PROGRAM and ABSTRACTS

Northeast Aquaculture Conference & Exposition
and the
37th Milford Aquaculture Seminar

January 11-13, 2017
Omni Hotel Providence
Providence, Rhode Island
### The 2017 NACE-MAS at a Glance

#### NACE/MAS Aquaculture Conference General Program

<table>
<thead>
<tr>
<th>Time</th>
<th>Location</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 AM - 5:00 PM</td>
<td></td>
<td>Recirculating Aquaculture Systems Workshop (Kent Room)</td>
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<tr>
<td></td>
<td></td>
<td>Field Trips (meet in the hotel lobby)</td>
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<tr>
<td>4:00 PM</td>
<td></td>
<td>Registration opens in the Hotel Lobby</td>
</tr>
<tr>
<td>7:00 PM</td>
<td></td>
<td>Opening Reception in the Narragansett Ballroom (trade show opens)</td>
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<tr>
<td>7:00 AM</td>
<td></td>
<td>Registration in Hotel Lobby</td>
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<tr>
<td>8:30 AM</td>
<td></td>
<td>Plenary Session in the Narragansett Ballroom</td>
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<tr>
<td>10:00 AM</td>
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<td>Break &amp; Trade Show opens in the Narraganset Ballroom</td>
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<tr>
<td>10:30 AM</td>
<td>Bristol/Kent</td>
<td>Shellfish Genetics and Breeding Forum</td>
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<tr>
<td></td>
<td>Newport/Washington</td>
<td>Public Health</td>
</tr>
<tr>
<td></td>
<td>Providence II/III</td>
<td>General Aquaculture</td>
</tr>
<tr>
<td></td>
<td>Providence I/IV</td>
<td>Social Aspects of Aquaculture</td>
</tr>
<tr>
<td></td>
<td>South County (classroom)</td>
<td>Farmer to Farmer: What Works and Doesn’t When it Comes to Biofouling Control</td>
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<tr>
<td>12:00 PM</td>
<td></td>
<td>Lunch in the Narragansett Ballroom</td>
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<tr>
<td>1:30 PM</td>
<td>Bristol/Kent</td>
<td>Aquaculture and the Environment I</td>
</tr>
<tr>
<td></td>
<td>Newport/Washington</td>
<td>Aquaculture Management</td>
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<tr>
<td></td>
<td>Providence II/III</td>
<td>Finfish farming</td>
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<tr>
<td></td>
<td>Providence I/IV</td>
<td>Data: what is available and what is needed</td>
</tr>
<tr>
<td></td>
<td>South County</td>
<td>Is the Algae Really Greener on the Other Side? West Coast Growers Perspectives on Raising Shellfish on the “Other” Coast</td>
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<tr>
<td>3:00 PM</td>
<td></td>
<td>Break in the Narragansett Ballroom</td>
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<tr>
<td>3:30 PM</td>
<td>Bristol/Kent</td>
<td>Aquaculture and the Environment II</td>
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<tr>
<td></td>
<td>Newport/Washington</td>
<td>Northeast Ocean Plan</td>
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<td>Providence II/III</td>
<td>IMTA</td>
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<td></td>
<td>Providence I/IV</td>
<td>Aquaculture Education: Is there something fishy going on at school?</td>
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<td></td>
<td>South County</td>
<td>Aquaculture Policy Forum</td>
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<tr>
<td>5:00 PM</td>
<td></td>
<td>Poster Session &amp; Happy Hour in the Narragansett Ballroom</td>
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<tr>
<td>6:00 PM</td>
<td></td>
<td>East Coast Shellfish Growers Association Annual Meeting (South County Room)</td>
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<tr>
<td>7:00 AM</td>
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<td>Dinner on your own out on the town</td>
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<tr>
<td>7:00 AM</td>
<td></td>
<td>Breakfast</td>
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<tr>
<td>8:30 AM</td>
<td>Bristol/Kent</td>
<td>Shellfish Biology</td>
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<tr>
<td></td>
<td>Newport/Washington</td>
<td>Shellfish Husbandry I</td>
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<tr>
<td></td>
<td>Providence II/III</td>
<td>Seaweed Farmers Forum</td>
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<td></td>
<td>Providence I/IV</td>
<td>Overview of 2016 Northeast Region Phytoplankton Blooms</td>
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<tr>
<td></td>
<td>South County</td>
<td>Roll Your Own (oyster seed that is) Growers Forum</td>
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<tr>
<td>10:00 AM</td>
<td></td>
<td>Break in the Narragansett Ballroom</td>
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<tr>
<td>10:30 AM</td>
<td>Bristol/Kent</td>
<td>Shellfish Health</td>
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<tr>
<td></td>
<td>Newport/Washington</td>
<td>Shellfish Husbandry II</td>
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<tr>
<td></td>
<td>Providence II/III</td>
<td>Kelp Farming</td>
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<td></td>
<td>Providence I/IV</td>
<td>Shellfish Theft Deterrence</td>
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<td></td>
<td>South County</td>
<td>Instrumentation for Site Evaluations</td>
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<tr>
<td>12:00 PM</td>
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<td>Lunch in the Narragansett Ballroom</td>
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<tr>
<td>1:30 PM</td>
<td>Bristol/Kent</td>
<td>Aquaculture Student Roundtable</td>
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<tr>
<td></td>
<td>Newport/Washington</td>
<td>Developing a Public Relations and Media Relations Plan for Aquaculture Business</td>
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<tr>
<td></td>
<td>Providence II/III</td>
<td>Mussel Farming and Seed Production</td>
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<td></td>
<td>Providence I/IV</td>
<td>Ocean Acidification</td>
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<td></td>
<td>South County</td>
<td>Shellfish Disease Diagnostics</td>
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<tr>
<td>3:00 PM</td>
<td></td>
<td>Break in the Foyer</td>
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<tr>
<td>3:30 PM</td>
<td>Bristol/Kent</td>
<td>Real-time Environmental Forecasting Workshop</td>
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<tr>
<td></td>
<td>Newport/Washington</td>
<td>Risk Management: How does it work?</td>
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<tr>
<td></td>
<td>Providence II/III</td>
<td>Scallop Aquaculture Forum</td>
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<tr>
<td></td>
<td>Providence I/IV</td>
<td>Shellfish Disease Diagnostics</td>
</tr>
<tr>
<td>5:00 PM</td>
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<td>Closing Refreshments</td>
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</tbody>
</table>
Welcome

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

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

NACE-MAS Organizing Committee

Chris Davis – Maine Aquaculture Innovation Center
Lisa Milke – NOAA National Marine Fisheries Service Milford Laboratory
Gef Flimlin – Rutgers University Cooperative Extension
Dale Leavitt – Roger Williams University
Thank you to our sponsors!

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NOAA NMFS NEFSC Milford Laboratory  
USDA/NIFA Northeastern Regional Aquaculture Center  
National Oceanic and Atmospheric Administration Aquaculture Program

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Skretting USA

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Connecticut Sea Grant  
East Coast Shellfish Growers Association  
USDA/NASS

**Associate Sponsors**
New Hampshire Sea Grant  
New York Sea Grant  
MIT Sea Grant
Thanks to Our Exhibitors

Formutech Inc.  
**Booth #1**  
*Jesse Fortune*  
135 Kent Street  
PO Box 893  
Charlottetown, PEI Canada C1A7L9  
855-599-0099  
info@formutech.ca

Future Nets & Supplies  
**Booth #2**  
*Clarence Blanchard*  
48 Armstrong Loop Road  
Pennfield, NB Canada E5H1007  
506-755-6728  
info@futurenets.net

Aquabotix Technology, Corp.  
**Booth #3**  
*Dawn Doraz*  
21 Father DeValles Blvd.  
Suite 106  
Fall River, MA 02723  
508-676-1000  
dawn@aquabotix.com

Hoopers Island Oyster Aquaculture  
**Booth #4**  
*Chris Wyer*  
2500 Old House Point Road  
Fishing Creek, MD 21634  
703-628-0071  
chris@hioac.com

Pentair Aquatic Eco Systems Inc.  
**Booth #5**  
*Eric Moore*  
2395 Apopka blvd.  
Apopka, FL 32703  
978-578-2740  
eric.moore@pentair.com

Aquaculture North America  
**Booth #6**  
*Jeremy Thain*  
4623 William Head Road  
Victoria, BC Canada V9C 3Y7  
250-474-3982  
jeremy@capamara.com

Skretting USA/Bio-Oregon  
**Booth #7**  
*George Demos*  
613 Durham Bridge Road  
Newport, ME 04953  
207-951-1622  
george.demos@bio-oregon.com

Fish VetGroup  
**Booth #8**  
*Jason Collins*  
350 Commercial Street  
Portland, ME 04101  
207-699-5901  
jason.collins@fishvetgroup.com

Reed Mariculture Inc.  
**Booth #9**  
*Eric Henry*  
900 E. Hamilton Avenue  
Suite 100  
Campbell, CA 95008  
408-426-5456  
eric@reedmariculture.com

Brooks Trap  
**Booth #10**  
*Garth Hersey*  
211 Beechwood Street  
Thomaston, ME 4861  
207-354-8763  
brooksinc@roadrunner.com
Thanks to Our Exhibitors!

Helix Mooring Systems
Booth #11
Peter Morrison
27 Farwell Avenue
Cumberland, ME 04021
207-489-9345
peter@helixmooring.com

Ketchum Supply Traps
Booth #16 & 17
Bob Ketchem
111 Myrtle Street
New Bedford, MA 02740
508-997-4787
bob@lobstering.com

Center For Cooperative Aquaculture Research
Booth #12
Steve Eddy
33 Salmon Farm Road
Franklin, ME 04634
207-422-9096
steve.eddy@maine.edu

Pro Act Bio Tech
Booth #18
Bill Campion
64 Church Street
Warren, RI 02885
401-486-2007
bill@proactbiotech.com

Maine Aquaculture Association
Booth #13
Rhonda Cook
PO Box 148
Hallowell, ME 04347
207-622-0136
rhonda@maineaquaculture.com

US Aquaculture Society
Booth #19
Gef Flimlin
1623 Whitesfield Road
Toms River, NJ 08755
732-349-1152
flimlin@aesop.rutgers.edu

Maine Aquaculture Innovation Center
Booth #14
Chris Davis
193 Clarks Cove Road
Walpole, ME 04573
207-832-1075
cdavis@midcoast.com

Seafood Health Facts
Booth #20
John Ewart
700 Pilottown Rd
Lewes, DE 19958
302-645-4060
ewart@udel.edu

University of Maine
Booth #15
Anne Langston
5784 York Complex
Orono, ME 04469-5784
207-581-4397
anne.bowden@maine.edu

RWU Diagnostics Lab
Booth #21
Roxanna Smolowitz
One Old Ferry Road
Roger Williams University
Bristol, RI 02809
401-253-1040
rsmolowitz@rwu.edu
Thanks to Our Exhibitors!

Global Aquaculture Alliance Ltd.
Booth #22
Steve Hedlund
2 International Drive, Suite 105
Portsmouth, NH 03801
603-317-5000
steven.hedlund@gaalliance.org

New England Marine & Industrial Inc.
Booth #27
Michael Richardson
200 Spaulding Turnpike
Portsmouth, NH 03801
603-436-2836
shannon@newenglandmarine.com

East Coast Shellfish Growers Association
Booth #23
Bob Rheault
1623 Whitesville Road
Toms River, NJ 08755
732-349-1152
bob@ecsga.org

NOAA Technology Partnerships Office
Table #1
Derek Parks
1305 East West Highway
SSMC4, Room 7602
Silver Spring, MD 20910
301-628-1010
derek.parks@noaa.gov

Rhode Farm Service Agency
Booth #24
Sheryl Michener
60 Quaker Lane Suite 49
Warwick, RI 02886
401-828-3120 opt.2
sheryl.michener@ri.usda.gov

USDA, NASS
Table #2
Sherry Deane
53 Pleasant Street
Room 3450
Concord, NH 03301
603-224-9639
sherry.deane@nass.usda.gov

USDA/NRCS
Booth #25
Walter Marshall
60 Quaker Lane, Suite 40
Warwick, RI 02886
401-828-1300
walter.marshall@ri.usda.gov

USDA Rural Development
Table #3
Tom McGarr
60 Quaker Lane, Suite 44
Warwick, RI 02886
401-826-0842
tom.mcgarr@ma.usda.gov

Bouctouche Bay Industries
Booth #26
Rheal Savoie
PO Box 216
Bouctouche, New Brunswick, Canada E4S 2J2
506-743-5455
rheal@bbigroup.ca
Thanks to Our Exhibitors!
## Program for Wednesday & Thursday Morning

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:00 AM</td>
<td><strong>NACE/MAS Aquaculture Conference Schedule</strong></td>
</tr>
<tr>
<td>8:00 AM</td>
<td>Recommencing Aquaculture Systems Workshop (Kent Room)</td>
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<tr>
<td>8:45 AM</td>
<td>Field Trips leave at various times (meet in the hotel lobby)</td>
</tr>
<tr>
<td>9:00 AM</td>
<td>Breakfast opens in the Narragansett Ballroom</td>
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<tr>
<td>10:00 AM</td>
<td>Break &amp; Trade Show opens in the Narragansett Ballroom</td>
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<tr>
<td>10:30 AM</td>
<td><strong>Shellfish Genetics and Breeding Forum</strong></td>
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<tr>
<td>10:30 AM</td>
<td>Assessing Opportunities for Aquaculture in Shellfish Growing Areas</td>
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<td>Adjacent to Wastewater Treatment Plant Outfalls:</td>
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<td></td>
<td>Determination of Viral Reduction Performance, Impacts on Shellfish</td>
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<td></td>
<td>Safety and Informing Harvest Managers</td>
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<tr>
<td></td>
<td>Steve Jones</td>
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<tr>
<td>10:30 AM</td>
<td>Enhancing a long-standing applied shellfish farming course through</td>
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<td>expanded access, public education, and online learning</td>
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<td>Azure Cygler</td>
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<tr>
<td>10:30 AM</td>
<td>Understanding social carrying capacity in Maine's aquaculture</td>
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<td></td>
<td>Teresa R. Johnson</td>
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<tr>
<td>11:00 AM</td>
<td><strong>Public Health</strong></td>
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<tr>
<td>11:00 AM</td>
<td>Shellfish and coastal water contamination from bird feces</td>
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<td></td>
<td>Steve Jones</td>
</tr>
<tr>
<td>11:00 AM</td>
<td>Mariculture in Quebec (Canada) moving forward : statement,</td>
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<tr>
<td></td>
<td>challenges, and perspectives</td>
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<td></td>
<td>Marie Lionard</td>
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<tr>
<td>11:15 AM</td>
<td>Applying surveillance and seasonal trend analysis to identify</td>
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<td>conditions that influence V. parahaemolyticus concentrations in</td>
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<td>New England shellfish</td>
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<td></td>
<td>Meghan Hartwick</td>
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<tr>
<td>11:15 AM</td>
<td>Offshore shellfish aquaculture in Federal water</td>
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<td></td>
<td>Ted Money</td>
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<tr>
<td>11:30 AM</td>
<td>Update on the development of small, local shellfish</td>
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<td>hatcheries and increasing hatchery production methods for</td>
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<td>existing hatcheries</td>
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<td>culturing the eastern oyster,</td>
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<td>Crassostrea virginica</td>
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<td>Kim Tetrauld</td>
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<tr>
<td>11:30 AM</td>
<td>Welcome home: Military veterans and shellfish aquaculture - a natural</td>
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<tr>
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<td>business fit parts I &amp; II</td>
</tr>
<tr>
<td>11:45 AM</td>
<td><strong>Social Aspects of Aquaculture</strong></td>
</tr>
<tr>
<td>11:45 AM</td>
<td>Who gets the farm vs. I'm not dead yet</td>
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<tr>
<td></td>
<td>Miranda Ries</td>
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<tr>
<td>12:00 PM</td>
<td>**Farmer to Farmer: What Works and Doesn't When It Comes to</td>
</tr>
<tr>
<td></td>
<td>Biofouling Control**</td>
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<tr>
<td>12:00 PM</td>
<td>This hands-on workshop will focus on new science-based and farm-</td>
</tr>
<tr>
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<td>tested remedies for biofouling.</td>
</tr>
<tr>
<td>12:00 PM</td>
<td>Attendees will be provided a brief overview of the various</td>
</tr>
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<td>organisms that cause problems for aquaculture gear, animals, and</td>
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<td>operations, be informed of the massive economic impacts on</td>
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<td>global aquaculture, and introduced to new promising remedies.</td>
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<tr>
<td>12:00 PM</td>
<td>Aquaculture producers from east and west coast will present the</td>
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<td>results of the field trials on their farms. Participants will have</td>
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<td>the opportunity to view coated and uncoated gear pieces, and ask</td>
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<td>farmers about their experiences with the different anti fouling</td>
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<td>coatings. Researchers will be on hand to listen to suggestions with</td>
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<td>respect to product development and future directions for</td>
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<td>biofouling research and to answer questions.</td>
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</tbody>
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**Chairs:** Paul Rawson and Marta Gomez-Chiarri

**Chair:** Paul Anderson

**Chair:** Mark Dixon

**Chair:** Teresa R. Johnson

**Chairs:** Tessa Getchis, Sandra Shumway, Alex Walsh, Stephan Bullard
Aquaculture and the Environment I

1:30 PM
Interactions between tides, currents, and water quality in the Damariscotta estuary
Brandon Lieberthal

Seasonality and size selective feeding of the eastern oyster (Crassostrea virginica) on phytoplankton in the Damariscotta River estuary, Maine
Laura Lubelczyk

Evaluating detritus as a supplemental diet for bivalve aquaculture
Adrianus Both

What makes an area productive for oyster aquaculture and why?
Carter Newell

Closer to the truth – chlorophyll a from in vivo fluorescence-based sensors
Judy Li

Aquaculture sustainability – what is it and how do we assess it?
Gary Wikfors

1:45 AM
A coastal ecosystem service valuation approach for sustainable resource management
Carrie Byron

Management considerations for expanding aquaculture in Massachusetts
Chris Schlissel

Seaweed production in Connecticut: an interagency effort to establish permitting guidance for seaweed intended for human consumption
Kristin DeRosa-Banick

Market analysis and strategic implications for Maine’s cultured shellfish
Chris Vonderweidt

Factors influencing catch rates of traditional eel traps in the St. John River, New Brunswick, Canada
Aruna Jayawardane

2:00 AM
Effect of strain and domestication on stress-growth-immune interactions in striped bass
Linas Kenter

Development of a novel taurine technology to support sustainable aquaculture
Catherine Pujol-Basley

Scratching the surface: a sentinel exploration of sea louse infestations in Cobscook bay, Maine.
Catherine Frederick

2:15 AM
We live in a data rich age. We now have access to more data and computing power and often that outpaces our ability to use it. But that does not mean we have all the data we need. Using the lens of east coast shellfish siting and permitting, we will address mapping data and placing it into a useable format for multiple stakeholders. We will hear about data we need in terms of not only environmental data and data on uses of the marine environment, but also about incorporating data on legal rules and regulations. This session will conclude with a discussion about the data requirements for siting. What is necessary for it to be effective? Is it too onerous, or do you believe more data are required?

Linas Kenter

2:30 AM
What makes an area productive for oyster aquaculture and why?
Carter Newell

Seaweed production in Connecticut: an interagency effort to establish permitting guidance for seaweed intended for human consumption
Kristin DeRosa-Banick

Market analysis and strategic implications for Maine’s cultured shellfish
Chris Vonderweidt

Factors influencing catch rates of traditional eel traps in the St. John River, New Brunswick, Canada
Aruna Jayawardane

2:45 AM
A strain comparison of striped bass cultured in recirculating systems at different salinities
Linas Kenter

Effect of strain and domestication on stress-growth-immune interactions in striped bass
Linas Kenter

Development of a novel taurine technology to support sustainable aquaculture
Catherine Pujol-Basley

Scratching the surface: a sentinel exploration of sea louse infestations in Cobscook bay, Maine.
Catherine Frederick

2:30 PM
Break in the Narragansett Ballroom
<table>
<thead>
<tr>
<th>Time</th>
<th>Location</th>
<th>Session</th>
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<tbody>
<tr>
<td>7:00 AM</td>
<td>Breakfast in location TBD</td>
<td>Registration in the Hotel Lobby</td>
</tr>
<tr>
<td>11:00 AM</td>
<td>Bristol/Kent</td>
<td>Trematode associated mortality in blue mussel populations in the Northeast U.S. by Ravanna Smolowitz</td>
</tr>
</tbody>
</table>
Program for Friday Afternoon

**Aquaculture Student Roundtable**
Chair: Charlotte Quigley

**Developing a Public Relations and Media Relations Plan for Aquaculture Business**
Chair: Erich Luening

**Mussel Farming and Seed Production**
Chair: Scott Lindell

**Ocean Acidification**
Chair: Joe Salisbury

**Shellfish Disease Diagnostics**
Chair: Dale Leavitt and Roxanna Smolowitz

1:30 PM
- We invite all undergraduate and graduate students, and postdoctoral researchers to join in an academic discussion concerning aquaculture. Topics may include selecting candidate species/crops, sea farm engineering, carrying capacity of aquaculture systems, product development, and how aquaculture will affect coastal communities. This session will follow a loose agenda, but will offer flexibility to change the course of the conversation to ensure equal participation of contributors on topics of interest to the group.

1:45 AM
- One of the challenges facing aquaculture professionals is explaining what they do, how they do it, and what they hope to bring to market to customers, business associations, and regulators. The message is as important as the product one grows and sells. In this session, table top attendees can discuss and learn ways to communicate their message effectively to the seafood industry through media channels and also with unique channels to the customers.

2:00 AM
- The Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS) and TruWeather Solutions, a private weather and water information services company, have partnered up to address water issues facing the aquaculture industry. Through the use of state-of-the-art environmental monitoring and models, an early warning system for shellfish growers and managers (including parameters such as harmful water quality conditions, predicted harmful temperature changes, weather, and others to be defined by the aquaculture community), can be delivered directly to mobile devices in the most efficient and easy-to-use formats to reduce risk and improve results for aquaculture growers.

2:15 AM
- Remote-setting eyed larvae of the blue mussel, Mytilus edulis, for seed production

2:30 AM
- One of the challenges facing aquaculture professionals is explaining what they do, how they do it, and what they hope to bring to market to customers, business associations, and regulators. The message is as important as the product one grows and sells. In this session, table top attendees can discuss and learn ways to communicate their message effectively to the seafood industry through media channels and also with unique channels to the customers.

2:45 AM
- Evaluation of a submersible mussel raft for use in semi-exposed sites

3:00 PM
- Break in the Foyer

**Real-time Environmental Forecasting Workshop**
Chair: Donald Berchoff

**Risk Management: How does it work?**
Chair: Paul Russell

**Scallop Aquaculture Forum**
Chair: Hugh Cowperthwaite

**Shellfish Disease Diagnostics**
Chair: Dale Leavitt and Roxanna Smolowitz

3:30 PM
- **The Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS) and TruWeather Solutions, a private weather and water information services company, have partnered up to address water issues facing the aquaculture industry. Through the use of state-of-the-art environmental monitoring and models, an early warning system for shellfish growers and managers (including parameters such as harmful water quality conditions, predicted harmful temperature changes, weather, and others to be defined by the aquaculture community), can be delivered directly to mobile devices in the most efficient and easy-to-use formats to reduce risk and improve results for aquaculture growers.** The workshop will show attendees capabilities and get feedback on priorities from potential users to create a useful product.

3:45 AM
- **Risk management programs are often too confusing, leaving growers confused and feeling left out. This session aims to combat that problem by highlighting programs available to growers – utilizing both a presentation and a panel format in which growers will discuss their personal experiences. Finally, a panel of decision makers will address their role in setting policy, prices and rates for the USDA Farm Service Agency (FSA) and how the shellfish industry can be involved in these decisions.**

4:00 AM
- **Risk management programs are often too confusing, leaving growers confused and feeling left out. This session aims to combat that problem by highlighting programs available to growers – utilizing both a presentation and a panel format in which growers will discuss their personal experiences. Finally, a panel of decision makers will address their role in setting policy, prices and rates for the USDA Farm Service Agency (FSA) and how the shellfish industry can be involved in these decisions.**

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5:00 PM
- Closing Refreshments by Registration Area
Oral and Poster Presentations

The first author is the presenting author unless otherwise indicated by *

Michael Acquafredda, Daphne Munroe, Lisa Calvo, Michael DeLuca
THERMAL TOLERANCE OF JUVENILE ATLANTIC SURF CLAMS (SPISULA SOLIDISSIMA): A STEP TOWARDS DIVERSIFYING THE NEW JERSEY SHELLFISH AQUACULTURE SECTOR

Cheyenne Adams, Lawrence Mayer, Paul Rawson
SEASONAL FEEDING AND GROWTH OF THE EASTERN OYSTER (CRASSOSTREA VIRGINICA) IN THE DAMARISCOTTA RIVER ESTUARY, MAINE

Bassem Allam, Emmanuelle Pales Espinosa, Guodong Wang, Roxanna Smolowitz, Diane Murphy, Gregg Rivara, Ximing Guo
DEVELOPMENT OF STRATEGIES TO MITIGATE QPX DISEASE IN THE HARD CLAM

Jeff Auger, Bill Mook
MECHANIZING OYSTERGRO CAGE FLIPPING

Simona Augyte, Charles Yarish, Sarah Redmond
TWO SEASONS OF KELP FARMING A UNIQUE PHENOTYPE OF SACCHARINA LATISSIMA FROM THE GULF OF MAINE WITH A FOCUS ON PRODUCTION

David Bailey
OPTIMAL METHODS FOR SETTING BLUE MUSSEL (MYTILUS EDULIS) SPAT IN A HATCHERY

Michelle Barbosa, Andrew Griffith, Caroline Schwaner, Christopher Gobler, Emmanuelle Pales Espinosa, Bassem Allam
ENHANCED SUSCEPTIBILITY TO MICROBIAL INFECTIONS IN BIVALVE LARVAE AND JUVENILES EXPOSED TO ACIDIFIED SEAWATER

Seth Barker
SEAWeed FarmING FORUM

Margaret Pilaro Barrette
APPRECIATION OF THE HIVE - THE VALUE OF A TRADE ASSOCIATION AND KEEPING IT WORKING

Margaret Pilaro Barrette, Miranda Reis, Joth Davis, Daniel Barth, Ralph Riccio
IS THE ALGAE REALLY GREENER ON THE OTHER SIDE? WEST COAST GROWERS PERSPECTIVES ON RAISING SHELLFISH ON THE “OTHER” COAST

Daniel Barth
WELCOME HOME: MILITARY VETERANS AND SHELLFISH AQUACULTURE-A NATURAL BUSINESS FIT
Donald Berchoff, Heather Kerkering, Peter Moore, Emily Patrolia  
REAL-TIME ENVIRONMENTAL FORECASTING APP FOR GROWERS, MANAGERS, AND REGULATORS TO REDUCE RISKS AND IMPROVE RESULTS FOR AQUACULTURE

Erich Berghahn, Tzachi Samocha, Michael Chambers  
FARMING PACIFIC WHITE SHRIMP (LITOPENAEUS VANNAMEI) IN A BIOFLOC SYSTEM AT JACKSON ESTUARINE LABORATORY, NEW HAMPSHIRE

Scott Borsum, Melanie Fuoco, Gulinhal Ozbay  
UNDERSTANDING AQUACULTURE’S ROLE IN RECLAMATION OF EASTERN OYSTER, CRASSOSTREA VIRGINICA, POPULATIONS IN DELAWARE INLAND BAYS

Adrianus Both, Damian Brady, Carrie Byron, Larry Mayer, Chris Parrish  
EVALUATING DETRITUS AS A SUPPLEMENTAL DIET FOR BIVALVE AQUACULTURE

Christian Brayden  
ASSESSING THE IMPACT OF ECOLABELS ON CONSUMER PREFERENCES FOR SEAFOOD: THE ROLE OF PRODUCTION METHOD, CERTIFICATION AND ORIGIN ON WILD HARVEST AND AQUACULTURE PRODUCTS

Joseph Buttner, James Carnazza, Anastasia Perullo, Laura Presutti  
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Michael Chambers, Corey Sullivan, Hunt Howell, Rob Swift  
INTEGRATED MULTI-TROPHIC AQUACULTURE RESEARCH, OUTREACH AND TRAINING FOR COASTAL COMMUNITIES IN NEW ENGLAND

Eric Chapman, Carrie Byron*, Di Jin, Tracey Dalton  
A COASTAL ECOSYSTEM SERVICE VALUATION APPROACH FOR SUSTAINABLE RESOURCE MANAGEMENT

Caitlin Cleaver, Teresa R. Johnson, Samuel Hanes, Molly Miller  
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Anoushka Concepcion  
IDENTIFYING AND ADDRESSING PROCESS-RELATED CHALLENGES TO THE EXPANSION OF SEA VEGETABLE AQUACULTURE IN CONNECTICUT

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Andrew Davidsohn, Carrie Byron
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Joth Davis, Betsy Peabody
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Joth Davis
ROCK SCALLOP AQUACULTURE POTENTIAL ON THE PACIFIC COAST

Kristin DeRosia-Banick, Anoushka Concepcion
SEAWEED PRODUCTION IN CONNECTICUT: AN INTERAGENCY EFFORT TO ESTABLISH PERMITTING GUIDANCE FOR SEAWEED INTENDED FOR HUMAN CONSUMPTION

Tobias Dewhurst, Carter Newell, M. Robinson Swift
EVALUATION OF A SUBMERSIBLE MUSSEL RAFT FOR USE IN SEMI-EXPOSED SITES

Kevin Duffy, Laura Rickard, Brandon Sirois, Jessica Bergstrom
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José A. Fernández Robledo, Marta Gómez Chiarri, Meredith M. White, William Mook
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CO-CULTURE OF BLUE MUSSEL (*MYTILUS EDULIS*) AND SUGAR KELP (*SACCHARINA LATISSIMA*): EXPLORING THE POTENTIAL OF SEAWEEDS IN DETERRING THE EFFECT OF DUCK PREDATION ON MUSSELS, CASCAPEDIA BAY (QC, CANADA)

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Tessa Getchis, Sandra Shumway, Alex Walsh, Stephan Bullard
FARMER TO FARMER: WHAT WORKS AND DOESN’T WHEN IT COMES TO BIOFOULING CONTROL

Tessa Getchis, Julie Rose, Sylvain De Guise, Nancy Balcom, Anoushka Concepcion
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Cem Giray, Lori Gustafson, Sebastian Belle, Matthew Branan, Kamina Johnson
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Ashley P. Hogan, Serena Moseman - Valtierra, Marta Gomez - Chiarrri
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Christopher Hunt, Joseph Salisbury, Douglas Vandemark, William Mook
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**Hollie M Putnam, Laura Spencer, Steven Roberts, Frederick W Goetz**
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**Charlotte Quigley**
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Gary Wikfors
AQUACULTURE SUSTAINABILITY – WHAT IS IT AND HOW DO WE ASSESS IT?

Theodore Willis, Molly Miller, Christopher Johnson, Mikoo Mendoza
RECONNECTING WITH THEIR MARINE ROOTS: MAINE’S NATIVE TRIBES EXPERIMENT WITH SMALL SCALE AQUACULTURE
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THERMAL TOLERANCE OF JUVENILE ATLANTIC SURF CLAMS (SPISULA SOLIDISSIMA): A STEP TOWARDS DIVERSIFYING THE NEW JERSEY SHELLFISH AQUACULTURE SECTOR

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In New Jersey, shellfish aquaculture is currently limited to two species: the hard clam (Mercenaria mercenaria) and the Eastern oyster (Crassostrea virginica). However, shellfish farmers eager to diversify have expressed interest in culturing new species. The Atlantic surf clam (Spisula solidissima) represents an ideal target species for diversification because it is native, grows rapidly, and fits into the established farming framework. To optimize the husbandry techniques required for sustainable and profitable farming, it is necessary to gain a thorough understanding of how temperature impacts the performance of the surf clam throughout its different developmental stages. This study, conducted from June–August 2016, examined the effects of five different temperatures (approximately 18˚C, 20˚C, 23˚C, 24˚C, and 26˚C) on the growth and survival of early juvenile surf clams (shell length = 0.696–2.269 mm). Three independent cohorts were tracked for 32 days and cultured using common nursery phase procedures (236 µm screen downwellers; 500 µm/750 µm screen upwellers). Shell height, shell length, and survival estimates were collected 2–3 times per week. Results suggest that colder temperatures reduce clam mortality, while temperatures between 20 and 24˚C promote the greatest growth. These findings and the results from an on-going study examining the optimal grow-out phase techniques for surf clam aquaculture will be incorporated into a manual of best practices. This manual will be made accessible to the state’s local shellfish farmers. Moreover, these results can be incorporated into species distribution models, and further refine the management of the lucrative wild surf clam fishery.

SEASONAL FEEDING AND GROWTH OF THE EASTERN OYSTER (CRASSOSTREA VIRGINICA) IN THE DAMARISCOTTA RIVER ESTUARY, MAINE

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Oyster farmers depend on the quantity and quality of the planktonic food, including phytoplankton and detritus, available to their crop. The characterization of the nutritional quality of food utilized by oysters could increase the accuracy of growth modelling, improving site selection and expanding the aquaculture industry in the state of Maine. As part of the Sustainable Ecological Aquaculture Network (SEANET) program, seasonal changes in the available nutrition and associated feeding and growth of the eastern oyster (Crassostrea virginica) were investigated. From June through October, 2016, bi-weekly water sampling was conducted in an intensively farmed segment of the Damariscotta River Estuary. Many water quality parameters were measured, including temperature, salinity, chlorophyll α, pheophytin, phytoplankton community assemblages, phytodetritus, turbidity, suspended particulate matter, particulate organic/inorganic matter (POM/PIM), and enzymatically hydrolysable amino acids (EHAA). EHAA content of water samples will quantify the bioavailable protein component of the
seston, including detrital particles. Collected under variable environmental conditions, food quantity and quality data will be compared to filtration, ingestion, and absorption rates in *C. virginica* and calibrated against growth. These data will be used to test growth models that include live phytoplankton and detrital variables. Data analysis is ongoing, but preliminary results will include seasonal variation in oyster feeding and growth rates, and the relationships to changes in water quality.

**DEVELOPMENT OF STRATEGIES TO MITIGATE QPX DISEASE IN THE HARD CLAM**

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The hard clam, *Mercenaria mercenaria*, is one of the most valuable commercial mollusk species along the eastern coast of the US. Throughout the past few decades, the hard clam industry in the Northeast was significantly impacted by disease outbreaks caused by a lethal protistan parasite known as Quahog Parasite Unknown (QPX). QPX is an opportunistic pathogen and the infection has been shown to be a cool water disease, with limited disease development at “warm” temperatures (21°C and above) under laboratory conditions. Previous field and laboratory work also demonstrated that clam susceptibility to QPX depends upon the geographic origin of the broodstock suggesting a genetic basis for clam resistance. This presentation will summarize the latest findings on strategies being developed to mitigate QPX disease. These include investigations of environmental conditions suggested to limit disease development and selection of resistant broodstock. Results showed that acute exposure of clams to “hot” temperatures (27°C and above) have the potential to promote healing of infected clams. Similarly, transplant of infected clams to areas exposed to high temperatures and low salinities promote disease remission. Finally, we used genome-wide candidate-gene association studies (GCAS) to identify genetic variants (single nucleotide polymorphism or SNP) associated with disease resistance in several hard clam strains. Variations in 7 genes showed significant allele frequency shifts among clams that survived QPX outbreaks. These SNPs are now being validated before being used for marker-assisted selection. Altogether, these findings offer possible options to reduce the impact of QPX disease in support of the aquaculture industry.

**MECHANIZING OYSTERGRO™ CAGE FLIPPING**

Jeff Auger, Bill Mook. Mook Sea Farm, 321 State Route 129, Walpole, ME 04573

OysterGro™ cages have several advantages for growing oysters to market size, including high oyster survival and growth rates, effective biofouling control through air-drying (which also improves shell shape), and the ability to sink them below winter ice. The manual labor required to regularly flip the cages up for air-drying during the growing season, is physically very demanding, limits the types of employees that can do the work, and can even constrain the growth and ultimate size of farms. At Mook Sea Farm we have mechanized our OysterGro™ system by developing a specialized vessel (analogous to a tractor) to which we attach a cage-flipping implement during the growing season. We will discuss how this system is used and the productivity gains achieved from its use.
TWO SEASONS OF KELP FARMING: A UNIQUE PHENOTYPE OF SACCHARINA LATISSIMA FROM THE GULF OF MAINE WITH A FOCUS ON PRODUCTION

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Locally sourced, high quality sea vegetables, in particular kelp, are sparking consumer interest and demand in New England. Despite existing challenges such as development of aquaculture systems and infrastructure, many opportunities are becoming available and driving farmers to meet consumer demand. The unique Casco Bay, Maine population of sugar kelp, Saccharina latissima forma angustissima, with desirable culinary traits was translated into a novel cultivated crop. In the intertidal, this kelp is adapted to withstand extreme hydrodynamic forces, an order of magnitude higher than the subtidal populations of sugar kelp that are usually found in more sheltered locations. We will showcase two years of data from the two geographically distinct open-water farms. Based on harvest results from two growing seasons, kelp biomass yields were higher than the common phenotype of sugar kelp. Highest yields were achieved the second growing season in Sorrento, Maine, with averages of up to 24.1 (±6.3) kg m⁻¹ of line with a plant density of 400 plants m⁻¹ of line. The phenotypic characteristics that make this kelp exceptionally adapted to extreme sea conditions were preserved at the open-water farm sites. This cultivated kelp has great potential as an economically valuable sea vegetable in the Gulf of Maine but care must be taken to protect the donor population. Although additional work needs to be done to bring this kelp to market, growing it also offers a suite of ecosystem services including nutrient bioextraction and temporary habitat formation.

OPTIMAL METHODS FOR SETTING BLUE MUSSEL (MYTILUS EDULIS) SPAT IN A HATCHERY

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The settlement behavior of blue mussels, Mytilus edulis compared to other typically cultured shellfish seed present a unique set of challenges during the rearing process. Hatchery trials at Woods Hole Oceanographic Institute in Massachusetts and the Downeast Institute in Maine yielded important information that can be applied to optimize this unique process. These trials focused on the type of materials available for competent larvae to settle on, the shape and position of material in the settling tank, the aeration required in the settling tanks, and the diets they prefer. Settlement and seed retention was found to be higher on the reusable NZ fuzzy rope and the NZ hatchery rope than the single-use Coir rope. The NZ ropes also allowed for higher stocking densities. A spiral NZ hatchery rope configuration in the upper half of the settling tank with vigorous aeration proved to be the most successful. Mussel spat and seed fed solely alternatives diets (Ori-one (Skretting) or Shellfish Diet (Reed Mariculture)) did not grow or survive as well as those fed typical live microalgae diets. However, spat fed a 50/50 mixture of live algae and an alternative diet performed as well as those only eating live microalgae. Fall 2016 trials will again test the 50/50 feed mixtures on spat as well as newly spawned larvae. The 50/50 mixture has great implications as a possible cost saving measure throughout the hatchery process. We will also report on a comparison of Spanish hatchery rope and the NZ ropes.
ENHANCED SUSCEPTIBILITY TO MICROBIAL INFECTIONS IN BIVALVE LARVAE AND JUVENILES EXPOSED TO ACIDIFIED SEAWATER

Michelle Barbosa¹, Andrew Griffith², Caroline Schwane¹, Christopher Gobler², Emmanuelle Pales Espinosa¹, Bassem Allam¹. ¹School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, NY 11790; ²School of Marine and Atmospheric Sciences, Stony Brook University, Southampton, NY 11968

A major stressor that has gained significant importance in the last few decades is a reduction in seawater pH resulting from elevated anthropogenic CO2 emissions in the atmosphere. Among marine organisms, shelled mollusks and most specifically bivalves are considered very sensitive to the effects of acidification. This study was designed to assess the physiological cost of resilience to acidification in the eastern oyster *Crassostrea virginica* and the hard clam *Mercenaria mercenaria*. Specifically, we evaluated the effect of acidification on immunity and resistance of bivalve larval and juvenile stages to major microbial pathogens. Wild adult clams and oysters were separately spawned and resultant larvae were cultured under normal (400ppm) or high (1000ppm) pCO2 conditions. Larvae (2 days old) and post-sets (28 days) grown under each condition were exposed to prominent bacterial pathogens of bivalves (*Vibrio coralliilyticus, V. alginolyticus*). Results showed that bivalves exposed to higher pCO2 conditions displayed significantly higher mortality rates following bacterial challenge than bivalves exposed to normal conditions. The study is ongoing and results from exposures of older bivalves will be presented. These findings improve our understanding of how simultaneous acidification and pathogen stress affects larval and juvenile shellfish and provide a more comprehensive view of the potential impacts of ocean acidification on shellfish resources.

SEAWEED FARMING FORUM

Seth Barker. Maine Fresh Sea Farms, 256 Lower Round Pond Road, Bristol, ME 04539

Multiple farms have been growing seaweeds in the northeast for 4-5 years or longer and have gained a wealth of experience. Is the future that of a one horse carriage (sugar kelp) or is greater diversity the answer? What have the challenges been on the farm, in product development, and in getting products to market? Are the opportunities that once seemed to be on the horizon in closer focus? Is IMTA a reality or an unrealized goal for the future? Has the interest level of the American consumer progressed to the point that solid markets are developing or is it for most still a novelty?

A panel of growers, business owners, and advisors will explore the future of seaweed farming with a file folder of lessons learned and a clear eye on the future. It is hoped that the audience can also be the panel and the panel, the audience, as we all share insights and ambitions.

APPRECIATION OF THE HIVE – THE VALUE OF A TRADE ASSOCIATION AND KEEPING IT WORKING

Margaret Pilaro Barrette. Pacific Coast Shellfish Growers Association, 120 State Ave NE #142, Olympia, WA 98501
During a fall day in 1905 a group of frustrated oystermen met at a hotel meeting room in Olympia, Washington. The discussion was filled with emotion and despair until a man by the name of George Draham shared a story. The unique story, about a whip-carrying man, encouraged the group to organize and ultimately changed the course of the shellfish industry along the Pacific Coast. From that meeting, the precursor to the Pacific Coast Shellfish Growers Association (PCSGA) was born. It hasn’t always been calm seas but the spirit of organizing has been carried forward to today’s shellfish producers. This presentation will discuss the value of united approach and the challenges facing member-supported organizations. It will also offer some guidance on remaining current among changing times and shifting priorities.

IS THE ALGAE REALLY GREENER ON THE OTHER SIDE? WEST COAST GROWERS PERSPECTIVES ON RAISING SHELLFISH ON THE “OTHER” COAST

Margaret Pilaro Barrette¹, Miranda Reis², Joth Davis³, Daniel Barth⁴, Ralph Riccio⁵. ¹Pacific Coast Shellfish Growers Association, 120 State Ave NE #142, Olympia, WA 98501; ²National Fish and Oyster, 5028 Meridian Rd. NE, Olympia, WA 98516; ³Puget Sound Restoration Fund & Owner, Baywater Shellfish Company; 10610 NE Manitou Park Blvd. Bainbridge Island, WA 98110; ⁴Patriot Shellfish Farms LLC, 115 Grimes Road, Centralia, WA 98531; ⁵Jamestown S’Klallam Tribe, 1033 Old Blyn Highway, Sequim WA 98382

There are several things that nearly all shellfish farmers, regardless of where they work, do and or worry about… such as tides, weather-compatible clothing, shellfish health, etc. There are also several things that are specific to a particular region. Among the differences, some may cause envy and make you consider picking up shop and moving west to a “better area”. Other differences stimulate joy and relief to know that there are things you don’t have to worry about.

Join Shellfish Growers from the West Coast so you can determine who’s got the greenest algae during an interactive panel session. Attendees will learn about different species currently being produced as well as new initiatives for emerging species. Examine research questions being pondered, growing methods being tried and efforts to use shellfish culture in restoration. Consider challenges in permitting a new farm along the west coast, a new role for Port Districts, and how interactions with and assistance from state and federal agencies is helping…or not. Discover west coast trends in marketing and how interacting with the public, agencies, tribes, and consumer is vital to growing the industry. Panelists will offer their perspective and then be put on the spot with some provoking questions both from the moderator and attendees.

WELCOME HOME: MILITARY VETERANS AND SHELLFISH AQUACULTURE – A NATURAL BUSINESS FIT

Daniel Barth.  Patriot Shellfish Farms LLC, 115 Grimes Road, 98531 WA

The US shellfish aquaculture industry is expanding. The US military is downsizing. America needs one million new farmers in the next ten years. Veterans want these jobs. Aquaculture is agriculture and Federal, State and Local programs are available to engage Veterans in shellfish aquaculture. It’s just a matter of figuring this out. America’s Veterans and Service members are highly trained, skilled and
dedicated to completing their mission. Learn ten reasons why it makes sense to hire a Vet. Learn about Tax incentives for hiring Vets. Be introduced to familiar faces of Veterans and hidden faces among us. Vets have served our country and perhaps it’s time to support our veteran community. Learn how to engage Vets and welcome them home from War. It just makes sense.

REAL-TIME ENVIRONMENTAL FORECASTING APP FOR GROWERS, MANAGERS, AND REGULATORS TO REDUCE RISKS AND IMPROVE RESULTS FOR AQUACULTURE

Donald Berchoff¹, Heather Kerkering², Peter Moore², Emily Patrolia². ¹TruWeather Solutions, Inc., 1303 Sawbridge Way, Reston, VA 20194; ²MARACOOS, 318 South College Ave., Newark, DE 19711

Shellfish aquaculture is a booming industry that generates millions of dollars in revenue and employs thousands of people. The growing success of the aquaculture market relies heavily on efficient and accurate forecasting of environmental conditions that could harm the product or conditions in which illness-causing bacteria can thrive. Illness incidence related to Vibrio parahaemolyticus (Vibrio) has increased by 52% in recent years (www.cdc.gov/foodnet), including in U.S. Mid Atlantic and Northeast areas. Higher water and air temperatures, which are projected to increase, can lead to elevated growth, and consequently, elevated harvest levels of Vibrio in shellfish. Not only is the health of consumers at risk due to vibrio and other water quality concerns, but also the health of the industry if a perception becomes commonplace that consumption of shellfish leads to illness.

A partnership between Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS) and TruWeather Solutions, a private weather and water information services company has been created to address these issues and protect the aquaculture industry. Through the use of state-of-the-art environmental monitoring and models, an early warning system for shellfish growers and managers (including parameters such as harmful water quality conditions, predicted harmful temperature changes, weather, and others to be defined by the aquaculture community), can be delivered directly to mobile devices in the most efficient and easy-to-use formats to reduce risk and improve results for aquaculture growers.

FARMING PACIFIC WHITE SHRIMP (LITOPENAEUS VANNAMEI) IN A BIOFLOC SYSTEM AT JACKSON ESTUARINE LABORATORY, NEW HAMPSHIRE

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Aquaculture is an important field in today’s world with the growing need for safe and sustainable food production. Biofloc aquaculture is on the rise in the US and utilizes pacific white shrimp grown in barns or greenhouses. To examine this new technology, Sea Grant funded a demonstration project at the University of New Hampshire’s Jackson Estuarine Lab greenhouse. Here we are testing the viability of a relatively low-cost system to determine the practicality of its use by farmers or fishermen. The system requires little space, making it ideal for small, tempered areas. The system consists of a 4m³ square
fiberglass tank, a fiberglass conical tank for settling out Biofloc, a protein skimmer, and a 1HP Taurus pump. Water is circulated by the pump through four venturis in the tank that provide aeration and suspension of the Biofloc. Stiff foam insulation panels are placed on the tank to maintain temperature and keep shrimp from jumping out. In order to create the Biofloc in the system, specific amounts of Frittzyme, sugar and Eco Probiotics were added. The tank is maintained at 29°C using a titanium heater and feed is distributed each day from a 12 hour belt feeder. The tank was stocked with 3,000, PL15 shrimp from Global Blue in Texas. After two months, their mean weight is 3.2g. Shrimp will be raised until harvest in December 2016. Challenges of maintaining the Biofloc and shrimp such as balancing ammonia, nitrite and nitrate levels with pH, oxygen and salinity will be discussed.

UNDERSTANDING AQUACULTURE’S ROLE IN RECLAIMATION OF EASTERN OYSTER, CRASSOSTREA VIRGINICA, POPULATIONS IN DELAWARE INLAND BAYS

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Delaware is currently the only state on the Northeast Atlantic seaboard without commercial shellfish aquaculture. Legislation is developing policy and protocols for implementation, as legalized aquaculture will soon be a reality. Three inland bays in Southern Delaware offer promising future locations for bottom leases, due to protection from open waters and ease of access for workers. The ecological services oysters contribute are more important than ever with the rapid development of the local watershed. Oyster aquaculture can help restore depleted wild populations of oysters while filtering the water, providing structural habitat, and creating a new sources of jobs. There is a unique opportunity to study directly how aquaculture facilitates restoration, but baseline statics are essential. This research aims to further understand the current oyster population by 1) developing baseline population locations and standardized survey methods to be used as a management to measure changes over time and 2) investigating population dynamics by analyzing genetics of spatfall within the Delaware Inland Bays. Oyster survey locations would be chosen by prioritizing habitat for hard substrate where oysters are more likely to settle and occur naturally. Standardized swaths will be run along a permanent transect line in order to determine a population density. Spat for genetic sequencing are collected by placing ceramic tiles throughout the three bays. Analysis is intended to identify if disease resistant oysters, from Rutgers University Haskins Shellfish Laboratory, supplied to local oyster gardening programs are spawning and populating the Bay and to access diversity of natural recruits.

EVALUATING DETRITUS AS A SUPPLEMENTAL DIET FOR BIVALVE AQUACULTURE

Adrianus Both\textsuperscript{1}, Damian Brady\textsuperscript{2}, Carrie Byron\textsuperscript{1}, Barry Costa-Pierce\textsuperscript{1}, Larry Mayer\textsuperscript{2}, Chris Parrish\textsuperscript{3}. \textsuperscript{1}University of New England, Marine Science Center, 11 Hills Beach Rd., Biddeford ME 04005 USA; \textsuperscript{2}University of Maine, Darling Marine Center, 193 Clarks Cove Rd., Walpole ME 04573 USA; \textsuperscript{3}Memorial University, Oceans Science Centre, 0 Marine Lab Dr., St. John’s NL Canada

Extractive shellfish aquaculture relies on the environment to provide food for the cultured species with little to no input from the aquaculturist. Phytoplankton is viewed as the major source of nutrition for bivalve aquaculture and it is weighed heavily in terms of site selection. While there is no doubt that bivalves can derive a large proportion of their nutritional needs from phytoplankton there is a growing
awareness that they also derive sustenance from detritus and food webs based on secondary heterotrophic production. With the increasing awareness of detrital use by bivalves the question arises should detritus be considered during site selection? The goal of the current study is to characterize and source the detrital material present in Saco Bay, ME, using stable isotopes ($\delta^{13}$C and $\delta^{15}$N), lipids and fatty acid biomarkers to determine its contribution to bivalve diets in the area. Nutritional quality will be evaluated using the C:N, lipid and fatty acid content, especially essential fatty acids such as docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA). Compositional knowledge of detritus, its abundance and its use by natural bivalves will be used to evaluate the potential for detritus to function as a supplementary diet and its role in site selection for bivalve aquaculture. While the main purpose of this study is to inform bivalve aquaculture, information generated by this study will also inform energy transfer within Saco Bay.

**ASSESSING THE IMPACT OF ECOLABELS ON CONSUMER PREFERENCES FOR SEAFOOD: THE ROLE OF PRODUCTION METHOD, CERTIFICATION AND ORIGIN ON WILD HARVEST AND AQUACULTURE PRODUCTS**

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The production of seaweed and bivalve shellfish represents a substantial and growing sector of the U.S. and global seafood industry (NOAA, 2016; Watson, 2016). While the increase in production of bivalve shellfish and seaweed has been matched by heightened seafood demand, consumers often experience confusion over the characteristics of products during the purchasing process. At the same time, producers and retailers struggle to determine optimal methods of production and marketing to maximize profits. Seafood labels play an important role in the communication of product characteristics from the producer to the consumer and vice versa.

This paper explores the impact of ecolabels on consumer preferences for seafood products. We examine three key attributes that may impact consumer choice: (1) preferences for production method: wild harvest or aquaculture products; (2) preferences for organic (aquaculture) or sustainably harvested (wild harvest) products; and (3) whether a product is labeled as imported, from the U.S., or from a consumer’s home state. We use data from a 2016 online consumer experiment (n=2000) and perform a conjoint analysis to improve our understanding of the role these three attributes may play in decision making. This work fills a key knowledge gap by examining consumer preferences for coastal shellfish (oysters, mussels, scallops and clams) and seaweed products across the nation.

Preliminary findings indicate that consumers prefer products from their home state regardless of production method or certification.

**SMALL AND MODEST SCALE AQUAPONICS ON MASSACHUSETTS’ NORTH SHORE**

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Aquaponics is the marriage of hydroponics and re-circulating aquaculture systems (RASs). Rather than produce one product, multiple crops are produced: fish, plants, and, increasingly, annelids. Solid and metabolic wastes generated by fish production are consumed and transformed by annelids and bacteria into nutrients for plants, which remove the modified fish waste and maintain water quality. Aquaponics can be pursued sustainably, with minimal environmental impact. While large, commercial-scale systems exist and require careful management, small to modest scale systems as learning tools in the classroom or for backyard production and personal consumption or supplemental income appear forgiving and user friendly. Data collected from nearly a dozen systems operating for 1.5 to 8 years in Hawaii provide guidance to establish and manage systems. Findings from Hawaii (and elsewhere) were applied to systems setup in an 800 ft² greenhouse constructed in Beverly, MA. Operation initiated in 2015 and validates the efficacy of aquaponics in Massachusetts and New England. The greenhouse and aquaponic systems were designed to run on solar energy (< 3 amps). Cool weather crops were produced from September to May and warm weather crops from June to September. Sunlight was sufficient to power the systems from mid-February to mid-November. Reduced daylight in fall and winter, coupled with cloudy/overcast days, required occasional supplemental electricity provided by a generator. Insight on permit requirements, fingerling selection and production, tube house construction, solar power setup, aquaponics system design, plant and fish stocking/management, system efficacy and where refinements are desirable has been gained.

INTEGRATED MULTI-TROPHIC AQUACULTURE RESEARCH, OUTREACH AND TRAINING FOR COASTAL COMMUNITIES IN NEW ENGLAND

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The University of New Hampshire (UNH) has been advancing open ocean aquaculture technologies since 1995. More recently, they have developed a floating integrated multi-trophic aquaculture (IMTA) raft for research, outreach and training. The current design allows for the culture of steelhead trout (Oncorhynchus mykiss), blue mussels (Mytilus edulis) and sugar kelp (Saccharina latissima). State and federal permitting agencies favor this type of culture because the lower trophic, shellfish and seaweed species, extract nutrients from the fish reducing nitrogen input to the ecosystem. The IMTA model allows farmers to grow several species for market and optimizes their lease space and 3D footprint. An extension program was established for training fishermen, students and entrepreneurs on the technology. Raft components fit into a 12 m container for shipping purposes. Upon arrival to their destination, parts can be unloaded and fabricated at harbor or on a beach. Scaling of the IMTA system and economics will also be discussed.

A COASTAL ECOSYSTEM SERVICE VALUATION APPROACH FOR SUSTAINABLE RESOURCE MANAGEMENT

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Increasingly, ecosystems are viewed as social-ecological systems (SES) where human livelihood is tightly coupled to the structure and function of ecosystems. In this study we applied a SES framework to Cobscook Bay, Maine, a productive boreal macrotidal estuary. Following the overfishing of the groundfisheries in the mid 20th century, towns in the Cobscook Bay region have lost thousands of jobs. Thus, we developed an integrated ecological-economic model to provide ecological and economic production potential estimates of three different commercially important shellfish species. We: 1) parameterized an Ecopath mass balanced food web model with existing primary literature data to estimate the ecological production potential; 2) developed several scenarios of ecological production — accomplished through either restoration or aquaculture; and 3) coupled the ecosystem food web model output with a regional input-output economic model using IMpact analysis for PLANning (IMPLAN) software. Our food web scenarios showed that shellfish biomass could be increased by 45 times without unbalancing the ecosystem food web. Our economic model suggests that the increase in shellfish biomass may result in an increase of the direct employment nearly 45 times. Our results suggest there is considerable ecological and economic potential for natural resource enhancement for the Cobscook Bay region. This work highlights the potential for SES work to inform policy and provides an important tool to guide stakeholder engagement activities.

LEARNING AND INFORMATION SHARING IN MAINE’S AQUACULTURE INDUSTRY

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Little is understood about how Maine aquaculture farmers learn and share information regarding farm management and practices. This limited knowledge has implications for how the industry operates in the state. The Sustainable Ecological Aquaculture Network (SEANET) seeks to support Maine’s aquaculture industry through the creation of an interdisciplinary sustainability science network that pursues research and development activities. In 2015, as part of SEANET, we conducted semi-structured interviews with 52 individuals involved in the Maine aquaculture industry including seaweed, finfish, and shellfish farmers, federal and state agency staff, and individuals who work for nonprofit organizations involved in aquaculture. Interviews were transcribed and analyzed using NVivo software to better understand learning among farmers, including the most important sources of information they rely on in making decisions about their farm. We report on farmer learning, information sharing and other elements that influence the success of individuals pursuing aquaculture. Farmers emphasized that experimentation is critical to the development of an aquaculture operation and a breadth of knowledge, from species biology to business management and marketing, is required to build a successful farm. Site selection, including the fine scale biological conditions, and the social context are other key elements to consider in order to be successful in farming. Gaining a greater understanding of these aspects of the industry and documenting farmers’ experiences could potentially support the growth of Maine aquaculture by sharing lessons learned with individuals interested in entering the industry or improving existing operations and in making recommendations to organizations that implement aquaculture training programs.
IDENTIFYING AND ADDRESSING PROCESS-RELATED CHALLENGES TO THE EXPANSION OF SEA VEGETABLE AQUACULTURE IN CONNECTICUT

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Interest in sea vegetable aquaculture in Southern New England is increasing, however, lack of federal guidelines regulating domestically cultivated sea vegetables poses a challenge to the expansion of this potentially new industry. The leading aquaculture regulatory agency in Connecticut requires guidelines be in place for any organism cultivated and processed in the state. Identifying and addressing potential hazards associated with the aquaculture and processing of sea vegetables will lead to established guidelines allowing for the sale of sea vegetables for human consumption. Objectives of this project will include the production of a hazards guidance document which will identify any biological, chemical, or physical hazards, associated with the production and processing of sea vegetables in Connecticut. In addition, companion GMPs, SOPs, and SSOPs will also be produced. Processing techniques on sea vegetables will be conducted to determine if and where hazards exist. In addition, investigations into processing facilities for sea vegetables in Connecticut will be conducted.

SCALLOP AQUACULTURE FORUM

Hugh Cowperthwaite, Coastal Enterprises, Inc. 2 Portland Fish Pier Suite 201, Portland, ME 04101

This seminar will provide an overview of scallop aquaculture efforts in Maine of the past 18 years. Participants will gain a better understanding of progress made regarding wild spat collection and various grow out techniques. Emphasis will be placed on current efforts that are underway in Maine to develop a robust scallop aquaculture industry for growers including techniques recently learned from Aomori, Japan. The presentation will include several video demonstrations of various equipment designed to handle high volume scallop production. The session will wrap up with an overview of future plans of grow out and equipment trails to demonstrate financial feasibility of scallop farming in New England waters as well as the production of a grower’s guide book to instruct farmers on how to grow scallops.

A SYSTEM AND METHOD FOR ONSITE SETTLEMENT AND RECRUITMENT OF SHELLFISH AND DEVELOPING REEF

Peter Danforth, Paul Matthews. Project SERV, Mattituck, NY 11952

The SSTS (Shellfish Set Trap System) is a system and method for developing a reef, and, more particularly, to a system and method for receiving shellfish in the veliger stage in a shellfish set trap system at the site of a reef, providing variable levels of protection, and incorporating the system into the reef. Project SERV (Spawning Early Release Vessel) and SUNY Southampton are currently investigating the benefits of the SSTS modules for oyster reef development. The modules are currently being set in Shinnecock Bay, NY. The results of this study show the outcome of setting 1 million pediveliger stage Crassostrea virginica (Eastern Oyster) on panels comprised of 80-120 cured oyster shell sandwiched between horse fencing and vinyl mesh in three separate occasions over the months of July to August 2015 in a 300 gallon hatchery raceway at the Great Atlantic Hatchery in Islip, NY. The SSTS modules were then delivered to the SUNY Southampton Marine Science Center located on
Shinnecock Bay, NY to overwinter off of their docks. The oyster size, number and health were monitored twice over the spring and summer of 2016. This is a presentation of the recent findings and recommendations for future projects.

THE IMPORTANCE OF PROTECTING SEEDED SOFT SHELL CLAMS (*Mya arenaria*) IN THE PRESENCE OF EUROPEAN GREEN CRABS (*Carcinus maenas*) IN SOUTHERN MAINE TIDAL MUDFLATS

Andrew Davidsohn, Carrie Byron. University of New England, 11 Hills Beach Road, Biddeford, ME 04005

Soft shell clams (*Mya arenaria*) hold 4% of the seafood market value in Maine, or 3% of the total poundage of seafood taken annually. In Maine, annual soft shell harvests have declined over 40 years by $30 million. At the same time, populations of invasive green crab (*Carcinus maenas*) have been increasing and are known predators of soft shelled clams. Recent work in eastern Maine demonstrates high predation rates of unprotected clams on mudflats by green crabs. However, little is known about the relative impacts of these invasive species compared to other predators in southern Maine mudflats. A field experiment was conducted to quantify survivorship of clams in the presence and absence of predators using different treatments: netting, flashing, and a control. For each of these three treatments, four plots of five replicate tubes (10 cm PVC) were arranged in Biddeford Pool mudflat, Biddeford, Maine. Netting, a typical method of protecting clams from crabs for commercial harvest, may also deter other predators, such as birds or fish. Aluminum flashing was used to create a 0.5 meter wall around four plots thereby excluding crabs but still allowing access to flying and swimming predators. Results show that netting was more effective in promoting clam survivorship than flashing with 84% clam survivorship compared to 63%, respectively. Interestingly, both exclusion methods (<1%) were equally effective compared to the open control plots (25%) in deterring green crabs, indicated by evidence of crushed shells, suggesting that clam populations are impacted by a diverse suite of predators.

DEVELOPMENT OF SEAWEED AQUACULTURE IN WASHINGTON STATE TO EVALUATE CAPACITY TO INFLUENCE SEAWATER CHEMISTRY, HABITAT POTENTIAL AND TO PROVIDE LOCAL FOOD AND FUELS

Joth Davis, Betsy Peabody. Puget Sound Restoration Fund, 382 Wyatt Way, NE, Bainbridge Island, WA 98110

A pilot-scale seaweed culture project in Puget Sound is under development to evaluate the capacity for aquaculture of sugar and bull kelp to influence seawater chemistry associated with ocean acidification, to provide habitat for macro-invertebrates and fishes and to provide biomass for food and fuel development potential. Project partners include the University of Washington, WDNR and NOAA Pacific Marine Environmental Laboratory and NOAA Manchester NW Fisheries Science Center where a seaweed cultivation laboratory has been established. A one-hectare area of kelp growing from the surface to 3 meters is being developed in 2017-2018 in north Hood Canal to evaluate carbonate chemistry measurements (pCO2, pH, DOC, DIN, O2, DO2) and salinity in surface seawater upstream and downstream of the kelp field. It is expected that production during daylight and respiration during the night will strongly influence carbonate chemistry variables, however little is known about the net
effect on ocean chemistry at this scale of cultivation. Modeling of seaweed production coupled with changes in chemistry variables will help inform the potential for using this approach to mitigate OA in other locations. Additional research will be conducted with marine organisms to evaluate comparative shell dissolution in pteropods placed upstream and downstream of the kelp field and on utilization of the seaweeds and structure for habitat. Additional work is ongoing to evaluate the potential for fresh sugar kelp in the local market place for sea vegetables and to provide substrates for local biogas production and fertilizers.

ROCK SCALLOP AQUACULTURE POTENTIAL ON THE PACIFIC COAST OF NORTH AMERICA

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Diversification of the shellfish industry on the US West coast is important to alleviate uncertainty associated with production trends for other commercial species. The purple-hinged rock scallop (*Crassadoma giganteus*) is a large scallop native to the North American west coast. It’s large size, relatively rapid growth, and wide natural distribution makes it an excellent candidate for culture, especially in the mid and southerly portion of its range. Larval, seed and juvenile growout techniques are under development for both diploid and triploid scallops; larval scallops are amenable to standard rearing techniques so long as diatoms (*Chaetoceros spp.*) and the red algae, (*Rodomonas salina*) are included in the diet. Juvenile growout is sensitive to density with scallops growing rapidly at 400 scallops per M2. Growout is relatively rapid with scallops attaining a shell length of 100mm after three seasons in Puget Sound. Additional research is planned on bioxin uptake, retention and detoxification in this species in 2017. Technologies to accommodate the behavior associated with the cementation stage for rock scallops will be discussed as well as prospects for developing a new aquaculture industry sector on the US west coast. A viable shellfish industry in the United States is critical to maintain rural economies that are dependent on marine resource development and working waterfronts and scallop culture can contribute to the range of species presently in aquaculture production.

SEAWEED PRODUCTION IN CONNECTICUT: AN INTERAGENCY EFFORT TO ESTABLISH PERMITTING GUIDANCE FOR SEAWEED INTENDED FOR HUMAN CONSUMPTION

Kristin DeRosia-Banick¹, David Carey¹, Anoushka Concepcion², Nancy Balcom², Tessa Getchis², Frank Greene³, Jenna Nicol³, Tracey Weeks³, Christine Applewhite⁴, Brian Toal⁵, Gary Ginsberg⁵. ¹Connecticut Department of Agriculture, Bureau of Aquaculture, P.O. Box 97, Milford, CT 06460; ²Connecticut Sea Grant, University of Connecticut, 1080 Shennecossett Road, Groton, CT 06340; ³Connecticut Department of Consumer Protection Food Program 165 Capitol Ave. Hartford, Connecticut 06106; ⁴Connecticut Department of Public Health Food Protection Program 410 Capitol Ave. Hartford, CT 06106; ⁵Connecticut Department of Public Health Environmental and Occupational Health Assessment, 410 Capitol Ave. Hartford, CT 06106

Seaweed production is an emerging aquaculture industry in the Northeast. The Connecticut Department of Agriculture Bureau of Aquaculture (DA/BA) is the lead agency for Aquaculture permitting in Connecticut, and has issued a number of seaweed aquaculture permits since 2012. Several state
agencies are involved in seaweed aquaculture permitting in terms of food processing and food protection, including the Department of Agriculture, the Department of Consumer Protection and the Department of Public Health. Based on a review of available literature and consultation with the Food and Drug Administration’s (FDA) Center for Food Safety and Applied Nutrition (CFSAN), seaweed is considered a Generally Recognized as Safe (GRAS) food when used as a spice, seasoning, or flavoring. When sold as a raw or processed sea vegetable product, the serving size would be significantly greater and it is appropriate to assess potential human health hazards that may be associated with the consumption of seaweed species cultivated in Long Island Sound.

The interagency group has used data gained through research and field studies to conduct a hazard analysis of the cultivation and production processes, which have been used to guide policy and recommendations for seaweed production in Connecticut. Guidance and permitting requirements vary depending on the end use of the product, a raw agricultural commodity or processed seaweed commodity. Permitting agencies in Connecticut conduct sanitation inspections of producers and have recommended seaweed producers follow Best Management Practices (BMPs) and HACCP in order to ensure the quality and safety of seaweed produced for human consumption.

EVALUATION OF A SUBMERSIBLE MUSSEL RAFT FOR USE IN SEMI-EXPOSED SITES

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The performance of a submersible mussel raft was analyzed using wave tank testing, numerical modeling, and full-scale field deployment. When submerged, the raft’s pontoons are flooded, and it is held vertically by lines attached to surface floats and horizontally by a spread mooring. This submerged configuration is used to reduce wave forcing and to avoid contact with floating ice during winters in northern waters. During the prototype design process, numerical modeling indicated that the submerged configuration exhibited significantly less heave (vertical) and pitch (rotational) motion than the surfaced configuration. Subsequent 1/10 Froude-scaled wave tank testing validated those predictions. Full-scale field tests, each about three weeks long, provided 6-degree-of-freedom motion and mooring load data for a variety of wave and current forcing conditions. This data set confirmed that the submerged raft oscillates with significantly smaller heave and pitch amplitudes than the surfaced raft for wave periods of interest (generally between 2 and 8 seconds). The submerged configuration greatly decreases vertical velocities and accelerations of the mussel rope attachment points, reducing feeding interruptions and mussel drop-off in storms. Consequently, harvest from the submerged raft was approximately 300% of typical harvests from surface rafts.

MEDIA ANALYSIS OF MAINE AQUACULTURE COVERAGE

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As aquaculture is increasingly touted as a sustainable solution to offset production declines in wild-caught fisheries, it is further driven into the public sphere through mediated content. The media serves as one critical repository for content about emerging “technologies” like aquaculture. Newspapers, especially those in rural industry-based communities, provide public audiences with baseline scientific information. As such, they are part of the local public discourse and aid in public opinion formation. Newspapers can amplify or attenuate public- or industry-related concerns by varying thematic content and source selection. To account for this influence, we will employ a content analysis of Maine newspaper coverage. We will examine aquaculture coverage (N = 505 articles) across five local newspapers for a fifteen-year period (2000-2015), comparing discussions about risks, benefits, research, economics, governance, aesthetics, and environmental sustainability. We expect to see differences within and between state papers, suggesting that variation in the aquaculture discourse may depend on the news organization, geographic focus, and/or period of publication. We will also reveal whether critical events such as public lease hearings play a role in orienting coverage for public consumption and opinion formation. Presently, we have identified and cleaned our sample. We trained independent coders and have begun formal reliability testing. This analysis will supplement past research on national newspapers’ coverage of aquaculture and inform the protocol of an upcoming study linking journalist perceptions with news coverage.

ACQUIRING MOLECULAR TOOLS FOR ADVANCING THE OYSTER GENETIC SYSTEM

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Ocean acidification, global warming, and diseases are threats to both fisheries and aquaculture. During the last decades, most genetic studies on the eastern oyster, Crassostrea virginica, have focused on understanding and ameliorating the impact of infectious diseases on oyster populations. To determine the genetic basis for resistance to diseases or other highly desired traits for aquaculture, a consortia of genome experts and the oyster research community is in the process of sequencing, assembling, and annotating the first reference genome for the eastern oyster. These efforts will help identify candidate genes involved in ecologically and economically important traits. Traditional breeding is an inherently slow approach for oyster strain selection. It requires crosses of oyster strains and numerous generations are needed to achieve the goals and not always the specific gene(s) responsible for a desired trait is identified; hence, making difficult later attempts for improving the available strains. With the genome of the Pacific oyster Crassostrea gigas already available and the genome of C. virginica underway, it is imperative to develop a genetic system that can interrogate the genes involved in different aspects of the oyster’s biology, from defense to shell formation. Here we discuss how to work towards the first stages of development of such a genetic system. Developing a genetic system for the eastern oyster would provide the necessary tools for testing the role of genes in disease resistance and adaptations to environmental and other stresses (e.g. global warming and ocean acidification).
CO-CULTURE OF BLUE MUSSEL (MYTILUS EDULIS) AND SUGAR KELP (SACCHARINA LATISSIMA): EXPLORING THE POTENTIAL OF SEAWEEDS IN DETERRING THE EFFECT OF DUCK PREDATION ON MUSSELS, CASCAPIEBA BAY (QC, CANADA)

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In Europe and Canada the economic losses in blue mussels (Mytilus edulis) farms due to duck predation represent a major problem. In this project, an alternative approach will be presented that aims to reduce duck predation in mussel-farms as traditional techniques are not effective in Quebec. These methods are generally either focusing on protecting mussels by isolating them in net or cages, or using active repelling techniques (sound, light, etc.). These techniques are often expensive, stressful to the duck population, only effective for a short time and do not take into consideration drifting ice. To solve this problem, the presented project intends to introduce the brown algae (Saccharina latissima) in co-culture over the mussel floating line, to visually shield the mussels. The hypothesis is that by hiding the mussels from ducks vision field, it will protect the production without imposing further stress on the ducks. Additionally, it is expected that the brown algae and blue mussels could benefit from each other by the spatial proximity in terms of production, consumption and excretion. This experiment beginning in august 2016 will be observing the resulting growth (biomass \ meter), survival rate (density \ meter) and overall mussel quality (Body condition Index).

SCRATCHING THE SURFACE: A SENTINEL EXPLORATION OF SEA LOUSE INFESTATIONS IN COBSCOOK BAY, MAINE

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Cobscook Bay is a tidally energetic system (tidal range ~5.7 m and tidal velocities > 2 m s-1) comprised of cool waters (annual mean of 10°C) capable of supporting marine aquaculture. The bay has three active Atlantic salmon Salmo salar farms in close proximity to Passamaquoddy Bay and New Brunswick, Canada. A high volume of tidal exchange also passes through the narrow channels of Cobscook Bay and produces a unique hydrodynamic environment. This research focuses on establishing sea louse infection trends and explores local mechanisms of transport and infestation to better define sources of infectious pressure. It is hypothesized that the degree of water connectivity between regions and unique properties of sampled sites nurtures infestation.
Sentinel cages were strategically placed in Cobscook Bay between June 2013 and June 2015. A total of 272 juvenile Atlantic salmon were deployed for seven days once a month to capture viable infectious pressure. All sites had a prevalence of 70% or greater by May, reaching 100% in late summer, which was maintained through the fall of sampled years. The earliest and highest rates of infestation were observed at Pembroke Landing (p < 0.05; Kruskal-Wallis Test), furthest from active farm sites. Temperature and salinity data were similar between sampled sites, but current velocities were significantly different. The greater levels of infestation observed at Pembroke Landing may be associated with the site’s unique water current profile, providing insight for future modeling and pest management strategies.

FARMER TO FARMER: WHAT WORKS AND DOESN’T WHEN IT COMES TO BIOFOULING CONTROL

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This hands-on workshop will focus on new science-based and farm-tested remedies for biofouling. Attendees will be provided a brief overview of the various organisms that cause problems for aquaculture gear, animals, and operations, be informed of the massive economic impacts on global aquaculture, and introduced to new promising remedies. Aquaculture producers from east and west coast will present the results of the field trials on their farms. Participants will have the opportunity to view coated and uncoated gear pieces, and ask farmers about their experiences with the different antifouling coatings. Researchers will be on hand to listen to suggestions with respect to product development and future directions for biofouling research and to answer questions.

WHAT IS THE FUTURE OF CONNECTICUT SHELLFISH?

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The Connecticut Shellfish Initiative is a stakeholder-based planning effort to grow and protect jobs, recreation and shellfish habitats, and to increase public awareness of the importance of these. For the past three years, a diverse group of shellfish interest groups have met to discuss and record broad recommendations to this end. The result of that effort is a document that not only identifies priority issues, but also provides context for broader public understanding about Connecticut shellfish and shellfisheries. Many successful efforts have been made, and are continuing to generate enthusiasm about the State’s shellfish heritage and its promising future. The next step is to draft an implementation plan. Several small committees will be formed to develop specific strategies for action for each recommendation, and to identify ways to measure and report on successes.
MAINE OYSTER PATHOGEN ZONATION

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Under current regulatory requirements for intra- and inter-state movement of bivalve shellfish for aquaculture purposes, American oysters (Crassostrea virginica) are typically screened for shellfish pathogens on a case-by-case basis, providing patchy data. Testing may also not always address agents of concern for international movement. Due to these factors and the availability of limited pathogen surveillance data, large information gaps exist on oyster pathogen prevalence in Maine, often making industry, regulatory and trade decision-making difficult. Under a cooperative relationship between the Maine Aquaculture Association, Kennebec River Biosciences and the United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) Veterinary Services (VS) Science and Technology Analysis Services (STAS) Center for Epidemiology and Animal Health (CEAH), pathogen screening was conducted on aquaculture and wild oyster populations (including Ostrea edulis) along the Maine coastline in order to develop a pathogen zonation plan for Maine. Objectives consisted of demonstration of pathogen/disease freedom and estimation of pathogen prevalence for pre-determined zones, and improvement of testing error estimation for specific pathogens. Calculations of sample size and disease freedom determination were based upon a beta-nomial Bayesian model. Testing consisted of histology, thioglycollate culture and agent-specific PCR. Findings are presented and discussed.

IMPROVED SITING OF KELP AQUACULTURE USING N15 STABLE ISOTOPE ANALYSIS

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Interest in farming seaweed using aquaculture techniques has skyrocketed in the Americas and Europe. More research is needed to determine how land use along urbanized coastlines in these areas could influence siting of seaweed farms. The objective of this study was to test if nitrogen isotopes measured in the tissue of sugar kelp (Saccharina latissima) grown in strategic locations could be used to improve siting of future kelp farms. Saco Bay, Maine was selected as the field site for this study because it is akin to many developed coastlines. It has a strong tourism industry, historic industrial operations, and it receives water from a major river, effluent from six wastewater treatment plants, water from tidal pools and salt marshes, and runoff from residential developments.

Buoys were deployed along two perpendicular transects in Saco Bay and mature kelp was attached to each buoy, along with temperature, light, and salinity sensors. Tissue samples were collected from the kelp every two weeks, and following rain events greater than 1 in. Samples were excised from the meristem, mid part, and distal tissue of the kelp and analyzed for their N15/N14 ratio. These results were compared with effluent data from the area’s wastewater treatment plants and discharge measurements from the Saco River in a spatial analysis tool to identify relationships between predicted dispersion of anthropogenic nitrogen and observed nitrogen isotope ratios in kelp grown on the buoys. Results from this and other parallel efforts may help to inform management plans for seaweed aquaculture along urbanized coastlines.
CAN THE BAY SCALLOP, *ARGOPECTEN IRRADIANS* BE SELECTED FOR HIGHER MEAT YIELD?

Emma Green-Beach. Martha's Vineyard Shellfish Group, Inc., 220 Weaver Lane, Vineyard Haven, MA 02568

On Martha's Vineyard, Massachusetts the working waterfronts are kept alive in part by the wild bay scallop fishery. In an effort to support the fishery and the significant economic supplement it provides to island towns, we investigated the potential to selectively breed bay scallops for larger adductor muscles. A resultant higher meat yield per harvested bushel of scallops should increase the dollar value of each commercially harvested limit.

Previously selected broodstock were spawned in the summer of 2015 and grown alongside a control group. Both groups were grown in Sengekontacket Pond and Menemsha Pond by the Edgartown and Chilmark shellfish departments, respectively, until November 2017. Two grow out sites were chosen both to ensure some scallop survive to the project’s end, as well as to possibly address site-specific or general environmental influence on muscle size, which clearly do exist. In November 2017 scallops were retrieved from both grow out sites, measured, weighed and shucked. Results on the potential to select bay scallops for higher meat yield will be presented.

HARVESTING THE INVASIVE REED, *PHRAGMITES AUSTRALIS* AS A POTENTIAL NITROGEN MITIGATION STRATEGY: PROGRESS OF THE FIRST FIELD SEASON

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Degradation of marine habitats by nitrogen eutrophication is a worldwide problem and has become one of the biggest challenges to shellfish restoration. Motivated by the need to improve water quality in order to reach our shellfish restoration goals, this project was designed to employ the competitive nature of this ubiquitous salt marsh plant to remove nitrogen from our estuaries. *Phragmites australis* is highly invasive in North America and outcompetes native vegetation, alters nutrient and water cycles, and excludes native animals. However, there is scientific evidence that *Phragmites* provide important ecological services, especially sequestration of nitrogen. This characteristic is exploited for nutrient management in eutrophied estuaries and lakes in other parts of the world, as well as in stormwater ditches and wastewater treatment applications.

Harvesting *Phragmites* offers an especially favorable means for bioextraction for these reasons: 1) *Phragmites* are known for their ability to assimilate nutrients and thrive in high nutrient environments. Their roots penetrate 6 feet deep and thus intercept both nitrogen rich groundwater and surface runoff. 2) *Phragmites* are abundant in the riparian zone of some ponds. The large amount of biomass could be harvested time and time again without the need to replant, cultivate or maintain, such is the case with cultured oysters or macroalgae. 3) *Phragmites* are an invasive species, and as such, harvest of the above ground biomass should require minimal permits compared to native vegetation. 4) Harvested *Phragmites* could potentially be utilized as a high N component in compost, turned into burnable pellets for biochar production or as a local, sustainable feed source for livestock. We will report on the progress made to address these aspects of *Phragmites* harvest for nitrogen mitigation.
REMOTE-SETTING EYED LARVAE OF THE BLUE MUSSEL, *MYTILUS EDULIS*, FOR SEED PRODUCTION

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Remote-setting technology for hatchery-produced eyed oyster larvae has enabled the efficient setting of larvae close to grow-out sites. The hatchery production of blue mussels would likewise benefit from the development of methods that would facilitate the setting of eyed larvae on grow-out ropes near grow-out sites remote from the hatchery.

To determine whether mussels would be amenable to remote setting, about 4 million eyed mussel larvae produced in the Martha’s Vineyard Shellfish Group Hatchery in October 2015, and were transported and released into tanks supplied with bag-filtered raw seawater at four sites away from the hatchery; one at indoor tanks at the Hughes Hatchery in Oak Bluffs, two in indoor tanks at Roger Williams University, and two in outside tanks on docks in Woods Hole and Menemsha Harbor. Mussel spat successfully attached to rope collectors at all sites and were cultured on a diet of both live (wild) and preserved phytoplankton. One group of eyed larvae tolerated being refrigerated out of water for about 18 hours prior to placement in the set tank. The Downeast Institute developed a remote settlement system using a solar array to keep the culture temperatures optimum for seed growth. Just prior to being field planted in December 2015 the mussel spat measured 2.6 mm on average. The results of those field plantings and additional remote setting trials conducted in Fall 2016 will be compared.

APPLYING ENGINEERING PRINCIPLES TO THE DESIGN OF RECIRCULATING AQUAPONIC SYSTEMS

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Aquaculture is agriculture, and agricultural systems may achieve economically sustainable production by integrating with other production systems. Integrated farming systems improve energy and resource utilization and offer an opportunity to monetize otherwise costly treatment processes. Integrated aquaculture farming systems (IAFS) are an ideal integrated farming model which produce fish and plants for food locally and sustainably. IAFS restructures the typical recirculating aquaculture production and waste stream treatment from an end-of-pipe treatment model to an internalized, integrated production process flow.

The overall goal of this research is to establish design and operational parameters, from an engineering perspective, for the development of IAFS. The project will characterize the processes critical to the integration of two traditionally separate production systems (hydroponics and recirculating aquaculture) and focus on developing an optimized, ‘engineered’ production system design which addresses water treatment requirements, productivity, and food safety.
The study is ongoing and is focusing on optimizing the production of food fish (e.g. tilapia, striped bass) and one or more type of food plant(s) (e.g. lettuce, herbs to start) in a controlled environment agricultural production setting. This research will establish the plant-available nutrient production rate from RAS using three different protein content feeds, develop a mechanism for liberating and reclaiming plant-available trace/micro-nutrients from the particulate effluent, and quantify the effect on plant nutrient uptake rates in a recirculating aquaponic system. This goal forms the foundation for the development of an economically sustainable, small and mid-size agricultural-based production model that can improve small, rural farming practices.

**INVESTIGATIONS INTO PRODUCING A NEW SUSTAINABLE CROP ON THE ISLAND OF MARTHA’S VINEYARD, THE SUGAR KELP SACCHARINA LATISSIMA**

**Amandine Surier Hall, Christopher Edwards.** Martha’s Vineyard Shellfish Group, Inc. PO Box 1552, Oak Bluffs MA, 02557

Although the states of Maine and Connecticut have been pioneering sugar kelp culture for years, developing complex farming and processing infrastructures as well as establishing permitting and handling procedures, Massachusetts is only now starting to consider this new crop’s potential. In November 2014, under funding from the Edey Foundation, the Martha’s Vineyard Shellfish Group started developing a spore seed-stock nursery at the state-owned Hughes Hatchery, on the island of Martha’s Vineyard. In November 2015, spools of healthy juvenile sugar kelp plants were produced. Two were deployed on an oyster lease site in the town of Oak Bluffs and one was suspended off our shellfish hatchery dock. Two additional spools were deployed in Rhode Island, one at a shallow site and the other on a mussel farm. All sites performed differently. To our surprise, the best growth was observed at the shallow site in RI. Both our island sites performed poorly. This 2016 season, with rising interest from shellfish growers and investors all along the MA coast, regulations and permitting procedures are being drafted. Our seed stock nursery is expected to produce more spools to satisfy the rising demand. We also hope to deploy lines at a variety of sites on island to get a better understanding of the optimal conditions needed to farm kelp.

**COASTAL GENTRIFICATION’S IMPACT OF AQUACULTURE EXPANSION: A COMPARATIVE ANALYSIS OF THREE BAYS IN MAINE**

**Sam Hanes.** Department of Anthropology, University of Maine, Orono, ME 04469

This study examines the impact of coastal gentrification on aquaculture expansion. Gentrification usually refers to the movement of higher income residents into inner cities, but an analogous process happens in rural areas. Newcomers, dubbed “amenity migrants,” move into rural areas primarily seeking scenic beauty. These areas historically have natural resource based economies, and the amenity migrants’ relationship to prior residents is complicated their different perspectives on resource use. Public acceptance can be a major impediment to aquaculture expansion, and this is especially true in areas where amenity migrants have made significant investments to enjoy coastal property. This study presents a comparative analysis of three major aquaculture regions in Maine, two of which are heavily gentrified, and seeks to explain varying levels of opposition in them. Our primary data source is over 200 aquaculture lease hearing transcripts, which were coded for qualitative analysis. We find that the
least gentrified of the regions had little conflict, despite it having far more finfish farms. The other two regions have extensive gentrification, and both have mostly shellfish farms, but levels of conflict are quite different. Due to divergent histories of how aquaculture developed in each region, amenity migrants in one of the regions had a much easier time fitting aquaculture into their coastal aesthetic and came to see it as part of Maine’s artisanal fishing activity. The study highlights the importance of understanding how amenity migrants come to fit aquaculture into their vision of an ideal seascape.

**BACK TO THE BIG OYSTER**

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New York City residents are reconnecting with their aquatic environment and oyster-rich heritage, but naturally occurring oysters are still elusive. If restored at large scales oyster filter feeding can help clarify waters while reef structures provide a home for hundreds of species, including nursery habitat for commercially harvested fish, and also attenuate storm surge. But large scale oyster restoration in waters closed to harvest poses challenges that are both biological and social: restored populations need genetic resilience to climate change in order to sustainably provide the estuarine resilience that comes with elevated biodiversity. Devising a win-win regulatory framework that builds oyster stocks in closed waters while protecting public health and the legal harvest industry requires stakeholder trust, imagination and will. Survey data among shellfish harvesters and restoration volunteers show that support for restoration is less a factor of stakeholder group identification and more related to the perceived risks to public health and the economy, and perceived ecosystem services. Our work explores these challenges and attempts to start a data-informed conversation about how large scale oyster restoration can be successful in New York, New Jersey, and beyond.

**DESIGNING A RECIRCULATING SEAWATER SYSTEM TO EXPLORE IMPACTS OF OCEAN ACIDIFICATION ON COMMERCIALLY IMPORTANT SPECIES**

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Increases in anthropogenic input of carbon dioxide into the atmosphere have resulted in widespread patterns of ocean warming and acidification, which may have major impacts on commercial fisheries and aquaculture. Ocean acidification (OA) may pose a particular threat to marine calcifying invertebrates, but the full consequences are still unknown. In the State of Maine, commercial fisheries landings and a growing aquaculture industry have a combined value in excess of $600 million, 75% of which is sustained by marine calcifiers. It is therefore critical to understand species-specific impacts of OA to sustain these economically important industries. Here, we describe a pilot study in which we designed a recirculating seawater system to explore the physiological impacts of OA on a model calciferous organism, the American lobster (*Homarus americanus*). We used Honeywell Durafet pH electrodes in combination with a LI-COR® LI-840A CO2/H2O gas analyzer and a PENTAIR Point FourTM RIU to monitor and maintain a constant pH of 7.6 across four replicate OA treatment tanks and
a pH of 8.2 across four replicate control tanks. Following the best practices available, we assessed temperature, dissolved oxygen content, salinity, ammonia, and nitrite twice daily, measured total alkalinity bi-weekly via titration, and used the program CO2SYS to calculate carbonate chemistry within each tank. Our study increases our knowledge on the potential use of recirculating seawater systems in the context of OA research, and makes suggestions for improvements on the design that will allow it to be applied to other commercially important species in Maine.

APPLYING SURVEILLANCE AND SEASONAL TREND ANALYSIS TO IDENTIFY CONDITIONS THAT INFLUENCE V. PARAHAEOMOLYTICUS CONCENTRATIONS IN NEW ENGLAND SHELLFISH

Meghan Hartwick12, Erin Urquhart23, Cheryl Whistler12, Vaughn Cooper24, and Steve Jones256.

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Vibrio parahaemolyticus and associated environmental condition surveillance and monitoring in the Great Bay Estuary, located in New Hampshire, US, has been on-going since 2007. This dataset provides a unique, long-term view of the trends and conditions that accompany the intra and inter-annual variation of V. parahaemolyticus concentration in oysters in a Northeast US shellfish growing area. We have built on our own and related recently published approaches to predict V. parahaemolyticus occurrence in oysters, to improve methods for modeling and forecasting V. parahaemolyticus concentrations in oysters and the surrounding ecosystem. Through the application of the emerging recognition that both seasonality and non-linear predictive parameters can have a large effect of the outcome of data analysis, we have developed improved approaches for analyzing and modeling this long-term data. The results of these analyses demonstrate the potential of trend analysis using times series and non-parametric methods to identify both temporal and environmental condition targets for focused mechanistic investigations that lead to more accurate predictive capabilities. While the construction of effective forecasting models imposes a simplified view of complex systems, we demonstrate here that by expanding upon traditional statistical approaches, we can both investigate the biological underpinnings of V. parahaemolyticus concentration variation and develop more robust predictive tools for informed shellfish harvesting practices that minimize or eliminate public health concerns.

HEMOCYTIC NEOPLASIA IN HARD CLAMS, MERCENARIA MERCENARIA: TRANSMISSIBILITY OF NEOPLASTIC CELLS

Katie Heisler, Kiserian Jackson, Abigail Scro, and Roxanna Smolowitz. Aquatic Diagnostic Laboratory, Roger Williams University, One Old Ferry Road, Bristol, RI 02809

In the summer of 2009, numerous 2-3 year old adult hard clams (Mercenaria mercenaria) in Wellfleet, MA began to surface and die. Pathological evaluation identified a new neoplastic disease, termed hemocytic neoplasia (HN). Examination of a sample of hemolymph (blood) from the pericardial sac of
affected animals showed few to abundant large, unusual cells. These tumorous cells caused significant obstruction of the vascular system and a loss of normal hemocytes. There was no histological or epidemiological evidence that suggested the causative agent was bacterial, fungal, or toxic in origin leading to the hypothesis that it is caused by a viral agent. Preceding studies in soft clams and cockles have successfully been able to transmit a similar neoplastic disease present in each species into naïve animals of the same species by injecting them with abnormal circulating cells from the affected animals (Oprandy et al, 1981 and Taraska and Böttger, 2013). This study attempted to repeat the transmission experiment in M. mercenaria however, while a change in cell characteristics was observed, the disease itself was not successfully transmitted. Knowledge of transmissibility of the disease in hard clams will be vital to its containment which could significantly impact the fishery and aquaculture industries.

DYNAMIC ESTUARINE CONDITIONS AND NITROGEN LOADING: HOW DO THESE FACTORS IMPACT THE GROWTH, SURVIVAL AND FUNCTION OF C. VIRGINICA?

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Coastal ecosystems provide significant ecological, commercial, and cultural value to the human population. As we continue to negatively impact these systems, particularly through nitrogen loading and climate change, a more thorough understanding as to how marine organisms will respond to a combination of stressors is needed. Rhode Island in particular has an invested interest to the Eastern Oyster, *Crassostrea virginica*, as its waters support many aquaculture businesses. The goal of this study was therefore to test how dynamic estuarine conditions (i.e. temperature, salinity chlorophyll a, and dissolved oxygen) affect the impact of nitrogen loading on the growth and mortality of *C. virginica*. This field experiment was conducted within Point Judith Pond in Narragansett, Rhode Island, by deploying oyster cages enriched with organic nitrogen, paired with cages left at ambient conditions at two sites, Billington Cove Marina and Bluff Hill Cove Oyster Farm, which are located in contrasting portions of the estuarine gradient. Water quality parameters were monitored, as well as growth and mortality measurements made over the course of four months. Preliminary results suggest that tidal influence has a greater influence on growth rate, then does short term nitrogen loading. Mortality was similar across all treatments and locations. Additionally, pilot studies indicate that oyster denitrification rates will increase with increasing nitrogen loads, however \(\text{N}_2\text{O}\) emissions appear insignificant at this time. Future experiments for this study will investigate how these environmental factors will affect *C. virginica*’s susceptibility to common protozoan and bacterial pathogens.

OCEAN ACIDIFICATION: WHAT IS IT, WHY DOES IT MATTER, AND HOW CAN IT BE MEASURED?

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Acidified environmental conditions, which stem from multiple processes, present a potential challenge to aquaculturists both now and in the future. This is a relatively new concept, and the scientific community is just beginning to produce data detailing acidification trends and conditions, as well as the specific effects of acidification on certain species. These data could be used by aquaculturists to determine their own vulnerability to acidified conditions; however, the technology to reliably and accurately monitor conditions has not been widely available to operators. In this talk I will discuss the basics of monitoring acidification, as well detail efforts to make quality data more available to individual aquaculturists and to the broader aquaculture community in general.

HEMOCYTIC NEOPLASIA IN HARD CLAMS (*MERCENARIA MERCENARIA*): ASSESSMENT OF NEOPLASIA THROUGH FLOW CYTOMETRY

Kiserian Jackson, Katie Heisler, Abigail Scro, Roxanna Smolowitz. Aquaculture Diagnostic Laboratory, Roger Williams University, Bristol, RI 02809

In 2009 a disease known as hemocytic neoplasia was found to be the cause of death for hard clams (*Mercenaria mercenaria*) in Wellfleet Massachusetts. This poses a problem as the mortality of the clams could lead to a notable impact on the fisheries and aquaculture farms in the area. Hemocytic neoplasia is responsible for the formation of large, abnormal cells characteristic of a large nucleus and a high nucleus to cytoplasm ratio. These abnormal cells clog the vascular system of the animal leading to mortality. Neoplasia can be typically diagnosed by hemocytology and histology. Both are efficient methods to determine if the disease is within adult clams and histology is believed to be the most efficient and costly method. Clams with neoplasia typically have tetraploid DNA while healthy clams display diploid DNA. Ploidy level is believed to increase with the severity of the disease. Ploidy was observed using Flow Cytometry to aid in identifying Neoplasia in clams collected from Wellfleet, MA. To determine a diagnosis of neoplasia 20% of the hemocytes in the blood need to be in the S-4N stages. Out of the 26 samples, 25 tested positive for neoplasia diagnosis and 1 sample tested negative. Flow cytometry displayed its effectiveness in diagnosing the disease of neoplasia in multiple samples at once. The information gained from this study can help track the transmission of the disease and lead to containment.

FACTORS INFLUENCING CATCH RATES OF TRADITIONAL EEL TRAPS IN THE ST. JOHN RIVER, NEW BRUNSWICK

Aruna Jayawardane. Maliseet Nation Conservation Council, 150 Cliffe Street, Fredericton, NB Canada E3A 0A1

A study was conducted in the St. John River, NB (Canada) to evaluate the influence of operational and environmental parameters on the catch rates of eel traps targeting American eel (*Anguilla rostrata*) in 2012. Influence of fishing depth, soaking time and water temperature on catch rates of eel traps was evaluated using a multifactor Analysis of Variance (ANOVA) model formulated based on Bayesian Statistics using WinBUGS, software. An analysis was also conducted to check the model for assumptions. Baited eel traps were randomly deployed varying depth (3.66 and 7.62m) in each sampling week. Information on water temperature of the river was obtained from the DFO fish way at Maetauac Dam. Traps were randomly retrieved after 24, 48 and 72 hours of deployment and weight of the catch was determined. A stepwise process based on Deviance Information Criterion (DIC) was used to
formulate an effective model to explain the variability of catch rates of eel traps. The best model formulated using above strategy contained the factors, temperature, soaking time and the interaction term between above factors. There were no substantial problems existing in terms of the normality assumption (chisq.F2.p=0.5225, ks.p=0.6). The formulated model did not violate the symmetry and the mesokurticity assumptions of the distribution (gb.p[1]=0.5965, gb.p[2]=0.72). The model estimated highest catch rates (3.9 kg hour-1) for eel traps soaked for 48 hours in water temperatures >20 °C and the lowest catch rates (0.65kg hour-1) for traps soaked for 24 hours in temperatures <20 °C.

UNDERSTANDING SOCIAL CARRYING CAPACITY IN MAINE’S AQUACULTURE INDUSTRY

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Sustainable ecological aquaculture is expected to create a new direction for working waterfronts threatened by the loss of traditional marine fisheries and other social-ecological changes. In Maine, working waterfronts are embracing aquaculture as a way for fishermen to diversify their livelihoods. However, the growth of aquaculture in a place is often limited by its social carrying capacity, or the amount of aquaculture development that can be supported in an area that does not result in negative societal impacts. We operationalize this concept in terms of conflict levels reflecting social acceptance and draw on a multi-scale, social-ecological systems framework to understand the complex social and ecological factors driving social carrying capacity across key sites in Maine. Using a mixed methods research approach, we compare levels of conflict seen as aquaculture has developed in Maine and seek to explain the variation observed. Understanding factors influencing the social carrying capacity can aid decision-making needed for the sustainable development of this industry.

ASSESSING OPPORTUNITIES FOR AQUACULTURE IN SHELLFISH GROWING AREAS ADJACENT TO WASTEWATER TREATMENT PLANT OUTFALLS: DETERMINATION OF VIRAL REDUCTION PERFORMANCE, IMPACTS ON SHELLFISH SAFETY AND INFORMING HARVEST MANAGERS

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This research project addresses current limitations for shellfish aquaculture and harvesting in potentially productive areas in the vicinity of wastewater treatment plants (WTPs). The project will develop 1) a standardized methodology for evaluating the effectiveness and consistency of WTP treatment of viral pollutants and 2) guidance to states on the application of this methodology to shellfish growing area classification and managing harvest restrictions around WTPs. Initial progress on the methodology applied to a variety of WTPs under varying treatment conditions will be presented. Project outreach will include key stakeholder groups (shellfish harvesters, aquaculturists, processors and resource managers) and provide guidance on the methodology and its implications for management. Safely managing existing shellfish growing areas and developing a regulatory path for the safe expansion of aquaculture
will create additional opportunities for the shellfish industry. This project will enhance economic, employment and environmental benefits in shellfish aquaculture and is a collaborative effort administered by NH Sea Grant, with CT Sea Grant extension, FDA, State of CT, State of NH, and Spinney Creek Shellfish Inc. contributing.

SHELLFISH AND COASTAL WATER CONTAMINATION FROM BIRD FECES

S. Jones¹,², D. Rothenheber³

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Although it is less of a public health concern compared to human fecal contamination, shellfish and overlying water contamination from birds is a concern due to the potential for human pathogens to be discharged with bird feces. Bird feces can contain high levels (10⁵ to 10⁷ per g) of bacteria used as indicators of fecal contamination and thus can affect classification of water quality in shellfish production areas when birds are abundant. Microbial source tracking (MST) methods have been used in many studies in northern New England to identify and determine the significance of birds as sources of fecal pollution to enable improving water quality by eliminating pollution sources. Earlier MST studies employed the use of Escherichia coli ribotyping while more recent studies use PCR detection of genetic markers specific to source species, like birds, to identify and quantify sources of fecal contamination. Studies in Maine, New Hampshire and Massachusetts have shown birds to be significant sources of fecal contamination in some places and at some times of year. They are different from most other fecal sources because they are not solely associated with loading from land, i.e., they can directly deposit feces to coastal waters. Herring gulls, cormorants and Canada geese are the most prevalent source species, reflecting their proximity to coastal waters and abundant populations. The impacts of bird feces on water quality classification and human health, as well as their significance relative to other sources, will be discussed.

TOTAL PHENOLIC CONTENTS AND ANTI-HYPERGLYCEMIC EFFECTS OF ALARIA ESCULENTA EXTRACTED BY VARIOUS METHODS

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Sea vegetables have been reported to contain various phenolics including compounds with antioxidant and anti-inflammatory properties. Phenolic acids derived from brown sea vegetables are also known as carbohydrate hydrolyzing enzyme inhibitors that are associated with anti-hyperglycemic effects. The present study evaluated the phenolic content and anti-diabetic potential of wild harvested Alaria esculenta (AE) extracted by different methods. One gram of dried, ground AE was re-suspended with 10 mL of water, with 50% methanol or 80% methanol for 6 hr with agitation. Homogenization was
conducted before or after the incubation, and a freeze-thawing method was applied to the water extract for 6 hr at -80 oC. The 50% methanol extracts showed the highest phenolic content (5.9 ± 0.3 mg/g) followed by water (3.9 ± 0.5 mg/g) and the 80% methanol extracts (3.0 ± 0.3 mg/g). In water extracts, the freeze-thaw samples contained the highest levels of phenolic compounds. The water extracts showed the strongest inhibitory activity against rat α-glucosidase and porcine α-amylase (IC50 113.2 ± 7.2 mg/mL and 56.3 ± 2.5 mg/mL) followed by 50% methanol (IC50 147.7 ± 4.0 mg/mL and 56.3 ± 2.5 mg/mL) and the 80% methanol extracts (IC50 216.0 ± 48.9 mg/mL and 246.9 ± 9.2 mg/mL). Our results suggest that the freeze-thaw water extraction method yielded the highest extraction efficiency for phenolic acid. These data demonstrate that sea vegetables, either wild or aquacultured, may contribute to the management of hyperglycemia when incorporated into the diet.

MILFORD PROBIOTIC STRAIN OY15 MOVES TOWARD COMMERCIALIZATION AND EFFECTS OF PROBIOTIC BACILLUS STRAINS ON OYSTER HEMOCYTE IMMUNE FUNCTIONS: RESULTS OF A COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENT (CRADA) BETWEEN THE MILFORD LABORATORY AND ENVERA LLC.

Diane Kapareiko1, Jennifer H. Alix1, Dorothy Jeffress1, Nantiya M. Abraham2, Thomas Hashman2, Jeffrey Holt2, Gary H. Wikfors1, 1 USDOC, NOAA, National Marine Fisheries Service, Milford Laboratory, 212 Rogers Avenue, Milford, CT 06460; 2Envera LLC. 220 Garfield Avenue, West Chester, PA 19380

Use of beneficial bacterial probiotics for controlling microbial pathogens in aquaculture is an environmentally-friendly alternative to antibiotics for disease prevention. The Milford Laboratory has isolated and evaluated a naturally-occurring bacterium (Milford probiotic strain OY15) (Vibrio alginolyticus) from the digestive glands of adult Eastern oysters (Crassostrea virginica). OY15 has been confirmed safe for co-culture with the microalgal feed T-ISO, safe for handling by human shellfish hatchery workers, and it improves survival of oyster larvae challenged with a Vibrio sp. larval shellfish pathogen by 20-35%. The Milford Laboratory has entered into a formal agreement with Envera LLC, which provided specialized expertise to determine if OY15 can be mass-cultured effectively and economically produced in a stable formulation for commercialization and marketing to commercial oyster growers. During this collaboration: Envera was successful in large-scale production of OY15 and has provided the Milford Laboratory with stable, freeze-dried and spray-dried formulations. The Milford Laboratory has performed flow-cytometric analyses to determine immune stimulation of oyster hemolymph by ten Bacillus strains currently sold commercially by Envera as probiotic strains for aquaculture. Two critical components of the innate immune system of shellfish for pathogen elimination are phagocytosis and reactive oxygen species release, which are stimulated by Milford probiotic strain OY15, and are the basis of a screening method we developed to discover potential probiotic candidates. Envera Bacillus strains ENV375 and ENV401 significantly stimulated phagocytosis and reactive oxygen species release, and show promise as potential probiotic strains, individually or combined, for use with oyster larvae.
EFFECT OF STRAIN AND DOMESTICATION ON STRESS-GROWTH-IMMUNE INTERACTIONS IN STRIPED BASS

Linas W. Kenter, Timothy S. Breton, Benjamin J. Reading, David L. Berlinsky. Department of Biological Sciences, University of New Hampshire, Durham, NH, 03824

An increase in striped bass aquaculture has generated significant interest in genetic improvement and broodstock domestication programs and among the traits of interest are growth and disease resistance. The current research was undertaken to evaluate striped bass strains for differential stress responsiveness. In this effort, striped bass (902.4±21.2g; Mean ±SEM) originating from wild-caught broodstock from rivers in Nova Scotia, Virginia and Florida were compared to an 8th generation domestic strain. Fish were PIT tagged, weighed, measured and stocked at a density of six fish/strain into six (1500L) tanks that were incorporated in a single recirculating system. Three tanks were assigned to the “stressed” treatment and fish were chased for 1min with a hand net on two days/week, while the other three (control) tanks were left undisturbed. Upon conclusion of the trial (14 weeks), the fish in the control and treatment tanks were chased, and one tank of each was bled at either 0, 1 or 3hrs post stressor. Growth, plasma cortisol levels, haematological parameters and selected hepatic gene expression patterns were compared among strains and treatment groups. Preliminary analyses indicate significant differences in cortisol, growth and immunocompetence among different striped bass strains under stressed and non stressed conditions.

This research was funded by the Northeastern Regional Aquaculture Center

A STRAIN COMPARISON OF STRIPED BASS CULTURED IN RECIRCULATING SYSTEMS AT DIFFERENT SALINITIES

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Striped bass and their hybrids are widely cultured in freshwater ponds. Few studies, however, have compared production characteristics in different saline environments or among geographic strains. In part one, striped bass juveniles produced from wild-caught broodstock from rivers in Delaware, Florida, South Carolina, Texas and Virginia were reared in triplicate salt water (30 ppt) recirculating systems for 12 months. At 30- day intervals, a minimum of 20% of the fish from each tank were sampled for growth parameters, and feeding rates were adjusted for tank biomass. After one year of age, the growth parameters of remaining fish were determined and a subset were PIT tagged, combined into a larger, “common-garden,” salt water, recirculating system and growth parameters monitored over an additional year. In part two, a selected strain of juveniles originating from NCSU were acquired as well as juveniles produced from wild caught fish from North Carolina, South Carolina, Virginia, Florida and Nova Scotia. All fish were reared in triplicate fresh (0ppt), brackish (5ppt) and saltwater recirculating (30ppt) systems. Fin clips from adult broodstock and all juvenile fish were collected and analyzed using 11 microsatellite markers, to determine parental contributions and identify families. Specific growth rates, feed conversion ratios and other parameters were calculated for each strain and differences among families were evaluated. Preliminary analyses confirmed significant growth differences among geographic strains and between salinities.

This research was funded by the Northeastern Regional Aquaculture Center
USING PASSIVE TIDAL ENERGY TO CLEAN AND TUMBLE OYSTERS

Jordan M Kramer. Winnegance Oyster Farm, 8 Pleasant Ave. #1, Portland, ME 04103

The removal of epiphytic (fouling) pests is one of the most labor, time, and cost intensive tasks in oyster aquaculture. Current methods of oyster tumbling and cleaning often require specialized motorized equipment that burns gas and is expensive to both procure and maintain. Much of this gear must be custom built or fabricated at great expense to the farmer. This equipment can be loud- creating conflict with nearby landowners and disturbance of wildlife. The movement of tides presents a potential free- and-green power source for oyster pest-maintenance.

This project tested two new suspended subtidal growth methods that used tidal flux to passively clean and tumble oysters. Oyster growth rates and the degree of fouling were measured on a monthly basis over the course of the 2016 growing season and compared to a control group grown using a conventional float-bag system. One of the experimental designs proved very effective at deterring fouling, but displayed poor growth rates. Further refinement of this design could provide growers an efficient and inexpensive means of controlling fouling.

AQUACULTURE EDUCATION: IS THERE SOMETHING FISHY GOING ON AT SCHOOL?

Anne Langston. Aquaculture Research Institute, 5784 York Complex, Margaret Chase Smith Policy Center, Building 4, Orono, ME 04469-5784

The Aquaculture Education Session aims primarily to create opportunities for exchange of the most current information about informal and formal aquaculture education initiatives across the northeast. This will include examples of after school programs, K-12 lesson plans, museum exhibits, 4H programs, nonprofit education programs, professional development or training programs...all related to aquaculture.

A series of speakers will present “lightning talks”, and/or exhibit your work, ideas, or curricula related to aquaculture education. The session will have two parts: part 1 focused on formal and informal K-12 aquaculture education, and part 2 focused on training programs and higher education.

ENHANCING A LONG-STANDING APPLIED SHELLFISH FARMING COURSE THROUGH EXPANDED ACCESS, PUBLIC EDUCATION, AND ONLINE LEARNING

Dale Leavitt1, Azure Cygler2, Jennifer McCann2, David Beutel3, Tiffany Smythe2, Robbie Hudson2.
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For over 15 years, Dr. Dale Leavitt at Roger Williams University in Rhode Island has offered an Applied Shellfish Farming course to aspiring shellfish farm professionals. The course is 14-weeks offered in the winter months and attracts a wide audience from around New England, has been very well received and highly regarded, and is considered informally by the state as a “must take” before individuals start their own Rhode Island shellfish farm application process. Since 2015, the authors have
been engaged in a NOAA-funded effort to: 1) Enhance and expand the content of Dr. Leavitt’s in-class course, including creating online course modules for distance learning, 2) Structure mentor-based learning and institutional knowledge sharing for the next generation of aquaculture extension professionals, academics, and community leaders, especially as those in these current roles will be retiring soon, and 3) Provide public education opportunities around aquaculture in the Ocean State. The three objectives have allowed the project team to engage the public, whose opinion on aquaculture varies, through field-based tours and hands-on learning as well as conversations with experts and growers, often transforming opinions through fact-based knowledge sharing. In addition, the project conducted both a Needs Assessment and Competency Evaluations (through national interviews and surveys) to determine what aspects of aquaculture education are regarded as most important to ensure successful 21st century aquaculture businesses. The online course modules (in development) will also allow people from around the nation to learn about shellfish farming and possibly structure their own state aquaculture education program in the future.

IDENTIFICATION BOOKLET OF COMMON NEW HAMPSHIRE SEA VEGETABLES FOR PUBLIC HARVESTING

Jacob Levine\(^1\), Gabriela Bradt\(^2\), Michael Chambers\(^2\).\(^3\). \(^1\)University of New Hampshire, 105 Main Street, Durham, ME 03824; \(^2\)Thompson Hall 105 Main Street, Durham, NH 03824, \(^3\)University of New Hampshire, Morse Hall, Suite 164, 8 College Road, Durham, NH 03824

The use of seaweed (sea vegetable) as a food source has gained the interest of the public in the coastal New Hampshire area. We have created a booklet that contains multiple points of information about common sea vegetables that are typically found along the New Hampshire coast. This includes intertidal location, peak harvesting period, and its longevity. Two forms of the booklet were created: a physical field guide that contains basic information on 10 common sea vegetables, and an online copy that contains 18 sea vegetables, their basic information, and how they are prepared for food use. This was done between June and August of 2016. These two forms of the booklet will be accessible to the public through New Hampshire Sea Grant.

CLOSER TO THE TRUTH -- CHLOROPHYLL A FROM IN VIVO FLUORESCENCE-BASED SENSORS

Judy Yaqin Li, Mark S. Dixon, Barry Smith, and Gary H. Wikfors. USDOC, NOAA, National Marine Fisheries Service, Milford Laboratory, 212 Rogers Avenue, Milford, CT 06460

Chlorophyll a has been used widely in shellfish aquaculture site selection and environmental studies as an indication of quantity of phytoplankton. Conventionally, chlorophyll a concentration is measured by chemical extraction and quantification of light absorption or fluorescence by extracted chlorophyll a. This time-consuming process yields accurate results but can provide only limited spatial and temporal coverage. Alternative, in vivo fluorescence-based chlorophyll a estimates, however, have inherent problems converting in vivo fluorescence to chlorophyll a. Taxonomic composition of the phytoplankton assemblage and physiological status of the community affect in vivo fluorescence. Moreover, non-photochemical quenching of fluorescence at high irradiance causes underestimation of
chlorophyll a during the day. Therefore, in vivo fluorescence-based chlorophyll a values need to be corrected to represent true chlorophyll a.

Laboratory studies with cultures of *Tetraselmis chui* and *Chaetoceros neogracile* showed that the diel cycle of chlorophyll a from fluorescence sensors responded to light, not circadian rhythm. Field measurements conducted in the Milford Harbor and elsewhere also showed persistent diel cycles of chlorophyll a from fluorescence, despite possible tidal influence. Both cultured, single species and natural phytoplankton communities adjusted fluorescence response to changes in light with no lag time. Comparison between true values of chlorophyll from the extraction method and fluorescence-sensor estimates showed that the fluorescence based method overestimated chlorophyll a during the dark period (up to 80%) and underestimated chlorophyll a (to only 50%) during the light phase. These results will be used to construct a detailed algorithm correcting fluorescence signals to more realistic chlorophyll values.

INTERACTIONS BETWEEN TIDES, CURRENTS, AND WATER QUALITY IN THE DAMARISCOTTA ESTUARY, MAINE

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The Damariscotta estuary in downeast Maine houses over one hundred acres of American oyster aquaculture, as well as several acres of blue mussel and seaweed aquaculture, and it is of economic importance to the region. The ecosystem of Damariscotta could be significantly altered by climate change as increasing temperatures, declining wind speeds, and rising sea levels affect the transport of particulate matter. This project explores the spatial and temporal variability of the water level and current cycles of the estuary, and how they are correlated to measures of water quality such as turbidity, salinity, pH, and oxygen concentration. Over a period of time from July to November 2016, hydrostatic pressure data were collected from twelve points along the river, which was used to compute the tidal elevation time series. In addition, velocity current profiles, water quality data, and wind data were obtained from buoys maintained by SEANET and NERACOOS. A harmonic analysis was used to study tidal phase propagation and amplification along the river. Statistical and analytical tools established correlations between the tides, currents, and wind speeds. These were used to predict how changing climate conditions will affect the flow of nutrients and waste products in the river. Results indicated that storm surge had a flushing effect on the river and climate change will change the water quality in the upcoming years.

INTEGRATING MUSSEL AND KELP LONGLINE CULTURE STRUCTURES AND MANAGEMENT

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Mussel (*Mytilus edulis*) farming and sugar kelp (*Saccharina latissima*) farming have been two of the fastest-growing sectors of marine farming in the Northeastern U.S. over the past ten years. Given that
both of these crops are individually being grown on the same basic longline structures on private leases in public waters, it makes sense to integrate the cultivation of these crops for several reasons; (1) better space utilization of limited permitted sites – “3D farming”, (2) shared use of the capital costs of expensive anchors, lines, buoys, (3) better risk management via crop diversification, (4) lower risk to protected species by using fewer vertical lines per unit of production. The additional benefits of using multiple complementary nutrient bio-extractive crops are improved ecosystem services such as (i) improved water quality, (ii) provision of structure resulting in nursery and foraging habitat for other species, and (iii) a sustainable seafood supply.

Starting in October 2016 we will investigate advances in marine aquaculture over the next two-years by developing (i) innovative gear designs that integrate two different crops into an offshore lease area (Figure 1), (ii) new engineering and in-situ trials to make offshore longline aquaculture more efficient and safer for protected species, (iii) methodology for efficient management and harvest of a dual-crop culture system. We are particularly interested in forming a working group (a community of stakeholders) with an interest in determining the most effective outreach materials, and in helping to design a workshop dedicated to resolving technical and regulatory issues.

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**AN ECONOMIC ASSESSMENT OF BLUE MUSSEL (***Mytilus edulis***) SEED PRODUCTION**

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There have been sporadic shortages of wild blue mussel (*Mytilus edulis*) seed in the Northeast due to high spatial and inter and intra-annual variability associated with natural settlement and predation, and changing climatic and oceanic conditions are also undoubtedly making wild spat collection less reliable. The complete dependence on wild seed places mussel farming at risk of shortages, decreases in cash flow and ultimately jeopardizes the economic viability of farms. Perhaps just as importantly, farmers who run out of product periodically are punished in the marketplace, because buyers strongly prefer to work with a steady supplier.

We examined our own hatchery production records, albeit on a research basis, and compared them to others who grow mussel seed for commercial (US west coast – *M. galloprovincialis*) and R&D purposes (EU Blue Seed project, Scottish Aquaculture Innovation Center in Shetland Islands, Cawthron Institute in New Zealand). We draw conclusions based upon the cost of hatchery seed production, and new opportunities to develop better yields at grow-out sites with optimum seed planting schedules. We also examine likely marketing, production and economic opportunities with selectively-bred hatchery mussels.
MARICULTURE IN QUÉBEC (CANADA) MOVING FORWARD: STATEMENT, CHALLENGES AND PERSPECTIVES

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Merinov (www.merinov.ca) is the largest Canadian center for integrated research applied to the seafood industry (fishing, aquaculture, processing and development). In mariculture, Merinov’s team work made recent advances in the province of Québec, closely working with seafarmers in the aim to stimulate the development and to ensure the competitiveness of this industry. In this sector, present challenges are the upholding of farming durability and resilience, by supporting actual production (Mytilus edulis and Placopecten magellanicus), and diversifying with new species culture and new combinations. For instance, a razor clam (Ensis directus) culture project recently started in Québec. The oysters (Crassostrea virginica) culture development is fast-growing since 2013 and will be extended to more areas in the province within few years. As well, the seaweeds cultivation, which exhibit a promising rise with Saccharina latissima, Alaria esculenta, Palmaria palmata and Chorda filum. Particularly, a NSERC industrial research chair has boosted the culture method development, and aims to build an operating zero waste sector. Moreover, a new combination is actually tested to reduce duck’s predation on mussel farms by co-culturing S. latissima. Finally, Merinov offers different services to seafarmers. Namely, the monitoring of environmental and biological parameters provides decision making data available on a specific and secure web platform. Also, the development or adaptation of aquaculture equipment is one of the most appreciated services, for example by fitting and rearranging a deck or designing a new industrial engine, which increases productivity.

DO BENTHIC HABITATS ASSOCIATED WITH DIFFERENT OYSTER FARMING METHODS HOST DIFFERENT FINFISH BIODIVERSITY?

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During the summer of 2016, a field project was conducted to describe habitat provisioning by different oyster culture methods in Long Island Sound: traditional bottom culture and off-bottom cage culture. This was accomplished by the deployment of baited fish traps as well as environmental DNA (eDNA) metabarcoding. eDNA is either nuclear or mitochondrial DNA released from organisms into their living environment. The source of aquatic eDNA can be bacteria, phytoplankton, animal feces, shed skin/scales, mucus, carcasses, and/or anthropogenic in nature; this project examined eDNA specific to finfish. For eDNA analysis, water samples were collected weekly from two sites representing different oyster culture methods and a rocky reef area that served as a control. After DNA extraction, the mitochondrial 12S rDNA gene of marine fish and mammals will be amplified by polymerase chain reaction (PCR). PCR amplicons will then be sequenced using the MiSeq next generation sequencing. This work will provide, for the first time, molecular evidence on finfish diversities associated with different oyster culture methods. eDNA data will be compared with observational data from baited fish.
traps. The ultimate goal is to establish a reliable and resource-efficient eDNA protocol to evaluate finfish diversities, and to provide sound science in support of policy making.

SEASONALITY AND SIZE SELECTIVE FEEDING OF THE EASTERN OYSTER (CRASSOSTREA VIRGINICA) ON PHYTOPLANKTON IN THE DAMARISCOTTA RIVER ESTUARY, MAINE

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Oysters are capable of ingesting a range of suspended particles from multiple sources, but phytoplankton are their primary source of nutrition. We investigated the phytoplankton size fractions responsible for oyster productivity and examined how seasonal changes in phytoplankton community composition affect oyster feeding over a growth season from May to October, 2016 in the Damariscotta River estuary as part of the University of Maine’s Sustainable Ecological Aquaculture Network (SEANET) Program. Four oyster feeding experiments were conducted from July to October, 2016 at a floating dock on the Damariscotta River in close proximity to an oyster farm. During each experiment, oysters were incubated with natural phytoplankton assemblages in a specialized flow-through chamber for 12.5 hours. Size fractionated chlorophyll a, and associated size fractionated flow and imaging cytometry and 14-C based net productivity measurements demonstrated that oysters were size selective feeders, consuming phytoplankton associated with the highest productivity in the 3 to 20 µm size range, when small pico- and nano- (<20 µm) phytoplankton dominated chlorophyll a biomass during the summer months. In all cases the nanoplankton size range was grazed, based on size fractionated chlorophyll a and flow cytometric particle size distributions. Over the course of the season, oyster grazing rates were highest in July and August then declined. Analysis is ongoing, but preliminary results suggest that oyster productivity may be optimized by knowledge of the seasonality and species composition of ambient phytoplankton assemblages.

DEVELOPING A PUBLIC RELATIONS AND MEDIA RELATIONS PLAN FOR AQUACULTURE BUSINESS

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One of the challenges facing aquaculture professionals is explaining what they do, how they do it, and what they hope to bring to market to customers, business associations, and regulators. The message is as important as the product one grows and sells. For one, aquaculture of all kinds runs into entrenched negative messaging from environmental groups who, ironically, partner with commercial fishing associations to slam most fish and shellfish farms before they even get started. A myriad of local and state boards and departments await startups in the permitting process, a daunting effort for most entrepreneurs. My specialist knowledge in the media and understanding of the aquaculture sector means that table top attendees can discuss and learn ways to communicate their message effectively to the seafood industry through media channels and also with unique channels to the customers.
OFFSHORE SHELLFISH AQUACULTURE IN FEDERAL WATERS

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In 2015, we obtained an Army Corps of Engineers (ACOE) permit pursuant to Section 10 of the Rivers and Harbors Act of 1899 to establish a commercial scale (33 acre) offshore mussel farm 7 nautical miles off the coast of Cape Ann Massachusetts (NAE-2012-1598 NEMAC Aquaculture). Conditions of this permitting allow the establishment of up to 3-longlines as a pilot study to determine feasibility and any possible habitat or protected species interactions.

This past summer, we deployed the first of 3 longlines as a pilot research study to explore best practices for offshore shellfish aquaculture as well as monitor for potential habitat effects or protected species interactions attributed to shellfish aquaculture in offshore waters. This site will also become a fixed monitoring station for measuring oceanographic parameters and shellfish growth dynamics.

After a successful pilot research study, we plan to modify our permit to expand the number of longlines to a commercial scale farm with 32 – 400 ft longlines. Our ultimate objective is to refine and enhance offshore shellfish aquaculture as an alternative fishing option for fishermen and lobstermen currently displaced or negatively impacted by current fishery restrictions by providing an incubator farm site for interested parties to try offshore aquaculture.

This report will focus on the process of setting out our first longline, reporting on our activity to date to disseminate what was learned about this process to others wishing to pursue offshore shellfish aquaculture.

EFFECTS OF SHELLFISH FARM PRODUCTION ON THE STRUCTURE OF COASTAL FOOD WEBS USING STABLE ISOTOPE ANALYSIS

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Aquaculture farms are an integral part of the coastal marine ecosystem and associated food web. Bivalve shellfish grown on farms filter feed ambient seston and in turn contribute biodeposits that are recycled back into the food web. Though most shellfish are protected from direct predation with nets or cages, activity near the farm site may attract opportunistic predators. Typically, farm production potential is considered in isolation of the larger food web and at best may only consider primary production of phytoplankton when calculating expected farm production. Also, little is known about how the presence of these farms alters the food web structure of coastal ecosystems. To investigate the role of bivalve shellfish farms in coastal ecosystems, stable isotope analysis ($\delta^{13}$C & $\delta^{15}$N) was used to identify trophic interactions of species near farm sites. Samples across trophic levels (fish, farmed mussels, other invertebrates, zooplankton, phytoplankton, and sediment) were analyzed. Food webs will be compared across a range of coastal sites both with and without farms to better understand how coastal food webs support shellfish farm production and what role farms have in structuring coastal food webs.
ASSESSING USE OF OYSTER CAGES AS FISH HABITAT

Renee-Mercaldo-Allen¹, Robert Alix¹, Eileen Bates², Paul Clark¹, Gabrielle Fignar³
Erick Estela Gomez⁴, Alexandrea Grusky⁵, Yuan Liu¹, Dylan Redman¹. ¹USDOC, NOAA, National Marine Fisheries Service, Milford Laboratory, 212 Rogers Avenue, Milford, CT 06460; ²Bowdoin College, Brunswick, Maine 04011; ³The University of the South, Sewanee, TN 37375; ⁴NOAA Fisheries, NEFSC, James J. Howard Marine Sciences Laboratory, 74 Magruder Rd, Highlands, NJ 07732; ⁵Convent of the Sacred Heart, Greenwich, CT, 06831

A field study was conducted at three sites in Long Island Sound near Milford, CT to compare fish populations in the vicinity of an off-bottom oyster cage farm, an on-bottom traditional oyster culture area and a natural cobble reef. We hypothesized that the oyster cage farm (4 large cages of 80 stacked trays of oysters) and cobble reef would offer more vertical structure and habitat for young fish than the on-bottom oyster culture site. Baited fish traps were deployed for ~24 hour intervals to collect data on fish and crustacean abundance, diversity, and size. Trapping was conducted from June through September 2016. Oyster cages, which provide vertical structure, likely offer habitat similar to that of a natural reef, while the presence of oysters and shell during on-bottom culture may also create valuable habitat for juvenile fish on otherwise featureless bottom. Subsamples of fish were collected monthly for stomach content analysis. Processing of fish trapping data is underway. Field trials were also conducted throughout the summer to evaluate feasibility of mounting GoPro cameras on oyster cages to document fish interaction with the cages. Video footage, used in conjunction with fish trap data, may provide insights into the value of cage farms as habitat for young fish and may be a more effective strategy than fish trapping alone. Research using GoPro methods developed this summer will be used during the 2017 field season.

LAW ENFORCEMENT’S ROLE IN PREVENTING AQUACULTURE THEFT IN RHODE ISLAND

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The mission and patrol activities of the RI Dept. of Environmental Management (RIDEM) Division of Law Enforcement will be presented. The Division of Law Enforcement enforces all laws and regulations pertaining to state lands, wildlife, fisheries and shellfisheries as well as activities subject to the jurisdiction of the Coastal Resources Management Council (CRMC), which is the primary aquaculture regulatory agency in Rhode Island. In regards to theft from aquaculture facilities, state statute states: Any person damaging, disturbing, interfering, or taking by any means whatsoever, or possessing the cultivated species in an area subject to an aquaculture permit, without the permission of the permittee, is guilty of a misdemeanor. Identifying such criminal activity presents many challenges as the cultivated species are private property held in public waters, most leases having no restrictions on public use other than a prohibition on wild shellfish harvesting. In addition, CRMC estimated there were 171 workers on aquaculture farms in 2015. Distinguishing these workers from potential thieves is a major issue for preventing larceny through routine patrol, therefore, we rely heavily on reports and tips from aquaculture business owners and other witnesses on potential illegal activity. Advice will be presented on what to do if you observe or suspect theft from your aquaculture operation and how you can help provide information that may assist in prosecution.
BIOLOGICAL AND CHEMICAL CHANGES IN ALGAL CONCENTRATES: WHAT DOES THIS MEAN TO OYSTERS?

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The production of live phytoplankton cultures as feeds for bivalve seed production in hatcheries and nurseries can consume 30-50% of the costs of a hatchery. Mass-culturing microalgae requires facility space, is labor intensive, and often is the limiting factor to shellfish seed production. Hatcheries induce spawning in the late winter, with bivalve seed needing to be nourished until May/June when out-planting is possible. One strategy to effectively stock up algal food for bivalve seed is concentrating phytoplankton to produce an “algal concentrate”, which may be used in hatcheries to feed young stages of shellfish weeks to months after they are produced. This could significantly improve efficiencies and productivity of hatchery operations.

Industry partner Tonie Simmons, Muscongus Bay Aquaculture (Maine), supplied samples of algal concentrates made at their facility. Muscongus Bay Aquaculture concentrated 4 species of phytoplankton Chaetoceros neogracile (Chaet-B), Phaeodactylum tricornutum (Phaeo), Tetraselmis chui (PLY429), and Nannochloropsis sp.(UTEX 2341)), with each species of the concentrates preserved in two different solutions. We analyzed the concentrates for cell number, dissolved oxygen, pH, carbon, nitrogen, phosphorus, silica, and fatty/acids over a 3-month time period to determine if there were changes in nutritional quality. Oysters also were fed weekly after sampling to determine if particles were filtered (ingested) or rejected (pseudofeces). Preliminary data indicated that even though cell numbers decreased, oysters were still ingesting the algal concentrate weeks after preparation; however cell integrity and nutritional content decreased over time. The preservation of nutritional quality appears to be key in the success of algal concentrates in the future.

CHALLENGES AND OPPORTUNITIES OF GOVERNANCE IN MAINE’S AQUACULTURE INDUSTRY

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The Sustainable Ecological Aquaculture Network adopts a social-ecological systems framework to better understand and inform the development of Maine’s aquaculture industry. A key driver in this framework is the governance system that enables and constrains the development of the industry. The governance system includes the Maine Department of Marine Resources reviewing and granting lease applications, lease application hearings seeking public participation, and the monitoring of established leases. To better understand the role of the governance system and how it influences the development of aquaculture in Maine, we conducted 52 semi-structured interviews with seafood farmers, non-profit and state agency staff, and state legislators knowledgeable about aquaculture. Interviews asked stakeholders to reflect on threats, vulnerabilities, and opportunities in the aquaculture industry including socio-cultural and regulatory topics. All interviews were transcribed and analyzed using NVivo software.
From this analysis, we report on stakeholder experiences and recommendations related to the governance of aquaculture in Maine and identify challenges and opportunities. Key challenges identified in interviews relate to the lease hearing process through which farmers must learn to navigate and the length of time required to obtain an aquaculture lease. Interviews also revealed an emerging governance challenge arising from the availability of limited purpose aquaculture leases that allow up to 400 square foot areas to be used for the growth of some shellfish and sea vegetables. LPAs allow for individuals to try aquaculture at relatively low cost and risk but the rapid growth of these leases poses management challenges.

CHANGES IN NUTRITIONAL VALUE OF ALARIA ESCULENTA DURING DEGRADATION WITH POTENTIAL FOR SHELLFISH PRODUCTION

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Bivalve shellfish feed on more than just phytoplankton and are known to consume detritus. However, little is known about the spatial and temporal dynamics of detritus ingestion and utilization for growth. In particular, kelp is abundant in Maine coastal waters and sheds detrital particles from blade tips as it degrades potentially providing a nutritional supplement to shellfish diets on nearby coastal farms. In order to detect the ingestion and subsequent utilization of kelp detritus for shellfish growth, one must first understand how the composition of kelp changes as it degrades. Stable isotopes (δ13C & δ15N) coupled with lipid and fatty acid profiles can be used to track the potential change in nutritional quality through degradation. In order to get a baseline for these isotope and lipid biomarkers, a controlled lab experiment was performed using Alaria esculenta from the same source that was grown in controlled environmental pool in the lab. Replicate kelp fronds were harvested and placed in 1-liter tumble cultures incubated in a bath (50º C) for 5 weeks. Half of the tumble cultures were held in the dark and the other held on an 8 hour per day light cycle. The results of this experiment will determine whether stable isotope and lipid signatures of kelp change during degradation and provide a baseline for future studies aimed at detecting uptake of kelp detritus in farmed shellfish. With additional field investigations, this work may provide insight to optimal farm site placement or lead to development of supplemental shellfish feeds.

EVALUATION OF EFFICACY OF FORMULATED PROBIOTICS FOR CRASSOSTREA VIRGINICA LARVAE AGAINST INFECTION OF VIBRIO CORALLILYTICUS RE22

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The Eastern oyster Crassostrea virginica is an ecologically and economically important species native to the East Coast of the United States and the Gulf of Mexico. Rearing of oyster larvae is a critical step in hatcheries to ensure a healthy and sufficient supply of seed to the aquaculture industry. Massive mortalities caused by vibriosis, however, prove economically detrimental to hatcheries. Probiotics are an inexpensive, practical, and natural method of disease control. Two probiotics, Bacillus pumilus RI0695 and Phaeobacter inhibens S4, were previously shown to protect oyster larvae from infection of Vibrio coralliilyticus RE22 (Karim et al. 2013). However we need stable and easy to use formulations of these
probiotics for practical use in hatcheries. We tested formulations of these probiotics to compare their efficacy in protecting larvae as compared to fresh cultures using a lab challenge assay as well as a hatchery trial. We show that formulations of these probiotics are effective in protecting the larvae from a *V. coralliilyticus* RE22 infection and safe for use in bivalve shellfish hatcheries.

**PROMOTING MARKET GROWTH FOR SHELLFISH THROUGH CLIMATE CHANGE ACTIVISM**

**Bill Mook.** Mook Sea Farm, 321 State Route 129, Walpole, ME 04573

The number of farms and the supply of half-shell oysters are increasing rapidly. It would be prudent for our industry to take steps to both help protect our ability to increase production, and to make a broader and more coordinated effort to promote our crops.

We have increasingly paid attention to ocean acidification (OA), calling for more monitoring and research. However, we are also vulnerable to other problems related to climate change including increasing temperature, freshwater runoff, and sea level rise, yet our industry has not considered the question of how we might address the root cause of these problems: greenhouse gas emissions.

Current lack of progress on GH gas reductions is largely caused by tremendous financial influence exerted by the fossil fuel industry on a highly partisan political process. The scale of this financial influence is new. Partisan politics are not. The creation of the EPA, and many key environmental statutes (i.e. The National Environmental Policy Act, The Clean Water Act, the Clean Air Act) were passed under the Nixon administration in the early 1970’s, which was also a highly partisan time in American politics.

Shellfish growers today might have a unique opportunity to reinvent the environmental activism of the 1960s and 70s, which is credited with changing the course of U.S. environmental policy. In doing so, our industry could provide the crucial impetus for changing national energy policy while simultaneously increasing demand for sustainably raised shellfish.

**HORSESHOE CRAB ACTIVITY AND INTERACTIONS ON RACK-AND-BAG OYSTER FARMS**

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Concern has recently been raised about the ability of horseshoe crabs (*Limulus polyphemus*) to safely navigate in and around intertidal oyster farm gear, and how farms may change shorebird foraging activity. During the 2016 crab spawning season, a series of experiments were conducted to assess the ability of crabs to move in, around and among the oyster farms to mate and spawn on the beach, and to survey the spatial distribution of dislodged eggs upon which Red Knots feed. These experiments included (1) testing rack heights for impairment of crab passage, (2) repeated crab census on paired farm/control sites to test if crabs avoid farms, and (3) spatial survey of dislodged egg distribution along the wrack zone. Results showed that all crabs, regardless of size, passed easily beneath racks 10 cm or
more above the bottom. Thus, regulated rack height of 30.5 cm (12”) should be sufficiently precautious to allow crab movement beneath racks. The crab census observed 853 crabs total, with no evidence of a difference in crab numbers among farmed and control transects (p=0.3, paired Wilcoxon signed-rank test). In total, 2 out of 853 (<0.5%) crabs were observed to be impinged on racks. Crab eggs washed up in the wrack zone were distributed unevenly throughout the survey region. Dislodged eggs were observed most frequently in the central portion of the survey area, and were not concentrated in the area of farms suggesting that in 2016, Red Knot foraging opportunities were not spatially coincident with farm locations.

**JUVENILE SPISULA, ENDEAVORS INTO BUTTER CLAM CULTURE**

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Through the years there has been much interest in growing surf clams (Spisula solidissima), with particular interest in growing them to a small “butter clam” size. Potentially, this could be accomplished within a year’s time which would make this species a desirable crop to augment current hard clam and oyster production. In response to interest expressed by Cape Cod growers, in late April 2015 the local hatchery produced several hundred thousand surf clam seed for experimental purposes. Seed were distributed to growers interested in working with this species; upwards of 50,000 – 60,000 4-6mm+ seed were available for each interested grower. In addition to technical advice, growers received pertinent references with background information highlighting critical information to consider when working with this species. This study was intended to monitor the growth and survival of this seed to gain insight into the needs of surf clams in terms of water and sediment conditions, temperature, handling, gear, planting density, and predation. Early results indicate a 1-year “butter clam” is feasible.

**EMERGENCE OF NEOPLASTIC DISEASE IN HARD CLAMS (M. MERCENARIA)**

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In recent years an emerging disease condition in hard clams (Mercenaria mercenaria) was observed during routine monitoring for another disease, QPX, or quahog parasite unknown. This emerging disease is a hemocytic neoplasia similar to the neoplastic condition affecting soft shell clams (Mya arenaria). Neoplasia in clams is not a novel discovery however, but finding the disease in hard clam populations and at high prevalences is novel and concerning. Within the past seven years this disease has been identified in aquacultured hard clams from 3 areas in southeastern Massachusetts and is revealed in stocks typically 1.5 years old or greater. Neoplasia caused and continues to cause significant mortality on shellfish farms, particularly within one town on Cape Cod where it was identified in 80% of moribund surface clams in some infected plots. Additionally, animals sampled from the population still buried in the sediment showed disease prevalences upwards of 40%. While the origin of the neoplastic cells and the cause of this condition are not known in hard clams, the occurrence of significant mortality in cultured stocks showed the neoplastic condition is capable of devastating populations of hard clams.
WHAT MAKES AN AREA PRODUCTIVE FOR OYSTER AQUACULTURE AND WHY?

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We will describe the results of LOBO buoy deployments, estuarine transects and water sampling in the fall of 2015 and through 2016 to better understand factors which control oyster growing area productivity (and makes one site better than another), and factors which control fluxes, benthic impacts and nutrient recycling rates among the estuary, the phytoplankton, and the bivalves. The importance of estuarine geomorphology, hydrodynamics, biodeposition and ammonium fluxes will be discussed, and the information will be presented in an aquaculture GIS system (ShellGIS). Integrating water velocity from a tidal flow model, water quality parameters including temperature, salinity, phytoplankton and detritus concentration, and algorithms characterizing density dependent food supply and demand in bottom and suspension culture, the user can specify oyster seed size, type of culture, stocking density and time of year seeded, and click on a map to get predicted growth rates, seed to harvest yields and times to market. Cost-effective methods for determining the temporal and spatial variation in bivalve growth drivers including low cost buoys and remote sensing will be discussed.

NORTHEAST OCEAN PLAN

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Over the past four years, the Northeast Regional Planning Body has worked with government, non-government organizations and industry to develop the Northeast Ocean Plan, which has recently been approved by the White House for implementation (see www.neoceanplanning.org). The Plan provides integrated regional ocean information and encourages improved coordination among government and with industry to promote informed and transparent decisions about aquaculture siting, in the context of other ocean uses and resources. The Plan has a number of relevant actions, including 1) using data from the Northeast Data Portal and other sources to map areas of federal waters where potential aquaculture impacts and conflicts or synergies are more likely to occur and should be considered when siting an aquaculture facility, and 2) developing information using Portal data and other sources to assist with the siting of aquaculture facilities, given the physical, biological, and chemical requirements of certain species and the logistical and operational limitations of different gear types. Through a panel and discussion, this session will give an overview of the Plan’s commitments, provide suggestions from NOAA Fisheries on how the plan can inform aquaculture regulatory and siting issues, including how these actions tie to other regional aquaculture planning and the Mid Atlantic Ocean Action Plan, and finally provide an industry perspective on how the Plan can be most useful. This session is a continuation of seeking feedback on these efforts through NACE and the Milford Aquaculture Seminar (MAS), following on discussions in 2012 and 2015.
A PRELIMINARY STUDY ON SCALLOP RIGHTING BEHAVIOR AND SHELL PHENOTYPE IN RESPONSE TO PREDATOR PRESENCE

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Many organisms display a righting reflex when turned over from their preferred resting position. Bay scallops (Argopecten irradians) possess an upper valve and a lower valve, with the latter being more cupped. In some specimens, the upper valve is of a darker color than the lower valve. In this experiment, the resting position of bay scallops was tested against two different predators, the Asian shore crab (Hemigrapsus sanguinus) and the Forbe’s sea star (Asterias forbesi). Thirty juvenile scallops (~15mm length) were placed into shallow trays of static seawater along with the selected predator within a cage. The rate of turnover was compared between both predators and a control group which was predator free. Turnover was identified using the color of the shell. When all scallops displayed their darker valve, the test, which was conducted three times, was concluded. Results demonstrated that there was little difference between the test groups and the control, as all scallops flipped within a similar amount of time. Understanding scallop response to predators could potentially assist in the selection of broodstock. Scallops that are better adapted to adjusting themselves and possess the correct shell phenotype for the environment might have a greater chance of survival. Additional studies will have to be conducted.

EFFECTS OF SELECTIVE BREEDING AND DIFFERENT SETTLEMENT SUBSTRATE ON GROWTH, SURVIVAL AND FIELD RETENTION OF HATCHERY-REARED BLUE MUSSEL (MYTILUS EDULIS) SEED

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Blue mussel, Mytilus edulis, rope culture in Maine and the northeastern United States is currently dependent on settlement and retention of mussel larvae and juveniles onto man-made substrates that can be harvested by individual farmers. The current business model of mussel culturists relies solely on this natural phenomenon which is driven by a number of variables, many of which the farmer has little control. To improve reliability of mussel culture, we examined the feasibility of producing mussel spat in a hatchery setting. Two major problems remain a deterrent for commercialization of hatchery-reared mussel seed: cost effectiveness and field retention, or drop-off. One potential solution to these problems is selective breeding of mussel broodstock to add value to the final product and develop a fast growing line of mussels that can be harvested in a shorter period of time.

To examine difference in growth, survival and field retention of three genetic lines (wild type, gold/striped and F1 fast growers) of blue mussels, field trials were initiated at the Blue Hill, ME Salt Pond in 2016. In addition, three types of commercially-available, specialized mussel rope were used to test field retention of mussel seed. Results of commercial yield and meat yield from 2015 wildtype hatchery seed will be compared to wild seed. Research cooperators at WHOI and Vineyard Sound also tested different sites and strategies for maximizing seed retention. Deployment method of seeded hatchery ropes with an emphasis on cost effectiveness, ease of deployment/harvest and commercial yield will be discussed.
METABOLIC EFFICIENCY AND NUTRITIONAL PROFILES IN COMMERCIAL GROWN BIVALVES TO OPTIMIZE FARM PLACEMENT

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Bivalve shellfish are more than just aquatic cows grazing phytoplankton. It is known that mussels (Mytilus edulis) and oysters (Crassostrea virginica), filter a variety of particles, including detritus and other organic matter. Little is known about how filter feeding bivalve diets vary across species, location, and season. Stable isotopes and lipids in the bivalve tissue can characterize sources of nutrition and identify spatial and temporal differences, which may help in optimizing farm placement. In order to model differences in ambient nutrition sources for shellfish, baselines must be established. Juvenile mussels and oysters were held in independently controlled recirculating systems and fed the same diet of phytoplankton. Both the phytoplankton and the tissues of the shellfish were analyzed for stable isotope $\delta^{13}C$ and $\delta^{15}N$ and lipids over a 60-day period. The rate of convergence over time of $\delta^{13}C$ stable isotope signatures between the phytoplankton and shellfish tissues provide insight on how quickly shellfish respond to changes in organic matter as a nutrition source. In addition, $\delta^{15}N$ provides a measure of trophic fractionation between the organic matter food source (i.e. phytoplankton) and prey (i.e. mussels, oysters). Lipid analysis was used to gain an understanding of the essential fatty acids and total lipid content in the shellfish tissues. The stable isotope and lipid values established will provide the baseline to measure trophic dynamics, organic matter sources, and general nutrition of shellfish across potential farm sites in the coastal environment and could be used to optimize farm placement and shellfish growth.

STUDIES ON DEPURATION OF ENTERIC VIRUSES BY BLUE MUSSEL (MYTILUS EDULIS) SEED USING MALE SPECIFIC COLIPHAGE (MSC) AS AN INDICATOR

Steven Pitchford, David Veilleux. USDOC, NOAA, National Marine Fisheries Service, Milford Laboratory, 212 Rogers Avenue, Milford, CT 06460

A major impediment to the expansion of the mussel shellfish industry, which depends mostly on wild set, is the restriction on collecting seed from closed areas. Current regulations include complete prohibition, or in other cases relaying the animals to clean water for holding periods of 6 to 12 months. These regulations impede access to areas of abundant fast growing natural set, prime sources of nearshore seed. We are investigating the question of how long it takes for mussel seed (<35mm) to clear viruses to acceptable levels in clean waters. In addition, we want to determine the feasibility of reducing relay holding times to achieve viral depuration from the present 6 or 12 months to 1 month in water temperatures over 10C.

The Male Specific Coliphage (MSC), are bacterial viruses (bacteriophages) that infect and replicate in Escherichia coli, the coliform bacterial indicator that is usually associated with closures. Coliforms and MSC levels will be measured and monitored in closed and semi-closed recirculation systems. We intend to use sub-micron mechanical filtration and ultraviolet radiation to remove coliform bacteria from the water that are purged from mussels via natural excretion. The systems employed will be 50 liters of seawater, and contain enough seed mussels to satisfy the tissue requirement for pathology. The mussels will be sampled at 24 hours, 48 hours, and 120 hours for the initial clearance data. The initial
experimental runs will first analyze bacterial and viral eradication times, followed by depuration rates of contaminated mussel seed taken from closed areas.

DEVELOPMENT OF INTERNAL IMMUNE CAPACITY ASSAYS FOR THE ATLANTIC JACKKNIFE CLAM, ENSIS DIRECTUS

Brian Preziosi, Timothy Bowden. School of Food and Agriculture, Aquaculture Research Institute, University of Maine, Orono, ME 04469

Ensis directus has been identified as a species with potential for use in aquaculture operations. Work towards this goal is currently in progress at the University of Maine’s Darling Marine Center. The grow-out phase for E. directus requires that the animals be planted outside the hatchery in their natural environment to keep algae-growing costs for the operation down. During this phase the clams are constrained to their holding containers and must cope with a variety of environmental impacts. Measuring internal immune capacity can provide valuable information on how environmental impacts will affect the health of E. directus and thus indicate which environmental impacts need to be addressed in order for grow-out to be successful. To this end we have optimized assays on the hemocytes (circulating blood cells) of adult E. directus to build a tool kit that can be used to assess the magnitude of an immune response to a given stimulant. The current work adds assays for cell viability (indicated by hemocyte morphology) and phagocytosis frequency to the tool kit. Both of these assays are inexpensive since are analyzed through visual counts. These assays, in addition to any others we develop, will be used to assess the immune capacity of clams from each season so differences in the immune response due to seasonality can be taken into account.

CAN GROWING SUGAR KELP LOCALLY REMEDIATE OCEAN ACIDIFICATION?

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Farmed kelp might do more than generate revenue, diversify the working waterfront economy, and provide consumers with essential nutrients – they may also phyto remediate, or restore coastal water quality. Through the act of growing and photosynthesizing, these small marine forests (natural or manmade) remove carbon dioxide from seawater, creating a ‘halo’ of higher seawater pH and saturation state ($\Omega$). In an ocean growing more corrosive to calcification, creation of this therapeutic refuge may be critical to the longevity of the growing shellfish aquaculture industry and to the persistence of Maine’s coastal ecosystems. We have gathered laboratory and field evidence that farmed sugar kelp are effective at remediating acidification for larval shellfish. At Bigelow Laboratory, we exposed five species of macrophytes (Saccharina latissima, Ascophyllum nodosum, Fucus vesiculosus, Ulva lactuca, and Zostera marina) to past, current and future pCO2 and temperature levels. CO2 consumption rates and ability to raise seawater pH and $\Omega$ differed across species, but increased at higher pCO2 treatments, with sugar kelp taking up the most CO2. In the field, instruments measuring CO2, pH, dissolved
oxygen, salinity, temperature, and depth were deployed inside and outside of the Ocean Approved sugar kelp farm in Casco Bay, Maine. From the time of deployment in early January through mid-February, CO2 was lower inside the farm, and as a result, pH was 13% higher and Ω was 23% higher. Our next steps are to determine the spatial extent of the remediated 'halo' and if the improved water chemistry can enhance the growth of mussels.

DEVELOPMENT OF A NOVEL TAURINE TECHNOLOGY TO SUPPORT SUSTAINABLE AQUACULTURE

Catherine Pujol-Baxley, Jonathan Bamford, Christopher Marx, Bonnie McAvoy, Daniel Smith, Martha Sholl, Lawrence Feinberg. KnipBio, 110 Canal Street, 4th floor, Lowell, MA 01852

KnipBio’s mission is to develop a proprietary single cell protein (SCP) platform that is able to principally serve as an alternative to fishmeal while also being a source of high-value ingredients important to aquafeeds. KnipBio Meal (KBM) is a single cell protein (SCP) that naturally contains carotenoids and has the potential to consolidate into a single product some of the most valuable molecules like pigments, antioxidants and/or amino acids for a low-cost sustainable aquafeed.

The 2-carbon (β)-amino acid taurine has been proven to be an essential nutrient used in feed composition for both animals and humans for development, heart function and even osmolarity. Removal of fishmeal from the diet of carnivorous fish species has had wide interest globally but diet formulations often become limited in taurine as a consequence. Diets based on terrestrial proteins or other alternatives may be challenged in supporting growth, particularly those intended for larval stages, without exogenous taurine addition. Production of taurine is predominantly done by chemical synthesis and is often supplemented in crystalline form in the feedstock which may not be optimal for bioavailability or might leach within an aqueous environment.

Using bioinformatic in silico tools, KnipBio first identified novel metabolic pathways that could lead to the biological production of taurine. Applying recombinant technology tools, we successfully engineered several microorganisms to then produce hypotaurine and/ or taurine through heterologous expression of various pathways. Heterologous expression of taurine in a combined “Protein + Taurine” platform biocatalyst is a powerful demonstration of the versatility and applications of the KnipBio technology. Future plans for this technology include testing within formulated diets to establish the efficacy and advantage of nutritionally enhanced SCP.

THE POTENTIAL FOR ENVIRONMENTAL CONDITIONING PRACTICES TO DECREASE IMPACTS OF CLIMATE CHANGE ON SHELLFISH AQUACULTURE

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Shellfish are a major contributor to marine aquaculture production. Shellfish production, however, is reduced by changes in seawater chemistry driven by ocean acidification (OA). There is a growing
rationale for examining the potential for acclimatization to OA, where exposure to stressful environments can prepare organisms for future stress. We tested the sensitivity of early life stages and the potential for geoduck clams to display acclimatization to ocean acidification, and the role of DNA methylation in the physiological response and environmental memory in a series of experiments. First, we exposed larval geoducks to ambient (~8.0) and low pH (~7.4) for 10 days and found that larval mortality is decreased and shell size increased in low pH conditions. Second, we exposed juvenile geoduck to ambient (~8.0), low (~7.4) and lower (~7.0) pH for 23 days, placed them in ambient common garden for several months, then re-exposed them to ambient (~8.0) pH and low pH (~7.4) for another 23 days. In geoduck juveniles there was a size benefit of preconditioning to low pH. Juvenile growth initially declined at pH ~7.4 and 7.0 in the first exposure, but when replaced in the ambient conditions, the initial exposure to low pH resulted in compensatory growth, such that the juveniles grew larger. Growth in the pre-exposed juveniles was also more resistant to low pH in the second exposure. This suggests an exposure memory that is potentially linked to epigenetic mechanisms such as DNA methylation, and that acclimatization to OA can result in benefits to geoduck growth.

AQUACULTURE STUDENT ROUNDTABLE

Charlotte Quigley. School of Marine Sciences, University of Maine, Orono, ME, 04469

We invite all undergraduate and graduate students, and postdoctoral researchers to join in an academic discussion concerning aquaculture. Topics may include selecting candidate species/crops, sea farm engineering, carrying capacity of aquaculture systems, product development, and how aquaculture will affect coastal communities. This session will follow a loose agenda, but will offer flexibility to change the course of the conversation to ensure equal participation of contributors on topics of interest to the group.

The goals of the roundtable are to:

- Discuss student research in an informal setting
- Foster interdisciplinary solutions to aquaculture problems
- Create cross-institutional connections
- Provide opportunities for connection with industry/stakeholders
- Discuss the state of aquaculture research and education at a university level
- Share student opportunities for funding, internships and research opportunities
- Discuss early career opportunities and challenges

TEMPERATURE TOLERANCE OF A CANDIDATE SEA VEGETABLE CROP, ALARIA ESCULENTA

Charlotte T. C. Quigley¹, Sarah Redmond², Susan H. Brawley¹. ¹School of Marine Sciences, University of Maine, Orono, ME, 04469; ²Maine Sea Grant, Franklin, ME, 04634

The harvest and aquaculture of seaweeds is a multi-billion dollar industry worldwide. Market demand and interest in integrated aquaculture offer increased opportunities for development of sea vegetable crops in Maine. Sea surface warming attributable to climate change is a key consideration when selecting candidate crop species. This study is investigating the temperature tolerance of the edible kelp
Alaria esculenta (L.) Greville (Laminariales, Phaeophyceae) along the Maine shore through reproductive phenological surveys and thermal experiments in the laboratory. To determine reproductive seasonality, bimonthly surveys were conducted on two transects at Lubec, Schoodic, and Pemaquid for two years. The phenological condition was quantified as the reproductive proportion of each population based on a random sample of 30 individuals/time point/transect. Analyses using univariate repeated measures found significant main effects for month and year; however, location was not significant. Strains from Lubec (northern Maine) and Two Lights (southern Maine) were cultured in the laboratory to provide seedstock (gametophyte) biomass for thermal experiments. Cultures were maintained at 12 °C, followed by step increases (2 °C/day) to 22 °C. The average proportion of healthy gametophytes following this treatment was 73% for northern strains but only 26% for southern strains. These results show that A. esculenta is reproductive virtually year-round in Maine, which means that wild seedstock can be available to sea farmers at any season. However, preliminary analysis suggests that thermal tolerance of seedstock varies from source to source and must be considered when establishing sea vegetable aquaculture.

CONDITIONING OF BLUE MUSSEL (MYTILUS EDULIS) BROODSTOCK USING MICROALGAL AND ALTERNATIVE DIETS

Paul Rawson¹, Scott Lindell², Kyle Pepperman³, Michael Devin⁴, and David Bailey². ¹School of Marine Sciences, University of Maine, Orono, ME 04469; ²104 Redfield Bldg., Woods Hole Oceanographic Institution, Woods Hole, MA 02543; ³Downeast Institute, 39 Wildflower Ln, Beals, ME 04611; ⁴Darling Marine Center, 193 Clarks Cove Rd, Walpole, ME 04573

The production of cultured blue mussels (Mytilus edulis) has increased steadily over the past decade, and given market acceptance the industry is poised to continue growing. Dragging seed mussels from wild beds or capturing wild spat and transferring the seed to culture sites historically have supported mussel culture in the Northeast. Limitations to the supply of seed, however, could pose a substantial impediment to industry growth. In contrast, the hatchery production of seed avoids the high spatial and temporal variability associated with the natural set of spat and variable climatic and oceanic conditions that are undoubtedly making wild spat collection less reliable. One obstacle to the production of hatchery seed is the volume and diversity of microalgae that must be produced, particularly during the conditioning of mussel broodstock. Identifying optimal microalgal diets or using readily available alternative diets, such as freeze-dried algal products or algal pastes, can alleviate the bottleneck associated with microalgal production in the hatchery. We have investigated whether blue mussels can be conditioned and spawned “out of season” and whether egg quality in mussel broods provided alternative diets is as high as the egg quality from broods provided different microalgal diets. Our preliminary results indicate that the average condition index (CI) is lower and variance in CI higher in broods fed alternative diets and highest in broods fed a diet high in diatom content. We will also present an analysis of lipid, carbohydrate and protein content of eggs from broods conditioned on different diets.

GAUGING THE CURRENT IMPACT OF BLISTER WORM ON THE NORTHEASTERN OYSTER CULTURE INDUSTRY

Paul D. Rawson¹, Dana Morse². ¹School of Marine Sciences, University of Maine, Orono, Maine 04469; ²Maine Sea Grant & Darling Marine Center, 193 Clarks Cove Rd, Walpole, ME 04573

The production of cultured blue mussels (Mytilus edulis) has increased steadily over the past decade, and given market acceptance the industry is poised to continue growing. Dragging seed mussels from wild beds or capturing wild spat and transferring the seed to culture sites historically have supported mussel culture in the Northeast. Limitations to the supply of seed, however, could pose a substantial impediment to industry growth. In contrast, the hatchery production of seed avoids the high spatial and temporal variability associated with the natural set of spat and variable climatic and oceanic conditions that are undoubtedly making wild spat collection less reliable. One obstacle to the production of hatchery seed is the volume and diversity of microalgae that must be produced, particularly during the conditioning of mussel broodstock. Identifying optimal microalgal diets or using readily available alternative diets, such as freeze-dried algal products or algal pastes, can alleviate the bottleneck associated with microalgal production in the hatchery. We have investigated whether blue mussels can be conditioned and spawned “out of season” and whether egg quality in mussel broods provided alternative diets is as high as the egg quality from broods provided different microalgal diets. Our preliminary results indicate that the average condition index (CI) is lower and variance in CI higher in broods fed alternative diets and highest in broods fed a diet high in diatom content. We will also present an analysis of lipid, carbohydrate and protein content of eggs from broods conditioned on different diets.

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Polydora websteri (blister worm) is a polychaete worm that burrows into the shells of several commercially important shellfish species, including those of the eastern oyster Crassostrea virginica. Although oysters can deposit new shell material over P. websteri burrows, the build up of mud and detritus inside of the worm burrow creates unsightly blisters that can impact the marketability of oysters and the reputation of a farm. Anecdotal information suggests that blister worm is a significant pest in the Northeast and that the impact of blister worm has increased as oyster culture operations in the region have expanded. In addition, there have been reported cases of substantial crop losses from heavy blister worm infestation. There are no reliable estimates, however, of the number of farms in the region impacted by this pest, the severity of these impacts, and potential remedies that have been applied by oyster farms. Our broader research and education program targets the onset of pest infestation to eliminate the need for costly treatment of infested oysters in conjunction with a survey of oyster farmers in the region. This survey will provide first-hand information from oyster farmers on the geographical scale over which problems with blister worm occur, the impact this pest species has on individual farm operations, how culture practices and farm location may affect whether farms are affected by this pest, and remedies that farmers have applied.

PREVENTATIVE TREATMENTS FOR THE CONTROL OF BLISTER WORM POLYDORA WEBSTERI IN THE EASTERN OYSTER CRASSOSTREA VIRGINICA

Paul Rawson¹, Karen Pianka¹, and Dana Morse². ¹School of Marine Sciences, University of Maine, Orono, Maine 04469; ²Maine Sea Grant & Darling Marine Center, 193 Clarks Cove Rd, Walpole, ME 04573

The polychaete Polydora websteri, or “blister worm”, burrows into the shells of several commercially important shellfish species, including those of the eastern oyster Crassostrea virginica. Infestations of blister worm can impact the marketability of oysters and the reputation of a farm and once established, it is very difficult to rid oysters of infesting adult blister worms. The life history of P. websteri, however, includes a dispersive planktonic stage; larval blister worms initially settle and form a mud tube on the external surface of the oyster shell. Recently settled worms do not have the protection of the burrow and are more vulnerable to harsh conditions than are adult worms. We have worked with three oyster farms in Maine on treatments, such as air-drying and washing of oysters, during the production cycle to reduce the settlement blister worm in their cultured oysters. Our results indicate that air-drying resulted in a substantial drop in the number of blister worm burrows and that washing in combination with air-drying resulted in even greater reductions. The effect, however, was highly dependent on the timing of treatment application relative to local weather patterns, annual variation in the settlement of blister worms, and other factors external to the experiment. Although in some cases we observed an order of magnitude decrease in the appearance of new burrows in treated versus control oysters, in no case did we observe a 100% reduction in the occurrence of blister worm on cultured oysters.

EXPERIENCES STARTING SMALL OYSTER SEED WITHOUT AN UPWELLER

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Small oyster seed is generally considered difficult to handle with poor survival unless grown in an upweller. However, some shellfish growers have demonstrated excellent survival with oyster seed as small as 2mm in length in standard gear without the use of an upweller for nursery culture. The indication from some of these growers is that stocking density and handling practices are keys to success. Small oyster seed is also cheaper, 2-3mm oyster seed is about half the price of 6-8mm seed, such that significant savings could be attained buying smaller seed. To more closely examine differences between small seed with/without upwellers, trials were run in two different seasons starting with 2.3mm (±0.4mm, year 1) and 4mm (±0.8mm, year 2) oyster seed. Seed were stocked at several densities in traditional bag culture, at several sites, and with at least 1-2 upwellers for comparison. Oyster growth in both years had oysters exceeding ½” (12mm) within 4-7 weeks depending on site. Upweller comparisons showed a slight growth advantage before reaching about 12mm in length, thereafter oysters grew just as well or faster in bags compared to upwellers. Mortality of seed growing to 12mm (1/2”) in both years was low (0-3%). Survival yield from estimated stocking number in year 2 averaged around 100%, while yield was much more variable in year 1 (51-100%), likely due to treatment by site. Starting with 3-4mm oyster seed seems a viable alternative to upwellers in smaller or beginning farm operations if seed are handled carefully.

WHO GETS THE FARM VS. I’M NOT DEAD YET

Miranda Ries. National Fish & Oyster Co. Inc. 5028 Meridian Rd NE, Olympia, WA 98516

How do you ask a farmer, who gets the farm? The answer to that question may be simple and result in an answer such as, my son or daughter. It could be an answer like, my long-time employee or even something along the lines of “I want to give it to charity”. Asking who gets the farm and creating a plan for how and when that happens are two monumental tasks that the average farmer puts off, sometimes until it’s too late. The idea that one day the owner/farmer is one day not going to be there running the company and tending to their land, often makes loved ones and even employees uncomfortable. As a 4th generation shellfish farmer, currently in a role of business manager, without any current ownership, I have 6 crucial steps that begin to help the process of succession planning begin. The ability to plan for a future before there is a health scare, accident or emotional uncertainty, gives family, staff and outside businesses a sense of security and a building block for a secure future.

NOVAEEL: THE SCIENCE BEHIND A COMMERCIALLY VIABLE EEL FARMING INDUSTRY FOR THE NORTH AMERICA.

Neil W. Ross¹,², Paul M. Smith¹, Alejandro Cohen² & James P. Fawcett². ¹NovaEel Inc., Halifax, Nova Scotia, Canada; ²Dalhousie University, Halifax, Nova Scotia, Canada

Eel farming is a major industry in Asia and is dependent on the yearly supply of glass eels or elvers from wild stocks, increasingly those of the American eel (Anguilla rostrata). Eels are grown to >300 g and mainly processed into Japanese-style Kabayaki. Glass eels from Maine and Atlantic Canada are currently shipped live to Asian growers, where they reach market size within 12 -18 months. NovaEel is developing eel farming technology to compete with Asian growers. Under farm stocking densities, eels will switch sex to males (~95%) that only reach 150-180 g after more than two years. All-female production using a synthetic version of a naturally-occurring hormone requires FDA approval. NovaEel
has conducted studies over the past two years to prove the efficacy and safety of 17β-estradiol (E2) for all-female eel production. E2 treatment resulted in the production of 90-95% females, growth rates comparable to Asian farms and no toxic effects to eels. With respect to safety for human use, a novel mass spectrometry method (LC-MS/MS) was developed to measure E2 levels in eel flesh. E2 was rapidly removed from eels following termination of the E2 treatment. The half-life of removal of E2 was 1 day, and E2 levels reverted to background (non-treated eel) levels within 5 days post-treatment. NovaEel has begun submissions to the FDA and Health Canada for regulatory approval to use E2 in eel aquaculture for all-female production.

PRIVATE LEGAL REMEDIES FOR THEFT FROM BIVALVE AQUACULTURE SYSTEMS


Criminals who steal product or equipment from a bivalve aquaculture system may face criminal prosecution. But, what about the losses that the growers are left to absorb? How can these businesses be made whole again? Attorney Andrew Rubin will discuss the private legal remedies that may be available to commercial growers subjected to theft, so that they can recover damages.

RISK MANAGEMENT: HOW DOES IT WORK?

Paul Russell. USDA Farm Service Agency, County Executive Director, 15 Cranberry Highway, West Wareham, MA 02576-1504

Risk management programs are often too confusing, leaving growers confused and feeling left out. This session aims to combat that problem by highlighting programs available to growers – utilizing both a presentation and a panel format in which growers will discuss their personal experiences. Finally, a panel of decision makers will address their role in setting policy, prices and rates for the USDA Farm Service Agency (FSA) and how the shellfish industry can be involved in these decisions.

USE OF LONG RANGE LOW LIGHT CAMERA SYSTEM FOR CONTINUOUS VIDEO SURVEILLANCE OF OYSTER BEDS ON CAPE COD

Dave Ryan. Cape Cod Oyster Company, 179 Old Falmouth Rd., Marstons Mills, MA 02648

Cape Cod Oyster Co, will share information related to the use of long range low light camera system for continuous video surveillance of oyster beds on Cape Cod.
DRYING TEMPERATURE, HUMIDITY AND TIME EFFECTS ON THE PHYSICO-CHEMICAL PROPERTIES OF SUGAR KELP (SACCHARINA LATISSIMA).

Praveen Sappati¹, Emily Duran-Frontera¹, Balunkeswar Nayak¹, Peter VanWalsum². ¹School of Food and Agriculture, University of Maine, Orono, ME 04469; ²Chemical and Biological Engineering, University of Maine, Orono, ME 04469

Sugar kelp (Saccharina latissima) is a marine macro algae and is a rich source of fibers, vitamins, minerals and antioxidants. Due to high amount of moisture (~92%), it is either sun dried or hot air dried for extending its shelf life. Hot air drying induces faster drying rate, but also leads to deterioration of texture and reduction in heat sensitive nutrients including vitamin C, antioxidants, phytochemicals and total phenolic content. The aim of this research is to optimize the drying parameters by studying the effect of hot air drying temperature, humidity and time on the physico-chemical properties (moisture content, water holding capacity (WHC), oil holding capacity (OHC), ash content, vitamin C, antioxidant capacity and total phenolic content) of sugar kelp. Fresh sugar kelp samples of approximately 450g were dried at air temperatures of 30-70°C with relative humidity levels of 25 and 50% and air velocity of 10.0 m/s in a convective dryer. Dried samples were stored at -80°C for further analyses. The ash content of the samples were found to be in the range of 23.32% - 33.05% (w.b) and are inversely correlated to the WHC (r = -0.84) and OHC (r = -0.84), which indicates that the textural properties are highly dependent on the ash content irrespective of the drying conditions. Vitamin C content showed a positive correlation with respect to the drying temperature (30 to 70°C, p<0.05) and increasing from (0.098 mg to 0.203 mg) and (0.128 mg to 0.211 mg) for humidity of 25% and 50%, respectively.

MANAGEMENT CONSIDERATIONS FOR EXPANDING AQUACULTURE IN MASSACHUSETTS

Christopher Schillaci, John M. Hickey. Massachusetts Division of Marine Fisheries, 1213 Purchase St, New Bedford MA 02740

Massachusetts seafood dealers reported purchasing over 38 million oysters and 6.5 million quahogs from Massachusetts aquaculturists in 2015- resulting in approximately $23 million paid directly to local growers. This represents more than a threefold increase in aquaculture landings between 2005 and 2015, and makes shellfish aquaculture one of the Commonwealth’s fastest growing and most valuable sources of local sustainable seafood. This increase in production also highlights the recent growth and significant economic potential associated with aquaculture in the Commonwealth. Currently Massachusetts has over 350 permitted private shellfish aquaculture operations, each with an average size of just fewer than three acres. The variability in the Massachusetts coastline, coupled with the number of individual operations, results in growers employing a wide array of culture and harvest practices. This variability can present a number of management challenges when evaluating the environmental, public health and competing use considerations associated with permitting new and expanding aquaculture operations. Balancing the economic and environmental benefits of aquaculture with the potential impacts requires permitting agencies to take a synergistic view of aquaculture management. This talk looks at the current status of the Massachusetts marine aquaculture sector and management considerations for future growth.
A COMPARISON OF CALCIUM CARBONATE SEDIMENT BUFFERS TO INCREASE THE LARVAL SETTLEMENT OF THE SOFT SHELL CLAM *MYA ARENARIA*

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Calcium carbonate in the form of aragonite and calcite is an essential constituent of shell formation in marine bivalves. As a result of natural processes, sediment pore water can become significantly undersaturated with respect to calcite and aragonite near the surface water interface (SWI). While this is a common occurrence in coastal sediments, anthropogenic changes to coastal and open ocean environments have intensified the process potentially resulting in significant impacts to bivalve populations that inhabit coastal sediments. The addition of calcium carbonate buffers to undersaturated sediments has been shown to offset these effects by increasing the aragonite saturation state, or the omega value (Ω), of interstitial waters and subsequently increase the rate of settlement of benthic bivalves. Various materials have been suggested as possible sediment buffers (shell-hash, marble chips); however, no research has directly focused on comparing the efficacy of different buffer materials and the most appropriate application concentration. In this study we compared the efficacy of four different locally available buffer materials, each at three different concentrations, to determine each buffer’s ability to increase the settlement and recruitment of *M. arenaria* and their potential as a resource enhancement methodology. Results indicate buffer materials, and increased concentrations of buffer materials, have a statistically significant correlation with both the (Ω) of interstitial waters and the rate of recruitment of *M. arenaria*.

**VIBRIO PARAHAEOMOLYTICUS MANAGEMENT FOR OYSTERS IN MASSACHUSETTS**

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In the last two decades, *Vibrio parahaeomolyticus* (V.p.) has become the leading cause of seafood-borne poisoning from bacteria in the US and world-wide (Daniels et al., 2000; Scallan et al. 2011). Especially concerning is the increased incidence of V.p. cases in the Northeastern US, where cases linked to locally harvested product were previously rare (DePaola et al; 2000; Jones, 2011; Xu et al., 2015; Urquhart et al. 2016)); since 2012 however, V.p. has rapidly emerged as a significant public health threat in the region resulting in harvest area closures, recalls, and the implementation of costly control measures for the harvesting and handling of oysters during summer months. The Division of Marine Fisheries and its partners have worked to develop a greater understanding of how environmental conditions, common culture practices and V.p. risk mitigation strategies impact the abundance of V.p. in oysters and V.p. illness occurrence. Through the characterization of V.p. illnesses and analysis of samples from Massachusetts harvest areas we attempted to determine: 1) whether changes in environmental conditions influence V.p. composition/abundance in oysters and correlate with disease; 2) the impact of common oyster culture activities such as air drying or extended culling and re-submergence on V.p.
composition/abundance in oysters; 3) the impact of transplanting oysters from an area considered of high risk for V.p. illness to an area considered of lesser risk for V.p. illness on V.p. composition/abundance in oysters and V.p. illness occurrence.

VIBRIO SP. ABUNDANCE IN OYSTERS, WATER AND SEDIMENT SAMPLED FROM VARIOUS TREATMENT/CULTURE CONDITIONS

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V. parahaemolyticus (Vp) and V. vulnificus (Vv) can cause gastroenteritis in humans when oysters are consumed raw. With increasing water temperatures, the concentration of Vibrio sp. bacteria increases in estuarine environments and can accumulate in the tissues of Eastern oysters as part of their filter feeding process. As water temperatures continue to rise due to climate change, predicting and mitigating risks of Vibrio outbreaks has become an important public health issue. Varying harvesting methods were used to give insight on whether certain techniques can reduce the concentrations of Vp within oysters. Four oyster farms at two growing areas, one subtidal and one intertidal, were sampled at two-week intervals between April and October 2015 in southeast Massachusetts. This study used a quantitative multiplex polymerase chain reaction (qmPCR) test method to assess Vp and Vv levels in the sediment, water column and oyster. The samples were also evaluated for occurrence of two pathogenic genes associated with the ability of Vp to cause the disease in humans. Vp was found to have a strong positive correlation with water temperature. Placing oysters in trays within the water column of the subtidal growing area depurates some of the total and pathogenic bacterial load. Growing out the oysters in trays along the bottom of the intertidal flat had reduced bacterial burdens; however, due to significantly different concentrations of Vp in the water and sediment between farms, the reduced bacterial levels cannot be fully credited to harvesting method (work funded by NOAA NAOAR4170071, WHOI Subaward #A101190).

FEASIBILITY OF UTILIZING EASTERN HEMLOCK AS THE PRIMARY STRUCTURE MATERIAL FOR A BLUE MUSSEL (MYTILUS EDULIS) AQUACULTURE RAFT

Dillon Shaw¹, Erin Owen², Thomas Stone². ¹Dewey’s Shellfish Headquarters, 712 route 17, Augusta, ME 04330; ²Husson University, 1 College Cir, Bangor, ME 04401

The State of Maine is an ideal location to produce rope-grown mussels. This sustainable method of aquaculture has been conducted in Maine since 1973. The purpose of the current project is to test a design for a blue mussel (Mytilus edulis) aquaculture raft using Eastern Hemlock as the primary structural material. Hemlock is strong, light and widely available in Maine, and could readily be used for commercial mussel rafts. The wood will be treated with an organic, citrus-based preservative that is volatile-organic-compound–free or VOC-free, to increase the petrifaction process, that is, change the physical characteristics of the Eastern Hemlock to make the wood better able to survive harsh oceanic conditions. To test the wood, random plug sampling will be conducted to look at water absorption of the wood. One sample each month will be taken for the duration of the project. The raft was deployed in
May 2015 at a site northwest of Peter’s Island on the Damariscotta River (43°54'34.8"N 69°34'02.5"W) and will be seeded with mussels for grow-out in spring 2017. After approximately 12 months, the mussels will be mature so the raft will be at its heaviest. An assessment can then be made of the suitability of hemlock for use in a commercial mussel raft. This assessment will be done by taking a series of measurements of the distance of the raft from the water surface over a complete growing cycle. The first measurement will take the height of the raft from the water when it is floating with no ropes. Then the ropes will be placed on the raft for seed collection and grow-out, when another measurement will be taken. Thereafter a measurement will be taken every two weeks of the same information.

NORTH EAST REGIONAL OCEAN PLAN OVERVIEW FOR AQUACULTURE

Mason Silkes. Salt Water Farms, American Mussel Harvesters, 165 Tidal Dr, North Kingstown, RI 02852

Offshore aquaculture will provide enormous expansion opportunities for domestic seafood production. As near shore sites for large scale operations are becoming more scarce, it is pertinent to locate farm sites in deeper offshore state waters as well as federal waters of the USA, a zone that reaches out to 200 miles from the coastline. The North East Draft Ocean Plan is a comprehensive document that among other objectives, maps out the federal waters of the New England region for the various stakeholder industries; Shipping, Fishing, Wind Energy, Marine Wildlife, and Recreational Activities. As drafted, aquaculture is included in the ocean plan because of its potential growth as a sustainable food Industry, and the economic growth it would bring to coastal communities. This presentation will discuss the Regional Planning Body, the draft of the ocean plan, the North East Ocean Data Portal and where our industry fits into the picture. It will go into detail about how the document will affect aquaculture growth at a federal level. In May we were invited down to Washington DC to meet with the Ocean Conservancy, speak with the Rhode Island delegation about this plan, and represent the aquaculture industry as stakeholders. This document, if it is passed will have significant effect on the future of our oceans, and this presentation aims to clarify how aquaculture in federal waters is currently standing with regard to this document that will likely be passed before the end of the year.

CAPTURING A WASTED OPPORTUNITY: CHARACTERIZATION OF AQUACULTURE WASTE AS A NUTRIENT SOURCE FOR HYDROPONICS

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Aquaculture produces 44% of the 167 million tons of seafood consumed annually worldwide. Capture fisheries continue to decline at a steady rate, while the aquaculture industry has grown nearly 6% annually in the last decade. This growth generates increasing amounts of nutrient-rich waste. In the United States, EPA regulations for wastewater discharge to watersheds require expensive energy-intensive treatment to remove excess nutrients from aquaculture effluent. Costs associated with waste removal systems can be mitigated by applying nutrient rich RAS waste stream into aquaponic production systems, effectively monetizing the effluent treatment processes. Previous waste-solids capture research suggests that the macro- and micro-nutrients in the captured solids from RAS meet or
exceed nutrient profiles required for terrestrial farming. Therefore, it may be feasible to integrate aquaculture effluent into a hydroponic production system without supplementation. The ongoing research here focuses on characterizing the macro- and micro-nutrient profiles of captured solid and soluble waste using three different protein content feeds for tilapia. The goal is to characterize the nutrient profile and production rate of aquaculture effluent for integration in aquaponics. The results from this study will be the basis for subsequent research on solids nutrient liberation and balancing aquaculture nutrient production with plant uptake in an integrated aquaculture system. Understanding and balancing nutrients within aquaculture systems allows for a more sustainable and economically viable model of integrated agricultural production.

**DESIGN MODIFICATIONS OF A LOW COST FLOATING UPWELLER SYSTEM (FLUPSY).**

**Michael Slade, Kim Tetrault.** Cornell Cooperative Extension of Suffolk, New York.

Cornell Cooperative Extension of Suffolk, New York has been actively building and operating Floating Upweller systems (FLUPSY) for almost 2 decades. The organization pioneered a design of low cost FLUPSY and has continued to promote the unit to interested parties. In the quest to maximize the efficiency and keep costs low, Cornell and the Suffolk Project in Aquaculture Training (SPAT) program has recently been building and experimenting with a new motor design that does not place the unit under the water. This design will be discussed in detail.

**SEA SCALLOP RESOURCE ENHANCEMENT IN THE OFFSHORE WATERS OF NEW ENGLAND**

**Ronald Smolowitz, Liese Siemann, Samir Patel.** Coonamessett Farm Foundation, Inc.

The Atlantic sea scallop (*Placopecten magellanicus*) is a valuable resource to New England coastal communities, but the stock has a volatile past. Stabilization of the stock would bring long term security to the fishery. In scallop fisheries outside of the U.S., there is a growing practice of enhancing scallop production though seeding and promoting natural growth. The first offshore USA aquaculture project, Seastead, was an effort to transplant wild caught scallop seed to a location south of Martha’s Vineyard. The objective was to enhance sea scallop production using the existing fishing industry. Since 2013, Coonamesset Farm Foundation (CFF) has focused on developing the tools and methods to transplant and monitor scallops. This research has pushed the limits of tools available to researchers, and has led to the development of unique methods for transporting, seeding, and monitoring scallops. The current research focus is to examine scallop behavior immediately post-transplant, as most dispersal occurs soon after dropping scallops in a new location. These behavioral observations will offer valuable insight into the effects and feasibility of successfully transplanting seeded scallops from areas of dense aggregations, where growth may be hindered, to areas where scallops may thrive. This presentation will review our scallop enhancement efforts from Seastead to the present.
TREMATODE ASSOCIATED MORTALITY IN BLUE MUSSEL POPULATIONS IN THE NORTHEAST U.S.

R. Smolowitz\textsuperscript{1}, J. Hamlin\textsuperscript{1}, C. Materna\textsuperscript{1}, M. Agnew\textsuperscript{1}, A. Scro\textsuperscript{1}, Katie Heisler\textsuperscript{1}, M. Griffin\textsuperscript{2}, D. Leavitt\textsuperscript{2}. \textsuperscript{1}Aquatic Diagnostic Laboratory, Roger Williams University, One Old Ferry Road, Bristol, RI 02809; RWU, \textsuperscript{2}One Old Ferry Road, Bristol, RI 02809

While aquaculture of mussels is common in other countries, it is only now that blue mussels (\textit{Mytilus edulis}), are being strongly considered as an important aquaculture species on the east coast of the U.S. However, populations of blue mussels on the east coast are plagued by periodic mortality that appears to be increasing in severity over the last few years. This has resulted in decreased wild population numbers, smaller sized animals and loss of populations along some coastlines. Mussel aquaculture currently collects wild seed in the spring to grow out in long lines. They are also affected by unexplained mortality. Our work examined blue mussels from 5 locations in Rhode Island, during the spring, summer and fall over two years to determine common diseases that may be important in aquaculture and that might provide potential connections to die offs noted in wild/cultured populations. Both histological and squash preparations of mantle tissue were used to both identify trematode infection caused by \textit{Proctoeces maculatus} and to rate the severity of infections. Condition index was correlated with infections and sex of the mussels. Infectious agents that contribute to disease and mortality in wild blue mussels on the northeast coast included \textit{Steinhausia mytilovum}, trematodes and \textit{Chlamydia sp}. Histologically, the characteristics and effects of the diseases, especially trematodal infections, on the animals changed over the season of infection and age of the animal and were correlated with mortality. This work was supported by Rhode Island Sea Grant (R/F-1416-42-1).

PRELIMINARY ASSESSMENT OF SURFICIAL ENTEROCOCCI ON SUGAR KELP (\textit{SACCHARINA LATISSIMA})

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Regulations, guidelines, and best practices for safeguarding Public health are well defined as they pertain to fecal bacterial pollution and filter feeding bivalves; both farmed and wild harvested. The National Shellfish Sanitation Program (NSSP) and the state agencies tasked with administering the program establish, based on water quality data and other risk factors, well defined and monitored coastal zones governing the access to shellfish resources along the coast. While the relationship between fecal coliform levels in seawater and the bioaccumulation of pathogens in shellfish is well established, this important relationship has not been assessed for farmed sea vegetables like sugar kelp (\textit{Saccharina latissima}). The goal of this initial study was to establish and standardize a protocol for assessing indicator bacteria on the surface of sugar kelp. Mature farmed sugar kelp was transplanted to experimental stations in Saco Bay near the mouth of the Saco River and destructively sampled at two week intervals with paired surface water samples from June-September, 2016. Several methods were compared using selective enterococci agar for enumeration of colony forming units. Methods tested include direct plating of kelp biofilm, and also agitating kelp in sterile seawater followed by direct plating and membrane filtration.
DEVELOPMENT OF A SIMPLE, LOW COST, ADJUSTABLE FARM SYSTEM FOR SEA
VEGETABLE CULTURE IN MAINE

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The economy and character of rural, coastal Maine (USA) is closely linked to maritime activities;
namely, wild-capture marine fisheries and its allied industries. Economic diversity and by proxy the
social-economic sustainability of working waterfronts worldwide has declined as capture fisheries that
support them have either consolidated or collapsed. Addition of farming sugar kelp (Saccharina
latissima) and other sea vegetables can diversify revenues for commercial fisherman. However, in order
for fishermen to successfully transition to farmers, key issues must be addressed to lower barriers to
entry and increase profitability of sea vegetable farming. Our priority has been to develop low cost,
flexible, and effective farming systems. Specifically, we developed and tested a versatile, highly mobile,
low cost sea vegetable system for use in protected coastal of the Gulf of Maine (GOM). Longline
systems currently employed by most seaweed farms are cumbersome and expensive to deploy, relying
on 500-1,000 kg dead-weight moorings, and use vertical mooring lines that result in slack and drift of
the system during low tides. We developed and successfully tested a system using only locally available
materials familiar to the commercial fishing industry in the GOM with up-front costs of less than $600
USD. The system was deployed in November of 2015 and seeded with 2-5mm sugar kelp. Gear
performance and production results were monitored throughout. On June 2, 2016, we harvested sugar
kelp and the total yield over the 50m farm was ~750kg or 14.4 kg/m.

SITE SPECIFIC HUSBANDRY & SPAWNING PROTOCOLS FOR TRIDACNA SP. AT
SOUND SCHOOL AQUACULTURE CENTER

Mitchell Stephens, Sound School, 60 South Water Street, New Haven, CT 06519

Tridacna sp. are a bivalve, from the Family Tridacnidae, that are commonly found in the Indo-Pacific
region. The vivid colors; blues, greens, and browns of their mantles are aesthetically pleasing to
aquarium hobbyists, generating a demand for Tridacna sp. in the aquarium trade. Creating land-based
aquaculture protocols for the spawning and husbandry of giant clams may help to relieve pressure on the
natural population from commercial collection of wild stock. Spawning techniques are being developed
at the Sound School Aquaculture Center in New Haven, Connecticut. Spawning attempts have been
conducted at the school in years past. No larvae have been set in the prior attempts. Three broodstock
cohorts of two clams each will be spawned; two cohorts will be of blue giant clams (Tridacna maxima)
while the third cohort will have brown giant clams (Tridacna squamosa). Staggered spawning will be
practiced, manipulating abiotic conditions for individual cohorts during each lunar cycle. By staggering
the spawns, conditioning of the other cohorts can be maintained; allowing for changes and adjustments
to the spawning process to be implemented more rapidly. A variety of methods will also be used to set
the larvae. It is hoped that by developing a protocol for producing Tridacna sp. at the Sound School that
some pressure from the aquarium trade may be removed from wild giant clam populations.
DEVELOPING SHELLFISH BY GENETIC APPLICATIONS FOR ADAPTATION IN A CHANGING CLIMATE

Sheila Stiles, Joseph Choromanski, Dorothy Jeffress. USDOC, NOAA, National Marine Fisheries Service, Milford Laboratory, 212 Rogers Avenue, Milford, CT 06460

Oceans and coastal waters have been recorded to become warmer globally over the last few decades. Different phenotypes or genetic markers could indicate various levels of diversity, plasticity or epigenetic effects of gene expression from switching on and off at different stages relative to environmental change. Genetic approaches for responding to such changes could involve genetic selection of valuable marine shellfish, such as scallops, oysters, clams and mussels. Results from relevant experiments that were conducted will be summarized. For example, scallops from a genetic line that were selectively bred for a phenotypic trait of a striped shell began to spawn at a lower temperature of 16 C, while scallops from other groups did not spawn. This occurrence suggested that lines of shellfish could be developed that would be adapted to different environmental temperatures. A preliminary experiment with two lines of juvenile scallops from different populations exposed to different pH levels suggested responses with greater effects of adaptation to geographic location rather than pH level. These examples indicate that organisms with genetic traits could have a selective advantage in various climate change scenarios. Results could serve as demonstration projects possibly suitable for models and for conserving genetic material and resources.

CAN STABLE ISOTOPES INDICATE THE GEOGRAPHICAL ORIGINS OF SEA LICE?

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The salmon louse Lepeophtheirus salmonis is considered the primary parasitic disease of salmon aquaculture and affects populations of both wild and farmed fish. Despite the current understanding of its widespread presence and detrimental effects on host salmonids, its complete life history strategy, particularly regarding overwintering, remains uncertain. The current study investigated the overwintering strategies of sea lice in Cobscook Bay, ME through stable isotope analysis (SIA). Separate populations of lice were collected from farmed Atlantic salmon in Cobscook Bay and from returning wild salmon at the Milford Dam, ME to determine if the isotopic signatures of lice from different fish stocks were unique. Preliminary studies experimented with sample processing protocols in order to establish the most efficient method for SIA of sea lice. Further analysis of δ13C and δ15N stable isotopes was used to track animal movement and food web interactions, and thus the origins of associated sea louse populations in the bay. Knowledge of where sea lice originate from and how they survive the cold season will improve the current understanding of sea lice ecology under cold stress and its effects on wild and farmed fish.

AQUALENS CONNECT FARM SURVEILLANCE CAMERA SYSTEM

Durval Tavares. Aquabotix, 21 Father DeValles Blvd., Fall River, MA 02723
Aquabotix President, Durval Tavares, will present their newest camera system, the AquaLens Connect. This camera system can be used to monitor farms from above and below the water. The AquaLens Connect is an underwater/all weather camera system designed to capture high quality video and still images at the click of a button. It captures full 1080p HD video and transfers a live feed to the user’s iPad or laptop computer. The AquaLens Connect includes a pan and tilt camera with digital zoom and has different lighting options including one that tracks with the camera. AquaLens Connect can be used individually or multiple units can be combined into a network of cameras, all controlled and viewed on one screen through Aquabotix's proprietary operating system. Whether used for occasional inspection or continuous surveillance, AquaLens Connect is easy to use and maintain.

**UPDATE ON THE DEVELOPMENT OF SMALL, LOCAL SHELLFISH HATCHERIES AND INCREASING HATCHERY PRODUCTION METHODS FOR EXISTING HATCHERIES CULTURING THE EASTERN OYSTER, CRASSOSTREA VIRGINICA**

**Kim W. Tetrault, Gregg J. Rivara.** Cornell Cooperative Extension, 3690 Cedar Beach Road, Southold, NY 11971

The Suffolk County Marine Environmental Learning Center, a facility of Cornell Cooperative Extension of Suffolk County, New York, has operated a shellfish hatchery on Long Island since 1991, with three additional hatcheries being added in later years. Over the past two decades, many inquiries have been made by commercial enterprises regarding shellfish culture methods. In an attempt to make hatchery techniques and protocol more accessible to prospective ventures, CCESuffolk has secured a research grant with New York Sea Grant to examine the use of algae concentrate as a sole food source for larval rearing and to evaluate high-density larval culture for eastern oysters. One goal is to determine the viability of small-scale “pocket” hatcheries and their ability to produce eyed pediveligers without using expensive resources such as live cultured micro-algae and large volumes of heated seawater. This presentation will summarize the outcome of production level larval rearing using combinations of live feed and algae concentrate. Also, the design and operation of a moderate/low cost high density larval rearing system will be described.

**BAY SCALLOP (ARGOPECTEN IRRADIANS) NURSERY AND GROWOUT STRATEGIES**

**Harrison Tobi, Daniel Ward.** Ward Aquafarms, LLC, 51 North Falmouth Highway, North Falmouth, MA 02556

The shellfish aquaculture industry in the northeast continues to expand, and many farmers are interested in producing additional species to diversify risk and bring in additional income. Bay scallop (Argopecten irradians) farming has been attempted by many aquaculturists, but success has been limited due to inefficient techniques in both the nursery and growout phases. The best nursery and growout techniques will vary in different environments, though research into all phases following the hatchery is necessary to produce bay scallops of a sufficient size to make a viable product. In 2016, Ward Aquafarms investigated different nursery and growout methods to optimize bay scallop growth in year one. Using custom designed downweller nursery systems, different bay scallop stocking densities were evaluated over the entire nursery period. Growth and survival of the bay scallops were calculated for each density every two weeks to determine the most efficient stocking density to maximize growth and yield. Once
the bay scallops reached appropriate size, they were then moved to three distinct growout environments to observe growth and survival in three areas of diverse site characteristics over a three month period. At each site, three different growout methods were implemented using floating bags, hanging trays, and bottom cages. Growth and survival for each growout method at each site were documented to determine the most effective growout methods for bay scallop aquaculture.

MARKET ANALYSIS AND STRATEGIC IMPLICATIONS FOR MAINE’S CULTURED SHELLFISH

Rob Veidenheimer¹, Chris Vonderweidt², Bill Mook³, Sebastian Belle⁴, Dick Clime⁵, Gary Moretti⁶, Jonathan Labaree⁷. ¹The Hale Group, 8 Cherry Street, Danvers, Massachusetts 01923; ²Gulf of Maine Research Institute, 350 Commercial Street, Portland Maine 04101; ³Mook Sea Farm, 321 ME-129, Walpole, ME 04573; ⁴Maine Aquaculture Association, 103 Water St # 4, Hallowell, ME 04347; ⁵Coastal Enterprises Incorporated, 30 Federal St, Brunswick, ME 04011; ⁶Bangs Island Mussels, Commercial Street, Portland, ME 04101; ⁷Gulf of Maine Research Institute, 350 Commercial Street, Portland Maine 04101

There is great enthusiasm for expanding aquaculture in Maine as an economic opportunity for coastal communities. Yet very little is known about existing and potential markets for products, particularly farmed shellfish, that a growing industry would produce. The Farmed Shellfish Market Analysis provides a data-driven, quantitative market assessment of the potential scale and scope of markets for Maine’s cultured shellfish. Maine is uniquely positioned to leverage and expand its aquaculture industry to capture a greater share of the marketplace for oysters, mussels, and scallops due to competitive advantages including: high quality products; available space; strong consumer brand affinity; location near distribution centers; and proximity to large population centers. Maine is positioned to be a growth leader in farmed oyster production, but needs to employ strategies to moderate price declines as supply increases over the next 3-5 years. Currently, Maine oysters command a price premium due to the high-quality perception of cold water oysters. Maine is positioned to be a growth leader in farmed mussel production, given its available capacity for growth, high quality growing environment, brand equity, and opportunity to displace Canadian product in close-proximity markets. Maine is particularly well-suited for scallop aquaculture growth, given the significant room for new sites and existing perception that Maine’s wild scallops are high quality. Achieving sufficient scale will require Maine to invest in development of scallop aquaculture capabilities.

SUGAR KELP (LAMINARIA SACCHARINA) AQUACULTURE IN SOUTHEASTERN MASSACHUSETTS

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There are no marine aquaculture farms in Massachusetts, and very few farms in the country that culture multiple species at different trophic levels on the same farm, despite the known synergistic benefits to both the farm and the environment. Sugar kelp (Laminaria saccharina) has been grown in Maine for several years, and has been supplementing wild harvest for commercial macroalgae businesses. In this project a sugar kelp nursery was developed, and then sugar kelp growout was added to the existing
oyster and bay scallop farm to; 1) take advantage of the known culture technique, 2) utilize an established market with great demand for the product, and 3) collaborate with other farmers in northern New England culturing the macroalgae who are very willing to assist in establishing new farms. The water temperature, climate and environmental characteristics of our farm are conducive to sugar kelp culture, as there are already natural beds found nearby. The nursery phase was very successful, and the seed string was installed at the site in December 2013. At the growout site however, the kelp did not grow to harvestable size, and therefore research is ongoing to determine why the kelp stayed small throughout the entire culture period. One potential factor may have been the late planting, and the fact that the winter of 2013/2014 was unusually cold, and therefore water temperatures were colder than average. Sugar kelp lines were again installed in 2014, and protocols to improve sugar kelp culture in Massachusetts are currently being evaluated.

INVESTIGATING THE “RUST TIDE” (COCHLODINIUM POLYKRIKOIDES) HARMFUL ALGAE BLOOM ON A COMMERCIAL SHELLFISH FARM AND POTENTIAL MITIGATION STRATEGIES TO REDUCE FUTURE IMPACTS

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Farming is, and always will be a risky business. Whether the particular challenge on the farm is primarily predators, flow, disease, theft, storms, or a mix of all of the above, it takes constant vigilance to keep the product growing and providing a consistent supply to the market. In the northeast, for the last 10 years, and increasingly in the last 5 years, a new threat has been added to the list: Cochlodinium polykrikoides, the causative microalgae behind the recent “rust tides”. While C. polykrikoides has been causing large biological and economic losses to the aquaculture industry in South Korea for decades, its emergence as a threat on the east coast of the US is a relatively recent phenomenon. This alga blooms in mid-summer when the water temperatures are the warmest, and typically doesn’t completely disappear until the water temperature declines in the fall. Studies on the impacts on commercially important shellfish such as eastern oysters (Crassostrea virginica), bay scallops (Argopecten irradians), and northern quahogs (Mercenaria mercenaria) were performed both in laboratory trials and in field experiments during a bloom in 2016. Cell densities, nutrient concentrations, and additional environmental data were collected throughout the bloom period to understand more completely the impact of these annual blooms on shellfish farms in New England. From these experiments, strategies for mitigation have been evaluated to establish methods to reduce impacts from the harmful algae as the blooms become more common.

DETERMINATION OF THRESHOLD CARBONATE CHEMISTRY PARAMETERS FOR JUVENILE EASTERN OYSTER CALCIFICATION

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There is overwhelming laboratory-based evidence that ocean and coastal acidification, generally resulting from increased carbon dioxide ($CO_2$) levels, negatively impact calcium carbonate shell-forming organisms such as Eastern oysters ($Crassostrea virginica$). In the open ocean, increased carbon dioxide is due to equilibration with atmospheric carbon dioxide. However, in coastal regions, the factors influencing carbonate chemistry are more complex and variable, with some coastal regions already experiencing $pCO_2$, pH, and calcium carbonate saturation state ($\Omega$) conditions that are not predicted for the open ocean until the end of the century. The Damariscotta River is one of these regions that experiences seasonally variable carbonate chemistry conditions, with conditions generally deteriorating from spring to summer. The majority of laboratory-based ocean acidification research considering the biological impacts on bivalves has focused on larval stages. However, from an aquaculture perspective, the conditions to which larvae are exposed can be highly controlled in a hatchery. Less research has considered how juvenile oysters will be impacted by ocean acidification, although evidence indicates they experience negative effects, including decreased calcification. Juvenile oysters are typically transferred from hatcheries to nursery lease sites during summer months, when water chemistry conditions are deteriorating. Through a field-based study, we propose to investigate the influence of seasonally-variable carbonate chemistry on juvenile oyster calcification rates using oysters grown in the Damariscotta River, which produces the majority of Maine’s farmed oysters. The objective of this work will be to determine threshold levels for pH, $pCO_2$, and $\Omega$, beyond which juvenile oyster calcification rates significantly decline.

**AQUACULTURE SUSTAINABILITY – WHAT IS IT AND HOW DO WE ASSESS IT?**

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The word “sustainable” has several formal definitions, but its over-use in fisheries and aquaculture discussions has obscured meaning such that the word is invoked with little thought to what really is intended. Everyone agrees that aquaculture needs to be “sustainable,” but how do we assess “sustainability?” Organizationally, NEFSC has taken on this challenge by re-titling a Branch in the new Ecosystems & Aquaculture Division as the “Aquaculture Sustainability Branch,” with the assignment to assess sustainability of aquaculture practices. In taking on this challenge, we recognize that there are several, hierarchical layers of sustainability. First, the organism under cultivation must be sustained by the culture practice and the environment containing it. Next, investments in infrastructure, energy, and effort must be more than compensated by the financial value of the product – the farmer must be sustained. The layer of sustainability that we often intend – ecological sustainability – is irrelevant if the first two levels are not affirmed. Ecological sustainability, however, lacks the clear criteria one can assign at the organism level (alive or dead) or the economic outcome (profitable or not). Fundamentally, ecological sustainability is a social construct in that it is defined by what the human community will tolerate and permit in terms of environmental modification. Thus, the job of aquaculture assessment science is to provide quantitative data on ecosystem interactions of aquaculture practices in the environments where they exist and, pro-actively, to develop cultivation technologies that address all levels of sustainability as humankind transitions to sourcing of seafood from cultivated fisheries.
RECONNECTING WITH THEIR MARINE ROOTS: MAINE'S NATIVE TRIBES EXPERIMENT WITH SMALL SCALE AQUACULTURE

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Harvesting shellfish and fish were critical activities for New England’s native peoples before European colonization and well into the 20th century. Shellfish remains make up around 90% of the identified material found at coastal archeological sites from the Carolinas into Maritime Canada. Maine’s native peoples expressly retained fishing rights in their treaties because of the importance marine species held for sustenance and survival. Overfishing and other ecosystem changes have left fewer and fewer opportunities for native peoples to subsist on marine derived protein in the modern day. The Passamaquoddy Tribe of Maine is experimenting with aquaculture as a means to rebuild and rediscover their marine roots. In partnership with the Sustainable Ecological Network (SEANET) EPSCOR at the University of Maine and the University of Southern Maine, tribal members are establishing kelp, clam and eel farms on the Pleasant Point reservation. The kelp farm is an experiment for training future kelp growers and conducting a proof-of-concept harvest. Half the kelp installation will double as an experiment using soft engineering to dampen shoreline erosion. The clam farm is an experiment in collective action and resource enhancement to see if local governance can help maintain access to regional flats. The eel farm is an attempt to provide tribal members with other, more lucrative outlets for their glass eel catch. In this presentation we will discuss the history, design, opportunities and challenges of these efforts. We will also highlight some of the unique challenges presented by the remoteness and geographic location of the reservation.
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