THE UNIVERSITY OF MAINE

Maine EPSCoR

SUMMER 2016 NEWSLETTER

High-tech buoys

Inspired students learn sensor technology at UMaine

From the director

MAINE HAS a unique environment to drive aquaculture research, as there are roughly 3,500 miles of coastline that serve as a living laboratory. Aquaculture was identified as a key growth sector for the state by the Maine Innovation Economic Advisory Board in the 2010 Science and Technology Action Plan. In 2014 alone, the aquaculture industry grossed $137.6 million in economic impact for the state.

Our current NSF EPSCoR Track 1 grant, the Sustainable Ecological Aquaculture Network (SEANET), consists of four research Themes: Ecological and Sociological Carrying Capacity; Aquaculture in a Changing Ecosystem; Innovations in Aquaculture; and Human Dimensions. These Themes collaborate through a variety of projects to positively impact Maine's working waterfront. Our latest issue of the newsletter includes information about some of the projects happening under SEANET.

SEANET presently consists of 37 faculty members, 93 undergraduate students and 41 graduate students who are engaged in aquaculture research this year at 10 institutions across the state.

During the past several months we have been busy with many projects under the SEANET grant, and related accomplishments include the following:

- Year 2 Annual Report approved
- Recent completion of a Project Summary Report containing 55 project summaries encompassing the entire SEANET research program
- Successful Reverse Site Visit in May with on-going follow-up dialogue with NSF
- Follow on grants totaling $5,995,388

The New England Sustainable Consortium (NEST) Track 2 project successfully ended in July and now we begin a new Track 2 project with New Hampshire and Rhode Island looking at the future of dams in the region under the leadership of the Senator George J. Mitchell Center for Sustainability Solutions' David Hart.

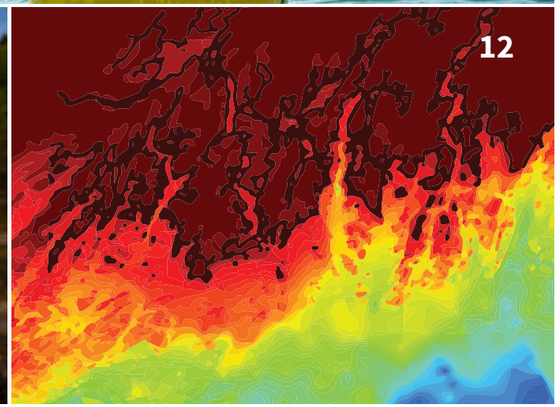
Finally, our Track 3 SMART (Stormwater Management Resource Team) program just completed its third and final year. Paige Brown, a high school student from Bangor and participant in the SMART program, won several competitions with her work in the program. The most prestigious award was the First Place Medal of Distinction for Global Good in the Intel Science Talent Search. SMART is waiting on confirmation of a new NSF grant to continue its momentum nationwide.

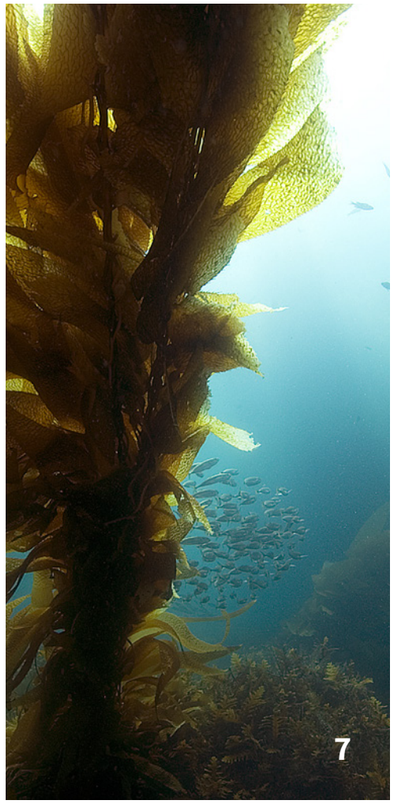
It is with great pleasure that I introduce our newly improved newsletter and invite you to read about our latest advances in research. Your interest in our research is tremendously appreciated.

SHANE MOEYKENS, PH.D.
Director of Research Administration and EPSCoR

Marine Ecology class from Darling Marine Center's field trip to Intertidal Pools at Chamberlain.

MAINE EPSCoR





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ON THE COVER:
Matthew Gray, postdoctoral research associate at the Darling Marine Center, views data from an ocean-observing buoy at the mouth of the Damariscotta River to help scientists understand how different types and scales of aquaculture can fit into Maine's multiuse working waterfront. The buoy is part of the National Science Foundation's EPSCoR program, the Sustainable Ecological Aquaculture Network (SEANET), focused on creating more sustainable coastal communities and ecosystems through a deeper understanding of how these systems interact with and influence each other.

What is Maine EPSCoR?

The Experimental Program to Stimulate Competitive Research (EPSCoR) was initiated at the National Science Foundation in 1978, and now encompasses EPSCoR programs at several other Federal agencies.

Maine EPSCoR at the University of Maine seeks to expand opportunities for more diverse faculty, staff, and student populations. Diversity brings different perspectives, skill sets, and helps broaden our vision. We recognize that geographic and societal challenges exist that require pragmatic solutions with achievable and measurable goals. Maine EPSCoR strives to enhance diversity in all elements of EPSCoR programs while increasing participation of underrepresented minorities in science, technology, engineering, and mathematics (STEM) disciplines.

Attaining aquaculture

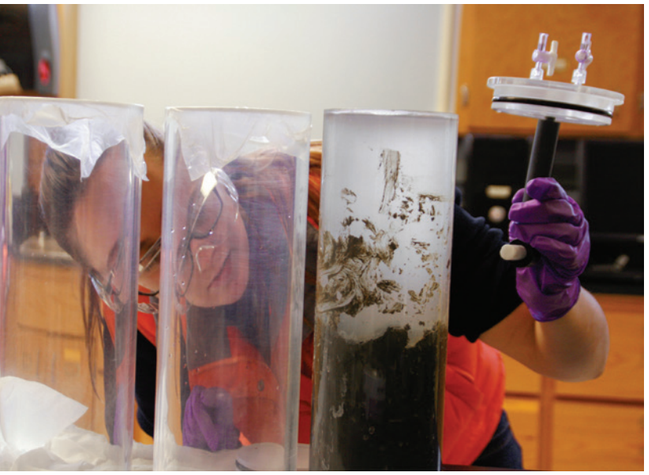
Adequate scaling for Maine's working waterfront

GRADUATE RESEARCH assistant Libby Gorse's lab is in the basement of Boardman Hall at the University of Maine. It's dark and harkens back to the 1950s with old test tubes and equipment on display in cabinets lining the hallway. Libby, on the other hand, is bright and cheery, excited about her work and bubbling to tell anyone about the research project she's spearheading under the Sustainable Ecological Aquaculture Network (SEANET) project. Working with Aria Amirbahman, professor of Civil and Environmental Engineering, the two are studying the effects aquaculture farms have on the sediment which lies below the farms.

Gorse, a civil engineering PhD student, has been interested in chemistry since the ripe old age of 13. Her father was an analytical chemist and Gorse followed in his footsteps by studying chemistry at Baldwin Wallace University in Berea, Ohio. She says she has been using some of the lab equipment involved since she was small.

The SEANET project is administered by Maine EPSCoR at the University of Maine. The five year, $20 million grant from the National Science Foundation will help Maine explore how different types and scales of aquaculture fit into Maine's multi-use working waterfront.

Research will involve environmental monitoring using field investigations and lab analysis along with buoy-based sensor technology to understand trophic dynamics of aquaculture within Maine's coastal ecosystem. Specifically, this is the study of how nutrients move from the physical environment into living organisms and then recycle back.



Ph.D. candidate Libby Gorse compares sediment samples in her lab in Boardman Hall at UMaine.

SEANET has purposely split the state into three separate bioregions as a means to study each specific area in depth. The Maine coast serves as a living laboratory allowing researchers to explore the special feasibility of aquaculture operations. Gorse's studies will occur in all three areas and will contribute to an understanding of the carrying capacity – what density of aquaculture operations can be maintained, what kind of sites, or how many sites are appropriate – considering local conditions.

"My study will look at the different bio-deposits from oysters, mussels, finfish, and all the different operations Maine supports," says Gorse. "We need to grasp how to balance aquaculture operations to keep everything healthy and know how many sites or types of sites are appropriate."

For SEANET, the studies are important as they will help determine how much aquaculture an area might be able to support. By studying the sediment below the farms, Gorse and Amirbahman hope to find out how best to advise aquaculture farmers regarding growth and placement of farms along the coast.

Amirbahman says, "It's important to know the footprint — chemical and biological — of these farms."

"It's especially important for us to understand the role that these operations have on the overall nutrient budget of these systems. It will help us understand where to site – for instance how far apart from each other these operations should be. What kind of flushing rate you have, for instance – dilution via the tide or the current that can solve a lot of problems."

COLLABORATION ACROSS DEPARTMENTS

To create the equipment for her study, Gorse worked with the Advanced Manufacturing Center (AMC) at UMaine to construct flux chambers to hold her sediment samples, which she uses in conjunction with a pump system to move water through the chambers, and a chiller unit to keep the temperature of the samples at a consistent bottom water level of 45–55 degrees Fahrenheit.

John Belding, director of the AMC says that the center works with researchers all the time to fabricate different products to help move research forward. "For Libby's project, we worked from drawings and pictures of other systems that were used at other universities. We came up with a design that met their needs based on what they were doing. Libby's research is specialized, so it needed some special equipment to accomplish it."

The system has taken months of testing and trial and error to get working just how Gorse envisioned it. Gorse hopes to have preliminary results of her testing in two to three months.

WORKING WITH STAKEHOLDERS

The next phase of the study will be to go to aquaculture farms and take samples from under the farms, and to also get samples from outside the area of the farms to compare. Amirbahman estimates that this will happen during the summer of 2017. Work like this has never been done in Maine, but will be of great importance in the next stage of research.

And, like the collaboration between UMaine departments, it's also of utmost importance for researchers to work closely with farmers. "We look forward to being educated and informed on the very practical aspects of this work," Amirbahman describes, "these are aspects that you don't read in scientific papers or books. These are people with experience. We need to get a better understanding of the impact of these facilities, especially on the environment and being able to inform them about the carrying capacity of the region."

Gorse and Amirbahman both hope this research will help develop and grow a viable aquaculture economy in the state of Maine. ■

Mini grants to bolster research

THE SUSTAINABLE ecological aquaculture network (SEANET), funded through Maine EPSCoR NSF, is pleased to announce three awards through its annual, competitive research mini-grant program. A total of $36,000 will be awarded to three projects which will augment the SEANET research portfolio by conducting studies pertinent to the strategic goals and bringing in researchers from outside institutions and businesses thus building the aquaculture research network in Maine. The mini-grants were awarded to the following projects:

How size selective are oysters? Size fractionated analysis of plankton communities in support of SEANET buoy data collection and geochemical and oyster growth models.
Cynthia Heil, Bigelow Laboratory; Nicole Poulton, Bigelow Laboratory and Carter Newell, Pemaquid Oysters

Determining the spatial extent of re-mediated water quality surrounding a kelp farm in Casco Bay
Susan Arnold, Island Institute; Nichole Price, Bigelow Laboratory; Joe Salisbury, UNH and Paul Dobbins, Ocean Approved

Can clam flat enhancement contribute to regional cooperation across municipal borders and economic scales of harvesters?
Theodore Willis, Passamaquoddy Tribe at Pleasant Point; Teresa Johnson, University of Maine and Brian Beal, University of Maine Machias

"Involving Bigelow Laboratory, the Island Institute, UNH, Pemaquid Oysters, the Passamaquoddy Tribe, and Ocean Approved in the sustainable aquaculture network is invaluable to the SEANET goal of increasing statewide research opportunities, collaborations and partnerships. These annual mini-grants allow SEANET to support emerging aquaculture research and these three projects are exciting examples of the type of innovation happening at institutions along our coast," says Paul Anderson, SEANET Research Director.

The next call for proposals will be in the fall of 2016.

The grievous green crab

Repurposing coastal Maine's top invasive species

Emily Tarr, a sophomore Marine Sciences student at UMaine collects green crabs during a recent field visit.

GREEN CRABS are an invasive species in Maine with no significant predators. They deplete resources by voraciously eating molluscan shellfish, destroying eel grass and marsh habitats, and causing erosion in bays and estuaries. The Sustainable Ecological Aquaculture Network (SEANET) is studying meaningful ways to use green crabs or parts of green crabs to develop value-added products.

Researchers with the SEANET project at the University of Maine are testing how to use green crabs in new and innovative ways. Although edible, the green crab has not reached a level of cuisine like other valuable crustaceans, in part because they are small and take much more effort to shell than their meat is worth. The green crab has been present in the U.S. since the mid-1800s, however their population has rapidly increased during the past 15 years or so. Many believe that warmer winters in New England are one reason for the population increase.

Clammers especially have a great interest in the outcome of these studies as the invasive pest is effecting their livelihood. The Maine Clammers Association provided the lab with 100s of green crabs last year for study purposes.

Researchers are evaluating the characteristics of parts of the green crab – particularly the proteins, which may then be used as additives for other products. Proteins have certain properties that make them valuable as food ingredients. They can be emulsifying, foaming, hold water, and form gel substances. For instance, emulsifiers allow water and oils to remain mixed together in an emulsion such as mayonnaise, ice cream, or sauces.

Proteins, extracted from egg whites, or soy and whey powders, have been added to food for years. Potential proteins from green crab would likely only be used in seafood products to avoid injury to those with seafood allergies. Potential uses include adding to battered products, like popcorn shrimp and fish sticks. The extra proteins in the batter can help reduce fat absorption in fried products, increasing the overall healthfulness of the products.

Currently, research is concentrated on the best way to separate the shell from the soft tissue of the green crabs and methods to maximize yield from the product. This is the first time research of this kind has been done on crustaceans. Proteins have been isolated from finfish, but not from crabs. The next phase of the research will look at the benefits of these proteins to humans, such as improvements in certain ailments like hypertension or diabetes. The hope is to find beneficial ways to use green crab proteins as food additives that create value and leads to commercial harvesting of these invasive creatures. ■

Bouhee Kang, PhD student in Food Science and Human Nutrition at the University of Maine, prepares a slurry of green crab tissue to extract proteins.

Students from Lincoln Academy lower a sensor that they built at the Darling Marine Center.

High-tech buoys

Inspired students learn sensor technology at UMaine

EXPOSING STUDENTS to marine technologies like the buoy sensors used in the Sustainable Ecological Aquaculture Network (SEANET) program enables a hands-on experience with marine science and technology.

Students are inspired to study marine sciences and engineering.

Computer programming students in Lincoln Academy's "Invent to Learn" class are investigating marine technology and its application, specifically to aquaculture in the Damariscotta River Estuary, thanks to funding from SEANET.

Using Sparkfun Inventor's Kits – equipment and materials that allow students to get started with programming and hardware interaction with the Arduino programming language – the high school students are programming light and temperature sensors, push buttons, LCD screens and more. By combining these components and 3-D printing techniques, students will build sensors capable of gathering water quality data similar to that collected by SEANET buoys deployed by researchers from the University of Maine and partner institutions in the Damariscotta River.

The sensor technology program is a collaboration between Lincoln Academy (LA) and the University of Maine's Darling Marine Center (DMC) in Walpole, Maine.

Lili Pugh, DMC's K–12 education coordinator, and Maya Crosby, LA's Cable Burns Applied Technology Education Center Program Director and Technology Coordinator, received a SEANET workforce development grant to introduce sensor technology and its application to high school students. The grant was designed to foster partnerships with organizations and institutions to boost K-20 science, technology, engineering and mathematics (STEM) outreach and education programs that are aligned with SEANET's research initiatives.

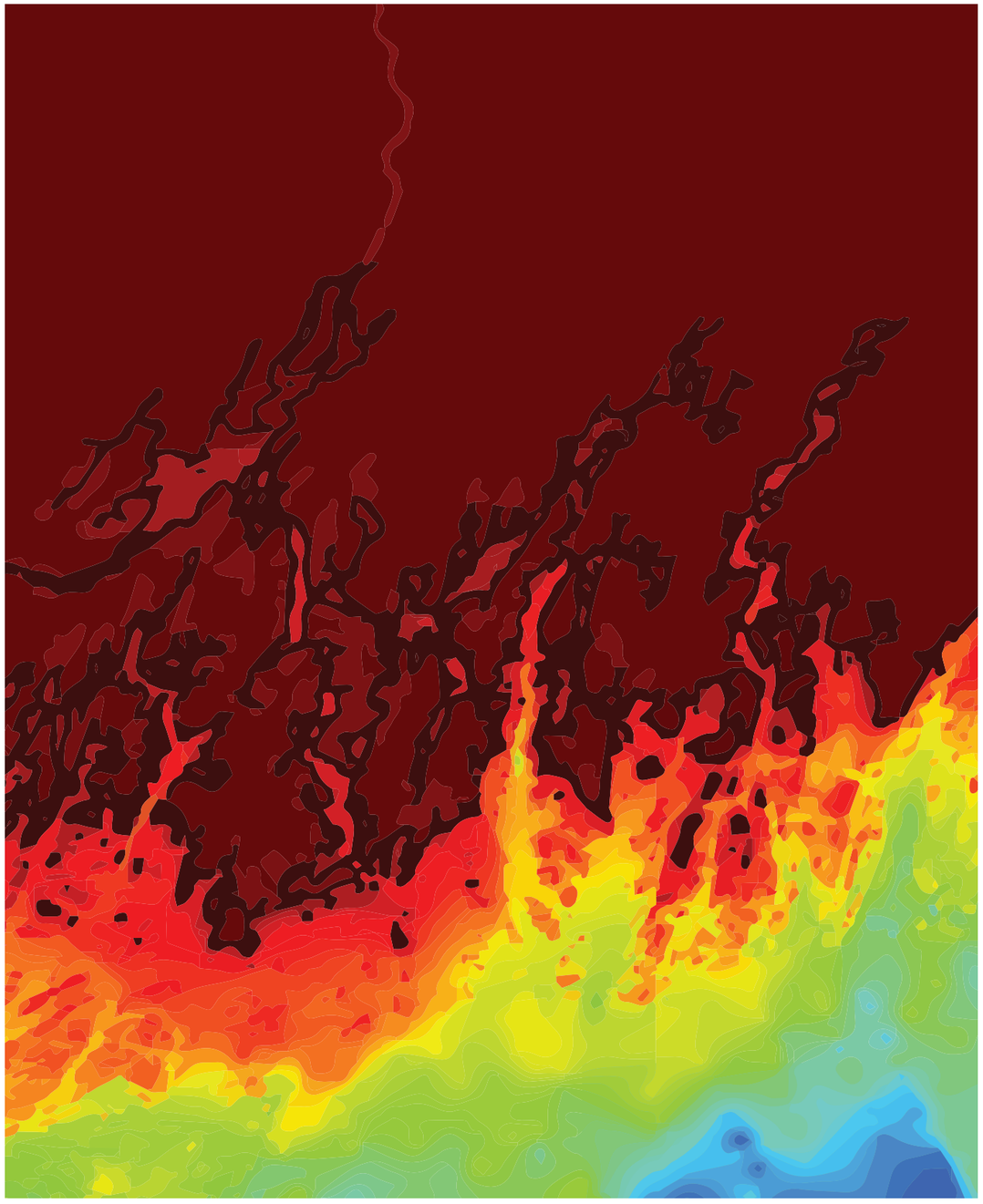
Introducing students to scientists and current research is a key part of the sensory technology program. Recently, Scott Morello, postdoctoral researcher with the Downeast Institute, spoke to students about how mussels adapt to intertidal habitats and how scientists use "robomussels"— temperature sensors embedded in artificial silicone mussels that mimic internal mussel conditions when out in the field — to study these adaptations.

Students from three LA classes — Invent to Learn, Marine Resources, and Oceanography — visited the DMC. They toured the shellfish aquaculture facilities, learned about the Damariscotta River environment, and talked with SEANET researchers who are deploying sensors and other marine technologies to monitor oyster growth and environmental conditions.

In the end, Pugh notes, "we hope that students will gain a greater appreciation of marine technology and how it can be applied to develop creative solutions relevant to our coastal economy."

This model will be used in other educational opportunities across the state of Maine.

For more information about workforce development and education programs, contact Laurie Bragg at laurie.bragg@maine.edu or 207.581.2295 ■



Midcoast Maine bathymetry map.

Mapping estuaries for **aquaculture suitability**

The importance of knowing your site

AQUACULTURE GROWERS and the Maine Department of Marine Resources (DMR) will have a new suite of tools to best site aquaculture growing areas.

The mapping tool will help growers farm smarter. "Trial and error" aquaculture will be replaced with a system that can calculate growing potential while also minimizing environmental and social impacts on Maine estuaries.

Finding the best places to grow oysters, mussels, scallops, and sea vegetables are the questions researchers with the Sustainable Aquaculture Research Network (SEANET) in Maine are trying to answer. Researchers are using several different mapping and sensing techniques to create a model that will advance aquaculture site prospecting for growers.

"Choosing the best site is the number one priority for growers," explains Damian Brady, assistant professor in the School of Marine Sciences at the University of Maine. "With this new tool, we can do a better job predicting where prospective aquaculture growing sites should be located."

The model uses a number of data sets, including bathymetry – high resolution maps that characterize the bottom of the estuaries; satellite data which collects temperature and chlorophyll (food for many aquacultured species); and data collected from the SEANET buoys which are launched in the estuaries during the growing season and collect hourly data about salinity, turbidity (how many particles are in the water), temperature, pH and several other factors.

The SEANET buoy network is supplemented with other smaller buoys and sensors involving students, citizen monitors, fishermen and aquaculturists. Bringing all these instruments together provides researchers with a powerful suite of tools to better understand what makes a farm successful.

This all helps ensure that conditions are right for a specific species to grow in the best places. For instance, oysters prefer warmer waters than mussels, scallops, and sea vegetables.

Growers are already accessing data from the current SEANET buoy network and the new integrated models will be disseminated to the public in later phases of the project.

Want to view SEANET data collected by the Land/Ocean Biogeochecmical Observatory (LOBO) buoy system? Visit maine.loboviz.com. ■

MAINE EPSCoR

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RETURN SERVICE REQUESTED

Maine State EPSCoR Committee:

Maine EPSCoR is overseen by the Maine Innovation Economy Advisory Board, a statewide steering committee of individuals from Maine's education, research, and business communities and state government. The Board is under the auspices of Maine's Office of Innovation.

Family interacts with the touch tank at the Maine Science Festival at the Cross Insurance Center in Bangor.

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Maine EPSCoR
Summer 2016

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