach a diverse audience–the messenger matters, not just the message.

FEEDING REGIMES FOR POST-SET BIVALVES – NEW RELEVANCE ARISING FROM THE REGIONAL SHELLFISH SEED BIOSECURITY PROGRAM

Gary H. Wikfors
NOAA Fisheries Service, Northeast Fisheries Science Center, Milford, CT 06460, USA

Thirty years ago, Milford Lab researchers conducted numerous experiments to define microalgal feeding standards – what, how much, and how often to feed – for several aquacultured bivalve species. The work was scientifically motivated, but not directly practical because, at the time, post-set seed from hatcheries customarily were moved to “raw water” as soon as possible, rather than being fed cultured algae. Concerns over pathogenic microorganisms in this raw water led to the establishment of the Regional Shellfish Seed Biosecurity Program (RSSBP; https://rssbp.org/) during the past decade, which has subsequently renewed interest in feeding requirements for seed in the 0.5-5-mm size range. The RSSBP and the changes to associated water filtration protocols are efficient at reducing pathogens; however, they also exclude all natural microalgal food sources, prompting the need for continued cultured microalgal feeding of post-set seed. In this talk, quantitative feeding standards for post-set Eastern oysters, Northern bay scallops, and Northern quahogs will be compiled, in terms of biochemical profile, daily ration, and timing of feeding; similarities and differences between species will be highlighted.

MUSSEL AQUACULTURE FEASIBILITY TRIALS IN EASTERN MAINE

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Eastern Maine's coastal communities have long been reliant on fisheries as a vital economic lifeline. However, since the mid-1990s, a significant shift occurred when the multispecies groundfish fishery collapsed and paved the way for lobsters to dominate the region's seafood economy. This transition has left these communities precariously dependent on a single fishery species that appears vulnerable in the face of projected climate changes. In light of these challenges, it becomes imperative to explore avenues for diversifying the income sources within Eastern Maine's ocean economy. In 2020, a collaborative three-year mussel aquaculture pilot project was initiated in Washington County, Maine. This innovative endeavor engaged three seasoned fishermen to determine if small-scale mussel farming could offer them a substantial economic return for their dedicated efforts. Each participant practiced suspended rope culture utilizing a single four-hundred square foot raft loaded with both hatchery-seed ropes and ropes “socked” with older "head start" mussels that had spent their first growing season in an abandoned lobster pound. Notably, cultured seed from both "traditional" blue mussels (*Mytilus edulis*) and a naturally occurring golden-shelled phenotype of the species were used in these trials. This pilot project yielded insights into the feasibility of cultivating mussels in the far eastern reaches of Maine. It examined critical factors such as growth rates, mortality rates, the quality of mussels produced, and the economic value they contributed. Equally important, it investigated how this aquaculture practice complemented the participants' existing fishing activities and assessed the reception of the broader fishing community in this region.

DERMO PRESENCE IN EASTERN OYSTERS RESTORED TO THE NEW YORK HARBOR

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Native to the New York Harbor, the Eastern oyster (*Crassostrea virginica*) plays a pivotal role as an ecosystem engineer, providing crucial ecosystem services including water filtration, storm protection, and support for biodiversity. However, this once-thriving oyster population has experienced severe depletion due to factors such as overharvesting, pollution, and habitat loss. Compounding these challenges, new

climate-related threats, particularly Dermo disease (caused by the protozoan *Perkinsus marinus*), have further endangered the species. Dermo has been present in Northeast coast waters since at least 1991, negatively impacting oysters by inhibiting growth, reducing reproduction, and causing significant mortality.

To evaluate disease risk, oysters were sampled from five distinct locations within the Harbor: 1) Soundview Park (Bronx River), 2) Brooklyn Bridge Park (East River), 3) Bush Terminal Piers Park (Upper Bay), 4) Paerdegat Basin (Jamaica Bay), and 5) Great Kills Harbor (Lower Bay). Among these sites, Great Kills Harbor, the oldest restored location, hosted the largest oysters (average shell length of 141 mm) but also exhibited the highest Dermo infection rates, with 20% of oysters showing heavy infection (Mackin scale of 3 or higher, which are typically considered to lead to mortalities). In contrast, Brooklyn Bridge Park, the newest restored site, featured smaller oysters (average shell length of 76 mm) and the lowest Dermo infection rate at 6.9%, with no heavy infections. Continuous monitoring of oyster diseases is crucial to understanding the impact of Dermo on New York oyster populations and making informed decisions about oyster restoration efforts.

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