PROGRAM and ABSTRACTS

Northeast Aquaculture Conference & Exposition
and the
41st Milford Aquaculture Seminar

April 27-29, 2022
Holiday Inn by The Bay
Portland, Maine

Northeast Aquaculture Conference & Exposition & Milford Aquaculture Seminar 2022

Holiday Inn by The Bay, Portland, Maine

Wednesday, April 27 2022					
9 AM - 1 PM	**Field Trips depart at various times (meet in the Hotel Lobby)**				
8:00 - 5:00 PM	**Workshops meet at various times**				
4:00 PM	**Registration opens in Hotel Lobby**				
7:00 PM	**Opening reception in the Casco Bay Exhibit Hall (Trade show opens)**				
Thursday, April 28 2022					
7:00 AM	**Registration outside State of Maine Grand Ballroom**				
7:00 AM	**Continental breakfast in the Casco Bay Exhibit Hall**				
8:30 AM	**Plenary Session in the State of Maine Ballroom (Vermont)**				
10:00 AM	**Break in the Casco Bay Exhibit Hall**				
	Vermont Room	**New Hampshire Room**	**Massachusetts Room**	**Rhode Island Room**	**Connecticut Room**
10:30 AM	**Seaweed Farmer Panel** Chair: Jaclyn Robidoux	**Sea Scallop Farming I: Hatcheries** Chair: Brian Beal	**Land-Based Aquaculture** Chair: Deborah Bouchard	**General Shellfish Aquaculture I** Chair: Katie McFarland	**Find the Money-Overview of USDA Farm Programs.** Chair: Paul Russell
12:00 PM	**Lunch in the Casco Bay Exhibit Hall**				
1:30 PM	**Seaweed Food Safety** Chairs: Carrie Byron & Jen Perry	**Shellfish Disease** Chair: Tim Bowden	**Recapturing and Reuse of Plastics in the Mariculture Industry** Chairs: Dana Morse & Abby Barrows	**Post-Secondary Workforce Development** Chairs: Anne Langston Noll & Keri Kaczor	**Updates on Projects, Policy, and Penchant for Investment in Northeast U.S. Aquaculture** Chairs: Dan Giza & Timothy Hogan
3:00 PM	**Break in the Casco Bay Exhibit Hall**				
3:30PM TO 5:00PM	**Emerging Species** Chair: Mark Dixon	**Design, Maintenance, & Economics of Wet Storage** Chair: Jesse Fortune	**Our Collective Role in Engaging the Public with Aquaculture Literacy** Chair: Brianna Shaughnessy	**Engineering in Aquaculture** Chair: Matt Bowden	**Implications of COVID Market Disruptions and Efforts to "Build Back Better"** Chair: Michael Rubino
4:00PM TO 5:00PM	**Women & Minorities In Aquaculture: Networking & Happy Hour in the Casco Bay Exhibit Hall**				
5:00 PM	**Poster Session Happy Hour in the Casco Bay Exhibit Hall**				
6:00 PM	**ECSGA Annual Meeting at "The Shop by Island Creek Oysters"**				
6:00 PM	**Dinner out on the town**				
Friday, April 29 2022					
7:00AM	**Registration in the Hotel Lobby**				
7:00AM	**Light breakfast in the Casco Bay Exhibit Hall**				
	Vermont Room	**New Hampshire Room**	**Massachusetts Room**	**Rhode Island Room**	**Connecticut Room**
8:00:00 AM	**Supporting Shellfish Hatchery Production** Chair: Karen Hudson	**Aquaculture's Social License to Operate** Chair: Bailey Moritz	**Fin Fish Health & Nutrition** Chair: Deborah Bouchard	**General Aquaculture** Chair: Mark Dixon	**K-12 Education** Chairs: Keri Kaczor & Scarlett Tudor
10:00 AM	**Break in the Casco Bay Exhibit Hall**				
10:30 AM	**Seaweed Farming** Chair: Gillian Phillips	**Sea Scallop Farming II : Growout** Chairs: Dana Morse & Hugh Cowperthwaite	**General Shellfish Aquaculture II** Chair: Katie McFarland	**Use of Probiotics in Aquaculture** Chairs: Marta Gomez-Chiarri & Diane Kapareiko	**Panel on Shell Recycling** Chairs: Tessa Getchis & David Carey
12:00 PM	**Lunch in the Casco Bay Exhibit Hall**				
1:30 PM	**Seaweed Processing & Product Development** Chairs: Mary Ellen Camire & Denise Skonberg	**Climate Impacts on Shellfish Farms: Your Perspective** Chairs: Sally McGee & Daniel Wieczorek	**Best Management Practices for Floating Shellfish Gear** Chair: Bob Rheault	**Hosting Visitors on Your Farm: What You Need to Know** Chairs: Afton Vigue & Natalie Springuel	**Ecosystem Services** Chair: Carrie Byron
3::00 PM	**Break in the Foyer**				
3:30 PM	**Upwellers & Other Nursery Technologies** Chairs: Dale Leavitt & Chris Davis	**Climate Change** Chair: Dan Wieczorek	**Best Management Practices to Maximise Ecosystem Services** Chair: Bob Rheault	**Business Support & Entrepreneurship** Chair: Christian Brayden	**Food Justice in Aquaculture** Chair: Adam St Gelais
5:00 PM	**Closing Remarks & Sendoff Toasts**				

Welcome

After pandemics and postponements, the NACE – MAS Planning Committee is delighted to welcome 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 thirty-five sessions on finfish, sea vegetables and shellfish culture, three informative workshops, seven field trips to area aquafarms, research facilities and a trade show including major aquaculture vendors from across North America. Furthermore, the NACE – MAS coincides with Maine Seaweed Week which you can learn more about elsewhere in this program. We hope that you enjoy the meeting.

NACE-MAS Organizing Committee

Chris Davis ~ Maine Aquaculture Innovation Center
Lisa Milke ~ NOAA National Marine Fisheries Service Milford Laboratory
Anne Langston Noll ~ Maine Aquaculture Innovation Center
Gef Flimlin ~ Emeritus Professor of Aquaculture, Rutgers University Cooperative Extension

with special thanks to:
Pat Widman ~ NOAA National Marine Fisheries Service Milford Laboratory
Sylvia Feeney ~ NOAA National Marine Fisheries Service Milford Laboratory
Sydney Avena ~ Maine Aquaculture Innovation Center
Heather Sadusky ~ Maine Sea Grant
Melissa Bailey ~ Holiday Inn by the Bay

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NOAA NMFS Office of Aquaculture
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USDA/NIFA Northeastern Regional Aquaculture Center

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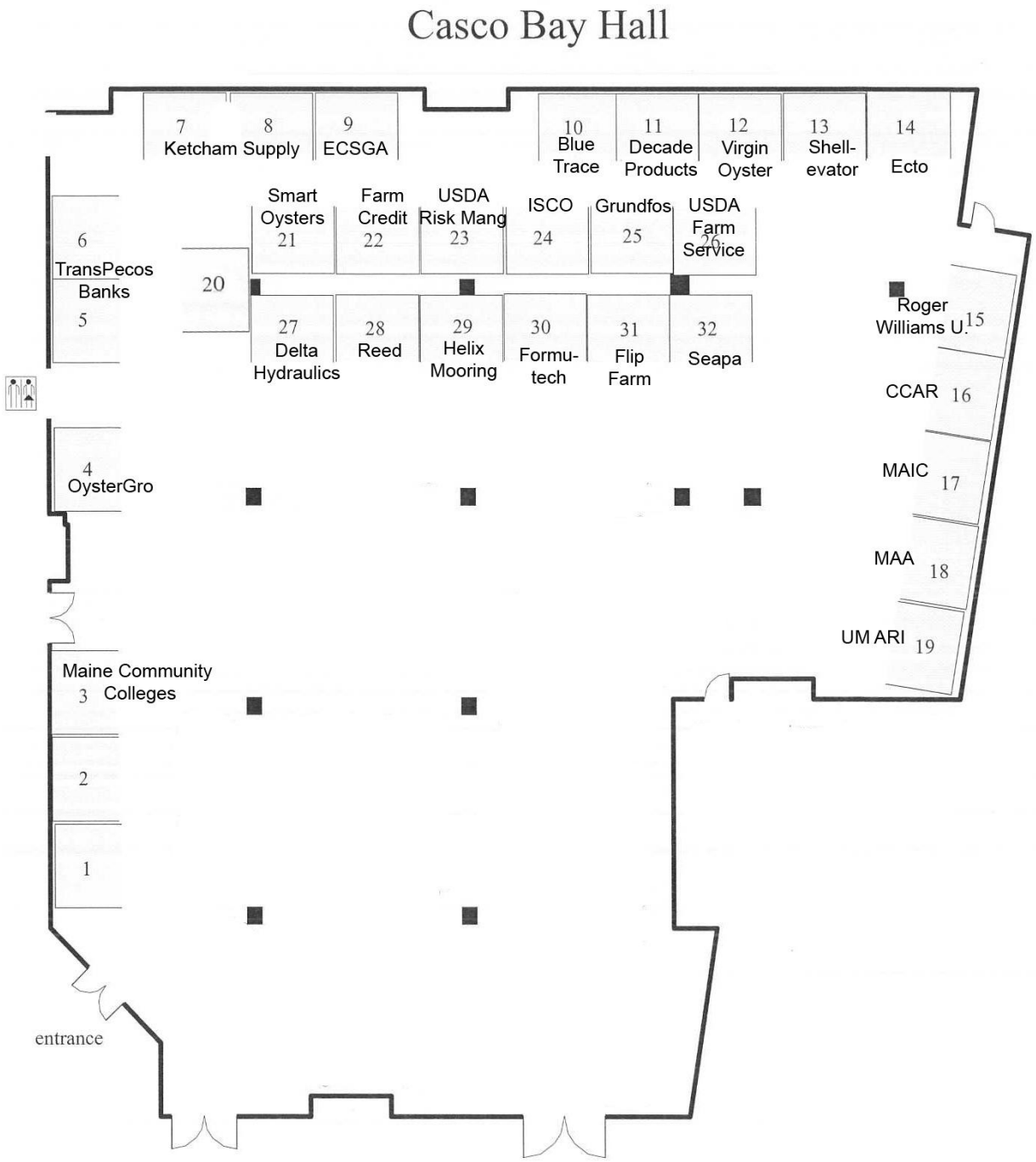

Booth 3
Washington County Community College
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nsawyer@wccc.me.edu; 207-214-7988
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Booth 4
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Booth 5/6
TransPecos Bank
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bklein@kslawllp.com

Booth 7/8
Ketchum Supply
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Booth 9
East Coast Shellfish Growers Association
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Booth 10
Blue Trace
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Decade Products
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https://www.bistools.com/

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https://www.virginoyster.com/

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Booth 20
General Materials

Booth 21
Smart Oysters
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manda@oceanfarmr.com
https://smartoysters.com/

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https://www.farmcrediteast.com/

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USDA Risk Management Education
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Booth 24
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Booth 26
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Booth 27
Delta Hydronics
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Booth 28
Reed Mariculture
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EXHIBITOR TABLES OUTSIDE CONFERENCE ROOMS

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https://www.usaquaculture.org/

Maine Center for Entrepreneurs
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National Aquaculture Association
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Gulf of Maine Research Institute
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Coastal Enterprises Inc
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https://www.ceimaine.org/advising/business/fisheries-and-aquaculture/

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https://downeastinstitute.org/

Atlantic Corporation
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Yokogawa Fluid Imaging Technologies
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https://www.fluidimaging.com/

Maine Seaweed Week

Friday, April 22 – Sunday, May 1

Maine Seaweed Week is happening during NACE/MAS 2022!

Seaweed Week is a statewide food and drink festival celebrating Maine's seaweed industry. During the 4th annual event, some of Maine's top restaurants and bars will offer seaweed-based entrees, cocktails & other specials. Brewers, bakers, distillers, chocolatiers, cheesemakers & other artisans will create limited-edition releases.

Seaweed Week will be hosting a seaweed farmer happy hour and create a restaurant guide for conference participants to find seaweed creations around town!

The festival will also offer special events throughout the week including a mixology workshop, species ID beach walk, and fresh-from-the-farm kelp buying program. Timed to Maine's annual kelp harvest, the festival's mission is to raise awareness for edible seaweed: a delicious, nutrient-dense, culinarily versatile, sustainable local food that supports working waterfronts and coastal communities in Maine.

Just point your camera to the QR code to visit Maine Seaweed Week!

NACE/MAS Aquaculture Conference Schedule

	Wednesday, April 27				
8:45 AM - 5:00 PM	**Field Trips & Workshops (meet in the Hotel Lobby)**				
4:00 PM	**Registration opens in the Hotel Lobby**				
7:00 PM	**Opening Reception in the Casco Bay Exhibit Hall (trade show opens)**				
	Thursday, April 28				
7:00 AM	**Registration in Hotel Lobby**				
7:00 AM	**Breakfast in Casco Bay Exhibit Hall**				
8:00 AM	**Plenary Session in the State of Maine Ballroom (Vermont/New Hampshire)** NOAA welcome address by Danielle Blacklock and Michael Rubino Rapid fire industry updates of issues facing the northeastern states				
9:30 AM	**Break & Trade Show Opens in the Casco Bay Exhibit Hall**				
	Vermont Room	**New Hampshire Room**	**Massachusetts Room**	**Rhode Island Room**	**Connecticut Room**
	Seaweed Farmer Panel *Chair: Jaclyn Robidoux*	**Sea Scallop Farming I: Hatcheries** *Chair: Mark Dixon*	**Industry Updates and Needs: Voices from the Land-based Aquaculture Industry** *Chair: Deborah Bouchard*	**General Shellfish Aquaculture I** *Chair: Katie McFarland*	**Find the Money-Overview of USDA Farm Programs** *Chair: Paul Russell*
10:30 AM	Though seaweed is celebrated as a miracle crop that requires "no freshwater, no land, and no fertilizer" to grow, farmers recognize that it takes more than seawater to run a successful seaweed farm. This session is an open conversation with seaweed farmers from across the US about ways in which they are responding, innovating, and building new opportunities in this rapidly emerging sector. Learn from the folks on the water, in the epicenter of domestic seaweed aquaculture!	Seven summers of spawning: Methods and lessons learned from spawning sea scallops in mid-coast Maine *Skylar Bayer*	It is becoming increasingly evident that for aquaculture to increase in the US, new platforms such as land-based recirculating aquaculture systems (RAS) will need to be expanded. Land based aquaculture, from tanks to aquaponic systems, offers a means to grow US production while farming fish closer to the markets thereby reducing transport costs and carbon footprint. During this panel, we will hear from Maine land based aquaculture and aquaponics industries on where they are in their development process and what their challenges are moving forward.	A GIS base tool for spatial planning and management of shellfish aquaculture in New Jersey *Michael De Luca*	This seminar will guide growers through the maze of USDA programs available to farmers. These programs can help growers mitigate potential risk to their operation or assist growers in recovering from a variety of disasters. The goal of the seminar is to assist growers in the development of a risk management plan and how USDA can be a partner. There will be presentations from the variety of USDA Agencies.
10:45 AM		Evaluating conditioning and spawning cycles in cultured and wild sea scallops, *Placopecten magellanicus*, in Penobscot Bay, ME *Phoebe Jekielek*		Quantifying farm-scale filtration rates associated with eastern oyster aquaculture in the northeast *Janine Barr (remote)*	
11:00 AM		Comparing the microbiome of wild and farmed Atlantic sea scallop (*Placopecten magellanicus*) veligers *Sarah Hosler*		Analysis of an Array of Submersible Mussel Rafts in Storm Conditions *Tobias Dewhurst*	
11:15 AM		A collaborative approach to investigate hatchery culture methods to produce commercial quantities of sea scallop, *Placopecten magellanicus*, spat for farmers in Maine *Adam St Gelais, Kyle Pepperman & Meredith White*		Reducing risk for shellfish farmers through real-time, automated, harmful algal bloom monitoring and mitigation *Dan Ward*	
11:30 AM				Shellfish and the Northeast: A Fifty Year Evolution of Our Interaction with these Succulent Shelled Creatures *Sandra MacFarlane*	
11:45 AM		Discussion		The evolution of extension at the Milford Lab: an example investigating poor clam growth in New Jersey Zach Gordon	
12:00 PM	**Lunch in the Casco Bay Exhibit Hall**				
	Vermont Room	**New Hampshire Room**	**Massachusetts Room**	**Rhode Island Room**	**Connecticut Room**
	Seaweed Food Safety *Co-chairs: Carrie Byron & Jen Perry*	**Shellfish Disease** *Chair: Tim Bowden*	**Recapturing and Reuse of Plastics in the Mariculture Industry** *Chairs: Dana Morse & Abby Barrows*	**Post-secondary Workforce Development** *Chairs: Anne Langston Noll & Keri Kaczor*	**Updates on Projects, Policy, and Penchant for Investment in Northeast U.S. Aquaculture** *Chairs: Dan Giza & Timothy Hogan*
1:30 PM	Evaluating the pathogen load of edible seaweed post-harvest under varying storage temperatures and drying conditions *Jessica Vorse*	Associations between MSX and Dermo diseases and eastern oyster health indicators in Long Island Sound *Meghana Parikh*	Oceanic pollution by plastics of all types and forms is a global problem, with around 10 million tons escaping into the marine environment annually; and yet the fishing and aquaculture industries are entirely dependent on plastics for all on-the-water operations. In this session, we will: - Review the nature and scope of plastics pollution from the global to the local scales - Introduce pilot work in Maine to capture retired plastics and fabricate useful products, as well as shellfish farming efforts with novel, non-plastic materials - Engage the audience in discussion to gather ideas, questions and opportunities, and to improve the networking of those interested in reducing plastic wastes from the aquaculture sector.	Maine Aquaculture Workforce Development Strategy Update *Jonathan Labaree*	National policy updates and impacts with emphasis on Executive Order 13921 *Kevin Madley*
1:45 PM	Impact of time of harvest and drying method on antimicrobial activity of *Saccharina latissima* against two *Staphylococcus* strains *Amber Cusson*	Developing a thermal shock method to control dermo disease and biofouling on oyster farms *Heidi Yeh*		Maine aquaculture occupational standards *Christian Brayden*	U.S. Marine Aquaculture: Federal Legislative Update *Drue Banta Winters (remote)*
2:00 PM	The effect of drying of on the survival of *Escherechia coli*, *Listeria innocua* and *Bacillus cereus* on sugar kelp *Richa Arya*	Cis-defensin antimicrobial peptides in the eastern oyster, *Crassostrea virginica* *Maureen Krause*		Aquaculture Research Institute's aquaculture workforce development programming *Mary Scarlett Tudor*	Grassroots advocacy to move the needle for US aquaculture *Sebastian Belle*
2:15 PM	Survival of inoculated *Vibrio* spp., *Salmonella* spp., *Listeria monocytogenes* and *Escherichia coli* on sugar kelp during refrigerated and ambient storage *Samuel Akomea-Frempong (remote)*	Bivalve transmissible neoplasia (BTN) in the Casco Bay steamers *José A. Fernández Robledo*		Developing an approved Restorative Aquaculture associates degree program for the Commonwealth of Massachusetts incorporating community educational outreach programming, industry collaboration, and Town shellfish initiatives *David Bill*	Lessons learned from open-ocean farms overseas *Corey Sullivan*
2:30 PM	Microbial safety and quality of commercial dried macroalgae for human consumption *Jennifer Perry*	Infection and disease profiles in aquacultured oysters progressing from hatchery to market		Developing an industry-relevant, community college based training program to prepare the next generation of Maine's aquaculture workforce *Anne Langston Noll & Kate Howell*	Kingfish Maine *Megan Sorby*
2:45 PM	Heavy metals in edible seaweed; an industry perspective *Steve Eddy*	*Ryan Carnegie (remote)*		AQUATRAIN: Free online entry-level oyster farmhand training user manual *Cam Ennis & Bob Rheault*	Trials and triumphs of coastal integrated multi-trophic aquaculture in the Northeast *Michael Chambers*
3:00 PM	**Break at the Casco Bay Exhibit Hall**				

Detailed Program for Thursday Afternoon and Friday Morning

3:00 PM	**Break at the Casco Bay Exhibit Hall**				
	Vermont Room	**New Hampshire Room**	**Massachusetts Room**	**Rhode Island Room**	**Connecticut Room**
	Emerging Species *Chair: Mark Dixon*	**Design, Maintenance, & Economics of Wet Storage** *Chair: Jesse Fortune*	**Our Collective Role in Engaging the Public with Aquaculture Literacy** *Chair: Brianna Shaughnessy*	**Engineering in Aquaculture** **Chair: Matt Bowden** *Chair: Matt Bowden*	**Implications of COVID Market Disruptions and Efforts to "Build Back Better"** *Chair: Michael Rubino*
3:30 PM	A ten year retrospective of seaweed farming in Maine *Jaclyn Robideux*	This panel session will hear from a variety of current operators who have incorporated wet storage into their respective facilities. The roundtable will offer insight on user experiences in terms of design and planning, regulatory approval, construction, operation, and upkeep of the systems. There will be a general focus on land-based, closed loop systems, however we will provide overview of other types of systems and also provide opportunity for questions from the floor	This facilitated panel of chefs, growers, and NOAA aquaculture professionals will share their insights into the important role of industry partnerships in achieving these aquaculture literacy goals. Panelists include: *Barton Seaver* - Professional Chef and Seafood Educator *Chris Schillaci* - Regional Aquaculture Coordinator, NOAA Fisheries *Mark Rath* - Aquaculture Manager, NOAA Sea Grant *Dan Ward* - Owner and Researcher, Ward Aquafarms *Jeremy Sewall* - Professional Chef and Owner, Row 34 *Maggie Allen* - CELC Coordinator & Grants Manager, NOAA Office of Education	Composite Lines for Reduced Risk of Marine Mammal Entanglement in Aquaculture Structures *Zach Moscicki*	Overview of COVID Market Effects on the US Seafood Market and Efforts to Build Back Better *Michael Rubino*
3:45 PM	Expanding green sea urchin production by removing key aquaculture challenges *Coleen Suckling*			Developing ropeless, autonomous depth controlled habitats for shellfish and other aquaculture farmers to enable US farmers to improve productivity and expand further offshore *Christopher Webb*	COVID-19 seafood literature review and implications for the NE/Mid-Atlantic region *Dave Love*
4:00 PM	Enhancing settlement success and post settlement survival in green sea urchin aquaculture *Tara Plee*			Investigating the integration of ropeless gear technology for inshore and offshore bivalve aquaculture to reduce entanglement risk with marine mammals and sea turtles *Matthew Bowden*	Where does Sally sell her sea shells during COVID? Analyzing seafood sales, distribution, and preferences for Maine and beyond in the new normal *Christian Brayden*
4:15 PM	Reproductive cycles of two developing commercial shellfish species in Massachusetts *Harriet Booth*			Quantifying risk and factors of safety for the ocean engineering of aquaculture structures *David Fredriksson*	Building resilience in New York's seafood industry through collaboration *Michael Ciaramella*
4:30 PM	Comparing growth and survival of two strains of surf clams endemic to massachusetts waters at a range of shellfish aquaculture sites *Josh Reitsma*			Mitigating risk of structural failure in a macroalgae cultivation structure for an exposed site *Toby Dewhurst*	Direct seafood sales during the COVID-19 pandemic: insights for the Northeast aquaculture sector *Joshua Stoll*
4:45 PM	Updates from the East Coast hard clam selective breeding collaborative *Bassam Allam*			Investigation of aquaculture system dynamics under fair and extreme weather conditions via numerical modeling *Richards C. Sunny*	Complications of a market pivot *Matt Gregg (remote)*
4:00 PM TO 5:00 PM	**Women & Minorities In Aquaculture: Networking & Happy Hour in the Casco Bay Exhibit Hall**				
5:00 PM	**Poster Session & Happy Hour in the Casco Bay Exhibit Hall**				
6:00 PM	**ECSGA Annual Meeting followed by a 7:00 After Party at The Shop by Island Creek Oysters** (123 Washington Ave, Portland)				
6:00 PM	**Diner out on the town**				
	Friday, April 29				
7:00AM	**Registration in the Hotel Lobby**				
7:00AM	**Continental breakfast in the Casco Bay Exhibit Hall**				
	Vermont Room	**New Hampshire Room**	**Massachusetts Room**	**Rhode Island Room**	**Connecticut Room**
	Supporting Shellfish Hatchery Production *Chair: Katherine McFarland*	**Aquaculture's Social License to Operate** *Chair: Bailey Moritz*	**Fin Fish Health & Nutrition** *Chair: Deborah Bouchard*	**General Aquaculture** *Chair: Mark Dixon*	**K-12 Education** *Co-chairs: Keri Kaczor & Scarlett Tudor*
8:00 AM	Enhancing commercial bivalve hatchery operations through utilization of a recirculating larvae culture system *Michael Congrove*	Moving public opinion on aquaculture: the message matters *Brianna Shaughnessy*	Autogenous vaccines in aquaculture *Bill Keleher*	Small-scale aquaculture recruitment in Maine through the limited-purpose aquaculture ("LPA") licensing system *Micah Conkling*	This panel of aquaculture educators will focus on efforts to develop classroom and informal aquaculture curricula and pathways for a skilled and ready workforce
8:15 AM	Larval oyster hatchery production failure due to toxic impacts of oxidized algal byproducts *Meredith White*	Improving public awareness and literacy about marine aquaculture *Kimberley Thompson*	Vaccinating the mucosal surfaces of teleost fish *Josh Cook*	Aquaculture Opportunity Areas: Updates *Kristy Beard (remote)*	
8:30 AM	Breakthrough of algal toxins into shellfish hatcheries - new lines of research needed to support production *Marta Sanderson*	Communications strategies for addressing social acceptability of shellfish aquaculture *Kristen Jabanoski*	The development and evaluation of liposomes and liposome-containing complex particles for improved health and nutrition of finfish *Matt Hawkyard*	Understanding the crossroads of human and ecosystems health: back bay shellfish farms as a model for studying coastal ecosystem feedback systems *Spencer Marquardt*	
8:45 AM	Shellfish hatchery crashes & production analysis: a case study at Horn Point laboratory *Matthew Gray*	Addressing constraints to shellfish aquaculture through quantifying public perception and attitudes along the Atlantic coast of the U.S. *Kelsey Schultz*	Roles of fish immuno-nutrition and nutrigenomics in the development of sustainable aquafeed: trends and prospects *Michael Habte-Tsion*	The Maine Aquaculture Hub: A network for sustainably strenthening aquaculture in the state *Heather Sadusky*	
9:00 AM	Microbiome perspective on oyster larval health in the hatchery *Bongkeun Song (remote)*	Building and maintaining public and political support for shellfish aquaculture in the pacific northwest *Bill Dewey*	Larval sea lice (*Lepeophtheirus salmonis,* krøyer) exhibit behavioral responses to pre-adult and adult conspecific cues *Robert Morefield*	Developing the 2021 Maine aquaculture economic roadmap: addressing the next decade of aquaculture in Maine *Heather Sadusky*	
9:15 AM	A survey of shellfish hatcheries on experiences with harmful algal bloom disruptions *Meghana Parikh*	Social licensing for offshore kelp farming in California *Eliza Harrison*	Finding the needle in the haystack: a novel method for the rapid enumeration of planktonic salmon lice in a mixed zooplankton assemblage using fluorescence *Cameron Thompson (remote)*	Building a Seaweed Safety Training Program to Enhance the US Seaweed Industry *Michael Ciaramella*	
9:30 AM	New recipe ideas from the Milford microalgae kitchen *Gary Wikfors*	Navigating the social license to operate: An area case study *Sydney Avena*	Exploring the use of lumpfish as a cleanerfish of sea lice on steelhead trout in New Hampshire coastal aquaculture *Michael Doherty*	The safety of AQUI-S® 20e (10% eugenol) as a sedative on juvenile striped bass, Florida pompano, and yellow clownfish *Rodman Getchell*	
9:45 AM	Physiological response of oyster larvae to interactive effects of climate change variables *Katherine McFarland*	Social license to operate in the aquaculture industry: A community focused framework *Emily Whitmore*	Supplementation of feed with an insect antimicrobial peptide does not improve resistance to *Yersinia ruckeri* infection in juvenile rainbow trout (*Oncorhynchus mykiss*) *Nathaniel Sibinga*	Recirculating aquaculture salmon network (RAS-N): understanding the barriers and needs of land-based atlantic salmon production in the U.S. *Catherine Frederick*	
10:00 AM	**Break at the Casco Bay Exhibit Hall**				

Detailed Program for Friday Morning and Afternoon

	Vermont Room	New Hampshire Room	Massachusetts Room	Rhode Island Room	Connecticut Room
10:00 AM	**Break at the Casco Bay Exhibit Hall**				
	Seaweed Farming *Chair: Gillian Phillips*	**Sea Scallop Farming II : Growout** *Co-chairs: Dana Morse & Hugh Cowperthwaite*	**General Shellfish Aquaculture II** *Chair: Julie Rose*	**Use of Probiotics in Aquaculture** *Co-chairs: Marta Gomez-Chiarri & Diane Kapareiko*	**Panel on Shell Recycling** *Co-chairs: Tessa Getchis & David Carey*
10:30 AM	Nurturing the successful growth and maturation of a domestic seaweed aquaculture industry: identifying and removing barriers and promoting opportunities *Anoushka Concepcion*	Linkages between hydrodynamics and biofouling in a sea scallop farm *Elisabeth Younce*	The development of a unique golden/striped phenotype in the blue mussel, *Mytilus edulis*, for hatchery production and value-added potential *Kyle Pepperman*	The use of probiotics in aquaculture: do they work, and, if so, what for, how, and when? *Marta Gomez-Chiarri*	Historic shellfisheries and efforts to replenish shell stock in Rhode Island waters *Michael Rice*
10:45 AM	The effect of distal-end trimming on *Saccharina latissima* morphology, composition, and productivity *Gretchen Grebe*	Assessing various grow-out techniques of deep sea scallops, *Plactopecten magellanicus*, in Maine's vacant lobster pounds *Breanna Salter*	Non-hatchery culture methods to produce soft-shell clam juveniles for public stock enhancement or private farming of Maine's intertidal flats *Sara Randall*	NOAA's Milford Laboratory partners with Prospective Research, Inc. and commercial shellfish hatcheries to confirm efficacy of probiotic strain oy15 in practical hatchery applications on two species of oyster larvae: the eastern oyster (*Crassostrea virginica*) and the pacific oyster (*Crassostrea gigas*) *Diane Kapareiko*	Exploring Connecticut's shell recovery, recycling and restoration efforts *David Carey*
11:00 AM	Optimizing yield potential and harvest efficiency of a scalable coastal and offshore marcroalgal farm *David Bailey*	The remainder of this session will use a hands-on workshop approach to work through the processes of scallop farming and the attendant issues in husbandry, equipment, harvesting, and sales of different scallop products. A full range of scallop farming-equipment will be displayed and will serve as the backdrop for both group discussion, and presentation of recent research and development	You are what you eat: can diet impact the flavor of sea scallops? *Tim Bowden*	Probiotics for eastern oyster hatcheries: commercial formulations and effect on microbial communities *Evelyn Takyi*	The ebb and flow of recycling shell on an island *Emma Green-Beech*
11:15 AM	Selectively breeding improved strains of sugar kelp, *Saccharina latissima*: three year summary *Scott Lindell*		Community aquaculture education through unlikely means *Michael Ciaramella*	Mechanisms of action of probiont phaeobacter inhibens (s4) against the shellfish pathogen *Vibrio coralliilyticus* (re22) *Jessica Coppersmith*	Restaurants to Reefs: Expanding shell collection capacity in NYC *Charlotte Boesch*
11:30 AM	A direct seeding approach to *Saccharina latissima* farming using gametophytes and juvenile sporophytes *Michael Marty-Rivera*		Creating an alternative market, habitat restoration, for farm-raised oysters in response to a COVID-19 associated supply chain collapse *Michael De Luca*	Bioprospecting the next generation of direct fed microbials for aquaculture *Dakota Hamill (remote)*	Cornell Cooperative Extension of Suffolk County's Shell Recycling Program *Gregg Rivara*
11:45 AM	Estimating seasonal production rate in sugar kelp using image analysis on a commercial seaweed farm in Washington state *Joth Davis*		Offshore shellfish aquaculture in federal waters *Edward Maney Jr.*	Discussion	New Jersey Marine Fisheries Administration shell recycling program *Scott Stueber (remote)*
12:00 PM	**Lunch in the Casco Bay Exhibit Hall**				
	Seaweed Processing & Product Development *Chair: Mary Ellen Camire & Denise Skonberg*	**Climate Impacts on shellfish Farms: Your Perspective** *Co-chairs: Sally McGee & Daniel Wieczorek*	**Best Management Practices for Floating Shellfish Gear** *Co-chairs: Bob Rheault & Mark Amaral*	**Hosting Visitors on your Farm: What you need to know** *Chair: Afton Vigue*	**Ecosystem Services** *Chair: Carrie Byron*
1:30 PM	As consumers in Europe and North America become more aware of wild-harvested and farmed seaweed, new food products are being developed to tap consumer interest. In this session, University of Maine researchers will provide updates on their NOAA-funded projects and industry representatives will discuss successes and challenges in product development. Gaps in knowledge such as product shelf-life and consumer preferences will be topics for the panel to address.	This interactive session will have participants answer a series of questions about impacts of climate change they have observed and how they have responded to those changes. Participants will also respond to questions about what they see as the greatest needs in the coming (5) years to address climate change. The results will be shared in real time for discussion during the session. The results will also be shared with government entities to help inform their investments in climate-related activities.	This workshop will bring together resource managers, growers, equipment manufacturers and extension agents to offer methods to minimize conflict and hopefully propose best practices that growers can consider in order to increase their chances of positive permit application outcomes. The workshop will close with an open discussion giving attendees an opportunity to share their experiences and ideas.	Aquaculture producers are increasingly diversifying their business to include customer interactions like direct sales, farm tours, and partnerships with local tour operators. We propose to offer a grower-focused professional development session at NACE to include three main components 1) rules and regulations around direct sales and tours (licensing, liability, insurance), 2) customer service training, and 3) opportunities for partnership with local tour operators like boat and kayak tours. We'll also distribute a pre-session survey to get a pulse on which topics are of most interest to conference attendees. To keep things interactive and conversational, we plan to invite a few farmers as well as tour operators to engage in a focused discussion around the topics at hand. This will give growers a chance to network with other professionals, learn from them, and ask questions.	Ecosystem services and wildlife interactions at oyster farms *Daphne Munroe*
1:45 PM					Defining a model of shellfish nitrogen removal at the oyster farm-scale: An example in Greenwich, Connecticut *Skylar Bayer*
2:00 PM					Shelf and bag oyster aquaculture cages provide habitat for fish similar to natural boulder reefs *Renee Mercaldo-Allen*
2:15 PM					Behavioral analysis of how native fish communities use oyster cages as structured habitat *GIllian Phillips*
2:30 PM					Developing shellfish aquaculture best practices to enhance habitat provisioning *Julie Rose*
2:45 PM					Supporting ecosystem services of habitat and biodiversity in seaweed (*Saccharina latissima*) aquaculture farms *Emily Schutt*
3:00 PM	**Break in the Foyer**				
	Upwellers & Other Nursery Technologies *Co-chairs: Dale Leavitt & Chris Davis*	**Climate Change** *Chair: Daniel Wieczorek*	**Best Management Practices to Maximise Ecosystem Services** *Co-chairs: Robert Jones & Bob Rheault*	**Business Support & Entrepreneurship** *Chair: Christian Brayden*	**Food Justice in Aquaculture** *Chair: Adam St Gelais*
3:30 PM	This session will cover basic aspects of upweller design and management and will also report on developing aspects of alternative technologies for nursery rearing shellfish.	Climate Risks and Response Options in the Gulf of Maine *David Reidmiller*	The session will cover a broad overview of the various types of aquaculture and some of the various ecosystem services associated (nutrient removal, habitat provision, eutrophication mitigation, benthic stabilization). Panelists will discuss their research on certain aspects of the various practices and how they might influence the provision of services. Panelists will be asked to propose potential Best Management Practices for growers to consider in order to optimize or maximize the provision of these services. The workshop will close with an open brainstorming session offering attendees an opportunity to share ideas on how to maximize the ecological benefits of restorative aquaculture. Panelists: *Dr. "Wally" Robinson Fulweiler* *Dr. Julie Rose* *Dr. Daphne Munroe*	*The Maine Aquaculturist:* Creation and post launch updates *Carissa Maurin*	The food justice movement is growing, amplifying the need for equity and social justice within the food system. The "Ocean food system" is often overlooked as a component of this movement, which has focused on terrestrial foods. A panel of experts will discuss how Food Justice principles can be adopted by industry and managers to promote socioeconomic diversity within the industry, specifically at the business ownership level. Panelists: *Imani Black, Minorities in Aquaculture* *Jon Russel, North Atlantic Marine Alliance* *Cristina Sandolo, UNE Ocean Food Systems* *Lisa Tossey, Maryland Sea Grant (remote)*
3:45 PM				Gulf of Maine blue economy innovation corridor *Blaine Grimes*	
4:00 PM		Environmental conditioning of clams to low pH enchanges robustness to environmental stress through acclimatory gene expression *Sam Gurr*		Maine aquaculture business planning tools *Christian Brayden*	
4:15 PM		Molecular features associated with oyster (*Crassostrea virginica*) and hard clam (*Mercenaria mercenaria*) resilience to ocean acidification *Caroline Schwaner (remote)*		Innovation seascape of aquaculture in the northeast *Luke Sawitsky*	
4:30 PM	On track to optimize the bottle upweller (BUPSY): modeling the flow dynamics of the BUPSY vessel *Dale Leavitt*	Effect of acute acidification exposure on American lobster embryos *Abigail Sisti*		Aquaculture risk management infographics - and a new crop insurance policy? *Christian Brayden*	
4:45 PM	How do you find those oyster cages on your deep water farm? The application of side-scan technology for visualizing cages on the bottom *Dale Leavitt*	Cumulative effects of ocean acidification and warming on the early development of American lobsters *Emily Rivest*		Maine aquaculture financial benchmarking report *Christian Brayden*	
5:00 PM	**Closing Remarks & Sendoff Toasts**				

Posters

Alexandra Ambrose	VIDEO DOCUMENTATION OF THE MARINE COMMUNITY USING OYSTER FARM AS HABITAT
Tuqa Al-Asadi	OPERATION AND PRELIMINARY ENERGY BALANCE OF A PORTABLE KELP DRYER IN MAINE
Sydney Avena	ASSESSMENT OF NURSERY GEAR TECHNOLOGY TO OPTIMIZE GROWTH, SURVIVAL, AND ECONOMIC EFFICIENCY IN FARMING ATLANTIC SEA SCALLOPS (*PLACOPECTEN MAGELLANICUS*)
Maggie Aydlett	NOVEL BOTTOM CULTURE OF SUGAR KELP (*SACCHARINA LATISSIMA*) FOR DIVERSIFYING MARINE FARMS
Timothy Bowden	HARRY OYSTER AND THE PARASITE OF DOOM
Carrie Byron	TEMPERATURE OF SEAWEED FROM POST-HARVEST TO PROCESSING
Ryan Carnegie	THE REGIONAL SHELLFISH SEED BIOSECURITY PROGRAM (RSSBP)
Angelo DePaola	SHELLEVATOR INNOVATION
Jay Esty	THE FUTURE IS NOW: BOSTON HIGH SCHOOLERS EXPLORE OCEAN FARMING
Jonathan Evanilla	USING AI TO FORECAST PARALYTIC SHELLFISH POISON (PSP) IN COASTAL MAINE
Charlotte Hickey	DEVELOPMENT OF VIBRIO SPP. DETECTION FOR THE CONSUMER MARKET
Cheryl James	DETERMINING GROWTH POTENTIAL OF THE EASTERN OYSTER BY VOLUMETRIC COMPARISON UTILIZING SODA BOTTLE UPWELLERS

Tom Kiffney	SITE SELECTION THROUGH DYNAMIC ENERGY BUDGET MODELS COUPLED WITH HIGH-RESOLUTION SATELLITE PRODUCTS
Jang Kyun Kim	TEMPERATURE AND PHOTOSYNTHETICALLY ACTIVE RADIATION EFFECTS ON EARLY DEVELOPMENT OF SPOROPHYTES IN THE BROWN ALGAE, *SACCHARINA JAPONICA* AND *S. LATISSIMA*
Luz M. Kogson	DEVELOPMENTAL STAGES OF THE GREEN SEA URCHIN (*STRONGYLOCENTROTUS DROEBACHIENSIS*) IN MAINE: THE UMAINE CCAR HATCHERY EXPERIENCE
Jamie Lau	COMPARING GROWTH RATES OF OYSTERS USING VARIOUS GROW OUT METHODS
Hayley Lemoine	LIVELIHOOD DIVERSIFICATION STRATEGIES IN THE UNITED STATES' COMMERCIAL SHELLFISH INDUSTRY
Anne Langston Noll	ASSESSMENT OF U.S. CONSUMER ATTITUDES AND PREFERENCES FOR DOMESTIC FARM-RAISED SEAWEED
Brian Preziosi	COMPARING THE PERFORMANCE OF SELECTIVELY-BRED AND WILD EASTERN OYSTER STOCKS IN RHODE ISLAND
Mike Tlusty	WHAT ARE YOUR OPINIONS TOWARD LAB-GROWN MEAT?
Benjamin Towne	EFFECTS OF PROBIOTIC PHAEOBACTER INHIBENS S4 TREATMENT ON THE BACTERIAL COMMUNITIES OF LARVAE RAISED IN UV TREATED AND NON-UV TREATED WATER

Be sure to attend the Poster Session/Happy Hour from 5:00 - 6:00 on Thursday and meet with the authors.

ABSTRACTS OF ORAL PRESENTATIONS AND POSTERS

SURVIVAL OF INOCULATED *VIBRIO* SPP., *SALMONELLA* SPP., *LISTERIA MONOCYTOGENES* AND *ESCHERICHIA COLI* ON SUGAR KELP DURING REFRIGERATED AND AMBIENT STORAGE

***Samuel Akomea-Frempong*, Jennifer J. Perry, Denise I. Skonberg**
School of Food and Agriculture, University of Maine, Orono, ME 04469

Bacteria such as *Vibrio* spp. persist in coastal waters and can potentially contaminate edible seaweeds. Pathogens such as *Listeria monocytogenes*, Shigatoxigenic *Escherichia coli* (STEC) and *Salmonella* spp. occasionally contaminate diverse foods and can present a serious health risk in minimally processed vegetables including sugar kelp. Therefore, the aim of this study was to evaluate the survival of these four pathogens inoculated on sugar kelp subjected to different postharvest storage temperatures. Sugar kelp was inoculated (7.0 logCFU/g) with a cocktail of two strains of *L. monocytogenes, Salmonella* and STEC and two species of *Vibrio*. STEC and *Vibrio* cultures were grown and applied in salt-containing media to simulate pre-harvest contamination, whereas *L. monocytogenes* and *Salmonella* inocula were prepared to simulate post-harvest contamination. Samples were stored at 4°C and 10°C for 7 days, and 22°C for 8 hours. Microbiological analyses were performed periodically (1, 4, 8, 24 hr, etc.) to evaluate the effects of storage temperature on pathogen survival. Pathogen populations decreased under all storage conditions, but survival was greatest for all species at 22°C, with STEC and *Salmonella* exhibiting significantly lower reductions (1.2 and 1.7 logCFU/g, respectively) than *L. monocytogenes* and *Vibrio* (2.5 and 2.4 logCFU/g, respectively). Populations of *Vibrio* and STEC decreased with storage temperature, whereas *L. monocytogenes* survived better at 4 than 10°C. Regardless of temperature all pathogens remained detectable at the end of the study duration. Results emphasize the need for strict adherence to temperature control for kelp. Temperature abuse may support pathogen survival, especially STEC, during storage.

OPERATION AND PRELIMINARY ENERGY BALANCE OF A PORTABLE KELP DRYER IN MAINE

Tuqa Al-Asadi, G. Peter van Walsum
Department of Chemical and Biomedical Engineering, University of Maine, Orono, ME 04469

Saccharina latissimi (Sugar Kelp) – a brown macroalgae native to Maine, is an important commodity as raw material for food, additives, and biomass. Seaweeds are highly perishable due to their high moisture content and will spoil quickly if not preserved. Drying the product prolongs storage life and minimizes transportation cost. A controlled drying environment deploying warm, dry air will extend seaweed life and retain the valuable bioactive components and nutritional value.

This project is examining the drying rate, temperature, humidity and energy efficiency of a shipping container-housed drying system. Drying runs show that as air passes through the drying chamber it decreases in temperature and gains humidity, with the exiting air showing a steady trend of rising temperature and decreasing RH as the process progresses. Partial recycling of the air achieves higher exit humidity, which reduces energy losses.

Analysis of the energy dynamics for the system shows that more data are needed to consistently close the energy balance, particularly with respect to metering the propane used, determining the temperatures of dryer surfaces, the rate of air flow through the system, as well as weather conditions, and orientation to the Sun. Estimated values for these variables suggest that the fuel consumption for drying a 100 kg (wet) load down to less than 20% moisture would take 4 – 5 hours and consume 3/8 gal propane per kg dry product. Insulating the walls of the container will likely be cost effective, especially if the dryer is operated on cloudy days or at night.

UPDATES FROM THE EAST COAST HARD CLAM SELECTIVE BREEDING COLLABORATIVE

***Bassem Allam*[1], Sarah Farhat[1], Emmanuelle Pales Espinosa[1], Arnaud Tanguy[2], Kimberly Reece[3], Jan McDowell[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 extensively cultured along the Atlantic seaboard of the U.S. 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. Several states regularly suffer losses in hard clam stocks due to disease (e.g. QPX in the Northeast) and environmental stress (e.g. heat waves in Florida). Therefore, the production of quality seed able to survive under harsh biological and environmental conditions represents a priority for the aquaculture community. This collaborative initiative builds on ongoing cooperation and new partnerships among Sea Grant programs, scientists and extension teams in five Atlantic states to develop a hard clam selective breeding program using state of the art genomic tools, for the benefit of clam farmers throughout the region. The team has just completed the sequencing and assembly of the hard clam genome and is currently re-sequencing clams collected from Maine to Florida to gather information about the genetic diversity of the species throughout its natural range in the U.S. Generated genomic data will be used to develop an efficient and cost-effective genotyping platform (SNP array) for *M. mercenaria*. This genotyping platform will enable genome-assisted selection for traits relevant to various regions supporting the growth of the hard clam aquaculture industry. These activities will serve as a basis to establish clam breeding programs linking scientists, extension networks and the industry to provide growers with superior clam stocks.

VIDEO DOCUMENTATION OF THE MARINE COMMUNITY USING OYSTER FARM AS HABITAT

Alexandria Ambrose, Daphne Munroe, Jenny Shinn, Lisa Calvo
Rutgers, The State University of New Jersey, Haskin Shellfish Research Laboratory, 6959 Miller Avenue, Port Norris, NJ 08349

Shellfish growers routinely observe fish and invertebrates interacting with their aquaculture gear. To quantitatively assess these observed interactions, point-of-view (GoPro) cameras were used to document fish activity in and around oyster cages, floating bags, and a natural marsh habitat on an oyster farm in the Little Egg Harbor region of Barnegat Bay, New Jersey in 2018 and 2019. At least 27 species from 4 phyla were observed across all days and sites in over 100 hours of video. Nekton abundance was determined using MaxN, defined as the maximum number of individuals of a given species present within each 1-minute segment of video. Species of both ecological and economic importance in the local ecosystem utilized the farm gear as habitat. MaxN values varied across sampled seasons and habitat type. Most frequently, juveniles of a given species were observed, suggesting that the oyster farm may support the natural nursery function of the marshes. Additionally, observations indicated a stochastic relationship between wildlife and human activity on the farm. This collaborative work is part of an ongoing effort initiated in Long Island Sound by the NOAA Milford Lab and is a first step towards a comprehensive regional network characterizing and evaluating fish habitat provisioning on off-bottom oyster farms. This research is being used to help inform decision making in the permitting process of shellfish aquaculture leases, as the gear has the potential to mimic the function of natural surrounding habitats.

THE EFFECT OF DRYING OF ON THE SURVIVAL OF *ESCHERECHIA COLI*, *LISTERIA INNOCUA* AND *BACILLUS CEREUS* ON SUGAR KELP

***Richa Arya*, Jennifer J. Perry, Denise I. Skonberg**
School of Food and Agriculture, University of Maine, Orono, ME 04469

Sugar kelp (*Saccharina latissima*) is a brown macroalga widely harvested in the Northeastern US. Drying can improve the microbial quality and shelf life of sugar kelp by reducing water activity and moisture content. However, the effect of this process on bacterial pathogens of significance is not well characterized. In this study, the effect of controlled drying conditions on the survival of pathogen surrogates *Listeria innocua, Bacillus cereus* and *E. coli* inoculated on sugar kelp was investigated. Fresh sugar kelp was washed and cut into blades of uniform size (15 cm). Each blade was inoculated with 10^7 log CFU/g inoculum level of *L. innocua, B. cereus* and *E. coli* (separately) and dried in a convective dryer at various parameters: two temperatures (40°C, and 50°C) and relative humidity levels (25% and 50%) to one of two target final water activities (0.3 and 0.5). Survival of *L. innocua, B. cereus* and *E. coli* on inoculated dried samples was assessed using cultural techniques. One-way ANOVA ($p<0.05$) was used to evaluate the effects of treatment temperature, relative humidity, and water activity on the reduction of inoculated pathogens. Drying treatments at different drying conditions significantly reduced the population of *L. innocua*, *E. coli* and *B. cereus* on the inoculated sugar kelp. Drying at 50 °C, 50%, 0.3 and 40°C, 25%, 0.5 parameters resulted in the maximum reduction of *E. coli* (4.24 ± 0.15 log CFU/g), *L. innocua* (3.36 ± 0.94 log CFU/g) and *B. cereus* (4.64 ± 0.05 log CFU/g) respectively.

NAVIGATING THE SOCIAL LICENSE TO OPERATE: AN AREA CASE STUDY

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

The social license to operate, or the unwritten social contract between an industry and the broader community, has recently been used to describe the relationship between the aquaculture industry and its stakeholders. In this study, we focus on social license to operate in the Damariscotta River area, where a well-established shellfish aquaculture industry is present. Oyster aquaculture in Maine began in the Damariscotta River in the 1970s, and in 2019 Damariscotta oysters comprised almost 70% of Maine's total aquacultured oyster harvest with a value of over $6.5 million. Today, there are 30 active experimental and standard aquaculture leases on the Damariscotta River for a total of 165.44 acres under culture. By utilizing a media analysis, lease hearing information, and a Q method study, we hope to evaluate the social license to operate for aquaculture present in the Damariscotta region and to determine best practices for sea farmers working with communities.

ASSESSMENT OF NURSERY GEAR TECHNOLOGY TO OPTIMIZE GROWTH, SURVIVAL, AND ECONOMIC EFFICIENCY IN FARMING ATLANTIC SEA SCALLOPS (*PLACOPECTEN MAGELLANICUS*)

Sydney Avena, Anne Langston Noll, Christopher Davis
Maine Aquaculture Innovation Center, 193 Clarks Cove Road, Walpole, ME 04573

The Atlantic sea scallop (*Placopecten magellanicus*) has a long standing commercial fishery in Maine and as Maine's aquaculture industry continues to grow, there is interest in developing innovative and cost effective techniques for sea scallop aquaculture. This study will assess four different aquaculture gear types for grow-out of farm-raised sea scallops (lantern nets, floating bags, bottom cages, and dark sea trays) to investigate growth rates and survival of sea scallops. Using these gear types will provide a comparison of growing sea scallops at the top, middle, and bottom of the water column. Additionally, the economic efficiency of using each gear type will be compared, specifically the capital cost and labor involved in deployment and maintenance. The information gained from this study will help inform farmers looking to enter the scallop aquaculture sector on the costs and benefits of using these gear types to culture sea scallops.

NOVEL BOTTOM CULTURE OF SUGAR KELP (*SACCHARINA LATISSIMA*) FOR DIVERSIFYING MARINE FARMS

Maggie Aydlett[1], David Bailey[1], Michael Chambers[2], Dan Smith[3], John Lovett[4], Scott Lindell[1]
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Kelp farming is a rapidly expanding industry in the Northeastern US and Alaska. Cool, nutrient rich water in the Gulf of Maine make the region ideal for growing kelp; 2020 harvests in Maine alone totaled more than half a million wet pounds, up from the previous years' 325,000 pounds, and the state issued 125+ permits covering 173 acres of coastal waters (Piconi et al. 2020). However, kelp farms in the southern

portion of the Gulf of Maine are virtually nonexistent, despite having healthy natural populations, due to gear restrictions in Cape Cod Bay that mitigate Right Whale entanglement during the winter months. Kelp farming provides a unique market diversification opportunity for shellfish farmers and commercial fishers in the Northeastern US. The kelp farming season ranges from November to June making it complementary to shellfish farming and many commercial fisheries which demand more attention during the warmer months. This project will test a novel on-bottom growing structure for *Saccharina latissima* with no vertical lines and stiff non-rope grow-lines. These gear modifications may make kelp farming possible in areas where traditional systems are prohibited. Deployment of the novel test structure will occur in late fall 2021 at 3 participating farm locations in the southern Gulf of Maine.

OPTIMIZING YIELD POTENTIAL AND HARVEST EFFICIENCY OF A SCALABLE COASTAL AND OFFSHORE MARCROALGAL FARM

***David Bailey*[1], Scott Lindell[1], Clifford Goudey[2], Domenic Manganelli[2], Hauke Kite-Powell[1], Charles Yarish[3], Loretta Roberson[4], Kendall Barbery[5], Tobias Dewhurst[6], Beau Perry[7], Alf Pryor[8], Nick Mangini[9], Michael Stekoll[10]**

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Seaweed farming is expanding rapidly in the US and is becoming an important component of our coastal economy. To maintain sustainable growth, both socially and economically, it is essential to 1) optimize the growing potential of permitted lease areas and 2) increase operational efficiency. Maximizing production per unit area will minimize the area required to meet the needs of a growing industry and reduce potential ocean user conflicts and natural impacts. The dense growing structures required to optimize production enable operational efficiencies that are not achievable with traditional farming practices. These efficiencies have the potential to reduce the cost of production, which will allow the industry to enter new markets. As part of the ARPA-E MARINER program an experimental test farm has been deployed over the past two years in Kodiak, Alaska with the goal of increasing yield per unit area and increasing operational efficiencies. During the first growing season 2019-20 the farm had 11,000ft of grow-line in a 1.9-acre footprint. Harvest yielded 59,000lbs at 5.5lbs/ft. The second growing season 2020-21 had 25,000ft of grow-line in a 3.3-acre footprint. The harvest of 68% of the farm yielded 86,600lbs at 4.95lbs/ft. Harvesting system optimization took place with the testing of a purpose-built barge and a commercial fishing boat. The fastest rate of harvest achieved was 15,000lbs/hr with an average harvest speed of 2,800lbs/hr. The test farm will be deployed for a third season with 44,000ft of grow-line in the same 3.3-acre footprint.

QUANTIFYING FARM-SCALE FILTRATION RATES ASSOCIATED WITH EASTERN OYSTER AQUACULTURE IN THE NORTHEAST

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Oyster aquaculture is the most common form of mollusk farming in the world and U.S. oyster production is valued at $192 million annually. In addition to its economic value, oyster aquaculture provides ecological value such as water quality improvement. Oyster filtration is influenced by environmental conditions such as water temperature, hydrodynamics, salinity, food quality and quantity, as well as oyster size and energetic demands. Although filtration is highly variable, average rates are often used to estimate the ecological impact of oyster filtration; therefore, there is a need for accurate, farm-specific estimates of filtration that account for this variation. To address this need, research was conducted between July 2020 and September 2021 to estimate annual farm-level filtration and clearance occurring at three oyster farms in the Northeast. The farms studied include a subtidal farm in Barnegat Bay, an intertidal farm in Delaware Bay, and a subtidal farm in Rehoboth Bay. Data were collected seasonally at each farm using a flow-through filtration chamber with ambient farm water. During each experiment oysters representing a range of sizes were placed in the chamber, from which oyster biodeposits were collected to calculate *in-situ* oyster filtration and clearance rates. Filtration varied among farms and experiment timing such that warmer temperatures and lower organic content of seston were generally associated with higher filtration rates. These experiments provide a robust dataset of oyster filtration observed under natural conditions across farms and may be used in a broader framework to inform development of nutrient management programs in the Northeast.

THE FUTURE IS NOW: BOSTON HIGH SCHOOLERS EXPLORE OCEAN FARMING

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Facilitated by a small grant from NOAA, 15 Green Ambassadors (GA, Boston high school youth who participate in a summer work-learning program offered at Thompson Island Outward Bound in Boston Harbor) -- gained an introduction to aquaculture (via clam-seeding and monitoring) and aquaponics (via systems they helped build, monitor and manage) during summer 2021. While the five-week experience was limited, it provided proof of concept and opened a door to future programming that will emphasize more aquaculture and sustainable food production. Not only did GAs grow fish, they ingested what they grew. Prior to their summer experience, only 3-4 of the participants had ingested soft shell clams. On the last day, all but 2 partook of one or more steamers.
The Green Ambassadors, largely 15-to18-year-old students of color from Boston Public Schools, have historically focused on land and terrestrial natural resource management. During the pandemic, program

managers increasingly focused on social and environmental justice work for the teens, who, isolated and slogging through remote learning, responded enthusiastically.

After their first foray last summer into aquaculture, the GAs are now keen to try sugar kelp production (and ideally expand into a seaweed-shellfish polyculture system) the GAs understand the beneficial climate impacts of regenerative ocean farming and because they appreciate the storm and flooding mitigation such farms can create along their urban waterfront. The goal is to spawn a more receptive and informed consumer that understands who appreciates sustainably sourced seafood.

DEFINING A MODEL OF SHELLFISH NITROGEN REMOVAL AT THE OYSTER FARM-SCALE: AN EXAMPLE IN GREENWICH, CONNECTICUT

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An overabundance of nitrogen in coastal and estuarine systems, eutrophication, is a major problem that concerns scientists, resource managers, policy-makers, and local stakeholders. Bivalves are particularly good at feeding on the phytoplankton that grows from the excess nitrogen, assimilating some of the nitrogen from their food into their tissue and shell as they grow. Therefore, modeling rates of shellfish nitrogen capture is an important tool for coastal marine spatial planning, policy, and management. In locations with established bivalve aquaculture industries, morphometrics, tissue, and shell nitrogen content can be combined with harvest numbers to assess aquaculture contributions to nutrient reduction and increased water quality. This approach accounts for only the removal associated with harvest, and most aquaculture operations have several year-classes growing simultaneously. Measuring bivalve feeding activities and total farm stock can provide a more immediate assessment of farm-scale nitrogen removal. In collaboration with local stakeholders (Greenwich Shellfish Commission and Stella Mar Oysters) we collected data to estimate farm-scale rates of nitrogen assimilation in cultivated eastern oysters in Greenwich Bay, Connecticut. These data include: (1) monthly water samples, (2) monthly oyster samples from Stella Mar Oysters, (3) field measurements of oyster filter feeding, including nitrogen absorption and (4) oyster excretion measurements. We incorporated these data into the existing Farm Aquaculture Resource Management (FARM) model to improve its estimates of nitrogen removal by a coastal oyster farm in Greenwich Bay. The methods employed in this project may also be applied elsewhere and for other shellfish industries and marine spatial planning efforts globally.

SEVEN SUMMERS OF SPAWNING: METHODS AND LESSONS LEARNED FROM SPAWNING SEA SCALLOPS IN MID-COAST MAINE

Skylar Bayer
Roger Williams University, One Old Ferry Way, Bristol, Rhode Island (current); Darling Marine Center, University of Maine, 193 Clark's Cove Road, Walpole, Maine (where the work was completed)

The sea scallop (*Placopecten magellanicus*) is a well-known and profitable commercial fishery in both Canadian and U.S. waters. The ability to control sea scallops as a resource has predominantly relied on fisheries management strategies such as long-term closures. Given the culinary demand for sea scallops, the ability to raise sea scallops in aquaculture settings from gametes through larval and juvenile stages to adults would ensure better sustainability and reliability of the resource. However, after many decades, sea scallops remain a difficult species to culture at commercially profitable scales, particularly at the larval stage. As a Ph.D. student, I spent seven summers (2011-2017) at the Darling Marine Center spawning sea scallops for fertilization and cultivating techniques in stimulating female scallops to spawn for both field and laboratory experiments. The Darling Marine Center is located on the Damariscotta River estuary in mid-coast Maine. This talk will review the spawning methods I developed from both my own trial and errors as well as knowledge and suggestions I received from others while at the Darling Marine Center. This talk will be presented with the goal of sharing information broadly that may be useful for sea culturing. In addition, I hope to collaborate with partners on future sea scallop spawning and culturing proposals and studies.

NON-HATCHERY CULTURE METHODS TO PRODUCE SOFT-SHELL CLAM JUVENILES FOR PUBLIC STOCK ENHANCEMENT OR PRIVATE FARMING OF MAINE'S INTERTIDAL FLATS

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Since the mid-1970s, Maine's soft-shell clam fishery has experienced "the best of times and the worst of times." In 1977, commercial landings peaked at 7.8 million pounds (mp). Since then, the fishery has experienced a steady decline (nearly 80%) reaching an all-time low of 1.4 mp in 2020. Landings declines are associated with losses of thousands of jobs (> 3,000), especially for clammers and buyers. Fisheries independent data demonstrate clam losses result from recruitment limitation – lack of settlement and/or high post-settlement mortality. This scenario has occurred while Gulf of Maine seawater temperatures have increased dramatically. While this clam has wide physiological tolerances to warm water (they are distributed in the northwest Atlantic from Virginia to Newfoundland), the warming has resulted in dramatic increases in predator populations, specifically the invasive green crab. We have developed a simple tool (a 1-ft x 2-ft x 3-inch deep wooden box lined with a fine, heavy-duty mesh that excludes predators > 1.9 mm) that has allowed us to measure clam recruitment limitation in intertidal soft-bottom habitats. Since 2015, we have deployed ~2,500 boxes along the entire expanse of the Maine coast. Boxes can be used by shellfish managers and community-based stewards to locate areas/regions of intense clam settlement. We have discovered areas where no commercial clams exist, yet boxes routinely contain > 1,000/ft^2 clam juveniles. Boxes can be scaled and deployed in these areas, and the juvenile clams used to enhance wild stocks using straightforward farming techniques that have been developed and tested.

A COLLABORATIVE APPROACH TO INVESTIGATE HATCHERY CULTURE METHODS TO PRODUCE COMMERCIAL QUANTITIES OF SEA SCALLOP, *PLACOPECTEN MAGELLANICUS*, SPAT FOR FARMERS IN MAINE

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Today in Maine, a grassroots initiative is taking place within the fishing community to develop captive aquaculture of the Atlantic sea scallop, *Placopecten magellanicus.* Using wild seed, farmers have been successful in transferring cultivation methods adapted from those well-established in Japan with *Mizuhopecten* (= *Patinopecten*) *yessoensis*. *P. magellanicus* has the potential to become a significant commercial farmed product in Maine and, while 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 has been a major challenge to overcome. Because they are a boreal species, sea scallops have one of the longest larval periods of any scallop lasting upwards of 45 days to settlement. This lengthy larval phase for sea scallops has proven to be a challenge to date, and is a major reason why no commercial hatchery production of sea scallop spat exists today in Maine or any other state in the northeast U.S. During the summer/early fall of 2021, the team, consisting of individuals from three shellfish hatcheries – one commercial, and two research/development – began a collaborative project to examine effects of two larval culture techniques (static vs flow-through) on larvae survival and growth. Protocols attempted to reduce variability in techniques between hatcheries by using broodstock from a single source, the same suite of cultured microalgae (common origin), and similar culture temperatures. In addition, water quality, bacterial diversity and loads, and lipid content of microalgae and scallop larvae were measured in each location. Team members from each hatchery will present results of these larval-rearing trials along with data on post-settlement success.

AQUACULTURE OPPORTUNITY AREAS: UPDATES

Kristy Beard
NOAA Fisheries Office of Aquaculture, Silver Spring, MD 20910

On May 7, 2020, the White House issued an Executive Order (E.O.) on Promoting American Seafood Competitiveness and Economic Growth (E.O. 13921), which requires the Secretary of Commerce to identify geographic areas containing locations suitable for commercial aquaculture, and complete a National Environmental Policy Act (NEPA) Programmatic Environmental Impact Statement (PEIS) for each area to assess the impact of siting aquaculture facilities there. These geographic areas will be referred to as Aquaculture Opportunity Areas (AOAs) once the PEIS is complete.

The process to identify and complete a PEIS for each AOA will result in the identification of a geographic area that, through scientific analysis and public engagement, is determined to be environmentally, socially, and economically suitable for aquaculture. The areas identified as AOAs will have characteristics that are expected to be able to support multiple aquaculture farm sites of varying types, but all portions of

the AOA may not be appropriate for aquaculture or for all types of aquaculture. NOAA will combine input received through consultation and coordination with Federal and non-Federal stakeholders, public comments, and spatial modeling by NOAA's National Centers for Coastal Ocean Science (NCCOS) that is based on the best available science.

NOAA will provide updates on our progress towards identifying the first two geographic areas containing locations suitable for commercial aquaculture, planning for the NEPA PEIS for each of those two areas, and the upcoming opportunities for input.

GRASSROOTS ADVOCACY TO MOVE THE NEEDLE FOR US AQUACULTURE

***Sebastian Belle*, Paul Zajicek**
National Aquaculture Association, P.O. Box 12759, Tallahassee, FL 32317

During 2021 the National Aquaculture Association celebrated its 30th year by focusing on farmer advocacy and not on celebration. How the NAA advocates, how you can advocate, the importance and value of aquaculture associations, and the key issues we are focusing on to move the needle for US aquaculture, to include but are not limited to: crop insurance, aquatic animal health, pandemic and catastrophic disaster assistance, economic development, applied research, public education, offshore farming and regulation will be presented.

ON TRACK TO OPTIMIZE THE BOTTLE UPWELLER SYSTEM (BUPSY): MODELING THE FLOW DYNAMICS OF THE BUPSY VESSEL

Maija Benitz, Celeste Hartley, Robbie Hudson, *Dale Leavitt*
Roger Williams University, 1 Old Ferry Rd, Bristol, RI 02809.

The bottle upweller system (BUPSY) is becoming a popular tool for the early nursery phase of shellfish production. Entraining small shellfish seed in an upward flowing water current contained within a vessel provides excellent growing conditions for the seed. However, there are numerous designs of the containment vessel currently being used with little knowledge as to the impact vessel shape or size may have on the dynamics of the seed within the fluidized bed. Moreover, questions remain about the ideal flowrates for growing seeds most efficiently. An open-source computational fluid dynamics model was selected and adapted for modeling various BUPSY configurations. Numerical meshes for four different BUPSY geometries were created. Initial testing indicates that the model will provide robust three-dimensional, time-varying predictions of seed motion. Using real-time measurements of oyster seed at varying stages of growth, the models will provide a preliminary assessment of the potential for each shape to support growth of oysters in the BUPSY. The preliminary model design and outputs are presented with a discussion of the next step in this research project, supported by the USDA-Northeast Regional Aquaculture Center.

DEVELOPING AN APPROVED RESTORATIVE AQUACULTURE ASSOCIATES DEGREE PROGRAM FOR THE COMMONWEALTH OF MASSACHUSETTS INCORPORATING COMMUNITY EDUCATIONAL OUTREACH PROGRAMMING, INDUSTRY COLLABORATION, AND TOWN SHELLFISH INITIATIVES.

David Bill
Northeast Maritime Institute, 32 Washington Street, Fairhaven, Massachusetts 02719

Northeast Maritime Institute (NMI) has served the maritime community as a premier professional maritime training institution. NMI is developing comprehensive educational, industry collaboration, and community outreach programing in Restorative Aquaculture. Since the collapse of the New England ground fishing industry, the continuous threat of the diminishing global wild fish stocks, climate change impacts on food production, and community food security concerns, aquaculture offers some viable and hopeful restorative solutions to these dire challenges. The NMI associates degree education and training program prepares graduates for entering the aquaculture work force with a regenerative mindset. Concentration in recirculating aquaculture, fin-fish aquaculture, shellfish aquaculture, or macroalgae will be customized by each student's passion and directed choice during two summer externships and a final capstone project. The academic program will incorporate extensive daily hands-on, experiential fieldwork on NMI's two aquaculture farm leases and with our enthusiastic industry partners. A graduate of the NMI Restorative Aquaculture degree program will be fundamentally equipped and have the mindset to enter the aquaculture workforce or matriculate for future study in an undergraduate program, or start their own aquaculture business.

The summer 5 day "Aquaculture Certificate" program is designed as a fun, experiential, educational, historical, hands-on experience for community participants of all ages (15 years and older) to promote community education and outreach for the public benefit. Key tenets designed into our NMI programming are community and industry collaboration and benefit as well as environmental awareness.

RESTAURANTS TO REEFS: EXPANDING SHELL COLLECTION CAPACITY IN NYC

Charlotte Boesch
Billion Oyster Project, 10 South Street, Slip 7, New York, NY 10004

Since 2015, Billion Oyster Project's Shell Collection Program collected 1.8 million pounds of oyster shell from over 75 NYC restaurants to reuse as oyster reef substrate in NY Harbor. During our presentation, Billion Oyster Project will discuss how we increased collection capacity in the last 6 years, and the major challenges we still face in reaching our ultimate goal to restore 1 billion oysters to NY Harbor, while engaging 1 million New Yorkers in the process, by 2035.

In 2017, we began operating in partnership with a wholesale seafood company, which gave us the ability to scale up the collection program. In 2019, we helped launch City Island Oyster Reef's community-led collection program, which is now collecting from 10 restaurants on City Island with BOP support. In June 2020, with Pew Charitable Trust, we launched the New York Alliance of Shell Collectors to promote collaboration between member organizations and advocate for more State support.

Expanding capacity has its limits, however, particularly due to space and funding limitations. In NYC, land is scarce. Securing enough curing space that's accessible for volunteers and our fabrication team has

proven challenging. In addition, the Shell Collection Program has been primarily supported by programmatic funders, which can be an unpredictable source.

As we discuss the successes, challenges and lessons learned from our Shell Collection Program, we'll recognize how our ability to secure a more predictable funding model and engage with chefs, volunteers, local government, and community partners to collect shells will help guide our program's future scalability.

REPRODUCTIVE CYCLES OF TWO DEVELOPING COMMERCIAL SHELLFISH SPECIES IN MASSACHUSETTS

***Harriet Booth*[1,2], Joshua Reitsma[1,2], Emma Green-Beach[3], Matthew Weeks[4], Ryan Burch[5], Roxanne Smolowitz[6], Abigail Archer[1,2], Dale Leavitt[7]**
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The spawning cycles of two potentially valuable commercial shellfish species in Massachusetts were examined to inform the aquaculture potential and wild fishery management of both species. The "southern" surfclam, *Spisula solidissima similis*, is a subspecies of *Spisula solidissima*, the commercially harvested Atlantic surfclam, and has been experimentally grown in Massachusetts coastal waters with recent success. The intertidal fishery for the razor clam, *Ensis directus*, has become increasingly important in areas of Massachusetts, but little is known about seasonal reproductive patterns of either species in the region. Members of the Cape Cod Cooperative Extension Marine Program examined a sample of 10 clams of each species at monthly intervals over two years. Morphometric data (shell length, weight) was collected before each clam was opened to visually determine gonadal development. A gonad tissue sample was then examined under a microscope to determine the presence/absence of germ cells, and to estimate the developmental stage. Preliminary results suggest that *E. directus* in Cape Cod Bay spawn in early to mid-May, followed by a potential second spawn in early September, information that has helped shape seasonal regulations for a local, commercial fishery. *S. s. similis* appear to spawn in late May/early June and again in mid-September. Based on this observational data, two successful hatchery spawns of wild *S. s. similis* broodstock were obtained, both in spring and fall, demonstrating that naturally ripened broodstock will spawn in a hatchery setting without conditioning.

HARRY OYSTER AND THE PARASITE OF DOOM

Tim Bowden, Liz Johndrow, Nicole Messerman, Grant Dickey, Mark Lawrence
School of Food and Agriculture, University of Maine, 5735 Hitchner Hall, Orono, ME 04469-5735 USA

'You're an oyster 'Arry! And a damn good one I'll warrant'. In 2010 the haplosporidian parasite of Eastern oysters (*Crassostrea virginica*), MSX (*Haplosporidium nelsoni*), appeared in the Damariscotta River Estuary, resulting in significant losses to commercial oyster operations. We have been following the status of the parasite within the estuary oyster populations over the intervening years. In 2012, 2014 and

2016 studies on commercial and wild oyster populations indicated a significant prevalence of the parasite despite the introduction of MSX resistant strains. Our most recent survey in 2019 indicated the parasite was almost completely absent, with only 3 positive samples. This was despite testing over 600 oysters that were sampled over an eight-month period, and from several locations. One suggestion for this change in prevalence was that a significant freshwater event in the estuary somehow negatively impacted the parasite. A search of rainfall and salinity records failed to support this theory. Harry lives to fight another day!

INVESTIGATING THE INTEGRATION OF ROPELESS GEAR TECHNOLOGY FOR INSHORE AND OFFSHORE BIVALVE AQUACULTURE TO REDUCE ENTANGLEMENT RISK WITH MARINE MAMMALS AND SEA TURTLES

***Matthew Bowden*[1], David Fredriksson[2], Michael Chambers[3]**
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All sea turtle species found in U.S. waters and several species of large whales, including North Atlantic right whales, are listed under the Endangered Species Act. In addition, large whales are protected under the Marine Mammal Protection Act. With a dwindling population of less than 400, North Atlantic right whales are one of the most critically endangered species, and entanglement in lines associated with fishing gear remains one of the most significant threats to this species' survival. Entanglement can result in serious injuries or mortality to endangered species and, in some cases, this problem is significantly impairing species recovery. NOAA Fisheries is actively working to reduce entanglements in the vertical lines used in fixed gear fishing. As marine aquaculture expands, concerns that the aquaculture industry may increase or re-introduce entanglement risks from the use of lines in aquaculture gear may limit industry growth in some areas. A number of ropeless technologies developed for use by the commercial fishing industry to reduce entanglement risk with fishing gear have conceptual value for integration with aquaculture gear as a way to expand aquaculture production in areas where entanglement risk with marine mammals and sea turtles limits industry growth. This presentation will discuss a techno-economic analysis of the viability of integrating ropeless technology in the bottom culture of various bivalve species.

MAINE AQUACULTURE BUSINESS PLANNING TOOLS

***Christian Brayden*, Sebastian Belle**
Maine Aquaculture Association, 103 Water St., Hallowell, ME 04347

For many years, Maine aquaculture producers have primarily relied on back-of-the-envelope calculations to plan their businesses. As more businesses ramp up production, and a growing number of new entrants join the sector, looking at a bank statement once per year is no longer going to cut it. The Maine Aquaculture Association (MAA) has worked with growers, lenders, and researchers to create Maine-specific aquaculture business planning tools. The tools, which focus on business and production planning, are based on species (oysters, mussels, scallops, and seaweed), production methods, and growth

rates provided by Maine researchers and the Maine aquaculture financial benchmarking studies. While tools from other regions and sectors may exist, growers in Maine needed a series of tools specific to the products they grow, the production methods they use, and the growth rates in Maine waters. The tools were designed to, with minimal input from growers, create a profit and loss statement, analyze farm profitability, and plan out inventory along with cash flow. At the request of growers, the tools can also track production, growth, and mortality rates on each site, metrics which can then be incorporated into updated farm projections. Lenders and financiers also reviewed the plans to ensure that they would be appropriate for growers seeking access to capital. Over 40 meetings have occurred with growers to discuss these business planning tools along with other business planning resources regarding benchmarking, risk management, and business strategy. The tools have received positive feedback and adoption from the Maine aquaculture sector.

AQUACULTURE RISK MANAGEMENT INFOGRAPHICS - AND A NEW CROP INSURANCE POLICY?

***Christian Brayden*[1], Sebastian Belle[1], Robert Cerda[2]**
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Risk management and crop insurance remain two notable, infrequently addressed issues in aquaculture. To aid producers, the Maine Aquaculture Association partnered with Science Crunchers, a science communication firm who specializes in translating scientific data to visual and written content, to provide a pair of two-pager infographics on risk management. The first two-pager identifies risk types, risk factors, and how to manage those risks, including insurance options. The second two pager provides a beginner's guide to risk management via a decision tree. Both products rely on graphics, visual groupings, and brief text to compartmentalize and facilitate the steps that can be taken on a farm to improve risk management and mitigation. In addition, MAA also wrote a white paper that overviews aquaculture risk management and mitigation in Maine, including a breakdown by categories of risk and available resources, along with a section explaining aquaculture crop insurance and the current options available. The Maine Aquaculture Association (MAA) is also working with the USDA Risk Management Agency (RMA) and Robert Cerda of Crop Insurance Systems, Inc. to draft an oyster-specific crop insurance policy, which was recently approved for development by the Federal Crop Insurance Corporation board.

MAINE AQUACULTURE FINANCIAL BENCHMARKING REPORT

***Christian Brayden*[1], Carole Engle[2], Jonathan van Senten[3], Sebastian Belle[1]**
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The Maine Aquaculture Association has released the first-of-its-kind Maine Aquaculture Industry Financial Benchmarking report, complete with two-page infographic summaries. The report, completed in partnership with Dr. Carole Engle of Engle-Stone Aquatic$ and Dr. Jonathan van Senten of the Virginia Seafood Agriculture and Experiment Station, presents results from the calculation of a series of benchmarks designed to serve as guidance for prospective Maine shellfish and seaweed producers for use in their business planning, as well as by lenders in the evaluation of loan applications. Maine oyster,

mussel, scallop, and seaweed farmers were interviewed and provided data based on the 2017 to 2019 growing seasons. Financial performance benchmarks and the types of risks and problems faced by shellfish and seaweed farmers were then summarized. These Maine benchmarks were also complemented by a review of the scientific literature and benchmarking studies from the European Union and elsewhere in the U.S. Benchmarks were calculated for production, expenses, breakeven prices and yields, profitability, financial, loan repayment, and efficiency (labor, capital, financial). The report can be used for one business to compare its performance with other similar businesses in the sector for a given year. Benchmarks also allow businesses to track which of their categories (i.e. production, expenses, yields) meet, exceed, or fall below industry averages and use that information to increase their profitability. Financial lenders and investors can also use these benchmarks to identify thresholds to predict financial success or failure of a startup business.

MAINE AQUACULTURE OCCUPATIONAL STANDARDS

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The Maine Aquaculture Association has released the first Maine Aquaculture Occupational Standards, which specify the current workforce skills and training needs of Maine's aquaculture sector. Altogether, four standards have been released, focusing on occupations related to (1) Marine Shellfish and Sea Vegetables; (2) Marine Finfish; (3) Land-Based RAS; and (4) Land-Based Shellfish Hatcheries. A supplementary document, the Maine Shellfish Aquaculture Career Pathways Map, designed to provide an overview of the most common job types, entry points, and career pathway opportunities in Maine's shellfish aquaculture sector today, has been included in the release as well. The occupational standards, completed in collaboration with the Gulf of Maine Research Institute, Educate Maine, and with support from FocusMaine, are intended to: (1) present education and training providers with a clear and comprehensive understanding of the specific technical skills and knowledge that are critical for the most common careers in each sector; (2) standardize workforce training in the state; and (3) establish an industry-led process to align training with workforce needs as the industry, and workforce needs, evolve. The 2020 Maine Aquaculture Workforce Development Strategy identified occupational standards to inform and standardize aquaculture training as a pillar of its recommendations. These standards, which are built on top of the findings included in the workforce development strategy, are based on extensive one-on-one interviews with aquaculture businesses and educational institutions across Maine.

WHERE DOES SALLY SELL HER SEA SHELLS DURING COVID? ANALYZING SEAFOOD SALES, DISTRIBUTION, AND PREFERENCES FOR MAINE AND BEYOND IN THE NEW NORMAL

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COVID-19 struck seafood producers with a quick and heavy blow. With the vast majority of seafood purchases, by value, essentially wiped off the table with restaurants closing, where were producers to turn? Many became innovative, creating and trying new sales and distribution methods to maintain cash flow and sell their product. Despite the arrival of COVID, their products kept growing, and they needed to be sold. The Maine Aquaculture Association (MAA), in partnership with FocusMaine, NOAA, and Sea Grant, has interviewed a network of seafood distributors across Maine, New England, and the U.S., and reviewed news and academic articles to analyze the effects of COVID-19 on the seafood supply chain, and how producers reacted. MAA released a guide in the fall of 2021 on aquaculture sales and distribution methods in Maine, highlighting the benefits and drawbacks of both longstanding and new methods. This will serve as the foundation for the NOAA-Sea Grant funded work in progress with Dr. Kanae Tokunaga, Dr. Caroline Noblet, Dr. Keith Evans, Sam Belknap, Keri Kaczor, Giselle Sillsby, and Allissa Miller-Gonzalez, which will explore, on a broader scale and in much greater detail, the new normal of seafood distribution in the U.S. and updated consumer preferences, using Maine as a case study for how to capitalize on seafood supply chain synergies and consumer tastes to expand Maine's aquaculture and seafood markets.

ASSOCIATIONS BETWEEN MSX AND DERMO DISEASES AND EASTERN OYSTER HEALTH INDICATORS IN LONG ISLAND SOUND

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MSX (*Haplosporidium nelsoni*) and Dermo (*Perkinsus marinus*) are two economically and ecologically important diseases that have caused extensive mortalities in natural and cultivated populations of the eastern oyster (*Crassostrea virginica*). We conducted the first analysis of a 20-year dataset to determine if these diseases are linked to indicators of oyster health, including body condition, size, and reproductive status. The dataset contained gross anatomical and histopathological findings of 9741 market-sized oysters collected at natural beds and aquaculture sites along Long Island Sound in Connecticut from 1997 to 2016. Statewide disease prevalence, intensity, and weighted intensity were calculated to illustrate MSX and Dermo trends over time. From 1997 to 2016, Dermo prevalence consistently remained between 48% and 75%, with a brief decrease to 31% in 2006. MSX prevalence greatly reduced from 42% to <1%. MSX intensity plummeted in 2012 but returned to previous levels between 2 and 3, while Dermo intensity decreased slightly over time. Our results showed that disease presence and severity are significantly associated with poorer body condition and smaller shell length. Dermo severity was associated with a more dramatic shift in body condition than MSX; whereas, observations of smaller shell lengths were more prominent in MSX-infected oysters. Links between disease and oyster spawn stages were inconclusive because of offseason reproductive data. Calculations of disease prevalence and intensity, as well as examinations of infectious disease links to oyster health indicators, provide a quantitative framework to inform management and restoration of vulnerable oyster populations in the face of enzootic disease.

TEMPERATURE OF SEAWEED FROM POST-HARVEST TO PROCESSING

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As the edible seaweed industry continues to expand, there is an increased need for food safety awareness in handling this food product. Seaweed is considered a "raw agricultural commodity" by the FDA and is, therefore, not well regulated. Storage temperature and duration can impact the microbial load and, thus, the food safety of edible seaweed. In this study, we record the temperature of the seaweed from the time of harvest to the time of processing using data loggers. Recorded seaweed temperatures are compared to ambient air temperatures for the same duration. Preliminary data shows that harvested seaweed, across multiple species, exhibit a consistently warmer temperature than the ambient air temperature during transport and storage. Higher temperatures could potentially mean higher pathogen replication and microbial load. We invite harvesters of any edible farmed or wild seaweed species to join our project team in helping us record the temperatures of harvested seaweed. This data will be useful in developing risk mitigation plans for food safety. Anonymity of data contributors will be protected.

CREATING AN ALTERNATIVE MARKET, HABITAT RESTORATION, FOR FARM-RAISED OYSTERS IN RESPONSE TO A COVID-19 ASSOCIATED SUPPLY CHAIN COLLAPSE

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As the COVID-19 pandemic shuttered restaurants across the nation a critical link in the shellfish aquaculture supply chain was lost, profoundly impacting oyster farmers. Without the restaurant market, oyster growers needed new outlets for their product. In response to this market collapse, a program was developed to provide an immediate alternative market for "overgrown" farm-raised oysters— habitat restoration. Central to the project's framework was the concept of the New Jersey Shellfish Exchange, a broker that could connect shellfish farmers with coastal habitat restoration practitioners and serve to facilitate the commerce and application of farm-raised oysters for restoration. The pilot Exchange brought together oyster farmers, nongovernmental organizations (NGOs), and regulatory stakeholders to develop a responsible, mutually beneficial approach. Important considerations included: pricing, equity in advancing the opportunity, criteria for eligibility, safe post-harvest handling and planting, restoration siting, potential disease transfer, predation, and oyster verification methods (oyster size and viability). Eighty thousand farm-raised oysters (>3.0" shell height), from 16 farms, were purchased at $0.65 each and planted in like-area enhancement locations. Cownose ray predation proved to be an issue at some planting locations and future approaches may require predator deterrents. Post-project grower surveys indicated strong interest in supplying restoration markets, they cited promotion of healthy coastal habitats as an important motivation. Inclusion of restoration markets in oyster farm business models can build social capital and economic resilience, while improving the quality of estuarine habitats, all of which are beneficial for the growth and sustainability of a vibrant oyster aquaculture industry.

YOU ARE WHAT YOU EAT: CAN DIET IMPACT THE FLAVOR OF SEA SCALLOPS?

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Scallops are prized for their flavor and texture. We hypothesized that feeding a specific diet of algae and diatoms to sea scallops (*Placopecten magellanicus*) in recirculating aquaculture would enhance their flavor compared with wild-caught scallops. A pilot study fed algae to two groups of scallops in recirculating water tanks. One group was fed a mixture of *Rhodomonas lens* and *Skeletonema dohrnii* (Rhodo/Skel); the other group received a mixture of *Chaetoceros muelleri* and *Thalassiosira weissflogii* (CHGRA/Weiss). A further group was maintained in un-filtered flow through tanks. These were considered 'wild'. Live farmed scallops and 'wild' animals were transported from the Downeast Institute to the University of Maine. Scallops were hand-shucked immediately, placed in plastic bags to separate diet treatments and tank replicates. The next day, scallops were rinsed with tap water and pan-seared for sensory evaluation. Consumers (n = 34) took part in the evaluation. All samples received mean scores between 6.9 and 7.8 (a 9-point hedonic scale where 7 = like moderately). The scallops fed the Rhodo/Skel mix had significantly higher flavor and overall liking scores ($p \leq 0.05$) than did the scallops fed the CHGRA/Weiss mix. The Rhodo/Skel samples had higher liking scores of 7.8 than the wild control that received liking ratings of 7.5 and 7.4 for flavor and overall liking, respectively. However, these differences were not significant, likely due to a lack of power in the design. These findings suggest that scallop flavor can be positively modified by diet and offer a distinct marketing advantage for Maine aquaculture scallops.

SEAWEED PROCESSING AND PRODUCT DEVELOPMENT OPPORTUNITIES AND NEEDS

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As consumers in Europe and North America become more aware of wild-harvested and farmed seaweed, new food products are being developed to tap consumer interest. Drying and freezing remain the primary processing techniques to extend shelf-life but both methods can affect quality and nutritional characteristics. More traditional approaches such as salting and fermentation are finding new applications in modern products. Minimal processing approaches such as high pressure processing to create fresh-like seaweed products are not yet commercially feasible. Which new technologies may be most useful and affordable for seaweed? Will consumers accept novel uses for seaweed? In this session, University of Maine researchers will provide updates on their NOAA-funded project and industry representatives will discuss successes and challenges in product development. Gaps in knowledge such as product shelf-life and consumer preferences will be topics for the panel to address.

EXPLORING CONNECTICUT'S SHELL RECOVERY, RECYCLING AND RESTORATION EFFORTS

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Oyster shells are key building blocks for the beds and shell is at times in short supply. In 2019, over 31 million oysters were harvested in Connecticut (CT Department of Agriculture). The vast majority of the oysters are sold for the half shell market, with little of that shell ever reclaimed as the state lacks a formal shell recycling program. The food service sector and the seafood consuming public lack a mechanism and economic incentives to reclaim the shell, divert it from landfills and return it to the beds where it is crucially needed to enhance recruitment, maintain ecosystem function and support commercial shellfish production. However, state agriculture officials have recognized shellfish restoration and shell recycling as a priority. In July 2021, Governor Ned Lamont signed Public Act 21-24, "An Act Concerning Connecticut's Shellfish Restoration Program, the Connecticut Seafood Council and the Taxation of Certain Underwater Farmlands." This law expands the Department of Agriculture's Shellfish Fund Program to allow the purchase of oyster shells, mature oysters and other materials, as well as contracting the use of vessels to conduct restoration work. In addition, the Department can receive private, state, or federal grants or direct funding to conduct shell recycling and shellfish restoration programs. Capitalizing on this opportunity, we are exploring cost-effective means to recover and recycle shell, and to increase the quantity of this important substrate returned to the water.

INFECTION AND DISEASE PROFILES IN AQUACULTURED OYSTERS PROGRESSING FROM HATCHERY TO MARKET

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Understanding the relative disease risk posed by aquacultured shellfish at different stages of production is fundamental for design of appropriate controls to maintain biosecurity in regional commerce. "Hatchery certification" to streamline commerce in small seed, for example, depends on a demonstration that small seed is typically disease free. Any efforts to relax time-consuming and expensive batch certification requirements for larger cultured product would require evidence that larger oysters are not generally more infected, and thus more hazardous, than nearby wild oysters whose infection profiles are assessed through ongoing monitoring programs. In support of improved regional disease management of shellfish pathogens, we have compiled years of data on regional infection of aquacultured oysters by major pathogens, and conducted new analyses of farmed, market-sized oysters in Virginia to understand their

disease profiles relative to wild background. Results show infections by *Perkinsus marinus* (dermo) and *Haplosporidium nelsoni* (MSX) to be generally absent from hatchery contexts, with dermo infections only gradually beginning to increase in prevalence once oysters are on raw water in nurseries and grow-out environments. MSX was typically not prevalent in cultured oysters of any size. Analyses of aquacultured market-sized triploid as well as tetraploid broodstock oysters consistently revealed infection prevalences well below the natural background in Chesapeake Bay. Collectively these data continue to indicate that aquacultured oysters are not particularly hazardous with regard to the parasitic diseases of the region, and that small seed in particular is the most biosecure product with regard to interstate transfers.

TRIALS AND TRIUMPHS OF COASTAL INTEGRATED MULTI-TROPHIC AQUACULTURE IN THE NORTHEAST

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Sea farming in the US is challenging at best. It differs from state to state and becomes more complex as you move offshore and into federal waters. Part of this complexity is due to population declines of the Northern Right Whale and potential gear entanglement. Nearshore, shellfish and seaweed aquaculture has flourished throughout the Northeast. However, finfish aquaculture has been stagnant. Despite NOAA's push for offshore aquaculture, it's still marred by regulatory pathways and dis-information from non-governmental agencies. To overcome these barriers, NOAA Sea Grant funded a multi-trophic aquaculture project to demonstrate the permitting process and economic feasibility to culture steelhead trout (*Oncorhynchus mykiss*), blue mussels (*Mytilus edulis*) and sugar kelp (*Saccharina latissimi)* from a floating platform. This presentation will focus on the challenges and successes of this project and share the new technology that is ready for entrepreneurs in the Gulf of Maine.

BUILDING RESILIENCE IN NEW YORK'S SEAFOOD INDUSTRY THROUGH COLLABORATION

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When the pandemic halted foodservice operations in March of 2020 the markets for New York grown seafood plummeted. The industry was left scrambling to identify alternative markets and novel ways to operate amidst a fluid and uncertain economic landscape. To identify the best avenues for assisting the seafood industry and fostering a more prepared and resilient seafood sector, NY Sea Grant created the Seafood and Seaweed Processing and Marketing Task Forces. Each task force was comprised of industry, agency, academic and NGOs from the seafood and seaweed sectors in New York. Through the task force efforts opportunities to support growth and resilience were explored and new tools and programs are being developed to achieve a more resilient and diverse seafood industry. This presentation will review the various interactive resources and upcoming opportunities designed to assist NY's Seafood industry

and build resilience to future challenges. These include the creation of interactive regulatory guides and a collection of supplementary topical resources focused on getting product to market through various avenues in New York State; free seafood HACCP training opportunities to support producers interested in exploring alternative markets; and an incentives program to increase abundance and transparency of New York farmed and fished products at retail outlets as well as consumer interest in purchasing these local products.

BUILDING A SEAWEED SAFETY TRAINING PROGRAM TO ENHANCE THE US SEAWEED INDUSTRY

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There is a growing seaweed industry in the US with increased interest in value-added production and expanding markets for edible seaweed products. With the industry still in its infancy many state and federal agencies are grappling with new producers coming to market and trying to better understand how to properly regulate seaweeds to ensure safe consumption. Through various regional and national seaweed efforts including the NOAA Sea Grant's Seaweed HUB, the lack of guidance and a formal training program was identified as a significant hurdle to the growth and success of this emerging industry.

Initially these efforts will seek to identify a team of professionals that is able and willing to collaborate on addressing the needs of the seaweed industry and the confusion surrounding seaweed safety and regulation. The team will work towards developing a strategy for a national seaweed safety training program to ensure uniform training nationally and facilitate discussions around seaweed safety and technology.

NURTURING THE SUCCESSFUL GROWTH AND MATURATION OF A DOMESTIC SEAWEED AQUACULTURE INDUSTRY: IDENTIFYING AND REMOVING BARRIERS AND PROMOTING OPPORTUNITIES

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Seaweed aquaculture is an emerging industry in the United States. Several states are actively cultivating seaweed at the commercial or research/investigative scale, however, several significant barriers exist which prevent the expansion of this new industry to meet its potential. Although efforts to address these barriers are currently underway in individual states, progress is slow due to limited resources and no mechanism facilitating an exchange of information. A comprehensive and collaborative effort was necessary to move this emerging industry forward. With the support of federal funds in 2019, the National Seaweed Hub, a partnership of 10 Sea Grant programs and their diverse stakeholders, was established

with the goal to support the successful growth and maturation of a domestic seaweed aquaculture industry through sharing of evidence-based, non-advocate information.

Diverse stakeholder-driven work groups were formed based on four common challenges identified through a national needs assessment conducted in early 2020: Market Opportunities, Post-harvest and Processing Infrastructure, Regulations, and Production Systems. Facilitated by Sea Grant Extension and National Sea Grant Law Center staff, work group participants are developing achievable work plans or strategies addressing barriers they determined to be priorities preventing the expansion of domestic seaweed aquaculture. An update of work group progress and work plan developments will be provided and made available on the Seaweed Hub's website (www.seaweedhub.org).

ENHANCING COMMERCIAL BIVALVE HATCHERY OPERATIONS THROUGH UTILIZATION OF A RECIRCULATING LARVAE CULTURE SYSTEM

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Typical bivalve larval hatchery practices rely on pumping near-shore coastal waters to support larval production. In such applications, suboptimal ambient water quality can at times cause impaired larviculture performance. The application of recirculating aquaculture systems (RAS), have long been investigated to allow reuse of larval production water, thereby minimizing impacts from fluctuating ambient coastal waters. This work has progressed over the last several years by integrating programming from the Virginia Institute of Marine Science Eastern Shore Lab, the Virginia Tech – Virginia Seafood Agriculture Research and Extension Center, Virginia Sea Grant, and Oyster Seed Holdings, Inc (OSH). Most recently, we have utilized the Fishery Resource Grant available from Virginia Sea Grant, to construct a pilot scale RAS larvae culture system that was operated alongside OSH commercial larvae culture during the 2021 production season. While we recorded generally low larval survival during the trial period, it was similar between the two systems with survival from egg to eyed larvae at 4.8% in RAS and 4.3% in standard systems. Hatch rate, defined as survival form egg to day 2 larvae, was different with survival in the RAS system at 42% and 26% in standard systems. Results, system design choices, and next steps will be discussed. Further research is already supported and will continue for the 2022 and 2023 production seasons.

HAS THE LPA SYSTEM BEEN SUCCESSFUL? SMALL-SCALE AQUACULTURE RECRUITMENT IN MAINE THROUGH THE LIMITED-PURPOSE AQUACULTURE ("LPA") LICENSING SYSTEM

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Maine's system for leasing publicly owned submerged marine lands for aquaculture development concerns the recruitment of ocean farmers into marine aquaculture in the state. Maine's "Limited-Purpose Aquaculture" (LPA) license was designed to induce small-scale farmers to enter the industry to experiment with a variety of means for achieving economic sustainability. This study analyzed recruitment of new ocean farmers into small-scale, low-trophic level (LTL) marine aquaculture in Maine through the LPA system. Through an online survey (n = 72) and a focus group (n = 7) of LPA-holders, data was collected on holders' experiences in sustaining their operations, which encompass costs-benefits analyses as well as issues of access to working waterfronts, equipment, expertise, and various markets. Sixty-seven percent (67%) of respondents indicated that they sold their LPA products, and 32% of those not selling their products reported that they wanted to sell them. Fifty-eight (58%) of respondents wanted to expand their aquaculture operations to scale beyond the LPA license parameters; 61% expressed discontent with the size of their farm. Survey and focus-group data demonstrated that although 85% of LPA holders felt that their experiences in the LPA system had allowed them to make informed decisions about whether or not to expand their farms, many were concerned about the administrative and resource barriers they faced in scaling up their operations.

VACCINATING THE MUCOSAL SURFACES OF TELEOST FISH

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The vaccination of fish is well established for many aquaculture species. Vaccinations typically occur by injecting the vaccine into the peritoneal cavity, directly into muscle tissue, or by dipping the fish in a vaccine solution. The first two methods tend to give a very high antibody response in the serum, which can lead to long-term protection of the vaccinated fish. Dip vaccination tends to give a short-term, low-level antibody response in the serum and a higher response at the mucosal surfaces. Unfortunately, protection by bath vaccination usually lasts less than a year and requires annual boosters. This is unfortunate, as many pathogens invade the host via the mucosal surfaces. Lacking an effective method to trigger a long-term immune response in the skin and mucosa makes it difficult to develop vaccines against pathogens that infect the skin and mucosal membranes. Developing an effective method to deliver vaccines to the epidermal surface of fish would revolutionize disease control in all commercial fish species. We are targeting the epidermal tissue of a fish's fin for vaccination. This structure is over 80% epithelia tissue and offers an excellent target for mucosal vaccination. Zebrafish (*Danio rerio*) will be used as a proxy for multiple fish species in the development of mucosal vaccines as they are inexpensive, small, and possess an extensive molecular toolkit. Here we present the first results of model vaccines injected into zebrafish and the major immune organs involved in the processing of mucosal and intraperitoneal injected vaccines.

MECHANISMS OF ACTION OF PROBIONT *PHAEOBACTER INHIBENS* (S4) AGAINST THE SHELLFISH PATHOGEN *VIBRIO CORALLIILYTICUS* (RE22)

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Disease outbreaks in oyster hatcheries can decimate the stock, delay production, and cause supply chain shortages for the rapidly growing oyster aquaculture industry. The addition of the probiotic bacterium *Phaeobacter inhibens* S4 (S4) to aquaculture systems has been demonstrated to protect oyster larvae against bacterial pathogens such as *Vibrio coralliilyticus* RE22 (RE22). The purpose of this study was to gain a more comprehensive understanding of the complex interaction between RE22 and S4 to identify novel pathways involved in probiont activity. RE22 and S4 were co-cultured for five hours, after which biofilm and planktonic samples were collected and subjected to transcriptomic analysis. Co-culture of RE22 with S4 led to a significant reduction in RE22 cells in the culture. Results of differential gene expression in the pathogen RE22 when in coculture with S4, as compared to expression in RE22 monocultures, revealed S4 induces the down regulation of genes involved in RE22 virulence and motility (e.g. Type 6 secretion system and flagellar assembly) and up regulation of genes involved in detoxification and bacterial immune response. These mechanisms complement previous research showing that the mechanisms of action of probiont S4 against the bacterial pathogen RE22 are multifactorial and include both antibiotic production and stimulation of immune responses in the oyster larval host. Elucidating these mechanisms of action will allow for the development of protocols that enhance probiotic activity and provide targets for the screening of other potential probiotics.

FARM PRODUCTION OF SEA SCALLOPS, *PLACOPECTEN MAGELLANICUS*

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Production of sea scallops is still in an experimental phase in Maine, but with strong advancements having been made in seed sourcing, nursery and growout production, siting, sales and marketing, biotoxin monitoring and economic modeling. Recent collaborative research in feeding, stocking density, and biofouling has given growers additional information with which to make their decisions, and the result of all this activity is the slow growth of the sector in Maine, in terms of scallops in production, number of farms, and the value of farmed products sold.

This session will use a hands-on workshop approach to work through the processes of scallop farming and the attendant issues in husbandry, equipment, harvesting, and sales of different scallop products. A full range of scallop farming-equipment will be displayed and will serve as the backdrop for both group discussion, and presentation of recent research and development.

IMPACT OF TIME OF HARVEST AND DRYING METHOD ON ANTIMICROBIAL ACTIVITY OF *SACCHARINA LATISSIMA* AGAINST TWO *STAPHYLOCOCCUS* STRAINS

***Amber Cusson*[1], Kristin Burkholder[1], Carrie Byron[2], Gretchen Grebe[2,3], Amy Deveau[4]**
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Antibiotic resistance is one of the greatest public health threats of our time, and the bacterium *Staphylococcus aureus*, of which there are numerous drug-resistant and drug-sensitive strains, is a pathogen of worldwide concern. Scientists are turning their focus to underexplored marine ecosystems to identify novel antibacterial agents effective against *S. aureus*. Here, we report inhibition of *S. aureus* strains Newman and USA300 by extracts from *Saccharina latissima*, sugar kelp, grown and harvested in the Western Gulf of Maine, USA. We examined how time of harvest throughout the growing season as well as drying method pre-extraction affected the antimicrobial activity of the kelp extracts. Optimal antimicrobial activity was observed at the beginning of April (203 days since sporing), when increased water pH and higher salinity levels were also observed. Oven-dried crude extracts showed greater inhibition against *S. aureus* Newman, whereas freeze-dried crude extracts demonstrated greater inhibition against *S. aureus* USA300. Overall, our data indicate that cultivated *S. latissima* from the Western Gulf of Maine possesses significant value-added antimicrobial activity, and identify early spring as an optimal harvest time to harness antimicrobial activity.

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

Christopher Davis[1], Anne Langston Noll[1], Qiujie Zheng[2], Nelson Wu[1], 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 is being 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 result of this project will 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.

SIMPLE ECOSYSTEM SERVICES PROVIDED BY SUGAR KELP – CARBON AND NITROGEN SEQUESTRATION IN BLADE GROWTH OVER A GROWING SEASON IN WASHINGTON STATE

Joth Davis
Blue Dot Sea Farm, Bainbridge Island, WA 98110

Seaweed farming in Washington state has attracted increased attention within the sea farming community investigating alternatives to growing shellfish. Blue Dot Sea Farms has been growing sugar kelp since 2016 and is engaged in research on the capacity for sugar kelp to sequester nutrients from the sea that may be subsequently removed at harvest. A two-year project investigating the potential for growing seaweeds to reduce local acidification resulted in the development of a model to help predict the effects of growing kelp on carbonate chemistry variables. An integral component of the model building necessitated estimating seasonal variation in net primary production. Since most of the tissue mass of sugar kelp is in the blade, a method was developed based on taking images of kelp fronds 7-14 days apart, estimating tissue accretion (e.g. growth) at the meristem and blade tissue loss (e.g. erosion) at the distal end of the blades and providing estimates of net carbon and nitrogen accreted and lost in blade tissue per day over the growing season. These results represent a means for estimating a simple field estimate of net production and do not account for carbon taken up but lost via respiration and exudate production. Based on rates of tissue accretion and loss in the blade, significant seasonal variation was observed over the growth season between January and May 2018 with a mean of up to 3900 square mm net blade accretion per day occurring during the peak growth period at this site in early May.

A GIS BASED TOOL FOR SPATIAL PLANNING AND MANAGEMENT OF SHELLFISH AQUACULTURE IN NEW JERSEY

***Michael De Luca*[1], Lucas Marzen[2], Jeanne Herb[3], Lisa Calvo[4], David Bushek[4], Russ Babb[5], Jeff Normant[5], Michelle Stuart[2], Zack Greenberg[6], Megan Kelly[5]**
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With National Sea Grant support, a team of Rutgers University researchers, in partnership with the New Jersey Department of Environmental Protection is using geospatial tools to weigh and analyze data about conditions affecting shellfish production to develop an interactive tool that can identify areas that are

suitable for shellfish aquaculture in New Jersey. Such a tool can be used as a resource to inform planning and policy regarding the diversity of uses of the State's coastal resources, and to identify potential conflicts with other uses of coastal waters. The project is not a comprehensive spatial plan for shellfish aquaculture in New Jersey; rather, it is a data-informed tool that can be used by state and federal agencies and the stakeholder community for aquaculture and coastal management policy, planning and applications for shellfish aquaculture operations.

Data that are incorporated into the interactive tool include:

- Hydrological characteristics;
- Areas not suitable for aquaculture development;
- Areas with physical limitations such as man-made obstructions;
- Climate and environmental data including information regarding current and projected climate or environmental conditions that could affect shellfish production;
- Current shellfish leased grounds ; and
- Social information regarding other coastal resource uses.

The project is complemented by funding from the Pew Charitable Trusts to survey areas for potential shellfish and submerged aquatic vegetation (SAV) restoration, and to map areas of shellfish and submerged aquatic vegetation where data are lacking to inform development of the GIS tool.

SHELLEVATOR INNOVATION

Angelo DePaola
Angelo DePaola Consulting

Permitting complications, regulatory burden, insurance gaps, manual labor reliance/shortages, occupational safety risks, NIMBY's, entanglement of endangered whales, bird defecation on gear, geographical and seasonal expansion of pathogenic vibrios, frequent harmful algal blooms, pollution, storms, flooding, heat domes, freezes, hypoxia, oil spills, freshwater diversion, invasive species, diseases, predators and thieves stifle investment in the most sustainable and environmental commodity in the food supply, bivalve mollusk aquaculture.

Shellevator™ (Shellfish Elevator) is an invention that overcomes all of these challenges unleashing the potential of shellfish aquaculture. Shellevator™ is an automated, scalable, and mobile oyster production vessel powered by compressed air. Thousands of oysters rise from the sea floor to above the sea surface in under a minute and a penny. This breakthrough patented invention is a method that replaces most of the heavy lifting and dangerous work of existing oyster production systems. Water flows in and out of ballast tanks beneath shellfish containers by simply opening valves to airlines connected to a compressed air source. Shellevator™ moves vertically through the water column like a dry dock facilitating laborious and costly oyster farming operations such as desiccation, density reduction, tumbling and harvesting. Shellevator™ is built with durable structural beams, scalable to any size, adaptable to any water body and hurricane ready.

The most transformative Shellevator™ advantage is seamless mobility ushering a paradigm shift from farming oysters to herding oysters to escape harm, purge human health hazards, improve growth/quality and adapt to the uncertainties of climate change.

BUILDING AND MAINTAINING PUBLIC AND POLITICAL SUPPORT FOR SHELLFISH AQUACULTURE IN THE PACIFIC NORTHWEST

Bill Dewey
Taylor Shellfish Farms, 130 SE Lynch Rd., Shelton, WA 98584, USA

Taylor Shellfish Farms has a public affairs team that works to educate the public, various stakeholder groups and policy makers about shellfish aquaculture. Much of this work is coordinated with the Pacific Coast Shellfish Growers Association and other shellfish growers.

The company employs a multifaceted approach to building social license. Enlightened by public opinion polling that showed them that people who eat shellfish like them more they now have three retail stores and five oyster bars under the company name, they sell their products in local restaurants and have the company logo and shellfish themed truck wraps on all their delivery trucks and semi-trailers. They have transitioned a historic waterfront processing plant into one of their oyster bars. At that location they have incorporated a demonstration plot and educational kiosks where customers get to experience a working shellfish farm. These public facing facilities are profitable but more importantly that have dramatically increased public and political support for our business. Other company and industry efforts include tours, beach clean-up events, shellfish themed festivals, Hill walks in Washington DC and Washington State, political fundraisers and product donations for ENGOs who support our efforts to protect water quality and shoreline environmental health.

Finally, Taylor Shellfish Farms strives to be a good neighbor. They are active in the communities where they farm and encourage their managers and employees to engage with neighbors and the community.

ANALYSIS OF AN ARRAY OF SUBMERSIBLE MUSSEL RAFTS IN STORM CONDITIONS

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A three-by-three grid of submersible mussel rafts was analyzed using an experimentally validated dynamic numerical modeling approach. When submerged, the rafts' pontoons are flooded, and they are held vertically by lines attached to surface floats and horizontally by a mooring grid. The rafts' decreased waterplane area and increased inertia reduce the heave and pitch natural frequencies so that they are below the frequencies associated with the greatest wave energy. This has been found to significantly reduce the motion of the rafts compared to the surfaced configuration.

The nine submersible rafts were anchored with 16 anchors and mooring lines. These mooring lines were connected to a grid of adjacent rectangular bays, with each corner (node) supported by a grid float. Each bay contains a raft connected to the submerged nodes of the grid by four bridle lines. The dynamics of the full system were modeled using a combined multibody and Finite Element Analysis (FEA) approach with dynamic loads computed using a modified Morison formulation. This model was implemented in the commercial code Orcaflex. A similar model for a single submersible raft was previously validated with full-scale field experiments. The full dynamic system was simulated in the maximum expected waves and

currents. Mean and maximum tensions in each grid line were quantified. Accelerations and velocities at the mussel rope attachment points were also examined, since these relate to mussel drop-off.

MITIGATING RISK OF STRUCTURAL FAILURE IN A MACROALGAE CULTIVATION STRUCTURE FOR AN EXPOSED SITE

***Tobias Dewhurst*[1], Michael MacNicoll[1], Zach Moscicki[2], Pete Lynn[3], Igor Tsukrov[5], M Robinson Swift[2], Michael Chambers[2], Beth Zotter[4], Melissa Landon[6]**
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A multi-tile kelp cultivation array was designed for an exposed site in the Gulf of Maine. This system employs novel components to minimize animal entanglement concerns (composite lines with large bending radius) and maximize grow line area per site area (modular tiles with low-scope mooring lines and helical anchors). Thus, simulations were used to understand the behavior of the prototype farm prior to deployment and quantify loads on the anchors and structural components. To mitigate the risk of structural failure without incurring excessive capital and operational costs, the system was evaluated using a simulation technique that has been demonstrated to predict mooring loads within 15% of those measured at sea for an exposed kelp farm.

Fifty-year extreme current speeds, significant wave heights and associated peak periods were quantified by incident direction and by month-of-the-year. Simultaneously considering the biomass growth by month of the year and the monthly current and wave extreme values reduced capacity requirements by 48% compared to the conservative assumption of maximum biomass with the maximum significant wave height and current speed, while maintaining safety factors in anchors and structural components consistent with marine industry standards.

EXPLORING THE USE OF LUMPFISH AS A CLEANERFISH OF SEA LICE ON STEELHEAD TROUT IN NEW HAMPSHIRE COASTAL AQUACULTURE

Michael Doherty
University of New Hampshire

Sea lice are copepodid ectoparasites that infect fish and are a costly challenge for finfish farming operations. Salmonids in particular are parasitized by lice to the extent that the salmon farming industry loses millions of dollars each year to mitigation treatments and damaged product. Chemotherapeutics are often used by the industry to reduce lice infestations, but these can have unintended effects on the environment and lice resistance. Lumpfish (*Cyclopterus americanus*) have in recent years been found to act as a cleaner fish of Atlantic salmon (*Salmo salar*), consuming sea lice off of the salmon's skin. Here in NH, we do not have any Atlantic salmon aquaculture, and our wild populations have been extirpated. We do, however, have an experimental steelhead trout aquaculture pen off the coast, operated by NH Sea Grant and UNH. Steelhead are a close relative of Atlantic Salmon and are also impacted by sea lice, though little is known about interactions between steelhead and lumpfish. We stocked steelhead and lumpfish into small experimental cages to explore whether lumpfish presence had an effect on sea lice

loads, and whether different lumpfish structures within the cage had an impact on those interactions. Highlighting the use of lumpfish as cleanerfish of steelhead trout may allow for a reduction of chemotherapeutics while mitigating damaging infestations of sea lice.

INDUSTRY UPDATES AND NEEDS: VOICES FROM THE LAND-BASED AQUACULTURE INDUSTRY

Meggan Dwyer, Deborah Bouchard
Aquaculture Research Institute, University of Maine, Orono, ME 04469

It is becoming increasingly evident that for aquaculture to increase in the US, new platforms such as land-based recirculating aquaculture systems (RAS) will need to be expanded. Land based aquaculture, from tanks to aquaponic systems, offers a means to grow US production while farming fish closer to the markets thereby reducing transport costs and carbon footprint. Land-based farming can also improve traceability, boost economies in rural communities, and ensure resilience in food systems during global disruptions. Over the last five years there has been major investment in land-based production in the US and especially Maine. The current US investment in land-based Atlantic salmon aquaculture alone is conservatively estimated at over $2.5B. However, for the land-based RAS industry to be sustainable and economically feasible, it must overcome biological and technological hurdles and be continuously optimized, which requires R&D and workforce development. During this panel, we will hear from Maine land-based aquaculture and aquaponics industries on where they are in their development process and what their challenges are moving forward.

Panelists will include:

- Megan Sorby, Operations Manager, Kingfish Maine
- Kate Holcomb, Director, Canopy Farms
- David Macek, Hatchery Manager, Micmac Farms
- David Noyes, Chief Technology Officer, Nordic Aquafarms
- Trevor Kenkel, President, Springworks Farm
- Sara Rademaker, President and Founder, American Unagi
- Greg Lambert, Production Manager, Cooke Aquaculture

HEAVY METALS IN EDIBLE SEAWEED; AN INDUSTRY PERSPECTIVE

Steve Eddy
Maine Coast Sea Vegetables, 430 Washington Jctn Road, Hancock, ME 04640

Macroalgae are well-known to bioaccumulate minerals and elements from seawater, often to many orders of magnitude. Although most of these contribute to human health, they also include the heavy metals arsenic, cadmium, and lead, all known to be detrimental to health. These heavy metals can likewise occur in drinking water, fruit juices or other beverages, and a variety of different foods. This has led the US and other nations, as well as the State of California, to establish regulatory limits on heavy metals in various beverages and foods, including in seaweed products. Maine Coast Sea Vegetables has sold dried seaweed since 1971 and has annually tested their products through 3rd party labs for contaminants of concern since the 1990's. Here, we present annual heavy metal test data for selected products dating back to 2004 and discuss the findings in the context of bioavailability, risk analysis, food safety regulations, and customer

perceptions. The findings indicate that although most seaweed species contain detectable levels of heavy metals, they remain safe for human consumption at the FDA Reference Amount Customarily Consumed (RACC) for dried seaweed of 5g per serving.

USING AI TO FORECAST PARALYTIC SHELLFISH POISON (PSP) IN COASTAL MAINE

Johnathan Evanilla[1], Nicholas R. Record[1], Stephen D. Archer[1], Benjamin Tupper[1], Kohl Kanwit[2], Bryant Lewis[2], Craig Burnell[1], Adrienne Tracy[2], David W. Miller[3]
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[3]Maine Department of Marine Resources, 22 Coaling Station Lane, Lamoine, ME 04605.

Alexandrium catenella is a biotoxin producing phytoplankton that blooms annually in the Gulf of Maine. Accumulation of its biotoxin, Paralytic Shellfish Poison (PSP), in shellfish causes fishery harvesting closures, which can have negative economic impacts on both shellfish harvesters and growers. A PSP forecasting system has been developed using deep learning, a type of artificial intelligence, to give advance warning of toxin levels to shellfish growers, harvesters and fishery managers to aid in their decision making. Predictions are made for multiple individual sites along the Maine coast on a weekly timeframe, and uncertainty is provided in the form of probability of closure-level toxicity. The forecasting system was tested during the 2021 PSP season with a small group of stakeholders, and achieved high accuracy predicting all closure-level toxicity events. Insights from the development of the forecast system and trial season will be shared. Dynamics between *A. catenella* abundance and PSP toxicity in coastal Maine are also being investigated, and a brief summary of findings will be shared. Finally, stop by this poster space to get a demo of our interactive forecast webpage which will be available to the public for the upcoming 2022 PSP season.

COMMUNITY AQUACULTURE EDUCATION THROUGH UNLIKELY MEANS

Emma Forbes (presented by *Michael Ciamarella*)
New York Sea Grant, 3 W. Main St. #112 Elmsford, NY 10523 USA

How do you engage new communities about aquaculture and what pairs well with fresh oysters? The answer to both is the same, wine and beer! New York Sea Grant took a unique approach to community engagement and education in aquaculture in the summer and fall of 2021, partnering with local breweries and vineyards to host a series of aquaculture education events. Over the summer, a series of four events titled “Meet Your Oyster Farmers” took place at local breweries across Long Island. Oyster farmers and aquaculture researchers from across Long Island were invited to speak at the breweries about why they got into aquaculture, how they culture their oysters, their business, current research, and farmers were encouraged to sell and shuck oysters. With 100+ community members attending over the course of the summer, great conversations were had between the farmers and community members, many of which had little understanding of shellfish aquaculture prior. In the fall, vineyards on Long Island and the Finger Lakes region hosted “NY Wine and Farmed Seafood” events. NY oysters, farmed salmon and farmed trout were paired with locally produced wine. Farmers were invited to set up a table to discuss with patrons about their business, product, and to answer questions. Both events provided a new way to engage community members about aquaculture, specifically aquaculture in New York, and begin to debunk long standing misconceptions the industry faces daily.

COVID-19 IMPACTS ON NEW YORK'S AQUACULTURE INDUSTRY

Emma Forbes (presented by *Michael Ciamarella*)
New York Sea Grant, 3 W. Main St. #112 Elmsford, New York 10523

To understand impacts to Covid-19 to the aquaculture industry in New York, New York Sea Grant called each producer in the state. Calls took place in October of 2020 and will again in October of 2021 to gauge the impacts of Covid-19, modifications to business models, and plans. This was done in lieu of a formal survey assessment to build relationships with the industry and allow for open and honest dialogue. In 2020, many farmers cited that Covid-19 had a negative impact on their businesses, yet they were able to transform and pivot to the changing climate and successfully regain sales again. One farmer stated, "We initially lost 98% of our sales to wholesale, but we pivoted to direct to the consumer and business picked up more than before. I will be basing my business model off this in the future." The conversations gave insight into the struggles of the industry, but also truly highlighted the resiliency and resourcefulness of New York's farmers. The information from these calls is used to direct future programming to support the industry.

WET STORAGE SYSTEM DESIGN AND MAINTENANCE: USER BASED PERSPECTIVES AND CONSIDERATIONS FOR IMPLEMENTATION, OPERATION, AND UPKEEP OF SHELLFISH LIVE HOLDING SYSTEMS

Jesse Fortune
Formutech Inc., 135 Kent St, PO Box 893 C1A 7L9 Charlottetown, P.E.I., Canada

Adoption of wet storage systems for shellfish live holding has been trending upwards across North America over the last decade. Small and large processors, farmers, and distributors have identified wet storage as a crucial aspect of their operational planning, however the rationale, design, and methodology for their usage varies considerably from user to user. This panel session will hear from a variety of current operators who have incorporated wet storage into their respective facilities. The roundtable will offer insight on user experiences in terms of design and planning, regulatory approval, construction, operation, and upkeep of the systems. There will be a general focus on land-based, closed loop systems, however we will provide overview of other types of systems and also provide opportunity for questions from the floor.

RECIRCULATING AQUACULTURE SALMON NETWORK (RAS-N): UNDERSTANDING THE BARRIERS AND NEEDS OF LAND-BASED ATLANTIC SALMON PRODUCTION IN THE U.S.

Catherine Frederick
University of Maryland Sea Grant Extension Programs, Institute of Marine and Environmental Technology, Baltimore, MD 21202

NOAA Sea Grant funded the Recirculating Aquaculture Salmon Network (RAS-N), a national collaborative project consisting of research institutions, industry, and government agencies from the Mid-Atlantic, Great lakes, and Northeast regions of the U.S. Together, the overarching goal of RAS-N is to build capacity for Atlantic salmon RAS production in the U.S. by identifying the barriers faced by

industry and addressing needs through research, education, and extension efforts. A holistic hub connecting the three regions was established in the first year of RAS-N to gather stakeholder input, including guidance, concerns, and ideas regarding barriers to production. The first RAS-N workshop was hosted by the University of Wisconsin-Stevens Point Northern Aquaculture Demonstration Facility during the Winter of 2019, which provided initial stakeholder input on industry barriers and needs. In 2020 a concept paper was developed to define technical, biological, and non-technical (economics, workforce development, etc.) challenges with feedback on potential solutions to those barriers. In 2021, a survey was developed to formally rank industry needs to target areas of highest priority by industry. This presentation will highlight the framework of the concept paper and survey results, which will be used to develop a road map.

QUANTIFYING RISK AND FACTORS OF SAFETY FOR THE OCEAN ENGINEERING OF AQUACULTURE STRUCTURES

***David Fredriksson*[1], Tobias Dewhurst[2]**
[1]Department of Naval Architecture and Ocean Engineering, United States Naval Academy, Rickover Hall, 590 Holloway Road, 11D Annapolis, MD 21402 USA; [2]Kelson Marine. Two Portland Fish Pier, Portland, ME 04101 USA

The techniques described in this presentation are intended to be used as a starting point for quantifying risk and factors of safety for the ocean engineering of aquaculture structures in the U.S, introduced for the Gulf of Mexico in Fredriksson and Beck-Stimpert (2019) and from details in Huang and Pan (2010). The approach described here relies upon the use of validated time domain numerical models, for which specific calculation techniques have been vetted through peer review. The risk analysis approach considers both extreme and operational conditions that follow suitable probability density functions with characteristics used as input to the validated model. The numerical model is then used to obtain a set of probability density functions of loading for farm components. The loading probability density functions are compared with those of ultimate strength provided by the component manufacturers. The risk is quantified as the probability of failure by the integrated area of the intersection between the loading and strength probability density functions. Factors of safety can then be determined as the tension (or stress) ratio at the strength and loading probability density function peaks. As material strength diminishes with wear, factors of safety can be adjusted. The approach also provides replacement period values calculated using the number of cycles to failure from both extreme and operational conditions. The replacement period values can also be adjusted if a quantified extreme event occurs. This information can then be incorporated into the engineering economics of the system and used with the storm return periods to determine encounter frequency. The techniques can be implemented to mitigate the risk of failure for specific ocean deployed systems for finfish, shellfish, macroalgae and those designed for integrated multitrophic products.

THE SAFETY OF AQUI-S® 20E (10% EUGENOL) AS A SEDATIVE ON JUVENILE STRIPED BASS, FLORIDA POMPANO, AND YELLOW CLOWNFISH

***Rodman Getchell*[1], Danielle Scott[1], Ana Griefen[1], Xanth El-Sayed[1], Adam Frosolone[1], Elena Demeter[1], Niccole Wandelear[2], Philippe Baneaux[3], Drew Kirby[3], Marilyn Blair[2]**
[1]Aquatic Animal Health Program, Department of Microbiology and Immunology, College of Veterinary Medicine, 930 Campus Road, Cornell University, Ithaca, NY, 14853 USA; [2]Aquatic Animal Drug

Approval Partnership (AADAP) Program, U.S. Fish and Wildlife Service, 4050 Bridger Canyon Rd. Bozeman, MT 59715 USA; [3]Center for Animal Resources and Education (CARE), College of Veterinary Medicine, Cornell University, Ithaca, NY 14853 USA

Tricaine (MS-222) is the only drug currently approved by the US Food and Drug Administration (FDA) for fish sedation. Cornell University researchers have teamed up with the USFWS Aquatic Animal Drug Approval Partnership (AADAP) to generate data to support approval of an additional fish sedative by FDA's Center for Veterinary Medicine (CVM). We are conducting a series of studies under an FDA concurred protocol to evaluate the safety of AQUI-S®20E (10% eugenol) to sedate marine fish to the handleable stage of anesthesia in saltwater. This project has generated margin of safety data to support a New Animal Drug Application to the FDA to approve the use of AQUI-S®20E for this indication in marine finfish. USDA AFRI and the FDA MUMS program funded our current research under this priority. The ultimate outcome of these studies will be the FDA approval of a fish anesthetic that requires no withdrawal period, i.e. an immediate-release anesthetic. We have conducted three target animal safety studies with AQUI-S® 20E and the data suggests there was an adequate margin of safety when juvenile Striped Bass *Morone saxatilis*, Florida Pompano *Trachinotus carolinus*, and Yellow Clownfish *Amphiprion clarkii*, were sedated with a dose of 400 mg/L or 600 mg/L. The statistical results from survival, fish health, and behavior qualitative comparisons will be presented along with histological comparisons of gills, liver, and posterior kidney cellular changes between those fish exposed to eugenol versus the negative control fish.

THE USE OF PROBIOTICS IN AQUACULTURE: DO THEY WORK, AND, IF SO, WHAT FOR, HOW, AND WHEN?

***Marta Gomez-Chiarri*[1], Diane Kapareiko[2], Gary Wikfors[2]**
[1]University of Rhode Island, 169 CBLS, Kingston, RI 02881, USA; [2]USDOC/NOAA/NMFS Milford Laboratory, 212 Rogers Ave, Milford, CT 06460, USA

The production of bivalve larvae and seed (juveniles) by hatcheries is a key step in aquaculture. The rapid expansion of oyster aquaculture in the northeast United States has led to a growing demand of seed production, which has been met by a diversity of hatcheries located in estuaries from Virginia to Maine. There is also growing demand for new species, including shrimp, bay scallops, bait and cleaner fish, or sea urchins. Hatchery seed production can be threatened by a variety of issues, including disease and environmental stress, which might be exacerbated by extreme weather events and human-driven pollution. Management of these issues requires an integrated approach to biosecurity that includes strategies such as careful site selection to ensure optimal water quality, the use of water treatment systems and other hatchery design elements, thorough cleaning and handling protocols, adequate nutrition, careful monitoring of water quality and larval performance, and a rapid response to mortality events. An additional tool to improve larval performance can be the use of probiotics. Probiotics are live microbes that, depending on the microbe, can improve water quality and prevent disease through a variety of mechanisms. In this interactive session and panel with scientists, hatchery managers, and probiotics industry representatives, we will provide an overview on the latest scientific advances on the use of probiotics in aquaculture, present results from controlled hatchery trials, and discuss how probiotics may be effectively and safely used to improve aquaculture production.

THE EVOLUTION OF EXTENSION AT THE MILFORD LAB: AN EXAMPLE INVESTIGATING POOR CLAM GROWTH IN NEW JERSEY

Zach Gordon
Connecticut Sea Grant, NOAA Northeast Fisheries Science Center, Milford, CT 06460

The NOAA Fisheries Milford Lab has been built on a history of working with industry members to solve issues related to shellfish aquaculture. Meanwhile, Sea Grant has built strong networks throughout the east coast using extension to drive linkages between research, industry, and regulators. A new Sea Grant extension role has been developed at the Milford Lab to enable, augment, and accelerate the exchange of ideas and information between the researchers there and end users, including the latest research results and tools and how they address existing and emerging needs. This position will combine the scientific knowhow from Milford with the network building capabilities of Sea Grant to better serve the Greater Northeastern shellfish aquaculture industry. A call from a grower experiencing problems with Hard Clams in New Jersey has led to a collaborative effort to investigate the issue. This provides an example of what the new Sea Grant presence can achieve. Milford researchers have begun to interpret present data, and will help to provide future data that will be valuable to making decisions about growing hard clams in this area in the future.

SHELLFISH HATCHERY CRASHES & PRODUCTION ANALYSIS: A CASE STUDY AT HORN POINT LABORATORY

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Shellfish hatcheries have become an increasingly important component of aquaculture production in the United States. Although the industry has been advancing technologically over time to stabilize production and supply, detailed production analysis has rarely been reported. To help fill the data gap and initiate a broader discussion on production trends, we report on long-term production trends (2011-2020) at Horn Point Laboratory's oyster hatchery, which included persistent production failure during the 2019 season. During the 2019 season, larval assays were conducted to determine drivers of production failure; however, no clear culprits were identified. Production metrics of interest where production yield (millions eyed-larvae produced) and production rate (days to reach the eyed larval stage). A variety of factors stretching across the entire production process (i.e. broodstock selection, conditioning, spawning, larval culture) were considered as possible predictors of production metrics. Furthermore, water quality in the Choptank River, the source of water for the hatchery, were used as input during analysis. Machine learning was used to train models of production yield and hindcast the specific conditions when the hatchery's production was most efficient. We identified several important factors that predicted production yield and production rate. Many of these factors the hatchery staff can manipulate or represent a stage in the production process, which improved, could lead to greater production efficiency. Collectively, we conclude that more research, data sharing, and cross-institution collaboration are needed to understand production variability within and among shellfish hatcheries to maintain high levels of consistent shellfish aquaculture production.

GULF OF MAINE BLUE ECONOMY INNOVATION CORRIDOR

Blaine Grimes
Chief Ventures Officer, Gulf of Maine Research Institute, 350 Commercial Street, Portland, ME

Throughout the Gulf of Maine region, entrepreneurs are focused on driving innovation in sustainable finfish, shellfish, and algae aquaculture, against the urgent drumbeat of our changing climate. Their solutions are essential to the region's global competitiveness and quality job creation. Our Blue Economy Initiative is a natural extension of GMRI's integration of scientific research, community development work, and educational outreach platforms to directly benefit coastal communities and the environment. We are building a collaborative commercialization platform, anchored in Portland, which will offer the critical capacity to incubate and accelerate technology-forward businesses; provide mentorship, technical, and market support; and leverage an expanding network of partnerships. Our Blue Economy Initiative offers a unique business development platform combining the technical expertise of GMRI and our regional partner network, business formation and support services, the committed resources of multiple partner institutions, and a path to accessing needed investment capital. The result will be enhanced global competitiveness of the Gulf of Maine seafood industry, high quality sustainable jobs, and a new generation of Blue Economy entrepreneurship. Together, we will reimagine and modernize our marine economy to achieve greater food security and climate resilience. Active partners include SeaAhead, University of Maine (Darling Marine Center and Aquaculture Research Institute), Center for Aquaculture Research, Bigelow Laboratories and the University of New Hampshire.

THE EFFECT OF DISTAL-END TRIMMING ON *SACCHARINA LATISSIMA* MORPHOLOGY, COMPOSITION, AND PRODUCTIVITY

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As kelp cultivation increases around the world, so does the need for farm management strategies that produce specific crop characteristics, optimize yield, widen harvesting windows, and prevent biomass loss. Distal-end trimming of macroalgae has been recommended as a farm management method addressing these needs. In this study, we trimmed cultivated *Saccharina latissima* sporophytes grown in the Western Gulf of Maine (WGoM) to 60 cm above the stipe-blade interface. We characterized the effect of trimming on the morphology, tissue nutrient content, stable isotope ratio, and nitrate reductase activity of the kelp. We also evaluated the economic trade-offs of trimming using a simple production model. The results suggest that trimming the blade to 60 cm may have minimal biological consequences. Additionally, the trimming appears to benefit "short" kelp blades in proximity to the trimmed blades. Daily yield (% increase in weight day^{-1}) after trimming was initially lower than the control, but late-season daily yields and crop-retention following storms were markedly improved. Ultimately, we conclude that growers could use trimming to acquire kelp biomass earlier in the season, retain late-season biomass, and potentially increase the total revenue gained from kelp farming if price premiums can be exacted for this biomass.

THE EBB AND FLOW OF RECYCLING SHELL ON AN ISLAND

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The Martha's Vineyard Shell Recovery Partnership was created as a pilot program under the guidance of the Martha's Vineyard Shellfish Group (MVSG) in 2011. MVSG has used shell for oyster spat-on-shell production and for bottom cultching particular estuaries, for many years. Bay scallop shell from the wild fisheries were usually used in the hatchery, while clam shell from 'off-island' was used for clutching. We saw the restaurants' shell waste as an untapped resource and an opportunity to improve our restoration methods and reduce the carbon footprints of both our operation and those of the partnering restaurants. At the time, the vision was that the concept would prove to be viable and worthwhile, and a commercial waste hauler would take over the program. Over the years we have realized that the small volume and seasonal nature of shell recycling on Martha's Vineyard will likely never warrant privatization. Simultaneously, we have realized the advantage of oyster shell over bay scallop shell for spat production. Thus, the program has been incorporated into MVSG's continuing initiatives. We operate it as a free service to businesses that are willing to put in the effort to help our estuaries and use it as a tool to discuss oysters, waste, habitat restoration, biodiversity, and coastal acidification.

COMPLICATIONS OF A MARKET PIVOT

Matt Gregg
Barnegat Oyster Collective & Forty North Oyster Farms

The Barnegat Oyster Collective markets and distributes oysters for fifteen independent oyster farms. Their primary outlet is restaurants in the New Jersey, New York, and Philadelphia areas. When restaurants closed from the Covid pandemic, the Collective was forced to take the long road to accessing consumers that were still hungry for oysters. Social media, altering a HACCP plan and building a database helped keep the lights on.

ENVIRONMENTAL CONDITIONING OF CLAMS TO LOW PH ENHANCES ROBUSTNESS TO ENVIRONMENTAL STRESS THROUGH ACCLIMATORY GENE EXPRESSION

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Sub-lethal exposure to environmental challenges may enhance ability to cope with repeated or novel changes, a process known as priming. Juvenile Pacific geoduck clams were sampled and gene expression data analyzed after acclimated at the pediveliger stage under ambient (921 µatm) and moderately-elevated pCO_2 (2870 µatm) for 110 days (40-150 days post-fertilization) and subsequently after a second 7-day exposure, a 7-day recovery, and a third 7-day exposure; exposures contained three pCO_2 treatments under the second (ambient: 754 µatm; moderately-elevated: 2750 µatm; severely-elevated: 4940 µatm) and two pCO_2 treatments under the third (ambient: 967 µatm; moderately-elevated: 3030 µatm). Across

timepoints, pre-exposed geoducks expressed sets of genes that had higher expression relative to naïve animals. Genes in processes identified with GO and pathway enrichment included histone methyltransferases and transcription factors, illustrating that priming may frontload transcriptional regulation modifiers. Further, pre-exposed clams were responsive to subsequent encounters, as functional analysis included quality control of mitochondria and immune defense under hypercapnic seawater and energy metabolism and biosynthesis under ambient recovery. In contrast, naïve clams expressed larger sets of genes with higher expression and were enriched for fatty-acid degradation and glutathione components at all timepoints, suggesting depletion of endogenous fuels and unsustainable energetic requirements if changes in carbonate chemistry exacerbated or persisted. Collectively, our transcriptomic data suggests post-larval acclimatory periods to elevated pCO_2/low pH could, via gene expression regulation, enhance robustness to environmental change in juvenile *P. generosa*. Such priming approaches may be beneficial for aquaculture, as global seafood demand intensifies concurrent with environmental change.

ROLES OF FISH IMMUNO-NUTRITION AND NUTRIGENOMICS IN THE DEVELOPMENT OF SUSTAINABLE AQUAFEED: TRENDS AND PROSPECTS

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At present, aquaculture provides over half of the total fish and shellfish food for human consumption globally. Feeds for aquaculture are traditionally based on fishmeal (FM) and fish oil (FO). This practice is good for the supply of essential nutrients, but the reliance on marine resources derived from capture fisheries is unsustainable due to their decreasing supply and rapidly increasing prices. Consequently, the continued growth of the aquaculture industry is dependent upon the development of sustainable feeds with alternative ingredients, generally derived from terrestrial agriculture. Aquafeeds should be nutritionally balanced, healthy, cost-effective and environment friendly. Therefore, I will discuss trends and prospects for fish immuno-nutrition and nutrigenomics in the development of sustainable aquafeed. Immuno-nutrition and nutrigenomics play important roles in 1) determining the right nutrient or combination of nutrients; 2) estimating the correct level of dietary nutrient; 3) evaluating alternative ingredients (FM and FO replacement studies); 4) balancing between harm and benefit of the immune responses; and 5) developing nutritionally balanced/healthy, cost-effective and environment friendly diets for fish. For example, if a plant/ animal meals (protein)-based diet showed similar growth performance as a FM diet, then the immuno-nutrition and nutrigenomics approaches help justify with confidence that these meals can replace FM partially or completely, which could support the production performance. Overall, immuno-nutrition and nutrigenomics are important approaches to evaluating alternative feedstuffs in the diets of cultured fish species, and ultimately, in the development of sustainable aquafeed.

BIOPROSPECTING THE NEXT GENERATION OF DIRECT FED MICROBIALS FOR AQUACULTURE

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Aquaculture is one of the fastest growing protein-producing industries in the world. Production levels are expected to double by 2030, but disease is still the leading cause of crop loss globally. With more stringent controls on antibiotic use and medicated feed, how can this industry grow with dwindling access to disease control tools? Probiotics, also known as direct-fed microbials (DFM's) when intended for animal use, have seen decades-long use as additives in both feed and water. The word "probiotic" usually stirs up connotations of questionable science, but does it have to be that way? Currently, commercial probiotic strains used for aquaculture and agriculture are derived from a very small list of approved microorganisms; in the United States, the GRAS (Generally Recognized As Safe) list comprises just 49 species of microorganisms from a handful of *genus*. Without question, nature has much more biodiversity to offer the aquaculture industry in the form of beneficial microbes. However, with probiotics being banned from extolling disease-mitigating claims on their label, and drug approvals being an expensive and lengthy process, how do researchers and companies present the efficacy of their probiotic without stepping over the line into therapeutic claims? How do farmers gain access to products they know are safe and effective? We will explore bio-prospecting as it relates to accessing novel microbes exhibiting traits desirable for solving aquaculture's leading problems, the regulatory path towards new DFM's, and how "science-backed probiotics" could fill the gap between traditional probiotics and therapeutics for researchers, companies, and farmers alike.

SOCIAL LICENSING FOR OFFSHORE KELP FARMING IN CALIFORNIA

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Within the funding framework of the ARPA-E Mariner Program, Ocean Rainforest launched a demonstration project in the Santa Barbara Channel to test the durability of an offshore seaweed cultivation system, as well as better understand how to minimize impacts on local communities, marine industries and surrounding ecosystems. During the initial stages of the project, Ocean Rainforest saw first-hand the skepticism, hesitation and apprehension surrounding seaweed aquaculture. In early discussions with various community stakeholders, Ocean Rainforest's proposed demonstration project was met with quick and forceful resistance. Conversations with regulatory agency representatives during the preparation and submission of an individual permit application further evidenced a broad uncertainty regarding the economic, social and environmental feasibility of seaweed aquaculture in the U.S.

In an effort to improve public awareness and understanding of seaweed aquaculture, Ocean Rainforest has actively engaged relevant community members in early project siting analysis, as well as shared relevant scientific information on environmental, economic, and social challenges and opportunities of seaweed aquaculture. Notwithstanding our community engagement efforts, the Ocean Rainforest team continues to face questions related to the nature, scope and ultimate benefit of aquaculture from within the local community. Given our experience and preliminary outreach efforts, it has become apparent that having a well-researched framework that describes the best strategies and approaches to building social license is essential for the growth and development of this regenerative industry.

Recognizing the need for improved messaging and education related to seaweed cultivation, a team of Masters of Environmental Science and Management students at UCSB's Bren School of the Environment has worked with Ocean Rainforest to conduct a public opinion survey within Southern California of their sustainable kelp cultivation strategy. In the coming months, this survey will inform an associated guide

detailing opportunities in seaweed aquaculture to use for strengthening social licensing. The framework for this project is specific to California; however, the resulting body of work will lay the foundation for similar social licensing campaigns for aquaculture in the United States and internationally.

Thus, the contents of this presentation would be two-fold: first, to discuss Ocean Rainforest's efforts to build social license for a proposed demonstration project in the Santa Barbara Channel; and second, share preliminary results of a survey intended to inform a framework that would improve understanding and support for offshore seaweed cultivation in the state.

THE DEVELOPMENT AND EVALUATION OF LIPOSOMES AND LIPOSOME-CONTAINING COMPLEX PARTICLES FOR IMPROVED HEALTH AND NUTRITION OF FINFISH

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The delivery of nutrients to aquatic organisms, such as marine and freshwater fish, is challenging due to the aquatic environment in which these animals live and feed. Many essential nutrients are water-soluble making them prone to loss from artificial diets when suspended in water, a term referred to as "nutrient leaching". Nutrient leaching is particularly problematic for small particles because of the inverse relationship between surface area to volume ratio and particle diameter. Microencapsulation is a group of techniques where particles are produced so that the payload is physically protected from the surrounding environment. Liposomes are a type of microparticle that encapsulate water-soluble nutrients by means of a phospholipid bilayer (lamella) and are commonly used in human medicine for the delivery of pharmaceuticals and vaccines. We have found that liposomes can be adapted for use in aquaculture and are highly efficient for the delivery of water-soluble substances to aquatic organisms. We have used liposomes to enrich cultured live feeds, rotifers and *Artemia*, with the water-soluble nutrient taurine. When fed to marine fish larvae, taurine-liposome enriched live feeds resulted in increased larval growth when compared to those fed unenriched live feeds. Liposomes can also be included in larger carrier particles, termed complex particles, which can be directly fed to fish without the need for live feeds. Current research efforts are focused on evaluating liposome-containing complex particles for a variety of uses including: 1) identifying compounds that promote feed uptake in fish, 2) delivery of complete nutrition to marine fish larvae and 3) use as an oral vaccine platform for disease prevention in finfish. This presentation will highlight some of the major outcomes of these efforts.

COMPARING THE MICROBIOME OF WILD AND FARMED ATLANTIC SEA SCALLOP (*PLACOPECTEN MAGELLANICUS*) VELIGERS

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Atlantic sea scallop (*Placopecten magellanicus)* is the second largest fishery in Maine, with the majority of scallops coming from the wild. Since wild scallop harvest is periodic, farming is seen as a way to meet year-round market demands. Most farmers must rely on wild-caught spat, however, as hatchery spawning success and larval survival has been variable for reasons not completely known. To explore the role of larval microbiomes in hatchery success, we will compare the microbiome of wild and farmed scallop veligers. Microbiome communities in veligers will be obtained by prokaryote 16S metabarcoding, and variation in the composition and function among wild and hatchery microbiomes will be explored visually and with statistical tests. The results from the wild scallops will show us the constituents of a healthy microbiome, and by comparing this to the farmed veligers we hope to be able to inform more successful scallop spawning and rearing methods in hatcheries. Many different factors such as diet, environment, and health influence the microbiome of all organisms, these same factors could be influencing the survival of the scallop larvae. Therefore, there is most likely a connection between the function of the veliger microbes and why they do not have a high survival rate in hatchery tanks, giving us insight on how to change aquaculture practices to be more successful.

COMMUNICATIONS STRATEGIES FOR ADDRESSING SOCIAL ACCEPTABILITY OF SHELLFISH AQUACULTURE

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Few Americans have firsthand experience with aquaculture, and studies suggest low public awareness of the benefits, risks, effects, and practices associated with the aquaculture industry. Additionally, nearly half of Americans have a negative view of farm raised seafood, despite the fact that it now makes up more than 50% of the seafood consumed globally. A significant challenge limiting the growth of the shellfish aquaculture industry is siting new or expanding aquaculture operations in the face of negative public perceptions. The use of narratives and storytelling about sustainable aquaculture has been found to be an effective way to increase public understanding and shift attitudes toward aquaculture. Evidence varies regarding to what extent the format of the narrative (e.g. film, text) affects persuasiveness of the story. Risk-benefit perceptions appear to be a key predictor of aquaculture acceptance. Use of evidence-based communications strategies will be important to fostering public understanding and changing consumer perceptions of aquaculture, and ultimately increasing social license to farm.

DETERMINING GROWTH POTENTIAL OF THE EASTERN OYSTER BY VOLUMETRIC COMPARISON UTILIZING SODA BOTTLE UPWELLERS

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Aquacultural Research Corporation in Dennis, Massachusetts was awarded a farmer grant from NE SARE to build a soda bottle upweller system, with a goal to determine the growth potential of the Eastern oyster, *Crassostrea virginica*, by volumetric comparison. Measurements were done on the volume (Liters/minute) of incoming heated seawater and on the density of the microalgae, *Thallasiosira pseudonana*. The two combine in a holding tank and feed the juvenile oysters. A TD 700 fluorometer was used to measure chlorophyll. Algae counts were also done in an effort to provide the oysters enough food to optimize growth. The seawater and algae flows going into the tank were adjusted. Adjustments of the flows going through the bottles were also made. The flows through the bottles were visually set ensuring there was enough tumbling motion. Liters/minute were then measured. In 2020 and 2021, numerous experiments were done in effort to identify whether growth was affected by oyster loading densities (by volume). Volume did not affect growth. There was, however, a pattern with growth being affected by the flow going through the bottles. In 2020, bottle flows had a range of 2-5 L /min. flowing through an average of 226 ml. oysters loaded into each bottle with an average of 5.94% growth. In 2021, the bottle flows had a range of 3-6 L min. with an average of 284 ml. of oysters/bottle and an average growth of 8.9%. This research has provided insight into the optimal conditions for running the soda bottle upweller system.

EVALUATING CONDITIONING AND SPAWNING CYCLES IN CULTURED AND WILD SEA SCALLOPS, *PLACOPECTEN MAGELLANICUS*, IN PENOBSCOT BAY, MAINE

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The sea scallop (*Placopecten magellanicus*) fishery is the third most lucrative marine fishery in the U.S., found in offshore populations and highly productive inshore aggregations supporting a state-managed fishery along the Maine coast. Recent declines in catch, compared to peak harvests in the 1980's, and projections forecasting demand for sea scallops to outstrip supply from fisheries has supported the rise in scallop aquaculture. However, biological and ecological effects of aquaculture on sea scallops is not well-understood and there is currently no hatchery production of scallop for culture. This study compares gonad ripening of sea scallops grown in aquaculture to those of wild scallop populations in Penobscot Bay, Maine. We hypothesize that there will be a difference in gonad ripening both between these two gear types and between farmed and wild populations. Farmed (n = 1983) were sampled from lantern nets at Hurricane Island, ME, July 2019 to mid-October 2019 and two additional partner aquaculture sites in 2020/21. Wild scallops (679) were sampled from beds adjacent to participating farms. Gonadosomatic indices (GSIs) were analyzed to identify gonad ripening and spawning events and temperature was monitored continuously at each site. Differences in spawn magnitude and timing were seen between gear types, sites, and between cultured and wild populations. Differences in gonad ripening and spawning in farmed vs wild populations may influence existing recruitment and growth assumptions in wild populations and simultaneously shed some light on existing challenges with hatchery applications.

NOAA'S MILFORD LABORATORY PARTNERS WITH PROSPECTIVE RESEARCH, INC. AND COMMERCIAL SHELLFISH HATCHERIES TO CONFIRM EFFICACY OF PROBIOTIC STRAIN OY15 IN PRACTICAL HATCHERY APPLICATIONS ON TWO SPECIES OF

OYSTER LARVAE: THE EASTERN OYSTER (*CRASSOSTREA VIRGINICA*) AND THE PACIFIC OYSTER (*CRASSOSTREA GIGAS*)

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The livelihood of the U.S. seafood aquaculture industry, valued at $1.5 billion in 2018 (FAO), depends upon healthy larvae to sustain dependable hatchery seed production of shellfish. Yet under intensive cultivation, bacterial disease is a major constraint to commercial shellfish larviculture, causing massive mortalities and financial challenges for the oyster industry. NOAA's Milford Laboratory's isolation, identification, and experimental application of probiotic bacterial strain OY15, a benign strain of *Vibrio alginolyticus*, has generated intense interest in the role of probiotic bacteria on the health and disease resistance of all life-history stages of oysters. This benign bacterial strain has shown significant, protective effects against a shellfish larval pathogen B183 (*Vibrio corallyliticus*) in experimental laboratory trials and improves survival by 20-35% in pathogen-challenged larvae of the Eastern oyster. To confirm practical application of probiotic strain OY15 in full commercial hatchery-scale trials, the Milford Laboratory has partnered with two oyster hatcheries: University of Maryland's Horn Point Laboratory Oyster Hatchery in Cambridge, Maryland, and Hawaiian Shellfish, LLC., of Keaau, Hawaii. Commercial hatchery-scale trials using a freeze-dried formulation of probiotic strain OY15 were performed to confirm OY15's probiotic effects on two species of oysters; Horn Point Hatchery conducted trials on the Eastern oyster (*Crassostrea virginica*), and Hawaiian Shellfish conducted concurrent trials on both Eastern and Pacific oyster larvae (*Crassostrea gigas*). These trials were the first time probiotic OY15 was used with Pacific oyster larvae, another commercially important oyster species. Survival and growth data from these hatchery-scale trials will be presented for both oyster species.

AUTOGENOUS VACCINES IN AQUACULTURE

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Vaccines have a long history of success within the aquaculture industry. Many of these have been fully licensed products which take longer to develop and cannot be easily changed to address emerging threats. The use of autogenous vaccines, which can target farm specific pathogen risks, has grown dramatically in recent years and offers a better solution to address losses on the farm. These can be tailored to meet a company's specific needs and can be updated as often as necessary providing an excellent return when compared to other approaches.

SITE SELECTION THROUGH DYNAMIC ENERGY BUDGET MODELS COUPLED WITH HIGH-RESOLUTION SATELLITE PRODUCTS

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Site selection is a crucial step in starting a successful oyster farm. Bivalve growth is controlled by temperature and food availability and each species has their own specific requirements. Matching the right culture species to the right location can be a difficult task since the tools/methods to measure food and temperature over a growing season are expensive or time consuming. This issue is compounded in Maine, as the coastline is made up of many narrow estuaries and small bays. Previous work has shown that coupling growth models with satellite derived temperature and food can reduce the uncertainty of exploring new farm sites. However, these studies used sensors with resolutions too coarse to retrieve data from Maine estuaries. Our work aims to (1) validate a dynamic energy budget model to capture growth of cultured Maine oysters (2) and examines the feasibility of using high resolution Landsat 8 sea surface temperature to drive the model. Future work will incorporate measurements of food (Chlorophyll and turbidity) to examine variability in oyster growth along Maine's coast.

TEMPERATURE AND PHOTOSYNTHETICALLY ACTIVE RADIATION EFECTS ON EARLY DEVELOPMENT OF SPOROPHYTES IN THE BROWN ALGAE, *SACCHARINA JAPONICA* AND *S. LATISSIMA*

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Saccharina is an economically important genus used not only in the food industry but also as an animal feed, alginate, cosmetics, nutraceuticals and most recently as a biofuel, etc. In response to climate change, it is important to develop new cultivars with thermal tolerance. *Saccharina japonica* is the most common aquaculture species in Asia, whereas *S. latissima* is cultivated in North America and Europe. Two strains of gametophytes of *S. japonica* and *S. latissima* were obtained from National Institute of Fisheries Science, Korea and the University of Connecticut, USA, respectively. The gametophyte strains of each species were crossed and cultivated under different temperatures (5, 10, 15 and 20 ℃) and photosynthetically active radiation (PAR; 5 and 40 μmol photons m^{-2} s^{-1}) for 20 days. Juvenile sporophytes were fully developed within 20 days at 5 and 10°C, while no sporophytes were observed at 20 °C in all crosses regardless of species. At 15°C, sporophytes were not developed at lower PAR in *S. japonica* but *S. latissima* developed juvenile sporophytes at all conditions. This result suggests that temperature is a main environmental factor determining the early development of sporophytes in *Saccharina japonica* and *S. latissima*.

DEVELOPMENTAL STAGES OF THE GREEN SEA URCHIN (*STRONGYLOCENTROTUS DROEBACHIENSIS*) IN MAINE: THE UMAINE CCAR HATCHERY EXPERIENCE

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Understanding the embryological process in the early developmental stages of the green sea urchin is key to identifying the time at which each stage happens. The green sea urchin (*Strongylocentrotus droebachiensis*) is endemic to the Gulf of Maine where it has long supported a commercial fishery. The University of Maine Center for Cooperative Aquaculture Research (UMaine – CCAR) sea urchin hatchery has been working to identify the timing of the developmental stages that occur after the fertilization of the gametes. In addition, CCAR has developed protocols for providing juvenile sea urchins for stock enhancement or for out-planting at aquaculture leases that specify a sole crop or a crop in combination with oysters or seaweed. The CCAR hatchery has collected images that show the developmental stages of the green sea urchin from fertilization to competent stage over several cycles.
The sequence of photos shows the early developmental stages and timing of the green sea urchin when fed three different microalgae species at water temperatures ranging from 9.0 ºC to 12.0 ºC.

CIS-DEFENSIN ANTIMICROBIAL PEPTIDES IN THE EASTERN OYSTER, *CRASSOSTREA VIRGINICA*

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Defensins are important antimicrobial peptide effectors essential to innate immunity in animals. While previous proteomic and genomic studies revealed multiple members of the small β-like *cis*-defensin family in *Crassostrea gigas* and other commercially important bivalve molluscs, no cis-defensin genes have been identified from the *C. virginica* reference genome. A bioinformatic approach including a custom profile hidden Markov model was applied to search the *C. virginica* transcriptome for defensin motifs and signal peptide sequences. A multigenic cluster of six cis-defensins previously described as noncoding RNA was identified, as well as two additional cis-defensins residing on separate chromosomes. Included in this discovery is the gene that codes for American Oyster Defensin, AOD, an antimicrobial peptide isolated in 2005 using a protein chemistry approach that has eluded genome mapping until now. The predicted peptide structures indicate that seven of the defensins contain three disulfide bonds and one defensin has four disulfide bonds, and all show strong sequence and structural homology with known antimicrobial defensins. Quantitative gene expression analyses confirm differences in defensin mRNA expression among tissues and following immune stimulation. The diversity of cis-defensin sequences in the eastern oyster and high sequence and structural polymorphism may be important for the oyster's adaptation and resistance to multiple potential pathogens. Additionally, these antimicrobial peptides might constitute a potentially rich source of antibacterial, antiviral, or antifungal compounds with applications in aquaculture and medicine.

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 are partnering to create and pilot a workforce training programming for aquaculture. The need for the program was identified in a recent report written by The Gulf of Maine Research Institute. This community college aquaculture program will enable students to graduate with either a 1-year Workforce Training Certificate or a 2-year Associate Degree. Associate Degree graduates will be able to choose from two concentrations: fin-fish aquaculture, and shellfish and macroalgae aquaculture. Badging and micro-credentials will enable students to demonstrate competency in specific, industry-relevant skills to prospective employers. Innovative teaching delivery solutions are being developed to promote hands-on yet remote learning opportunities for students across Maine. The content of the programming will meet 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.

Educate Maine and FocusMaine have partnered to pilot one of these programs: the Aquaculture Pioneers program. The Aquaculture Pioneers program is aimed at providing a pathway to long-term careers in Maine's aquaculture sector. Students from Maine's community colleges will be the initial target audience with a focus of increasing diversity and equity in the sector. Launching in summer 2022, this paid internship program will connect aquaculture businesses to new talent and introduce students to industry standards and best practices for sustainability through meaningful, hands-on experiences while providing a pathway to emerging apprenticeship programs.

COMPARING GROWTH RATES OF OYSTERS USING VARIOUS GROW OUT METHODS

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This project quantified the effects of gear treatment and stocking density on the growth and survival of *Crassostrea Virginica* during a three-month summer grow out period at the Wolfe Neck Oyster Farm in Casco Bay, Maine. Gear type and growing method has a significant impact on growth and survival of oysters. In this experiment, oysters of <1-inch, 1.5 inch, and 1.75 to 2-inch size classes were grown in floating surface ADPI grow out bags (at 4 quart, 6 quart, and 8 quart stocking densities) and growth and survival compared with similar sized oysters at similar stocking densities in wire mesh bottom cages resting on the seafloor. Oyster grow out bags floating in warmer surface water (65°F to 72°F) resulted in faster growth rates compared with similar sized oysters grown in bottom cages sitting on the seafloor (59°F to 63°F). Oysters of <1-inch, 1.5 inch, and 1.75 to 2-inch size classes grown in floating gear showed growth rates of 0.27 (± 0.033) mm/day, 0.30 (± 0.067) mm/day, and 0.35 (± 0.08) mm/day, respectively. This compares to growth rates of 0.20 (± 0.055) mm/day for 1.5-inch oysters, and 0.21 (± 0.073) mm/day for 1.75 to 2-inch oysters, respectively, for those reared at similar stocking densities in cooler water temperatures in bottom cages. In addition to faster growth rate, oysters grown in surface water yielded better survivorship (89.22%) compared to similar stocking densities of oysters grown in bottom cages (85.18%). Significant biofouling and impeded water flow of bottom cages compared with

surface gear resulted in the differences noted in both growth and survivorship. This study provides some of the first data on growth and survivorship of oysters using two distinct rearing methods in Casco Bay.

HOW DO YOU FIND THOSE OYSTER CAGES ON YOUR DEEP WATER FARM? THE APPLICATION OF SIDE-SCAN TECHNOLOGY FOR VISUALIZING CAGES ON THE BOTTOM

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Working with cage culture on your subtidal farm can be challenging when the water depth exceeds your ability to view the structures on the bottom. Losing cages due to cut off buoy lines, placing cages on top of each other, identifying whether the cage landed right-side up or upside down, along with a number of other risks can affect your ability to manage your farm and can interfere with optimal oyster growth. Sidescan sonar is a tool that would allow farmers to visualize their cages on the bottom; however, the technology traditionally has been very expensive to install and somewhat challenging to operate. As recreational fish finder technology has advanced, the new instruments have incorporated both side-looking and down-looking sonar to their ability to detect shapes (fish or otherwise) in the water column or on the bottom. Building off a program developed by Delaware Sea Grant and the University of Delaware to detect ghost crab traps in their inland bays using commercially available fish finders, Blue Stream Shellfish explored the use of fish finders to visualize cage placement and orientation on the bottom of their deep-water oyster farm. With funding from a USDA-SARE Farmer's Grant, we adapted a Humminbird Solix fish finder to be portable for movement between farm vessels and used it to visualize our bottom cage array to allow us to optimize cage management on our farm. We will showcase the adaptations made to the instrument and demonstrate its ability to visualize deep-water cages on the bottom.

LIVELIHOOD DIVERSIFICATION STRATEGIES IN THE UNITED STATES' COMMERCIAL SHELLFISH INDUSTRY

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Commercial fishing has a long and rich tradition in the United States. Over the last few decades, marine aquaculture has been growing, offering new opportunities in seafood production. In the case of shellfish, there seems to be heightened potential for livelihood diversification between shellfish fishing and farming driven by similarities in variables such as harvesting logistics and regulatory structures. However, it is unclear how easy this shift is in practice, the degree to which these industries utilize similar skills, routines, and knowledge, and whether they provide similar levels of job satisfaction. There is limited research looking at fishing-farming diversification (participating in both industries) or transitions (abandoning one for the other) in the U.S. This study uses semi-structured interviews with shellfish fishermen and farmers to understand the behaviors, values, perceptions, and attitudes that motivated them to diversify or transition into aquaculture, or abstain from either, in different coastal communities along the east coast of the U.S. The data being collected will be used to evaluate the assumption that shellfish farming is a logical alternative or additional livelihood for fishermen from the standpoint of individuals

employed in these industries. Given that interactions between shellfish aquaculture, coastal communities, and other stakeholder groups are not well understood, there is a need for critical scholarship on the human dimensions of aquaculture. This research will contribute to this understanding by providing information on the social value structure of shellfish aquaculture across different geographies.

SELECTIVELY BREEDING IMPROVED STRAINS OF SUGAR KELP, *SACCHARINA LATISSIMA*: THREE YEAR SUMMARY

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Seaweed farming in the Gulf of Maine has expanded rapidly over the past decade. As part of ARPA-E's MARINER program, we have conducted a selective breeding program to improve the productivity and composition of sugar kelp, which could serve new markets for food, animal feeds, bio-products and eventually biofuels. Our population genetics studies of sugar kelp prompted the development of two breeding programs: one for Southern New England and the other for the Gulf of Maine. We maintain about a thousand unique gametophytes that can be used as parents for generating crosses. Kelp crosses were planted in "common garden" farm arrays over three seasons (2018 through 2021) in New Hampshire and Connecticut. Trait measurements and analyses of yield, composition, and morphology for 734 family plots and 9,666 individual kelp blades will be presented. One highlight is that several plots exceeded 20 kg/m harvest wet weight with the top plot weighing 28 kg/m or 4 kg/m dry weight – about 4 times the commercial average. We have used pedigree, genotypic marker data, and harvest assessment data to predict offspring performance, and we have improved the efficiency of on-farm testing and phenotyping. Ultimately, we are meeting our goal of selecting sugar kelp that yields more than 20% increased dry matter per unit area per generation. We have sequenced the whole genome for ~300 parents and tested their crosses. We have also completed an annotated reference genome for sugar kelp that enables the identification of natural mutations on targeted genes to potentially create non-reproductive sporophytes

COVID-19 SEAFOOD LITERATURE REVIEW AND IMPLICATIONS FOR THE NE/MID-ATLANTIC REGION

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The COVID-19 pandemic has been very disruptive for aquatic food systems. Global production of marine capture fisheries and aquaculture was down by 0.7% and 1.3%, respectively, in 2020 compared to a year before and global fisheries and aquaculture exports were down 5.8% and 3.2% by value and volume in 2020. Impacts from the initial shock of the pandemic rippled through value chains at multiple stages, scales, and countries, and shifted consumer demand. Access to markets has shifted due to lockdowns, and preferences may be toward retail. COVID-19 disruptions have also led to innovations such as the adoption of new technologies or increases in direct-marketing channels, although some sub-sectors, businesses, and individuals have not been able to adapt, particularly small-scale producers. We are conducting a literature review on COVID-19 impacts, responses and adaptations and will present any data specific to the NE/Mid-Atlantic region, and lessons learned and adaptation strategies from other sectors/markets that could be applied to the NE/Mid-Atlantic region.

SHELLFISH AND THE NORTHEAST: A FIFTY YEAR EVOLUTION OF OUR INTERACTION WITH THESE SUCCULENT SHELLED CREATURES

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Northeast biome diversity - rocky shores, submerged ledges, cold boreal currents, and warmer Gulf Stream water resulted in a fifty-year evolution of research, management, and a vibrant industry, all related to shellfish. Research, anchored by such facilities as the Darling Marine Center in Maine, the NOAA fisheries lab in Milford, CT, Rutgers Haskin Lab in NJ and universities and institutions in between, built on past pioneering work conducted in the region. Basic research and practical application coalesced, people from many stakeholder groups formed small neighborhood “Friends of..” groups and embayment-wide organizations, recognizing the value of maintaining the water quality necessary for shellfish consumption. The role of land uses, contaminants and drainage became an important line of investigation, aided by the advent of mesocosms to manipulate environmental conditions. Advancements made through hatcheries allowed a diversity of species- oysters, quahaugs or hard clams, bay scallops, soft shell clams, mussels, sea scallops, razor clams, and sea clams, has been a primary reason for the wealth of documents and expansion of the industry. Extension has been a primary conduit between research and managers and industry. States exhibit diversity of management from state control to full municipal control in areas classified as approved for harvest. The industry displays diversity and innovation in the species they grow and culture methods. Finally, the role of shellfish has evolved from food and jobs to using them for their filtering capacity to assist in nitrogen reduction and pollution abatement.

NATIONAL POLICY UPDATES AND IMPACTS WITH EMPHASIS ON EXECUTIVE ORDER 13921

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On May 7th, 2020, President Trump signed a new Executive Order (EO) promoting American seafood competitiveness and economic growth. This Executive Order 13921 aims to propel the United States forward as a seafood superpower by strengthening the American economy; improving the competitiveness of American industry; ensuring food security; providing environmentally safe and

sustainable seafood; supporting American workers; and ensuring coordinated and transparent federal actions. Specifically, the Executive Order calls for the expansion of sustainable U.S. seafood production through:

- More efficient and predictable aquaculture permitting
- Cutting-edge research and development
- Regulatory reform to maximize commercial fishing
- Enforcement of common-sense restrictions on seafood imports that do not meet American standards

This presentation will overview the aquaculture related portions of EO 13921 and describe responsive developments. Additionally, we will highlight opportunities for stakeholder input toward coordination and planning of Aquaculture Opportunity Areas provided for in the EO.

OFFSHORE SHELLFISH AQUACULTURE IN FEDERAL WATERS

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Since 2016, the NEMAC offshore mussel farm has demonstrated that long-line shellfish aquaculture is a viable activity in federal waters in the Atlantic. Growing conditions are more stable, food supply more abundant, and yields are twice as high as coastal mussel farms using rafts. Duck predation, invasive fouling and parasites are not an issue. So, what is holding up the acceptance and commercial expansion into deeper offshore waters?

UNDERSTANDING THE CROSSROADS OF HUMAN AND ECOSYSTEMS HEALTH: BACK BAY SHELLFISH FARMS AS A MODEL FOR STUDYING COASTAL ECOSYSTEM FEEDBACK SYSTEMS

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Back bay and marsh habitats have documented public and economic value offering recreational opportunities as well as providing important public safety services such as storm surge protection and water purification. These habitats are an ideal model system for studying the ways that human systems, such as shellfish farms interact with coastal processes. Shellfish farms act as local economic drivers and are one of the lowest impact forms of animal-based food production while providing a plethora of ecosystem functions. One of those ecosystem functions is physical interaction with flow, potentially stabilizing sediment and protecting vulnerable shoreline from vegetation loss and erosion. Farms commonly use structures in nearshore waters, including cages, bottom netting, or floating structures to prevent predators from accessing crops. These structures will alter small-scale coastal sedimentary processes and hydrodynamic dissipation yet, the nature of these interactions is poorly characterized and understood. To better understand the extent of hydrodynamic damping provided by shellfish farms, the wave energy at a full-scale working farm using floating bags and bottom cages, was measured using arrays of pressure sensors oriented in two parallel lines over the extent of both gear types. A third control array measured the unobstructed wave field. The findings from this experiment show that both gear types

decrease the wave energy reaching the shoreline, which implies increased sediment accretion and shoreline protection in regions with farming equipment. Understanding this complex interaction will improve farm siting and management decisions that will consider continued health of nearshore habitats that rely on sedimentary processes.

A DIRECT SEEDING APPROACH TO *SACCHARINA LATISSIMA* FARMING USING GAMETOPHYTES AND JUVENILE SPOROPHYTES

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The kelp farming industry in the U.S. is highly dependent on wild population collections for a source of meiospores. Harvesting reproductive plants from the wild can have a negative impact on these populations if not enough time and care is given for them to recuperate. As the kelp industry grows this impact will likely increase as well. Therefore, we are exploring alternate methodologies where gametophytes are vegetatively cultured and held in cold storage in order to seasonally produce seedstring. Juvenile *Saccharina latissima* sporophytes and gametophytes can be applied by spraying directly onto the seedstring or rope instead of the traditional meiospore settling techniques. This approach has the potential to reduce pressure on wild populations, reduce nursery time, space and cost requirements for hatcheries supporting kelp farming industries. Preliminary results from experimental plots show that the direct seeding technique can produce large quantities of adult sporophytes after a growing season in the Gulf of Maine. Further investigation on application methods will be required to increase effectiveness of this technique and provide opportunities to work with strains that result from selective breeding programs of kelp.

THE MAINE AQUACULTURIST: CREATION AND POST LAUNCH UPDATES

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In October 2020, the Gulf of Maine Research Institute (GMRI) and Maine Aquaculture Association (MAA) [sponsored by FocusMaine] launched a free-to-use aquaculture business knowledge portal, called *The Maine Aquaculturist*. The site was created with one customer in mind – Maine's aquaculture industry. Our aim was to help Maine aquaculture businesses fully utilize the incredible suite of business-relevant support resources provided by various organizations. The creation process was driven by extensive user testing with a variety of aquaculture businesses, including new and veteran growers. Therefore, the resulting architecture, design, and features of *The Maine Aquaculturist* were created based on direct industry feedback. After launch, the site's usage was tracked using Google Analytics. Industry involvement was key in the creation of *The Maine Aquaculturist* therefore, additional user testing sessions were conducted post launch. Anecdotal industry feedback was also gathered post launch. As a result of these user testing sessions and the Google Analytics statistics, it was decided to refine the first version of the site and *The Maine Aquaculturist* 2.0 was launched in September 2021. These updates included the addition of new pages, minor changes to the visual design, and the optimization of some advanced features.

PHYSIOLOGICAL RESPONSE OF OYSTER LARVAE TO INTERACTIVE EFFECTS OF CLIMATE CHANGE VARIABLES

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For calcifying organisms, such as bivalves, short term exposure to increased ocean acidification (OA; elevated ρCO_2) reduces growth rate, increases mortality, and disrupts shell formation in larvae. Climate change predictions suggest rising temperatures and increased rainfall events causing prolonged low salinity exposure, both of which can intensify the negative effects inflicted by OA alone. Understanding how climate change will affect essential aquaculture species is critical to long term ecological and economic stability. We used the eastern oyster (*Crassostrea virginica*) as a model species in a full factorial design to test the interactive effects of temperature (23 and 27^{o}C), salinity (17 and 27), and OA (700 and 1,800 µatm pCO_2) during larval development. The combined effects of salinity and OA significantly reduced growth, resulting in the lowest growth in treatments with both high OA and low salinity. Salinity alone also had a significant negative effect on larval survival that was intensified when coupled with high OA. Differential gene expression data will also be used to identify response to climate change variables at a molecular level to help inform breeding programs by highlighting vulnerabilities and possible avenues for selective breeding. These data will be incorporated into predictive models and used to help inform breeding programs. Understanding the interaction of these three environmental variables, OA, temperature, and salinity, is critical to projecting the long-term effect of climate change on aquaculture species.

CLIMATE IMPACTS ON SHELLFISH FARMS: YOUR PERSPECTIVE

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This interactive session will have participants answer a series of questions about impacts of climate change they have observed and how they have responded to those changes. Participants will also respond to questions about what they see as the greatest needs in the coming (5) years to address climate change. The results will be shared in real time for discussion during the session. The results will also be shared with government entities to help inform their investments in climate-related activities.

SHELF AND BAG OYSTER AQUACULTURE CAGES PROVIDE HABITAT FOR FISH SIMILAR TO NATURAL BOULDER REEFS

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Aquaculture gear may augment natural seafloor as structured habitat for commercially and recreationally important fish species. Underwater video census was used to document fish abundance and community composition on shelf and bag style oyster aquaculture cages and on boulders within natural structured rock reef habitat in Long Island Sound. Action cameras were mounted on study cages deployed at active commercial shellfish farms in Milford, Norwalk and Westport, Connecticut, and on single cages on low relief sand and shell seafloor in Milford. Video was similarly collected amongst boulders on a cobble and boulder reef in Milford. Eight-minute video segments were recorded hourly from 7 am to 7 pm. Data loggers monitored seawater temperature, light intensity, and current speed. Fish abundance (MaxN) was calculated for all videos. Deployments were conducted from May to September in 2018 and 2019.

Higher numbers of fish were associated with cages as compared to boulders. Cunner were the dominant species in boulder habitat early in the season while black sea bass were the most abundant species on cages. The fish community associated with cages was comprised of a similar variety of life history stages as observed on boulders. Our results suggest that multi-tiered oyster aquaculture cages contribute complex structure to seafloor environments that provide quality habitat and ecosystem services for fish.

LARVAL SEA LICE (*LEPEOPHTHEIRUS SALMONIS*, KRØYER) EXHIBIT BEHAVIORAL RESPONSES TO PRE-ADULT AND ADULT CONSPECIFIC CUES

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In the larval stage of the parasitic copepod *Lepeophtheirus salmonis*, the free living copepodid must locate and settle on a salmonid host. Chemosensory mechanisms play a role in determining whether a potential host is suitable for attachment, yet the full suite of chemical cues and resulting behavioral mechanisms used for host location and aggregation are unknown. After maturing, pre-adult females and adult male sea lice emit sex pheromones. Once mated, gravid females reduce the production of sex pheromones. The aim of this study was to investigate the potential that cues from pre-adult female and adult male sea lice influence copepodid behavior. Behavioral bioassays were conducted with copepodids exposed to water conditioned with three stages of conspecific lice (pre-adult female, adult male, and gravid female), and Atlantic salmon (*Salmo salar, L.*) conditioned water. Experiments demonstrated that copepodids exposed to water conditioned with the salmon host, pre-adult female or adult male sea lice elicited behaviors characteristic of arrestment, whereas sea lice exposed to gravid female conditioned water did not. These results suggest that *L. salmonis* larvae respond to the cues of lice stages known to produce sex pheromones, and we conjecture that they may serve to aggregate conspecifics and amplify infestations.

OPTIONS AND IDEAS FOR RECAPTURE AND RE-USE OF RETIRED PLASTICS FROM THE MARICULTURE INDUSTRY IN THE NORTHEAST US AND ELSEWHERE

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Oceanic pollution by plastics of all types and forms is a global problem, with around 10 million tons escaping into the marine environment annually; and yet the fishing and aquaculture industries are entirely dependent on plastics for all on-the-water operations. Relief of this worldwide problem requires actions on many levels: reduction, R&D of alternative materials, recapture of waste plastic materials, transportation assessment, and ideally their re-manufacture into other useful items, all of which must be profitable enterprises to function for any reasonable length of time. Increasingly, resources are available from plastics recovery, to fabrication with recovered materials, and DIY machinery that can democratize the process of recycling and adding value to retired aquaculture gear.

In this session, we will:
- review the nature and scope of plastics pollution from the global to the local scales,
- introduce pilot work in Maine to capture retired plastics and fabricate useful products, as well as shellfish farming efforts with novel, non-plastic materials
- engage the audience in discussion to gather ideas, questions and opportunities, and to improve the networking of those interested in reducing plastic wastes from the aquaculture sector.

COMPOSITE LINES FOR REDUCED RISK OF MARINE MAMMAL ENTANGLEMENT IN AQUACULTURE STRUCTURES

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The University of New Hampshire, in collaboration with Otherlab and Trophic LLC, is developing technology to enable lower cost whale-safe offshore macroalgae mariculture through funding from ARPA-e's MARINER program and the World Wildlife Fund. Given that offshore aquaculture structures are perceived to pose a risk to the critically endangered North Atlantic Right Whale, developing technology that can reduce the risk of marine mammal entanglement has been central to our project goals. By replacing synthetic fiber ropes with composite rods, we believe that the chances of marine mammal entanglement can be significantly reduced, if not eliminated. Because they have rigidity and a minimum bending radius beyond which they break, composite lines cannot loop around whale appendages; the line would break or loosen before the formation of a wrap. Our project aims to demonstrate the efficacy of this technology as an entanglement prevention measure and to develop operational and technological methods for enabling practical use of such materials as structural or grow-lines in macroalgae aquaculture. We have designed and tested devices for terminating our composite lines, allowing for use as tension members. We have successfully deployed these lines as mooring and grow-lines on pilot scale kelp farms

in the ocean. And finally, we are continuing to evaluate the durability of these materials used in the context of kelp mariculture.

ECOSYSTEM SERVICES AND WILDLIFE INTERACTIONS AT OYSTER FARMS

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Shellfish farms not only rely on healthy and clean waterways for habitat, they also contribute directly to cleaning and improving productivity of those habitats. Through filter feeding, shellfish help to clean water, improve water clarity, and support habitat for other ecologically important species such as seagrasses. By providing structure, shellfish farms can be attractive to mobile fish and crustaceans, and to the shellfish themselves. The structures used to farm oysters, including bottom cages and floating bags, can help to stabilize shorelines and protect from erosion caused by wave and sea level rise. Additionally, interaction among farms and wildlife that may use habitat near to or occupied by farms are important to characterize, ever more so important when the wildlife species in question are ones of special concern. All of these processes, services and interactions are important to understand and quantify, particularly as shellfish aquaculture grows in the US and globally. Recent and ongoing projects in New Jersey have been addressing these various ways that shellfish farms support ecosystem services or interact with important wildlife species. These studies aim to quantify farm-scale filtration and nitrogen removal, habitat provisioning and wave dampening by oyster farm gear, and endangered species interactions at coastal farms. The main results of these studies are identified in a framework that supports coastal management and decision-making.

A SURVEY OF SHELLFISH HATCHERIES ON EXPERIENCES WITH HARMFUL ALGAL BLOOM DISRUPTIONS

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In the United States, operators of shellfish hatcheries have expressed concerns that harmful algal blooms (HABs) are increasingly causing larval and post-set mortalities. NOAA Fisheries, with the guidance of a commercial advisory committee, conducted a mail-in survey to better understand producer concerns and experiences with HAB-related hatchery disruptions. Of 114 mailed surveys, responses were received from 29 hatcheries located in the New England/Mid-Atlantic (NE - 59%), Southeast (SE - 34%), and West Coast (WC - 7%) regions. Hatcheries reported raising 15 different bivalve species, with most facilities cultivating eastern oysters (*Crassostrea virginica* - 83%) or northern quahogs (*Mercernaria mercenaria* – 52%). Nearly all participants were aware of the potential effects of HABs on shellfish hatcheries, and 69% were concerned about HABs negatively affecting their operations. Regional differences were observed, with 47% of NE facilities having experienced a HAB event, as compared to 20% of SE hatcheries. Recognition of hatchery disruptions was dependent upon HAB monitoring; 80% of hatcheries that monitor for HABs reported experiencing disruptions, as opposed to 11% of hatcheries that do not monitor. Across all regions, the majority of hatcheries responded that they would like help monitoring for HABs. From the survey, we concluded that the threat of HABs is an immediate concern for hatchery producers and that there is a need for additional education and resources to monitor HABs on-site. As a

part of survey follow-up, respondents were directed to NOAA's National Phytoplankton Monitoring Network and the *Phyto* smartphone app, two resources for collecting and identifying local HABs.

THE DEVELOPMENT OF A UNIQUE GOLDEN/STRIPED PHENOTYPE IN THE BLUE MUSSEL, *MYTILUS EDULIS*, FOR HATCHERY PRODUCTION AND VALUE-ADDED POTENTIAL

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Blue mussel, *Mytilus edulis*, aquaculture in Maine is poised for expansion with many mussel farms increasing production to keep up with consumer demand; yet the majority of mussel farms in Maine depend on collecting wild seed to propagate their farms. Large spatial and temporal variation in wild mussel larval dispersal and capture create risks to Maine mussel farms and may act as a barrier to expansion. To combat the reliance on wild seed collection and provide options for farmers, the Downeast Institute (DEI) has developed a method for the hatchery production of seeded mussel ropes for the Maine mussel farming industry. A major component of the hatchery process is the development and maintenance of select broodstock chosen for positive attributes such as phenotype, fast growth, and disease resistance. DEI focused breeding efforts to create a line of mussel broodstock that produce a unique golden and striped phenotype, which adds value to the final product and offers new approaches to marketing the product. The development of hatchery and nursery growing methods, and the development of the select broodstock was a partnership between DEI and a commercial mussel farm, Blue Hill Bay Mussels. We will discuss how the line of broodstock was created and how the relationship between a research and development institution and industry partner helped spur innovation and the rapid development of commercially viable hatchery-reared mussel seed.

MICROBIAL SAFETY AND QUALITY OF COMMERCIAL DRIED MACROALGAE FOR HUMAN CONSUMPTION

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As aquaculture of macroalgae expands both in scale and species of focus, consistent attention has been given to the lack of microbial quality and safety data for these products. Maine Coast Sea Vegetables, Maine's longest established purveyor of seaweeds for human consumption, conducts extensive microbial testing on their dried products through external laboratories. These data represent a valuable tool that can be utilized to direct research focus and inform regulatory decision-making with regard to bacterial pathogens of concern. Aggregated data for a subset of species of interest (*Palmaria palmata, Alaria esculenta, Laminaria digitata, Ascophyllum nodosum* and *Fucus vesiculosis*) demonstrate high microbiological quality, with average total aerobic counts ranging from 2.48-3.58 logCFU/g and average fungal counts ranging from 2.02-2.62 logCFU/g. *Palmaria palmata* demonstrated the highest average counts while *A. nodosum* exhibited the lowest. Coliforms were detected in 16% (36 of 219) of samples tested, again with *P. palmata* yielding significantly more positive results than other species. Of 36

samples positive for presence of coliform, only 11 of these were confirmed to contain *Escherichia coli* and none of these isolates were confirmed pathogenic. Moreover, none of the dried seaweed samples analyzed were found to contain detectable levels of either *Staphylococcus aureus* or *Salmonella enterica.* These data further reinforce the overall high microbial quality of seaweed products and suggest that focus on pathogenic contamination should be primarily directed at *E. coli*, which has previously been identified as a pre-harvest contaminant and demonstrates capability to survive on multiple species of macroalgae following dehydration.

BEHAVIORAL ANALYSIS OF HOW NATIVE FISH COMMUNITIES USE OYSTER CAGES AS STRUCTURED HABITAT

***Gillian Phillips*[1,2], Renee Mercaldo-Allen[2], Adam Armbruster[3], Peter Auster[4], Paul Clark[2], Christian Conroy[3], Mark Dixon[2], Erick Estela[2], Yuan Liu[1,2], Lisa Milke[2], Dylan Redman[2], Barry Smith[2], Alison Verkade[5], Julie Rose[2]**

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Documenting fish behavior in and around oyster cages may enhance understanding of the ecosystem services provided to fish by aquaculture gear. Action cameras (GoPro®) were used to collect video of fish activity adjacent to shelf and bag cages on a shellfish farm located near Milford, Connecticut in Long Island Sound. Video was simultaneously recorded on a nearby rock reef to compare fish interactions on cages to activity on natural structured boulder habitat. Commonly observed fish behaviors included foraging, sheltering, escape, agonistic displays, and station-keeping. Collaboration with resource managers identified those fish species and behaviors of highest priority and aided in development of a behavioral scoring matrix. Analysis of all reproductive behaviors in all species recorded as well as analysis of Cunner, Black Sea Bass and Scup are ongoing. Preliminary observations of fish behavior suggest that cages may provide food, shelter, refuge, and other habitat services much like boulders on natural reefs. Understanding the value of oyster cages as fish habitat may inform regulatory and permitting processes when siting new shellfish farms.

ENHANCING SETTLEMENT SUCCESS AND POST SETTLEMENT SURVIVAL IN GREEN SEA URCHIN AQUACULTURE

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Hatchery methodologies in the Northeastern US have yielded low settlement success and post-settlement survival for the green sea urchin (*Strongylocentrotus droebachiensis*) causing high seed production costs for this emerging aquaculture species. The transformation from planktonic larvae to benthic juveniles, known as settlement, and the survival of these newly settled juveniles are critical

aspects for sea urchin aquaculture to be successful. It has been suggested that different biological and chemical cues such as bacteria, benthic diatoms, macroalgae, or even altered temperature can promote settlement. In this study, we test these by examining the settlement success of *S. droebachiensis* larvae exposed to differing biofilms (e.g. *Nitszchia sp., Cylindrotheca closterium,* Adult *S. droebachiensis*) and conditioned seawater treatments (Adult *S. droebachiensis* or macroalgae chemical cues) under two temperature regimes of 12 and 14°C to determine whether settlement can be enhanced. It has been suggested that the low survival rate of newly settled juveniles in hatcheries is associated with the lack of optimal food sources. To address this, an experiment was conducted to determine if differing diatom and macroalgae food sources under two temperature conditions of 12 and 14°C increases survival. This study elaborates on the chemical and biological cues that induce high larval settlement success and post settlement survival, and we discuss the next steps in optimizing cultivation conditions.

COMPARING THE PERFORMANCE OF SELECTIVELY-BRED AND WILD EASTERN OYSTER STOCKS IN RHODE ISLAND

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Eastern oyster (*Crassostrea virginica*) aquaculture is rapidly expanding in the United States of America, but production can be constrained due to losses from diseases. When it comes to endemic illnesses, hatcheries and breeding programs have developed oyster lines through selective breeding with improved performance when exposed to disease-causing parasites, an efficient disease control strategy for a variety of diseases. To identify stocks for development of a selective breeding for improved performance in the Northeast region, two selectively-bred lines of *C. virginica* were grown alongside four wild stocks (Green Hill Pond and Narrow River, Rhode Island; Thames River Ram Island, Connecticut; Tisbury Great Pond, Martha's Vineyard, Massachusetts). Oyster growth and survival was monitored over a 5-month period after spawning and deployment at a Rhode Island farm. Growth of individual oysters was also tracked via pit tags with unique digital ID numbers. Disease presence will be assessed by qPCR. Results so far show that oysters from the 2 selectively-bred lines were more consistent in size and shape than oysters from the wild stocks. Performance of oysters from the six stocks deployed in summer 2021 will be followed through 2022. Moreover, we will evaluate performance of the same six stocks for two years after spawning in 2022 and deployment at two additional locations in Rhode Island. These trials will provide background information for the development of a regional breeding program in Southern New England.

BIVALVE TRANSMISSIBLE NEOPLASIA (BTN) IN THE CASCO BAY STEAMERS (SUMMER 2021)

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Bivalve Transmissible Neoplasia (BTN) is a leukemia-like transmissible cancer affecting steamers (*Mya arenaria*) and other marine bivalves. The clamming industry is an important economic activity in Maine, and clams also serve as a vital nutrient cycler in estuarine systems. By knowing where BTN is occurring, outbreaks could be mitigated by removing or isolating infected clams. In the summer of 2021, we conducted a BTN survey in three sites in Maine where BTN was previously reported: The Dam in Quahog Bay, Gurnet Landing on Harpswell Island, and Long Cove on Orrs Island. The sampling consisted of 25-32 clams/sites in June and July. We ran quantitative PCR (qPCR) to quantify the cancer cells within clam's blood for the diagnostic. We reported BTN at all three sites with variable prevalence over time, ranging from 0-17%. We also sampled the water (300-1,500 ml) surrounding the clam beds; in this case, the water was filtered, and the filtrate was subjected to qPCR, resulting in positives for BTN. The limited sampling in this survey was not enough to accurately establish the relationship between cancer cell prevalence in the water and BTN prevalence of clam populations. Nevertheless, the copy number for BTN DNA from July samples was significantly higher than those from June (17,900-55,000 copies/mL vs. 0.3-0.9 copies/mL), suggesting the possibility that there is seasonal variability in cancer cell release from diseased clams. These results also hint to a population of diseased individuals able to maintain a low level of the disease without decimating the clam population.

CLIMATE RISKS & RESPONSE OPTIONS IN THE GULF OF MAINE

David Reidmiller
Gulf of Maine Research Institute, 350 Commercial Street, Portland, ME 04101

The unprecedented warming in the Gulf of Maine over the past 10-15 years is well-documented—and the consequences of that warming on marine ecology and the downstream seafood supply chain are increasingly coming into focus. This talk will briefly touch on a range of climate-related risks to the Gulf of Maine, while also sharing various response options to those risks, including some examples of climate action by regional industry leaders.

COMPARING GROWTH AND SURVIVAL OF TWO STRAINS OF SURF CLAMS ENDEMIC TO MASSACHUSETTS WATERS AT A RANGE OF SHELLFISH AQUACULTURE SITES

***Joshua Reitsma*[1,2], Harriet Booth[1,2], Abigail Archer[1,2], Paul Wittenstein[3], Emma Green-Beach[4], Matt Weeks[5], Patrick Ross[6], Mark Begley[7], Mike Dunbar[8], Steve Wright[9], Craig Poosikian[10], Iris Pickard[11], Alex Brown[12], Dan Martino[13], Greg Martino[13], Brandon Small[14]**
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Previous work in Massachusetts has shown that Atlantic surf clams have potential as an emerging aquaculture species. While clam growth has been relatively rapid in all studies, survival has been challenged by warm waters and intertidal conditions typical of many aquaculture areas in MA. Most aquaculture work in the region has been done with the more common and well-known Atlantic surf clam, *Spisula solidissima solidissima*, though the Southern surf clam, *Spisula solidissima similis* also populates the mouth of many estuaries on the southern side of Cape Cod. While the aquaculture potential of Southern surf clams has been examined in more southern regions no known attempts have been made in New England areas.

To determine the aquaculture potential of one species versus the other, seed from both species were obtained using local parent stock in summer of 2020 and verified for genetic identity. The seed of both species were planted at nine different shellfish aquaculture sites representing a range of conditions including subtidal and intertidal. Seven of the sites were monitored closely for growth and survival comparison between the two species using mesh-covered trays buried in the sediment and sampled at roughly bimonthly intervals. Data are being collected into fall of 2021, but early results suggest some clear advantages in survival and sometimes with growth using Southern surf clams, *Spisula solidissima similis*, over Atlantic surf clams, with the most pronounced differences in intertidal conditions.

BMPS TO MAXIMIZE ECOSYSTEM SERVICES

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

The session will cover a broad overview of the various types of aquaculture and some of the various ecosystem services associated (nutrient removal, habitat provision, eutrophication mitigation, benthic stabilization). Panelists will discuss their research on certain aspects of the various practices and how they might influence the provision of services. Panelists will be asked to propose potential Best Management Practices for growers to consider in order to optimize or maximize the provision of these services. The workshop will close with an open brainstorming session offering attendees an opportunity to share ideas on how to maximize the ecological benefits of restorative aquaculture.

Panel participants:

- Dr. “Wally” Robinson Fulweiler
- Dr. Jon Grabowski
- Dr. Julie Rose
- Dr. Daphne Munroe

BMPS TO ADDRESS CONCERNS ASSOCIATED WITH SHELLFISH AQUACULTURE IN FLOATING GEAR

Robert Rheault[1], Mark Amaral[2]
[1]East Coast Shellfish Growers Association; [2]Lighthouse Consulting Group

The ECSGA developed a Best Management Practices module for shellfish farming about a decade ago. The free, web-based module has been adopted by hundreds of farmers helping them describe their operations and the various steps growers can take to minimize conflict and show how their operations are compatible with other users of the commons. Subsequently shellfish farmers have developed a variety of

novel gear types that restrict navigation and are more visible to boaters and waterfront homeowners such as: Oyster Gro, SEAPA, Hexcyl baskets, Flip Farm and flip bags). These gear types bring unique permitting challenges and deserve their own set of Best Practices to minimize conflicts and facilitate permitting. This panel will bring together resource managers, growers, equipment manufacturers and extension agents to offer methods to minimize conflict and hopefully propose best practices that growers can consider in order to increase their chances of positive permit application outcomes. The workshop will close with an open discussion giving attendees an opportunity to share their experiences and ideas.

AQUATRAIN: FREE ONLINE ENTRY-LEVEL OYSTER FARMHAND TRAINING USER MANUAL

Robert Rheault[1], *Cameron Ennis*[2] and Azure Cyglar[3]
[1]East Coast Shellfish Growers Association, [2]Education Exchange, Charlestown, RI, [3]Coastal Resources Center, University of Rhode Island

What is It & How Does It Work?
How Could This Possibly Benefit an Employer Without Creating More Work?
How Can You Possibly Utilize, Tailor or Even Fund Something Similar?

In 2015, five Rhode Island oyster farmers sat down after work for a sandwich and two beers and started talking about what they wanted in an entry-level employee and the conversation grew and evolved into a sector driven employment training program funded by the RI Department of Labor initiative known as Real Jobs RI… seven years and countless learning experiences later, we're pleased to bring our successful in-person RI oyster farmhand training to you: online and for free. Explore the training modules, fundamental components, online platform, common implementation pitfalls, employer utilization, government/nonprofit application and potential braided funding sources. See how overlapping industries are recognized, embraced and fostered throughout various stages of the aquaculture career pathway. Browse the customized applications for the farm owner, the biology teacher, government contractor and your future aquaculture employee; there's something in here for everyone. Nothing can replace hands-on experience, but we'll put some practical tools in your shed for you to put to work.

HISTORIC SHELLFISHERIES AND EFFORTS TO REPLENISH SHELL STOCK IN RHODE ISLAND WATERS

Michael Rice
Department of Fisheries, Animal & Veterinary Science, University of Rhode Island, Kingston, Rhode Island, 02881

Fisheries biologist Daniel Pauly coined the term "shifting baseline syndrome (SBS)" in 1995* to describe how scientists, fisheries managers, and stakeholders often forget the biological abundance of earlier times—thinking that contemporary fishery populations (or those in recent memory), including shellfish, are somehow the norm. This misconception often leads to overestimation of truly sustainable shellfish harvest rates (MSY) and results in declining shellfish biomass over time. Historic landing data, past laws and policies for managing shellfisheries and aquaculture in Rhode Island back to the 18th Century provide clues to past population norms estimated to be >100 times current values. In 1735, shellfishery

conservation concerns prompted a statute prohibiting oyster harvest for kiln production of quicklime. Gear restrictions began in 1766, and by 1798, they instituted the first aquaculture grant, in part to privatize the oyster fishery to provide economic incentive for better shellfish bed management. Legislation in 1852 required all oyster shell stock to be returned to state waters. Given trends of acidification of marine soils and possible associated cascade effects on shellfish recruitment, and subsequent effects on future shellfishery yields, it is important to recognize the scope of calcium carbonate reserves in the historic high standing crop biomass oyster reefs and its role as a pH buffer in coastal ecosystems. **Pauly, D. 1995. Anecdotes and the shifting baseline syndrome of fisheries. Trends in Ecology & Evolution 10(10):430.*

CORNELL COOPERATIVE EXTENSION OF SUFFOLK COUNTY'S SHELL RECYCLING PROGRAM

Gregg Rivara
Cornell Cooperative Extension of Suffolk County, Suffolk County Marine Environmental Learning Center, 3690 Cedar Beach Road, Southold, NY 11971

Cornell Cooperative Extension of Suffolk County's Marine Program was founded in 1985. In 1991 the author started a municipally-funded shellfish hatchery on the North Fork of Long Island at a community college marine science center. Over the decades we have primarily grown hard clam, oyster and bay scallop seed for resource enhancement for three of the five East End towns on Long Island. In addition, we provide shellfish from eggs to juveniles for studies with our colleagues from universities in New York. In the late 1990's and early 2000's we started experimenting with spat on shell oysters. In 2010 the New York City Department of Environmental Protection approached us to build two reefs- one each in the boroughs of Kings and Queens. It was at this time that we realized that we needed a lot of shell for even a small three-dimensional reef. In 2017 New York State awarded us $5.25 million to build a state-of-the-art shellfish hatchery including four-meter diameter set tanks to increase our production capabilities for providing spat on shell for five oyster sanctuaries in Nassau and Suffolk counties. In order to accomplish this, we had to "up our game" and collect many more shells than in the past. The talk will highlight some of the issues we faced and how they were solved.

CUMULATIVE EFFECTS OF OCEAN ACIDIFICATION AND WARMING ON THE EARLY DEVELOPMENT OF AMERICAN LOBSTERS

***Emily Rivest*[1], Brittany Jellison[1,2], Abigail Sisti[1], Brett Sweezey[1,3], Gabriel Thompson[1], Jeffrey Shields[1]**
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Water temperatures in the Gulf of Maine are increasing at an alarming rate, and concurrent ocean acidification (OA) will likely be a threat multiplier for marine ecosystems and several commercially important species. Previous studies on negative impacts of OA and warming on American lobsters has focused on short-term exposure experiments with individual life history stages. To address this knowledge gap, we investigated cumulative effects of exposure to OA and warming conditions across the early development of American lobsters – from early embryogenesis to hatching. We documented the

interactive effects of the two co-stressors on the development and physiology of the lobster embryos. To best capture cumulative effects across the early life history, we exposed ovigerous females to a combination of two seasonally varying temperatures (present-day and elevated) and two constant carbonate chemistry treatments (present-day and acidified) for five months. Each month, we sampled embryos and measured egg development, metabolic rate, biochemical composition, and enzyme activity. In our initial assessment, we have found that the physiology of American lobster embryos was sensitive to warming and tolerance to OA conditions. Long-term embryogenesis and brooding during early development may provide resilience to this particularly susceptible life stage.

SEAWEED FARMER PANEL

Jaclyn Robidoux
Maine Sea Grant, Orono, ME

Though seaweed is celebrated as a miracle crop that requires “no freshwater, no land, and no fertilizer” to grow, farmers recognize that it takes more than seawater to run a successful seaweed farm. This session is an open conversation with seaweed farmers from across the US about ways in which they are responding, innovating, and building new opportunities in this rapidly emerging sector. Learn from the folks on the water, in the epicenter of domestic seaweed aquaculture!

DEVELOPING SHELLFISH AQUACULTURE BEST PRACTICES TO ENHANCE HABITAT PROVISIONING

***Julie Rose*[1], Renee Mercaldo-Allen[1], Paul Clark[1], Jonathan Grabowski[2], Stephen Kirk[3], Lisa Milke[1], Daphne Munroe[4], Gillian Phillips[1], Dylan Redman[1], Kelsey Schultz[2], Jenny Shinn[4], Christopher Schillaci[5]**
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Shellfish aquaculture gear creates complex structures that can increase the abundance and diversity of wild fish relative to reference habitats, and occurrences of habitat-related behaviors such as foraging, shelter, and reproduction have been documented on gear. Ongoing research programs in Connecticut, Massachusetts, and New Jersey seek to quantify fish interactions with aquaculture gear using underwater action cameras and explore cultivation practices that may increase habitat services provided to wild fish assemblages. A variety of gear types were examined, including multiple styles of bottom cages and floating gear. Video was collected on subtidal and intertidal leases, and across a wide range in density of fouling organisms attached to gear. Video was recorded across the typical shellfish summer growing season, and into the fall and winter months, to assess potential impacts of winter gear removal on local fish assemblages. The speed at which fish return to shellfish gear post-disturbance was quantified through the use of continuous video. Results from these field programs will be synthesized, practices that favor habitat enhancement identified, and areas in need of additional research will be discussed. Information on best practices can aid resource managers in developing a permitting framework that includes ecosystem services provided by aquaculture in the regulatory process and may improve farm

planning by identifying those practices undertaken by growers that are of greatest benefit to fish communities. A better understanding of how shellfish farming positively influences fish communities may increase social license for aquaculture among coastal communities and stakeholders.

OVERVIEW OF COVID MARKET EFFECTS ON THE US SEAFOOD MARKET AND EFFORTS TO BUILD BACK BETTER

Michael Rubino
NOAA Fisheries

A recent NOAA Fisheries market snapshot report (along with a NOAA and Sea Grant commissioned work on aquaculture impacts led by Virginia Tech) found that revenues of US seafood producers declined anywhere from 10% to 80% in 2020. However, US supermarket and restaurant data (reported at the National Fisheries Institute's market outlook conference in January 2021) showed that sales of seafood in the US went up 7% in 2020--led by sales at supermarkets of imported seafood. US harvesters, including those in the Northeast US (wild and farmed) were particularly hard hit because of reliance on a) food service/restaurants (which shut down for a while) and difficulties of pivoting to quantities, product form, and packaging required by supermarkets; and b) reliance on exports to foreign markets and processing plants (half of US wild catch is exported) which were disrupted by shipping delays and temporary closure of processing in Asia. Other reasons may include lack of sufficient cold storage and supermarket shoppers' preference for imported seafood species. While importers may have been the short-term winners, COVID is forcing a reassessment of options all along the seafood supply chain. The industry is searching for new sources of supply and new markets, seeking to shorten the supply chain by sourcing more domestic seafood, and adapting to new product forms and market delivery methods. This reassessment could be good news for domestic producers and will help put U.S. seafood back on American plates.

SHOW ME THE MONEY! USDA FARM PROGRAMS FOR RISK MANAGEMENT

Paul Russell, Thomas Smiarowski
University of Massachusetts Risk Management Team, United States Department of Agriculture

This seminar will guide growers through the maze of USDA programs available to farmers. These programs can help growers mitigate potential risk to their operation or assist growers in recovering from a variety of disasters. The goal of the seminar is to assist growers in the development of a risk management plan and how USDA can be a partner. There will be presentations from the variety of USDA Agencies.

Farm Service Agency (FSA): The FSA provides many of the disaster financial support programs to all farmers including aquaculture. FSA also provides credit programs through both direct and guaranteed loans.

Natural Resources Conservation Service (NRCS): The NRCS provides both technical and financial support to farmers to improve their operation's environmental concerns. Many states in the northeast have developed special practices to assist shellfish growers with a variety of upgrades to their operations.

Risk Management Agency (RMA): The RMA is responsible for the development and support of federal crop insurance policies and programs. Crop insurance policies are sold through private insurance companies and agents. Crop insurance policies receive subsidies from USDA to make them affordable to growers and offer a variety of options to meet the individual growers needs. RMA is currently developing a policy for oysters for the eastern seaboard.

DEVELOPING THE 2021 MAINE AQUACULTURE ECONOMIC ROADMAP: ADDRESSING THE NEXT DECADE OF AQUACULTURE IN MAINE

***Heather Sadusky*[1], Gayle Zydlweski[1], Sebastian Belle[2], Christopher Davis[3], Deborah Bouchard[4], Hugh Cowperthwaite[5]**
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The *Maine Aquaculture Economic Roadmap*, a plan for the next decade of aquaculture in the state, is set to be released in fall 2021. Developed in collaboration with a variety of stakeholders, the plan outlines four goals for the sector along with specific action items needed to achieve each goal. It is intended to be a blueprint for industry, government, nonprofits, municipalities, the public, researchers and more to use in working towards a future for Maine's aquaculture sector that creates triple bottom line sustainability.

The development of this 10-year roadmap was coordinated by the Maine Aquaculture Hub, a network for sustainably strengthening aquaculture in the state. It was one of 10 Hubs funded nationwide, and is supported by six founding organizations: Maine Sea Grant, Maine Aquaculture Association, Maine Aquaculture Innovation Center, University of Maine Aquaculture Research Institute, and Coastal Enterprises, Inc.

To gather input for building the new *Maine Aquaculture Economic Roadmap*, ten Focus Group meetings were held via Zoom and numerous one-on-one phone calls made. A total of 140 people across Maine provided input and feedback on this plan. The authors of the roadmap would now like to share the approach used in building the plan and gathering input, lessons learned from the process, plans for implementation, and measuring progress.

Achieving the four goals outlined in the roadmap will require engagement from government, nonprofits, research institutes, municipalities, aquaculture producers, and others. Action items identify specific needs that ultimately will work toward the greater goal – some items are already underway, while others are just beginning. Progress toward these action items will also be shared, with updates on specific projects that speak to the needs outlined in the roadmap, as well as the strategy for measuring progress. To gauge its effectiveness, several assessments are planned throughout the life of the 10-year roadmap.

By presenting the *Maine Aquaculture Economic Roadmap*, the authors aim to bring awareness to the plan and its action items, as well as provide insight to the process

ASSESSING VARIOUS GROW-OUT TECHNIQUES OF DEEP SEA SCALLOPS, *PLACTOPECTEN MAGELLANICUS*, IN MAINE'S VACANT LOBSTER POUNDS

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Supply-demand conditions of the Atlantic sea scallop (*Placopecten magellanicus*) market suggests the species is well suited for aquaculture, as the U.S. scallop market has an annual landed value of approximately $380 million, while scallop landings in Maine dropped 42% from the 2017 to 2018 season. Utilizing vacant lobster pounds in Washington and Hancock counties as grow-out nursery sites may help bridge the gap between supply and demand in the fishery. In June 2021, five modified trap wire cages with concrete runners were deployed in two lobster pounds in Beals and one in Steuben. One cage was deployed off the DEI pier to compare growth rates and environmental data. Each cage contained 42 juvenile scallops with an average shell length of 58 mm and HOBO temperature loggers were used in each of the sites. In August 2021, seed scallops with an average shell length 2.5 mm were deployed in three lantern nets in one pound in Beals and one lantern net off the pier. Preliminary data suggests grow-out of scallops in lobster pounds may be feasible. After two months, juvenile scallops in pounds grew on average by 8 mm in length, in comparison with pier scallops which grew by less than 1 mm. Though mortality rates remain relatively low, some cages suffered as much as 30% loss and further modifications to gear may be necessary to reduce green crab predation.

BREAKTHROUGH OF ALGAL TOXINS INTO SHELLFISH HATCHERIES - NEW LINES OF RESEARCH NEEDED TO SUPPORT PRODUCTION

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Shellfish hatcheries typically treat water by some combination of filtration and ultraviolet radiation to reduce impacts from shellfish pathogens. Recently, hatcheries have struggled to move shellfish through the hatchery phase, slowing industry growth and cutting into profits. Harmful algal blooms (HABs) have received attention as a possible contributing factor, and new data suggest HAB toxins can persist in the environment, remaining long after blooms have terminated. Little is known, however, of the extent to which these toxins or HAB cells in source water can breakthrough into hatcheries.

To begin investigations into HABs as an impediment to shellfish production, post-treatment hatchery water from one research and four commercial hatcheries was sampled for (1) toxin presence by liquid chromatography coupled with tandem mass spectrometry (LC-MS/MS) and (2) HAB cell enumeration. Seven toxin groups, likely produced by six different HAB species, were detected within post-treatment hatchery water, despite a lack of identifiable HAB cells within the facility. In a more targeted study, source water was then followed and sampled at each step of a treatment cycle in the VIMS Aquaculture Genetics and Breeding Technology Center Gloucester Point Hatchery; two treatment steps showed particular promise for decreasing toxin concentration in the water. With toxin breakthrough now documented in commercial hatchery facilities even during non-bloom conditions, future studies are needed to understand any impacts of chronic exposure of early-life stages to these toxins, alone and in combination with other stressors, as well as studies of breakthrough possibilities and water-treatment options during more-intense bloom conditions.

NEW RECIPE IDEAS FROM THE MILFORD MICROALGAE KITCHEN

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Enrichment of natural water to enable microalgal culture began with E.G. Pringsheim in the mid-20th Century. Within a few decades, enrichment recipes advanced from natural components, e.g., soil extract and minerals, to purified, industrial chemicals. The f/2 seawater enrichment developed by Guillard in the 1960s, incorporating refined chemicals, remains the industry standard for culturing microalgae in hatcheries. After 50 years of f/2 use, we investigated possible improvements with a 21st-Century perspective.

The first f/2 component considered was EDTA, a synthesized chemical that can be considered a persistent organic pollutant. EDTA was replaced by alginic acid, glucuronic acid, or dextran, or a natural bacterial siderophore desferrioxamine B, to culture *Chaetoceros calcitrans* and *Tisochrysis lutea*. All three saccharides significantly improved microalgal growth and yields.

Noting that dissolved organic matter, much of bacterial origin, in natural waters is not enriched in f/2, we tested the possible growth-promoting effects of living bacteria or cell-free exudates from bacteria reportedly symbiotic with microalgae. Of ten bacteria tested with five microalgal strains, two microalgae showed improved performance with living bacteria, but exudates from nine bacteria supported appreciably higher growth rates and yields of nearly all microalgae tested.

Finally, we explored the use of antioxidant compounds to relieve oxidative stress in six microalgal strains. Combined N-acetylcysteine and pluronic F127 enrichment accelerated growth 20-40% in *Chaetoceros calcitrans, C. muelleri,* and *Pavlova salina*, increasing *Chaetoceros* yields >25%. Other microalgae did not benefit from this enrichment. These results indicate potential to improve seawater enrichments for microalgal live-feed production in hatcheries.

INNOVATION SEASCAPE OF AQUACULTURE IN THE NORTHEAST

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Blue Angels Program, SeaAhead

In the aquaculture industry, SeaAhead is focused on advancing the development of “enabling technologies” for the aquaculture sector. These include alternative feed materials, automation and sensing on farms and in processing facilities, hatchery and broodstock development technologies, filtration technologies, processing technologies, and others that help the development of sustainable aquaculture. We are not typically focused on financing farms or purchasing physical assets.

We have seen an influx of RAS-oriented companies due to the expansion of farms in the Northeast and globally. We think that RAS has a lot of promise, but it has not been proven; technologies that can increase efficiency, product quality, and lower cost are highly relevant to this developing field. We have also seen interest in mariculture for macro and microalgae. There is a need for innovation across all levels of the supply chain, including hatchery, production, and technologies and methodologies, and market/product creation. While nutrient and carbon credits have been discussed, we have not seen many plays specifically targeting that market. While nearshore net-pen aquaculture is not something that is

highly prevalent in the US, we do see companies that are targeting that as a market as well. These typically focus on minimizing the impact of those farm operations on the local environment, either via targeted feed and medicine delivery, parasite and disease control, data collection and analysis, and minimizing interactions with local megafauna either with entanglements or predation. Offshore aquaculture in the Northeast is dependent on the regulatory landscape, a gating factor for growth.

ADDRESSING CONSTRAINTS TO SHELLFISH AQUACULTURE THROUGH QUANTIFYING PUBLIC PERCEPTION AND ATTITUDES ALONG THE ATLANTIC COAST OF THE U.S.

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Despite the economic and ecological benefits that shellfish aquaculture provides, there are significant barriers to expansion of the aquaculture industry as a result of possible environmental impacts (real or perceived) and social concerns from coastal stakeholders. Coastal residents may perceive aquaculture as a nuisance, and the sentiment of not in my back yard (NIMBYism) is a common response to proposed increases in local shellfish aquaculture operations. Additionally, it is unclear whether certain types of aquaculture gear are perceived more favorably than others, making it challenging for growers to anticipate and avoid conflicts with other stakeholder groups. To better understand these societal concerns and determine the potential drivers behind negative perceptions of oyster aquaculture, coastal residents along the Eastern U.S. were surveyed using a Qualtrics panel. Results revealed that the majority of coastal residents would support aquaculture expansion. However, acceptance of different shellfish aquaculture methods varied, with acceptance of bottom culture and open tray cultivation higher than off-bottom gear types. Aquaculture knowledge and support of aquaculture expansion were determined to be the two most important predictors for gear acceptance. These findings have important management implications as they can help inform managers on how to engage with the public and better support industry and community relations.

SUPPORTING ECOSYSTEM SERVICES OF HABITAT AND BIODIVERSITY IN SEAWEED (*SACCHARINA LATISSIMA*) AQUACULTURE FARMS

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Most kelp (*Saccharina latissima*) farms in the Gulf of Maine are ephemeral, being fully deployed and removed every growing season. We assess whether the deployment of gear and growth of biomass at these farm sites provide seasonal habitat used by other organisms. Habitat, and the biodiversity of other species associating with farms, is considered a type of "supporting" ecosystem service. Ecosystem services are the benefits humans receive from healthy ecosystems. Of all ecosystem service categories – supporting, provisioning, regulating, and cultural, – supporting services are the least studied for temperate seaweed aquaculture. Understanding the ecosystem and human benefits of seaweed farming

beyond the provisioning of harvested biomass to established markets will promote sustainable industry growth. We quantified mobile vertebrates (fish, seals) and crustaceans (crabs, lobsters) interacting with kelp farms using GoPro cameras. We also assessed small (< 5mm) invertebrates using mesh settling devices suspended at the same depth as kelp lines (2m). Both fish and invertebrate visual surveys were paired with environmental DNA (eDNA) analysis. Preliminary results suggest that kelp farm habitat has little to no impact on the biodiversity of species in this region as few observations of vertebrates were made during the last 12 months. Other studies reveal kelp farm habitat values varying based on a range of factors including: species cultivated, local environmental characteristics, farm management practices, etc. Through a collaboration with University of New England, University of Auckland and The Nature Conservancy, we are working to understand geographic differences in habitat provisioning and biodiversity at kelp farm sites.

MOLECULAR FEATURES ASSOCIATED WITH OYSTER (*CRASSOSTREA VIRGINICA*) AND HARD CLAM (*MERCENARIA MERCENARIA*) RESILIENCE TO OCEAN ACIDIFICATION

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Predicted decreases in oceanic pH and increases in pCO_2 will further exacerbate acidification already threatening coastal marine ecosystems. The resulting alterations in carbonate chemistry can have detrimental impacts on many commercially and ecologically important species such as the eastern oyster (*Crassostrea virginica*) and hard clam (*Mercenaria mercenaria*). This study investigated the molecular mechanisms associated with resilience to OA, focusing on both acclimation and adaptation in these species. Adult oysters and clams were spawned and larvae were reared in ambient (pCO_2 of ~600 ppm) or acidified (~1200 ppm) conditions immediately upon fertilization. RNA and DNA samples were collected throughout development and processed for gene expression (RNASeq) and SNP profiling (ddRADSeq). Both species had significant changes in variant frequencies and gene expression levels in similar pathways, including biomineralization, calcium ion binding, and cytoskeleton organization. Downregulated genes identified in both species were related to immune processes, supporting prior research demonstrating immunodepression in clams and oysters exposed to OA. This study identified molecular markers and mechanisms associated with resilience to acidification, which is a highly-needed step for the development of marker-assisted selection of ocean acidification resilient oysters and clams.

OUR COLLECTIVE ROLE IN ENGAGING THE PUBLIC WITH AQUACULTURE LITERACY

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Aquaculture has the potential to increase access to sustainable sources of healthy food and enhance resilience in coastal communities. However, in order for its sectors to expand successfully, aquaculture must be more broadly accepted, particularly within the communities where it is practiced. Deliberate efforts to increase public aquaculture literacy (public understanding of different sectors, knowledge of career paths, opportunities to engage with planning efforts, etc.) will be crucial in reaching the full potential of a socially, economically, and environmentally sustainable industry. Engagement with the science and processes of aquaculture doesn't end once a product is harvested, nor does it start at the dinner table. New methods and innovative approaches for connecting across sectors to co-develop aquaculture literacy efforts can help bridge these gaps. Together, industry members, educators, extension agents, and other aquaculture professionals can ensure that the information shared with the public on farms, in restaurants, and through news or policy is consistent and engaging. This facilitated panel of chefs, growers, and NOAA aquaculture professionals will share their insights into the important role of industry partnerships in achieving these aquaculture literacy goals. After an overview of their background in aquaculture outreach and communications, panel members will be asked to discuss how groups can and should work together to improve public understanding of aquaculture. What key components, regionally and nationally, need to be integrated into these efforts? What common goals emerge across sectors?

COVID permitting, the panel will be composed of:
- Barton Seaver - Professional Chef and Seafood Educator, (Portland, ME)
- Chris Schillaci - Regional Aquaculture Coordinator, NOAA Fisheries (Gloucester, MA)
- Cindy Sandoval - Communications Specialist, NOAA Fisheries Office of Aquaculture (Silver Spring, MD)
- Dan Ward - Owner and Researcher, Ward Aquafarms (North Falmouth, MA)
- Jeremy Sewall - Professional Chef and Owner, Row 34 (Boston, MA)
- Maggie Allen - CELC Coordinator & Grants Manager, NOAA Office of Education (Washington, D.C.)

MOVING PUBLIC OPINION ON AQUACULTURE: THE MESSAGE MATTERS

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Expansion of the aquaculture industry hinges on the backing of local residents and other stakeholders capable of withholding necessary social, political, or financial support. Variations in level of enthusiasm for marine aquaculture have prompted several public opinion surveys as a way of assessing overall support for, or resistance to, the expansion of aquaculture in the US. These studies generally find that although the majority of the public do not have strong objections to the sector, there is consistently a smaller, but vocal, group that opposes marine aquaculture. A second common finding is a broad lack of awareness of marine aquaculture in the US. Missing are answers to 1) how malleable public opinion about

aquaculture is; and 2) what specific benefits of aquaculture in general and seaweed farming in particular most influence support for the industry.

We will share the outcomes of two surveys conducted by a consulting firm as part of a series of aquaculture projects managed by the Aquarium of the Pacific in Long Beach, California. We will focus on our findings of how different thematic messages (i.e., environmental, economic, social) resonated across survey participants of different socio-demographic attributes (i.e., income, education, ethnicity). We will also show how baseline familiarity with marine aquaculture/seaweed farming affects malleability of participant opinion about the sector. This work provides critical insight to aquaculture literacy efforts which aim to equip community members with the knowledge needed to engage in decision making processes for marine aquaculture development in their 'ocean neighborhoods'.

SUPPLEMENTATION OF FEED WITH AN INSECT ANTIMICROBIAL PEPTIDE DOES NOT IMPROVE RESISTANCE TO YERSINIA RUCKERI INFECTION IN JUVENILE RAINBOW TROUT (*ONCORHYNCHUS MYKISS*)

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Insect meals are a promising ingredient that could help reduce the use of fishmeal in aquaculture feeds and improve overall sustainability. A potentially relevant aspect of insect physiology is their antimicrobial peptide (AMP) immune response: when exposed to potential pathogens, insect hemocytes produce an array of AMPs with broad antimicrobial function. Several of these AMPs have been shown to be stable, meaning that insect meals are likely to contain some degree of antimicrobial activity. Indeed, in poultry and swine, insect-derived AMPs added directly to the diet have been shown to improve disease resistance. We aimed to test whether dietary insect AMPs could improve health in an aquaculture context. Cecropin A (a moth AMP) was selected because of its strong *in vitro* inhibition of *Yersinia ruckeri,* the causative agent of enteric red mouth disease (ERM). Juvenile rainbow trout (*O. mykiss*) fed a conventional aquaculture diet supplemented or not with Cecropin A were challenged by immersion with *Y. ruckeri* and observed for a period of 30 days. Results indicate that Cecropin A did not improve fish survival relative to the control diet. Tissues were collected from survivor trout at several time points post-infection. Experiments are in progress to assess bacterial presence and load in intestine, spleen, and kidney as a marker of disease progression and clearance.

EFFECT OF ACUTE ACIDIFICATION EXPOSURE ON AMERICAN LOBSTER EMBRYOS

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Ocean and coastal acidification are occurring against a backdrop of natural spatial and temporal variability in carbonate chemistry. For the commercially important American lobster, subtle negative impacts of acidification have been documented for larval and juvenile life stages. However, experimental conditions may not capture the full range of carbonate chemistry conditions that lobsters likely experience now and in the future. To address this gap, we explored the short-term effects of exposure to a broad range of acidification conditions on American lobster embryos. Additionally, we investigated whether physiological responses varied across embryonic development by repeating acute exposures at three timepoints during embryogenesis. Following each acute exposure period, the development stage, oxygen consumption rate, biochemical content, and enzyme activity of embryos were assessed. Our results indicate that American lobster embryos are resilient to a broad range of carbonate chemistry conditions over the short term, but physiological responses are highly variable among lobster broods, with some showing marked changes and others exhibiting little change.

MICROBIOME PERSPECTIVE ON OYSTER LARVAL HEALTH IN THE HATCHERY

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The eastern oyster, *Crassostrea virginica,* is an important economic resource of the Atlantic and Gulf coasts of the US, but habitat loss, overfishing and diseases have contributed to a widespread decline in oyster populations and traditional oyster industries. In recent decades, hatchery-based, largely intensive aquaculture using fast-growing, disease-resistant domesticated oyster lines has produced an oyster renaissance. Contemporary oyster culture continues to be challenged substantially, however, because of production problems in the hatcheries. Crashes at the hatchery level can occur regularly, with mortality sometimes attributed to bacterial outbreaks and low water quality. The maintenance of proper microbiomes at the larval stage may be a potential avenue for preventing or limiting hatchery crashes. We have examined the effects of water treatments on larval microbiomes and their contribution on the survival and growth of larvae in a research hatchery. Two different water treatments were used to rear oyster larvae: sand-filtered water (MECH) and sand-filtered and UV-treated water (STD). Larval microbiomes were examined in two growth stages of larvae (days 2 and 9 post-fertilization) using Illumina Miseq sequencing of 16S rRNA genes. Significant differences in larval microbiomes were found between the two water treatments. Higher survival and growth of larvae were found in the STD than the MECH treatment. We also identified the bacteria in Altermonadales, Flavobacteriales and Sphingomonadales within the core microbiome supporting larval survival. These findings provide insight into the importance of hatchery water quality and the potential contribution of a core larval microbiome in oyster health and hatchery success.

UPDATES ON PROJECTS, POLICY, AND PENCHANT FOR INVESTMENT IN NORTHEAST U.S. AQUACULTURE

***Megan Sorby*, Dianna Fletcher**
Kingfish Maine

Kingfish Maine is currently in the permitting phase to construct and operate a land-based recirculating aquaculture system (RAS) facility growing yellowtail kingfish, *Seriola lalandi*, on an approximately 94-acre parcel of land in Jonesport, Maine. Production start for the 6,000-8,000 tons capacity facility is scheduled for the second half of 2023.

Kingfish Maine is collaborating with the University of Maine's Center for Cooperative Aquaculture Research (CCAR) in Franklin, Maine to build its Yellowtail broodstock for production at the proposed Jonesport facility.

Kingfish Maine is part of The Kingfish Company, which currently operates a land-based recirculating aquaculture system in the Netherlands. The Kingfish Company is a pioneer and leader in sustainable land-based aquaculture and is currently trading on the Merkur Market [Euronext: KING]. Current annual production capacity at its Kingfish Zeeland facility in the Netherlands is 1,250 tons of Yellowtail Kingfish. Expansion is underway and capacity in the Netherlands will reach 3,000 tons in the second half of 2022.

The Kingfish Company's production is based on advanced RAS technology, which protects biodiversity and ensures bio security. The fish are grown without use of antibiotics and vaccines. Operations run on 100% renewable energy, sourced from wind, solar and biogas.

Its products are certified and approved as sustainable and environmentally friendly by Aquaculture Stewardship Council (ASC), Best Aquaculture Practices (BAP) and British Retail Consortium (BRC). It was the winner of the 2019 Seafood Excellence Award, and it is recommended as a green choice by Good Fish Foundation.

FOOD JUSTICE IN AQUACULTURE

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The food justice movement is growing, amplifying the need for equity and social justice within the food system. The "ocean food system" is often overlooked as a component of this movement, which has focused on terrestrial foods. For example, the Atlantic coastal region is experiencing an expansion of community scale aquaculture production, especially oysters. The historic USA oyster fishery drove economic development of our coastal regions, and Black oysterers played critical roles in developing the industry while barriers to advancement and to wealth accumulation in general prevented many Black oysterers from experiencing the full array of compensation, benefits, and legacy that the booming industry could have provided. Now, the modern-day oyster aquaculture industries in MD, DE, and NJ lack racial diversity at the business ownership level. This is but one example our panelists will discuss including barriers to entry in aquaculture, the history of Black oystermen in the mid-Atlantic, and food justice. We will discuss how Food Justice principles can be adopted by industry and managers to promote socioeconomic diversity within the industry, specifically at the business ownership level. This panel session will consist of short presentations by panelists, open discussion/Q & A. Likely panelists include

Imani Black of Minorities in Aquaculture, Jon Russel of the Northwest Atlantic Marine Alliance and Cristian Sandolo, recent graduate of the Ocean Food Systems PSM program at the University of New England. Other panelists may be added. The session will be moderated by Adam St. Gelais of the University of Maine Aquaculture Research Institute.

DIRECT SEAFOOD SALES DURING THE COVID-19 PANDEMIC: INSIGHTS FOR THE NORTHEAST AQUACULTURE SECTOR

***Joshua Stoll*, Sahir Advani**
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Food systems are susceptible to systemic shocks. The World Bank estimates that the COVID-19 pandemic alone could force as many as 100 million people into poverty and lead to increased malnutrition. One notable bright spot has been direct seafood marketing arrangements that connect seafood harvesters directly to consumers. We present research on market demand for directly sourced seafood during the pandemic using Google analytics data from seafood companies across North America. We discuss these results in the context of the expanding aquaculture sector in the Northeast and Mid-Atlantic regions and the role that direct marketing could play in strengthening local and regional food systems.

NEW JERSEY MARINE FISHERIES ADMINISTRATION SHELL RECYCLING PROGRAM

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In 2019, the New Jersey Marine Fisheries Administration (MFA), in partnership with Rutgers Cooperative Extension, Stockton University, and Jetty Rock Foundation, established a shell recycling program in Atlantic City to collect shell from the Hard Rock Casino and two Atlantic City restaurants. Shell is collected weekly using a 175-bushel capacity dump trailer equipped with a hydraulic lift-arm, providing a streamlined collection process and increased capacity. The shell is cured for six months at the MFA Nacote Creek Research Station before being planted on the Mullica River oyster seed beds, one of the last self-sustaining oyster populations on the Atlantic coast of the state and only three miles from the curing site. In 2021, the MFA executed the first annual shell plant with 55 tons of recycled shell (plus 15 tons of purchased shell) deployed over a 2-acre parcel. Staff loaded shell onto a barge and transported it to the reefs, where they used high-pressured water cannons for deployment. State funding for the dump trailer and conveyor purchases were critical, along with utilization of existing state vessels, a tractor, and ample waterfront shell storage. Restaurant participation is limited by their storage capacity and MFA's availability to pick up more than once weekly. Spat monitoring is planned each autumn. Promotions via logos on trailer stickers, collection bins, and clothing has been successful at bringing attention to the program, along with professional videography of the inaugural planting event. The program continues to expand within the Atlantic City area and has garnered interest statewide.

EXPANDING GREEN SEA URCHIN PRODUCTION BY REMOVING KEY AQUACULTURE CHALLENGES

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In this presentation we will overview a project which addresses the major challenges which inhibit sea urchin aquaculture production in the Northeast, funded by the Northeastern Regional Aquaculture Centre. In summary, it works towards adapting and improving upon existing technology to improve the success and lower green sea urchin seed production costs. In tandem we are working towards increasing awareness of the availability of hatchery seed by working through collaboration with regional industry and extension staff towards increasing grower interest in seed uptake.

LESSONS LEARNED FROM OPEN-OCEAN FARMS OVERSEAS

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The extensive coastline of the United States creates a large diversity of environments which each present a unique set of challenges and opportunities for aquaculture installations and operations. The Northeast has both sheltered sites for which traditional finfish farming equipment is suitable as well as exposed open water environments which require equipment and operating procedures that are specifically designed for such high energy sites. The viability of an open-ocean finfish farming industry in the Northeastern United States is assessed in the context of the challenges and successes of existing farms in other countries and locales.

Fully exposed sites create engineering and operational challenges, which can be amplified by the high cost of labor in the United States. However, the industry is transitioning towards more digital and automated operations making U.S. farms more viable and competitive. Local infrastructure within the region is also more amenable to operating a complex, technologically advanced farm than more remote sites. Furthermore, basing production closer to major markets and the ability to market a New England produced fish makes for a more compelling and profitable model. Examples of active open-ocean farms operating in foreign countries and remote U.S. locations indicate that an open-ocean industry in the Northeast United States could be viable.

INVESTIGATION OF AQUACULTURE SYSTEM DYNAMICS UNDER FAIR AND EXTREME WEATHER CONDITIONS VIA NUMERICAL MODELING

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The National Aquaculture Act of 1980, the NOAA Marine Aquaculture Policy, and Executive Order 13921 ("Promoting American Seafood Competitiveness and Economic Growth") direct NOAA to facilitate domestic aquaculture and preserve ocean sustainability in the United States. Call for increased aquaculture demands for farms in exposed ocean conditions. Therefore, the need for rigorous ocean engineering analysis of aquaculture systems will be required. Numerical modeling is a powerful tool to analyze the dynamics of aquaculture systems under different wind, currents, and wave conditions. Simulations can be conducted to better design aquaculture systems to prevent failure of gear due to extreme weather conditions. This presentation analyses how a mussel dropper longline system and an oyster cage system would respond under fair (0.15 m/s ocean currents and 1m, 4s wave) and extreme (0.15 m/s ocean currents and 5m, 8.8s wave) environmental conditions. These systems are numerically modeled and studied in a simplified manner using MATLAB code and two-dimensional simulations using an open-source computational fluid dynamics (CFD) software, OpenFOAM. In the codes, input waves are modeled based on the linear wave theory (airy wave theory), and the forces on the structures are estimated using Morison equations. The hydrodynamic coefficients used in Morison equations are estimated via CFD simulations. This presentation also analyses how the numerical modeling results, such as tension in the mooring lines, can be incorporated into the aquaculture system design, considering factors like significant wave height and return periods.

PROBIOTICS FOR EASTERN OYSTER HATCHERIES: COMMERCIAL FORMULATIONS AND EFFECT ON MICROBIAL COMMUNITIES

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Larval eastern oysters (*Crassostrea virginica*) grown in shellfish hatcheries are susceptible to bacterial diseases, particularly Vibriosis. The marine bacterium *Phaeobacter inhibens* S4 (S4) protects larval eastern oysters against challenge with the bacterial pathogen *V. coralliilyticus* RE22 (RE22). A liquid formulation of probiont S4 has been developed for commercial use in shellfish hatcheries. The goal of this study is to test the efficacy of the commercially-produced formulation of S4 in protecting larval oysters in oyster hatcheries. Eight hatchery trials were carried out in four different hatcheries in the years 2019, 2020, and 2021. The S4 formulation (10^4CFU/mL) was added to *C. virginica* larvae culture tanks daily from day 1 post spawning to day 6 or 12. Treatment of larvae in the hatchery with the S4 formulation did not significantly affect the larval survival in any of the trials, but significantly increased growth in two trials. Treatment also led to a significant increase in Relative Percent Survival (RPS) when larvae were

exposed to the pathogen RE22 (10^5CFU/ml) for 24 hours in a laboratory challenge as compared to untreated challenged larvae (Range of RPS = 46 ± 19 % - 74 ± 11 % $p < 0.05$). Probiotic treatment led to subtle changes in microbial communities in larvae as determined using 16S rRNA gene sequencing. Further analyses will focus on the potential relationship between performance, bacterial community structure, and environmental variables to enhance S4 performance in a hatchery setting. These experiments confirm the safety of the S4 liquid formulation and may prevent larval losses to Vibriosis.

FINDING THE NEEDLE IN THE HAYSTACK: A NOVEL METHOD FOR THE RAPID ENUMERATION OF PLANKTONIC SALMON LICE IN A MIXED ZOOPLANKTON ASSEMBLAGE USING FLUORESCENCE

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The salmon louse, *Lepeophtheirus salmonis*, is an obligate ectoparasite of salmonids and the principal environmental challenge constraining salmonid aquaculture in Norway. Salmon aquaculture expanded rapidly from a few thousand tonnes of fish produced in 1980 to 2.4 million tonnes produced in 2018, with Norway comprising more than half the global production (FAO, 2020). However, the epidemic growth of salmon lice at farms and spread of the infectious planktonic stages to wild fish is considered an environmental impact of salmon farming and an obstacle to sustainable growth. Through the management framework of the traffic light system, salmonid production in Norway is tied directly to the risk of salmon lice induced mortality on the wild populations of Atlantic salmon. The risk assessment uses information from several models, and monitoring data from farms, sentinel cages, and wild caught salmonids. Notably, all the monitoring data is of the parasitic stages attached to fish, and the models which forecast the spread of the infectious copepodid stages are reliant on that same data. The relative rarity of the planktonic stages of salmon lice in comparison to other animals captured in a zooplankton assemblage is an obstacle to estimating their abundance and distribution. Due to the prohibitively laborious task, the planktonic stages remain understudied and unmonitored despite their importance to the spread of the parasite between salmon farms and to wild salmonids. Here we present a novel method for the enumeration of those planktonic salmon lice in a mixed zooplankton sample using fluorescence aided microscopy.

IMPROVING PUBLIC AWARENESS AND LITERACY ABOUT MARINE AQUACULTURE

***Kim Thompson*, Mackenzie Nelson, Emily Yam**
Aquarium of the Pacific, 100 Aquarium Way, Long Beach, CA 90802 USA

Public surveys have shown that Aquariums are trusted sources of information about ocean conservation and sustainable food systems. There is great potential for Aquariums to promote aquaculture literacy by engaging visitors about responsible marine aquaculture as part of broader conservation and sustainability efforts. The Aquarium of the Pacific in Long Beach, California has been integrating content about marine aquaculture and sustainable ocean-based food systems into exhibits and education activities for more than a decade. Marine aquaculture is prominently featured as part of a sustainable future in a short film and live animal exhibits within the Aquarium's newest wing, Pacific Visions. In 2021 the Aquarium's education and Seafood for the Future programs received funding from NOAA's Office of Education and World Wildlife Fund to develop a number of new education projects, including the development of a tactile activity for kids visiting the Aquarium to learn more about responsible ocean farming, a seaweed aquaculture module for the PBS Learning Media Center, and bilingual aquaculture education content. These funds are also providing support for the Aquarium of the Pacific to work with other Aquarium partners in the NOAA Coastal Ecosystem Learning Center network to develop an aquaculture messaging framework. Join us to learn more about the Aquarium of the Pacific's many aquaculture education programs and the future of aquaculture education at Aquariums.

WHAT ARE YOUR OPINIONS TOWARD LAB-GROWN MEAT?

Michael Tlusty, Georgia Mavrommati
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In an effort to minimize climate change through greenhouse gas emissions, changes to the food system are needed. One potential for change is through the creation of cellular-based agriculture. Also known as lab-based meat or lab-grown meat, this new food system offers benefits in that it may result in a smaller GHG footprint, may be more humane, and may have lower overall negative externalities compared to terrestrial proteins and some aquaculture products. Being an even newer protein on the block than aquaculture, it is unknown how the aquaculture industry will respond to this new foodstuff. This poster is an opportunity to collect data regarding the thoughts of the community at NACE about this nascent protein. Please stop by the poster to take the survey.

EFFECTS OF PROBIOTIC *PHAEOBACTER INHIBENS* S4 TREATMENT ON THE BACTERIAL COMMUNITIES OF LARVAE RAISED IN UV TREATED AND NON-UV TREATED WATER

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Hatcheries that rear larval eastern oysters (*Crassostrea virginica*) use different prevention methods such as ultraviolet (UV) irradiation to treat water to reduce bacterial diseases, particularly Vibriosis. Past studies have identified strains of *Vibrio* spp. that are pathogenic to oyster larvae and are a constant concern for hatcheries. The marine bacterium *Phaeobacter inhibens* S4 (S4) has been demonstrated as an effective probiotic that provides protection to larval oysters when challenged with the pathogen *Vibrio*

coralliilyticus RE22. Formulations of this probiotic have been developed for commercial use in the hatchery. The goal of this research is to determine the effect of a S4 formulation on the microbial communities of larvae raised in UV treated water and non-UV treated water. Hatchery trials were carried out in two different hatcheries in January 2021 and July 2021. The S4 formulation (10^4CFU/mL) was added to *C. virginica* larvae culture tanks daily mixed with the microalgal feed from day 1 post spawning to day 6 or 12. Analysis of bacteria community diversity in larval oysters was performed using 16S rRNA gene sequencing. Preliminary results show the bacterial community of larvae differed by hatchery and UV/nonUV treatment. The probiotic S4 treatment also resulted in subtle changes in the bacterial community of the larvae raised in UV and non-UV treated water. Further analyses will focus on the response of the bacteria community of larvae raised in UV and non-UV using metatranscriptomics. This research will aid in improving best management practices for oyster hatcheries.

AQUACULTURE IN K-12 EDUCATIONAL PROGRAMMING AND PATHWAYS FOR A SKILLED AND READY WORKFORCE

M. Scarlett Tudor[1], Keri Kaczor[2]
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Globally aquaculture is growing rapidly, but one of the identified bottlenecks affecting the expansion of the U.S. industry is low recruitment into the aquaculture workforce (Swann and Morris, 2001). A demographic analysis of the current U.S. aquaculture industry shows that most private business owners are over 50 years of age and there are very few younger people entering into the business (Walsh, 2011). Advancing aquaculture education at all levels, from elementary school to college and continuing education, is vital to secure an educated and trained aquaculture workforce for the future. Many K-8 aquaculture related programs develop a strong basis for aquaculture education by introducing STEM concepts to youth audiences and making the education accessible to diverse audiences. Programs engaging students with hands- on experiences and curricula can spark interest and guide them on an aquaculture related career pathway. Micro-credentials verify and showcase relevant workforce skills, and these “digital badges” provide transparency for employers on how the learner developed and proved their competencies. Moderated by UMaine Aquaculture Research Institute and Maine Sea Grant, the panel will focus on classroom integration, field/laboratory assets, and pathways towards a skilled and ready workforce.

Panel:

- Aquaculture ME!, Morgan Cuthbert, Educator, Frank H. Harrison Middle School
- Student-Led Aquaculture Education, Eric Litvinoff, Aquaculture Teacher, Marine Science Magnet High School
- Resources for Educators, Willie Grenier, Executive Director, Maine Agriculture in the Classroom. www.MaineAgintheClassroom.org
- 4-H Aquaculture Toolkits, Laura Wilson, 4-H Science Professional, UMaine Cooperative Extension
- Industry 4-H Aquaponics Program, Melissa Malmstedt, Education & Outreach Coordinator, UMaine Center for Cooperative Aquaculture Research
- Building a Diverse Aquaculture/NOAA Workforce Through High School Aquaculture Education and Engagement, Christopher Schillaci, National Marine Fisheries Service
- Let’s Find Out, Dianne Tilton, Executive Director, Downeast Institute

- Growing with Students, Madison Maier, Aquaculture Manager, Hurricane Island Center for Science and Leadership
- Aquaculture Educational Opportunities for Students and Educators, Patrick Burnham, Educational Programs Coordinator, Herring Gut Coastal Science Center
- Micro-credentials for Aquaculture Skills, Laura Wilson, 4-H Science Professional, UMaine Cooperative Extension

AQUACULTURE RESEARCH INSTITUTE'S AQUACULTURE WORKFORCE DEVELOPMENT PROGRAMMING

***M. Scarlett Tudor*[1], Melissa Malmstedt[2]**
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The Aquaculture Research Institute (ARI) at the University of Maine has developed several new aquaculture workforce development programs with the core objective to promote careers in the aquaculture industry to workers of all types (i.e. professional development and degree seeking students). UMaine is offering a new micro-credentialing program designed to take a learner from foundational knowledge to application in a real-world work-setting. ARI has collaborated with groups across UMS to develop an aquaculture micro-credentialing pathway. This pathway includes ARI's new hands-on skills development courses in Aquatic Animal Husbandry, Aquatic Animal Health, Recirculating Aquaculture Systems, and more. These hybrid courses allow learners to gain foundational knowledge online that will be implemented with further skills development during the week-long laboratory sessions. Skills gained in these courses will include skills sets identified in Aquaculture Occupational Competencies approved by the Maine Aquaculture Association. Laboratory sessions take full advantage of the aquaculture facilities across UMS giving students experience with industry sized facilities and cutting-edge research. ARI also offers an Industry Partnered Externship Program allowing learners to demonstrate and reinforce their skills within an aquaculture setting. This externship program matches students with industry hosts allowing students to gain experience in the aquaculture industry while conducting projects/research lead by the industry partner. A recently awarded AFRI SAS grant to ARI and University of MD, will aid in further development of ARI's land-based aquaculture education programming and expand workforce development opportunities to more diverse audiences.

HOSTING VISITORS ON YOUR FARM: WHAT YOU NEED TO KNOW

Afton Vigue[1], Natalie Springuel[2]
[1]Maine Aquaculture Association, 103 Water St 4th floor, Hallowell, ME 04347; [2]Maine Sea Grant, Orono, ME 04469

Aquaculture producers are increasingly diversifying their business to include customer interactions like direct sales, farm tours, and partnerships with local tour operators. We propose to offer a grower-focused professional development session at NACE to include three main components 1) rules and regulations around direct sales and tours (licensing, liability, insurance), 2) customer service training, and 3) opportunities for partnership with local tour operators like boat and kayak tours. To keep things interactive and conversational, panelists will include farmers as well as tour operators to engage in a focused discussion around the topics at hand. This will give growers a chance to network with other professionals, learn from them, and ask questions.

Panelists:

- Kohl Kanwit (DMR)
  Patrick Chamberlin (Allen Insurance & Financial)
- Hannah Collins (Maine Office of Tourism)
- Peter Milholland (Seacoast Tours of Freeport)
  Kelly Punch (Mere Point Oyster Co)
- Joanna Fogg (Bar Harbor Oyster Co)

MAINE AQUACULTURE WORKFORCE DEVELOPMENT STRATEGY UPDATE

Chris Vonderweidt[1], Jason Judd[2], Sebastian Belle[3], Christian Brayden[3], Carissa Maurin[1]
(presenting author is *Jonathan Labaree*[1])
[1]Gulf of Maine Research Institute, 350 Commercial Street, Portland Maine 04101; [2] Educate Maine, 482 Congress St #303, Portland, ME 04101; [3] Maine Aquaculture Association, 103 Water St 4th floor, Hallowell, ME 04347

In 2019, The Gulf of Maine Research Institute (GMRI), Maine Aquaculture Association (MAA), and Educate Maine published *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 and anticipates future workforce needs as the industry matures and rationalizes. The strategy recommends a core vocational system of Community College, Career Technical High School, and Department of Labor (DOL) Apprenticeship; and development of industry-derived occupational standards to guide programming and create a consistent set of standards for aquaculture workforce training.

The project partners have been working directly with Southern Maine Community College, The Mid-Coast School of Technology, Washington County Community College, and DOL Apprenticeship to highlight their unique potential as aquaculture workforce training providers and instigate new programs. Despite C19 occurring shortly after the *Strategy* was published, we have found success. Our presentation will provide an update on current progress and future implementation plans.

EVALUATING THE PATHOGEN LOAD OF EDIBLE SEAWEED POST-HARVEST UNDER VARYING STORAGE TEMPERATURES AND DRYING CONDITIONS

***Jessica G. Vorse*[1], Carrie Byron[1], Kristin Burkholder[2]**
[1]University of New England, School of Marine and Environmental Programs, Biddeford, ME 04005 USA; [2]University of New England, School of Biological Sciences, Biddeford, ME 04005 USA

Seaweed is becoming increasingly popular in the American diet, so it is necessary to evaluate the safety of industry's current post-harvest storage and processing methods to ensure the risk of foodborne pathogens on edible seaweed remains low. We evaluated the pathogen load of edible seaweed post-harvest under three different storage temperatures (4˚C, 10˚C, 20˚C) and two different drying methods (air- and freeze-drying). The focal pathogens for this project were six of the most common food pathogens in the US: *Listeria monocytogenes, Salmonella enterica, Staphylococcus aureus, Escherichia coli, Vibrio vulnificus* and *Vibrio parahaemolyticus*. We tested all six pathogens under each treatment condition on both sugar kelp (*Saccharina latissima)* and rockweed (*Ascophyllum nodosum*) as these are the most commonly farmed and harvested species in Maine, respectively. We inoculated a known concentration of pathogen onto freshly harvested seaweed, treated it under a storage temperature or drying method, and then sampled it to determine impact of treatment on pathogen viability and load. Our preliminary results indicate that storage at 20˚C leads to replication while storage at 4˚ and 10˚C is effective at halting the replication of focal pathogens; however, as expected, no storage temperature resulted in notable pathogen death. On the contrary, both air-drying and freeze-drying are effective means to produce log scale reductions in surface pathogen load for all focal species. These results are promising for industry as they corroborate historical evidence that current post-harvest storage and processing conditions are producing products safe for human consumption.

REDUCING RISK FOR SHELLFISH FARMERS THROUGH REAL-TIME, AUTOMATED, HARMFUL ALGAL BLOOM MONITORING AND MITIGATION

***Daniel Ward*[1], Michael Brosnahan[2], Mrunmayee Pathare[2]**
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The US shellfish aquaculture industry has begun to confront numerous environmental factors that can restrict the production and economic viability of both small and large-scale operations. Principal among these challenges are harmful algal blooms (HABs), which can impact farmed animals causing lower growth rates and high mortality, degrade the ecosystems supporting aquaculture, and contaminate seafood products with dangerous toxins. The dinoflagellate *Margalefidinium polykrikoides*is a leading cause of HAB-associated fish kills, and reports of *M. polykrikoides* blooms in U.S. waters are also becoming more and more frequent, impacting aquaculture operations from Chesapeake Bay to Long Island, and throughout Cape Cod which has resulted in high levels of juvenile shellfish mortality associated with these events. Ward Aquafarms partnered with WHOI to determine strategies to mitigate HAB impacts on farmers, including early notification, ongoing monitoring, and farm management strategies. A cornerstone to these strategies is a new technology – called Imaging FlowCytobot (or IFCB) - that provides continuous, real-time, automated monitoring of the phytoplankton community around farms. By targeting a hot spot for *M. polykrikoides* blooms, the project provided valuable in situ descriptions of these blooms that were translated into new tools that can provide short term bloom forecasts. The in-situ mitigation strategy was to enable automated protection of juvenile shellfish that are especially vulnerable while growing within nursery systems through automatic image classification, and subsequent automatic shutdown of nursery pumps when harmful *M. polykrikoides* were present.

DEVELOPING ROPELESS, AUTONOMOUS DEPTH CONTROLLED HABITATS FOR SHELLFISH AND OTHER AQUACULTURE FARMERS TO ENABLE US FARMERS TO IMPROVE PRODUCTIVITY AND EXPAND FURTHER OFFSHORE

Christopher Webb
Ai Control Technologies (AiCT)

Restorative submerged underwater platform-based ocean seafood farm with little or no surface lines and with hurricane proof anchors connected by horizontal ropes with surrounding screens to protect from endangered species like right whales. The platform depth is controlled by AiCT proprietary electronics sensors and machine learning algorithms that control platform depth to seek out and maintain depth, in near perfect conditions, that are often impacted by global warming and seasonal changes.

Long-term Goals: Our long-term goal is to assist US aquaculture farmers both small and large in replacing certain labor-intensive, repetitive processes with artificial intelligence (AI) and automation to maximize growth while minimizing to-market costs.

Once designed, built, tested, and validated, we will have a system and technology that will allow large aquaculture farmers and rural traditional farming communities to prosper by adopting up to date low-cost technologies to improve operator health and safety, dramatically reduce operating expenses (OPEX), in-water boat costs, competitiveness against importers and allow operations scaling by moving further offshore.

Overall, AiCT technology will facilitate quick responses to upcoming storms (automated submergence), prevent sinking to the bottom from rafts that need more buoyancy as crop grows, eliminate risk significantly and provide a reliable control system for this environmentally sustainable method of growing food.

LARVAL OYSTER HATCHERY PRODUCTION FAILURE DUE TO TOXIC IMPACTS OF OXIDIZED ALGAL BYPRODUCTS

***Meredith M. White*[1], Andy Stevenson[1], William H. Mook[1], Steve Zimmerman[1], Bethanie Edwards[2]**
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Mook Sea Farm, an oyster hatchery and farm on the Damariscotta River in Maine, experienced persistent larval production failures in 2020. The afflicted larval oysters were unable to digest microalgae and therefore, unable to grow. Extensive problem-solving efforts by our team and collaborating scientists indicated a relatively widespread water quality issue. Larval bioassay and histological evidence pointed towards a hydrophobic toxic compound that adsorbed to microalgal cell walls, damaging larval gastric epithelium. It was determined that UV photooxidation, and other forms of oxidation, greatly exacerbated the problem. This meant that the compound had not previously existed in our intake water, as we have used UV sterilization without issues for over 20 years. Analytical testing and larval bioassays supported the hypothesis that the toxic compound is an oxylipin, an oxidized byproduct of algal polyunsaturated fatty acids (PUFAs), produced by some phytoplankton species in response to stress. Additional testing to confirm this hypothesis is forthcoming, but this hatchery failure appears to be related to environmental change resulting in a phytoplankton community composition shift or increased stress response, which then results in the release of PUFAs, followed by oxidation to toxic oxylipins by our UV sterilizer. This is beyond the capacity for an individual hatchery to fully characterize and understand, and therefore highlights the need for increased communications/collaborations among hatcheries to share production

issues that seem unrelated to proprietary processes. Sharing these experiences with each other and with scientists will help us overcome issues faster and may lead to increased federal support.

SOCIAL LICENSE TO OPERATE IN THE AQUACULTURE INDUSTRY: A COMMUNITY FOCUSED FRAMEWORK

***Emily Whitmore*[1], Matthew Cutler[2], Eric Thunberg[3]**
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With aquaculture development becoming increasingly important in meeting global food needs, understanding social barriers to development is essential. Social license to operate (SLO), a concept that describes community acceptance and approval of incoming industry, offers a lens for better understanding these barriers and an opportunity to identify strategies for successful development. While this concept has recently gained traction within the aquaculture industry, it remains poorly understood. Efforts to measure and predict social license have begun, yet these efforts primarily focus on company actions and impacts. This study seeks to expand the utility of social license within the aquaculture sector by developing a preliminary quantitative framework that can predict a community's willingness to issue SLO prior to siting. Using social acceptability research, I identify seven themes that have been empirically shown to predict public approval: environmental values, economic values, use-conflict, knowledge of aquaculture, experience with aquaculture, confidence in government, and perceptions of safety. Situating these themes within a tested path model of social license, it is clear that they operate through trust—a central component of SLO. Specifically, the framework positions community characteristics as moderators between company actions and SLO. Based on these indicators, certain communities are found to be more or less likely to be willing to trust incoming companies, and thus SLO-generating actions will be more or less effective depending on community receptivity.

U.S. MARINE AQUACULTURE: FEDERAL LEGISLATIVE UPDATE

Drue Banta Winters
American Fisheries Society, 425 Barlow Place, Bethesda, MD 20814

Join American Fisheries Society's (AFS) Policy Director for a federal legislative update on offshore aquaculture. Learn more about the society's position statement on marine aquaculture and its work to advance a clear, predictable, regulatory framework to enable growth of offshore aquaculture in the U.S. in a conscientious, environmentally sustainable manner. Hear about AFS' efforts to bring policy-makers on Capitol Hill information on the advances in science, technology and best practices that have decreased the environmental footprint and increased the sustainability of marine aquaculture. Learn how you can help engage in Washington on this important top.

DEVELOPING A THERMAL SHOCK METHOD TO CONTROL DERMO DISEASE AND BIOFOULING ON OYSTER FARMS

***Heidi Yeh*[1], Grace Jackson[2], David Bushek[1]**
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Dermo disease, caused by the parasite *Perkinsus marinus,* is a prevalent problem in northeastern oyster stocks. We attempted to exploit known temperature vulnerabilities via thermal shock treatments (a novel approach) to reduce disease loss. Oysters living intertidally in the Southeast are regularly exposed to temperatures exceeding the thermal tolerance of *P. marinus*—but not that of the oysters—which may limit the proliferation of the parasite within oysters. Because oysters have a higher thermal tolerance than *P. marinus*, such exposures may reduce parasite loads without harming the oysters. A series of experiments were conducted, including in vitro tests, short term tank experiments, and long-term farm experiments to assess the effectiveness and viability of heat shock as a treatment for Dermo disease in oysters. Effects of treatment frequency and seasonality on oyster mortality, biofouling, and microbiome composition were also assessed.

LINKAGES BETWEEN HYDRODYNAMICS AND BIOFOULING IN A SEA SCALLOP FARM

***Elisabeth Younce*, Kimberly Huguenard**
University of Maine, Orono, ME

The linkage between hydrodynamic patterns and rates of biofouling on lantern nets for scallop cultivation in Maine is not well understood. By a better understanding of how variations in current velocity and turbulence link to biofouling, farmers would be enabled to make informed equipment decisions to help optimize their net profit. This study characterizes the hydrodynamics along a scallop longline over multiple months, while quantifying and qualifying the biofouling rate along that same longline. Tidal cycle surveys (~12.4 hrs) were conducted during neap tides and measured lateral and longitudinal transects of current velocities in and around the farm using a towed Acoustic Doppler Current Profiler (ADCP). Additionally, a second ADCP was moored near the farm, in order to obtain a long term time series of a velocity profile that can be used to quantify turbulence parameters. Changes in these two sets of measurements will be linked to varying biofouling rates in order to understand the two-way interaction of how biofouling modifies the flow field, and how the modified flow field may influence biofouling patterns along the farm. This analysis was conducted on an experiment farm at the Darling Marine Center in the Damariscotta River estuary in Maine. The biofouling time series created through this study will deepen understanding of how fast nets are fouled over time, and by what species. An overall goal of this study is easy replication, so that farmers could apply similar biofouling monitoring methods and refer to this study as helpful reference for decision making.

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