



Maine EPSCoR

Green crabs

Invading Maine's classrooms







From the director

NSF EPSCoR ADVANCES EXCELLENCE in science and engineering research and education in Maine. Three NSF EPSCoR grants are currently underway in our state, and I'd like to take this opportunity to highlight each of the three programs.

Our current NSF EPSCoR RII 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) that are collaborating through a variety of projects to positively impact Maine's working waterfront. SEANET consists of 42 faculty members, 78 undergraduate students and 39 graduate students who are engaged in aquaculture research at 10 institutions across the state. Recent accomplishments include:

- Successful AAAS review completed in March, 2017, which reviewed the project against plan and objectives
- SEANET faculty and students have been highly productive in the past year, publishing 33 journal articles and conducting 128 conference presentations, helping to disseminate SEANET research results to the broader community
- Follow-on grants totaling \$7,691,243 awarded since beginning of the grant in 2014

The NSF EPSCoR RII Track-2 grant, the Future of Dams project, is led in Maine by UMaine's Mitchell Center for Sustainability Solutions and includes five partner institutions (e.g., the University of New Hampshire, the University of Rhode Island). A team of 19 faculty, 2 postdoctoral fellows and 21 graduate students conducts stakeholder-engaged, solutions-driven, interdisciplinary research to examine the complex tradeoffs associated with alternative management decisions about dams (e.g. relicensing hydropower dams, removing obsolete dams, enhancing fish passage). The team uses a wide range of innovative tools (e.g. fish survival analysis, production possibility frontiers, dam failure risk assessment, multi-criteria decision analysis, biogeochemical budgets, negotiation simulation, media discourse analysis, participatory systems dynamic modeling) to develop decision-support tools for government, the private sector and non-governmental organizations.

Maine's NSF EPSCoR RII Track 3 grant, the SMART (Stormwater Management Resource Team) program, is transitioning to a new NSF-INCLUDES award with the goal of scaling up the SMART model to eight other states (AL, CA, FL, ID, MO, MS, NC, NY) through a collective impact process. The University of Maine Stormwater Management Research Team (SMART) program began in 2014 to engage female and underrepresented minority (URM) high school students in locally-relevant and interactive STEM research. SMART provided University of Maine-designed water data collection equipment, science and engineering training and community mentor connections. Students collected over 4,000 water measurements in their local communities, and entered these data points (such as temperature, conductivity and pH) into a common online database. SMART has trained 200 students and 25 teachers in the science and engineering of stormwater.

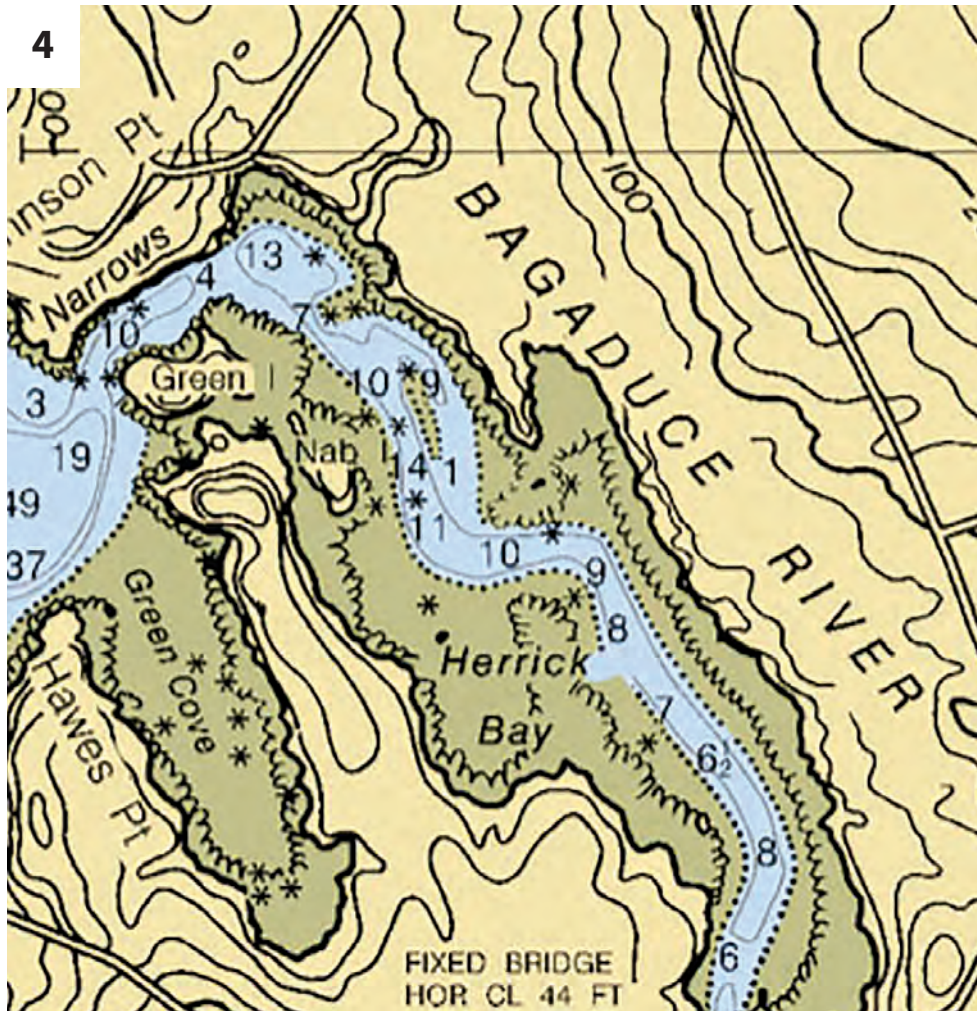
It is with great pleasure that I share our newsletter and invite you to read about our latest advances in research and education. Your interest in our research is tremendously appreciated.

SHANE MOEYKENS, PH.D.

Director of Research Administration and Maine EPSCoR

Marine ecology class from Darling Marine Center's field trip to intertidal pools in Chamberlain.





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 and 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.

ON THE COVER:

This UMaine Student is searching the inner tidal zone for green crabs at the Darling Marine Center in Walpole. Green crabs are the most damaging invasive species in the New England coastal zone; they have a major impact predated aquacultured species. As part of the SEANET project, high school, undergraduate and graduate students have been studying the impacts of climate change on the life cycles of green crabs, analyzing the effects of the crabs on soft shell clams and researching methods to mitigate their damage to Maine's aquaculture industry.



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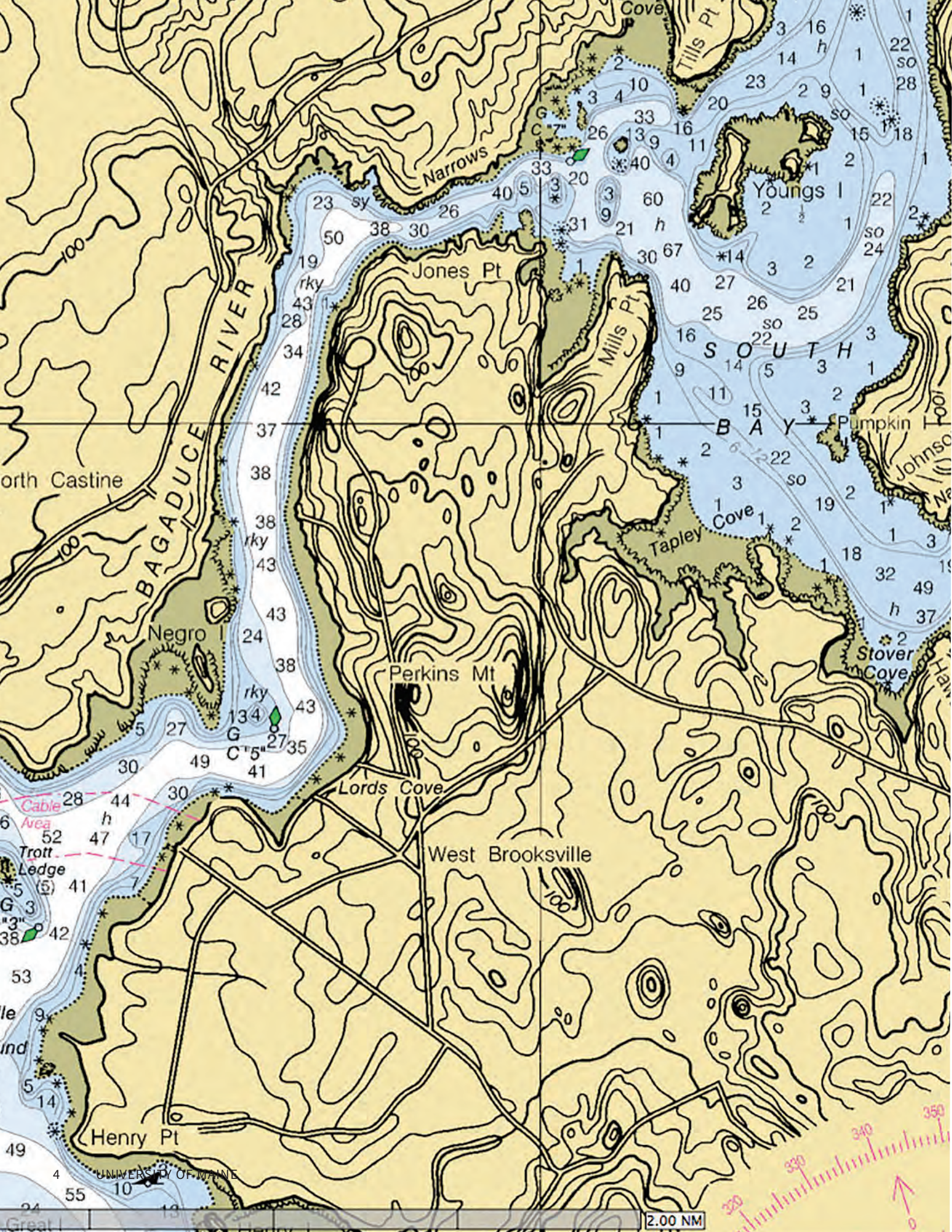
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Aquaculture – Putting Maine on the Map

First stop: University of New England

WITH EARTH'S POPULATION of more than 7,375,455,089 increasing by one person every 16 seconds, there's an intense demand for nutritious, high-protein foods.

Aquaculture — the farming of aquatic plants and animals — is helping to meet the need. And it's the fastest-growing form of food production.

In Maine, innovative research is being conducted to better understand how aquaculture interacts with the state's coastal ecosystems and surrounding communities.

The University of New England — including faculty, staff and graduate and undergraduate students — is one of the lead partner institutions working to advance aquaculture in Maine through SEANET, the Sustainable Ecological Aquaculture Network program.

Established through a \$20 million grant awarded by the National Science Foundation to Maine EPSCoR at the University of Maine, SEANET provides researchers at multiple institutions with opportunities to utilize the unique coastal landscape as a living laboratory for sustainable aquaculture study.

In addition to UMaine and UNE, partners include Bowdoin, Cobscook Community Learning Center, Downeast Institute for Applied Marine Research and Education, Maine Maritime Academy, Saint Joseph's College, University of Maine Machias and the University of Southern Maine.

Gretchen Grebe, a UMaine graduate student based at UNE, examines nutrient availability in Saco Bay. With a research-intensive farm grant provided by SEANET, Grebe collaborates with area shellfish and kelp farmers to strengthen understanding of the relationships between aquafarming and the environment.

Her interdisciplinary approach draws on ecological principles, phycology (the study of seaweeds and other algae), coastal resource management, biochemistry and marine entrepreneurship.

Grebe's findings will provide sea farmers with valuable information about site selection.

"The results of my research will provide kelp farmers and harvesters with more information about the best places to grow and harvest kelp to maximize the nutritional value and quality of their products," she says.

The research is intended to help ensure only top-quality food from the sea reaches consumers' plates.

Adrianus Both, also a UMaine graduate student at UNE, is examining the nutritional value, origin and quality of detritus (organic matter produced by the decomposition of marine organisms) in Saco Bay. He wants to determine detritus' capacity as a supplementary diet for shellfish aquaculture.

"This research informs energy transfer within ecosystems, as well as expanding the site selection criteria for aquaculture," says Both, whose findings will enhance the potential for successful expansion of sea farming along Maine's coast.



Dr. Ursula Roese and former undergraduate student Kyle Martin setting up field experiments to investigate chemical defense compounds in brown algae.

Carrie Byron, one of four new tenure-track assistant professors funded by the SEANET grant, is expanding research she began during her Ph.D. dissertation. Her focus is on food web dynamics as they pertain to shellfish farms and coastal aquaculture. Byron's goal is to understand how aquatic foods are sustainably grown.

Byron, with Both, Grebe and Adam St. Gelais, looks at dietary preferences of shellfish. She wants to determine whether shellfish prefer detritus to other particles.

"Shellfish feed on whatever particles are in the water," says Byron, an assistant professor at UNE. "There is a direct link to the ecosystem, and that ecosystem is feeding the farm. I'm trying to understand those dynamics — the processes on the farm that have an influence on the ecosystem."

Byron and the team also want to understand how detritus contributes to shellfish growth.

"We know shellfish are capable of consuming detritus, but we don't know how that energy gets incorporated (if at all) into their tissues for growth," she says.

The Ecophysiology lab of Markus Frederich at UNE has used SEANET funding to investigate the effects of invasive green crabs on the shellfish industry.

Green crabs pose a threat to aquacultured shellfish raised in the intertidal zone. So understanding their behavior can inform mitigation strategies, including deployment of netting and fencing to protect shellfish on farms.

The lab has focused on the stress response of soft-shell clams in the presence and absence of green crabs, as well as the differences in physiology and destructiveness

among genetically different populations of green crabs.

UNE graduate student Amanda Keegan exposed soft-shell clams to various densities of crabs in the field and in Frederich's lab. She found that clams in the presence of crabs had stunted growth, which indicates they reallocate energy resources toward a stress response.

Interestingly, the strongest responses of soft-shell clams — including shell opening and heart rate — occurred in the presence of a dead clam. Thus, an alarm signal for the clams may be due to the odor of a dead animal of the same species rather than due to the presence of a predator.

UNE graduate student Louis Logan has studied green crabs from Newfoundland, Nova Scotia, Maine and Iceland. He found that crabs from Nova Scotia — a genetic hybrid between the Maine and the Newfoundland populations — are the most aggressive.

However, the elevated aggression is not correlated to the destruction of eelgrass beds. The more aggressive Nova Scotia animals — which are currently moving south into Maine — don't burrow to hide.

The less aggressive Maine population of green crabs do burrow, uproot, and destroy eelgrass plants.

In Ursula Roese's Chemical Ecology lab at UNE, work is focused on expanding sea vegetable aquaculture. Chemical defense compounds of brown macroalgae have been a major focus. Several undergraduate students, including UNE sophomore Andrea Call, are examining algal defense compounds.

"To defend themselves, land plants often produce compounds that fight off pathogens and herbivores," says Roese, an associate professor in the Department of Biology.

"As our research over the past few years has shown, brown algae that are only distantly related to land plants are responding in similar ways. These secondary metabolites may not only affect algae-specific pathogens and herbivores, but may also have medicinal properties for humans."

With her students, and using gas chromatography-mass spectrometry, Roese identified compounds that are upregulated in response to stress in the seaweed *F. vesiculosus*.

The next step for Roese, who teaches medicinal plant biology, will be to test extracts of these algae on human pathogens in collaboration with colleague, Kristen Burkholder, a microbiologist.

St. Gelais, an assistant research scientist with the UNE

“Because of the buzz generated by SEANET, there are many more people interested in sustainable aquaculture here and in this region.”

—Adam St. Gelais

Center for Excellence in the Marine Sciences, has led the conceptualization and construction of a sea vegetable nursery and research lab in the UNE Arthur P. Girard Marine Science Center in Biddeford.

In addition to supporting research efforts, the nursery is a regional hub for farmers to source their “seed.”

The nursery has established partnerships with several new kelp farming companies and provided seed kelp to farmers in southern Maine and Casco Bay.

“After communicating closely with our community partners in the sea vegetable industry, it was clear that limited outlets for sourcing their seed was an issue,” says St. Gelais.

“Southern Maine was in need of leadership in this area and UNE’s infrastructure, faculty and staff expertise are well-suited to fill this important role.”

Additionally, St. Gelais established a demonstration kelp farm in Saco Bay that serves as UNE’s field research platform for sea vegetables. Last season, the farm grew just shy of one ton of sugar kelp and it’s on track to surpass that total in 2017.

“Our demonstration farm allows the UNE Ocean Food Systems Group to address research questions from engineering and ecology to product safety and ecosystem services,” says St. Gelais. “The farm is being leveraged by research teams across SEANET institutions and disciplines.”

Barry Costa-Pierce, director of the UNE Center for Excellence in the Marine Sciences and a co-principal investigator on the SEANET project, says UNE research projects have helped aquaculture garner attention throughout the state.

“Because of the buzz generated by SEANET, there are many more people interested in sustainable aquaculture here and in this region,” he says.

Costa-Pierce has developed partnerships and teams to work on priority aspects for the expansion of sea vegetable and shellfish aquaculture in Maine. He’s also expanded relationships between SEANET and the state’s coastal communities.

Opportunities for interdisciplinary collaboration have enhanced partnerships with industry and other academic centers throughout the nation and world, and enhanced community building at the local level.

Research conducted through SEANET could lead to discoveries that address constraints on aquaculture, from engineering to social ecology.

Costa-Pierce says the potential for growth is exciting.

“There has been a tremendous ingress of new ideas and partnerships, and an influx of energy, with insights into not only applied, but basic sciences here,” he says.

UNE’s aquaculture research has several goals. Researchers — including Grebe, Both, Byron, Roese, Frederich, St. Gelais and Costa-Pierce — are advancing understanding of local ecosystems and their capacities for sea farming.

And, they’re learning more about conducting local aquaculture in a socially responsible way.

Second stop: Maine Maritime Academy (MMA)

MAINE MARITIME ACADEMY (MMA) is a small public college nestled in the coastal town of Castine, Maine. Jim McKenna, associate professor of Marine Biology at MMA and Chair of the Academy’s Corning School of Ocean Studies, is one of several researchers participating in SEANET.

McKenna’s research primarily involves gathering baseline information from Maine’s coastal landscapes. In particular, his work focuses on the fundamental characteristics of the Bagaduce River system. The data he collects allows researchers to formulate thoughtful questions aimed at deepening our understanding of the river’s potential to support sustainable aquaculture.

To date, McKenna and his students have set up a series of seven monitoring stations along the length of the estuary. These stations allow researchers to measure characteristics of the water columns, such as temperature, salinity, light availability and oxygen concentration. This information helps students to gain a better understanding of how the river system works.

“Some of what we are focusing on includes studying green crab populations in certain parts of the Bagaduce



Maine Maritime Academy students conduct water quality testing.

River,” explains McKenna, “Monitoring the data helps us to understand several factors, including how the green crab’s larval systems move about in the water column.”

The partnership between SEANET and MMA provides both students and faculty members at the college with invaluable opportunities for research. “The faculty is not only very interested in doing research, but they also use research as a critical tool to enhance the education that undergraduate students receive,” states McKenna.

Taking part in applied research allows students to witness the progression and expansion of their work, as well as to contextualize it within the larger aquaculture operation in Maine. The insight that students gain through their involvement with a project such as SEANET adds depth to their educational experiences and results in a greater sense of meaning and impact.

“I am extremely interested in and excited about showing students how science and research can be used to advance meaningful socioeconomic decision making,

as well as advancing the aquaculture industry in the state of Maine, through SEANET,” explains McKenna. “It shows students that their work can be applied to solving real-world problems, beyond a senior research project. It’s more than just a grade. Many students are Maine residents that plan to stay in Maine after graduating. By acquiring these skills, it helps develop much needed research skills which improve the knowledge base in Maine.”

The professional collaboration and networking opportunities available through SEANET are a major contributing factor to the program’s success, McKenna believes. Cooperation between individuals and institutions encourages researchers throughout the state to learn from one another, and to build on the work of their peers.

McKenna sees his involvement with SEANET as a way to explore his own interest in applied research, and in the potential of such research to contribute meaningfully to decision making in ecosystem management. The Bagaduce River project is not just about systematic data collection and analysis. For him, it is also about examining the role that humans play in the bigger ecological picture.

“I firmly believe that we are increasingly going to rely on the oceans as a source of food for human populations, and it’s clear our current means of acquiring food from the ocean is insufficient. We need better techniques because our current system is unsustainable,” McKenna states.

If managed properly, he believes the research being conducted in partnership with SEANET has the potential to benefit food resources, ecological management, and the sustainable economic development of Maine’s working waterfronts in coastal communities. McKenna hopes that his findings will provide the Bagaduce River community with the tools necessary to make informed decisions about aquaculture and ecology in the future, and that the work of SEANET as a whole will help to ensure that Maine remains a key player in the aquaculture industry for years to come. ■

Discovery

Interactive Aquaculture Exhibit at the Maine Discovery Museum Brings Virtual Reality to Visitors

BANGOR, MAINE – The Maine Discovery Museum (MDM) recently unveiled a brand new, interactive exhibit that uses virtual reality technology to bring aquaculture to life. The University of Maine's Sustainable Ecological Aquaculture Network (SEANET) program, administered by EPSCoR, provided support for the new exhibit, which is the first of its kind in the country.

“People leave the museum knowing that aquaculture is a rapidly growing industry in Maine, and that it offers real careers which require STEM knowledge.”

—Trudi Plummer

“The exhibit is in a relatively small space, but thrives within its own room,” says Trudi Plummer, MDM’s Director of Education. “The walls, both in and out of the room, are part of the exhibit. Inside the room, visitors find themselves in a working waterfront atrium, with boat murals and an oyster and mussel farm that children can harvest. There is even a virtual reality salmon farm that visitors can operate with staff supervision and guidance.”

The exhibit offers visitors the chance to learn about sustainable aquaculture along Maine’s coastline while gaining a unique perspective. Those who participate become immersed in the aquaculture experience, surrounded by pools of fish that they can interact with virtually.

“It really does feel like you’re suspended in the water,” says Plummer. “It’s been great to see all the adults trying it out as well.”

Neil Greenberg, right, assistant director of aquatic operations at the UMaine Aquaculture Research Institute, dives with the fish in the virtual reality 3-D fish farm. University of Maine senior Eric Morrison, center, developed the virtual reality experience.

One of the exhibit’s main goals is to educate visitors about aquaculture, but that is not its only purpose. Plummer, who is passionate about environmental health, believes that the exhibit could not have come at a better time.

“People leave the museum knowing that aquaculture is a rapidly growing industry in Maine, and that it offers real careers which require STEM knowledge. The exhibit connects to the issue of environmental sustainability, and to the deeper concept that is our responsibility with, and in, nature,” she explains. “I want people to remember that aquaculture farms depend on the health of the ocean.”

Inside the exhibit, there’s a layer of math engagement going on that Plummer didn’t anticipate.

“The app inside the exhibit shows the children two different values they can get for their shellfish harvesting,” she says. “They see what the store would pay them, and they see how much the store would then sell those same shellfish for. So we’ve been witnessing a lot of estimating and calculation, as well as having conversations about things like value, market price, and the economy.”

The Museum plans to grow and develop the exhibit, and to stay abreast of aquaculture and ecology developments along Maine’s working coastline. ■



Education and Aquaculture: Maine students get their feet wet

BY CAITLIN YOUNG
ME EPSCoR Student Writer

AQUACULTURE — THE FARMING OF AQUATIC PLANTS AND ANIMALS — has been the world's fastest growing form of food production for the last four decades, driven by rising human populations and an increasing demand for food. Through its seed grant initiative, the Sustainable Ecological Aquaculture Network (SEANET) provides support for aquaculture education and outreach programs designed by organizations working to increase K-20 STEM engagement in Maine. The resulting interdisciplinary programs teach students about science and ecology while imparting technical skills, strengthening community connections, and raising awareness of the value of aquaculture in Maine.

"Many students are interested in science and in doing field work, but don't necessarily see opportunities to do that, or to build a career from it — particularly a career that would keep them in Maine, and in their community," says Susan Little Olcott, marine biologist and Grant Coordinator for Brunswick High School. Last year, in cooperation with SEANET and the Marine Resource Center in Brunswick, Brunswick High School developed an applied aquaculture program focusing on hardshell clam cultivation. A mud flat at the head of Maquoit Bay, located just a mile and a half from the school, serves as the site of their outdoor classroom. Last fall, students in the Marine Biology and Service Learning classes explored methods for keeping invasive green crabs away from the shellfish that would be grown there this spring. In April, a new group of students will be putting their first batch of seeded clams in the mud.

The Marine Resource Center spearheaded the project, explains Olcott: "They saw that there are all kinds of emerging opportunities for people to do aquaculture work right here: farming, scientific monitoring, marketing, community outreach — all these different little fingers of an emerging new industry."

This led the Marine Resource Center to define two goals. First, to teach students the skills they will need to be involved in this emerging industry, and to make

them aware of the various opportunities surrounding its development. Second, to raise public awareness of the value of coastal resources.

"We want to let people know that not only is this an ecologically valuable place, it's an economic resource, and it's providing these opportunities for kids in the community," says Olcott of the mud flat site. "It's worth taking care of."

Students and residents alike have responded to the project with enthusiasm. With the help of a local design professional, the students developed informational posters about green crabs and aquaculture. Those posters have since been hung at a boat launch near the mud flat. Some local businesses have donated supplies.

"There's been so much positive feedback. People who live in Brunswick know about traditional shellfish harvesters, and they see people out there, but they're not necessarily aware of the possibilities for aquaculture. I think they're kind of surprised to hear that's what we're working on," Olcott says. "And also, I think they're pleasantly surprised to hear that the kids are getting out in the mud, and actually doing the work."

When asked about the future of the project, Olcott is optimistic. "This is seen as a demonstration project," she explains, "and it's been very successful in that way. It's a small project, in the scheme of things, but it's helping to build momentum in a much broader way — within the Brunswick school system, within our own community, with other communities around Casco Bay — potentially even with other districts."

Brunswick High School is hoping to expand the program to run through the summer, which would allow interested students to participate in every stage of the cultivation process. The recent success of the aquaculture project has even led to discussions about the possibility of developing an entire marine program at the high school. Expanding to include elementary and middle school grade levels has also been discussed. Olcott is particularly interested in the student mentoring opportunities this

might present. While visiting the site with her two daughters, she noticed that the high school students, “who had only been doing this for a little while,” were nonetheless quick to start showing their younger counterparts the ropes.

“It just kind of happened naturally,” she says.

The Hurricane Island Foundation, another SEANET partner, is an educational nonprofit organization located in the Fox Islands archipelago. Awarded a seed grant to support the development of a dynamic aquaculture curriculum, the Foundation has provided teachers at Deer Isle-Stonington High School and the Edna Drinkwater School in Northport with kits that allow them to experiment with growing kelp in classrooms. Once their kelp lines are established, the students travel out to Hurricane Island and plant them in Penobscot Bay. Spring and summer visitors to Hurricane Island participate in the kelp harvesting process. The immediate success of their pilot program has inspired the Foundation to make the jump from kelp to scallops, and they now facilitate ongoing programs using both sea crops. Alongside this hands-on component, the Foundation has worked to establish a strong teacher-professional development program on the subject of aquaculture.

“Students on the working waterfront often get very disenchanted with school, because many could go out on the water and earn more money than their teachers lobstering,” says Dr. Jennifer Page, Director of Education at the Hurricane Island Foundation. At the same time, due to environmental concerns, “The message they’re getting now is that the way that they’re working on the waterfront isn’t always going to be there.” Hurricane Island’s aquaculture program helps keep students engaged in learning, while ensuring that they will be able to earn a living working on the water for years to come — even if that requires responding and adapting to environmental change.

By working with students, the Foundation is able to communicate the value of sustainable aquaculture to



Brunswick High School students check and rebait their traps for green crabs in Maquoit Bay in Brunswick.

entire communities, affecting grassroots change. Page explains, “The scallop aquaculture we’re doing with Vinalhaven students is being housed at the Vinalhaven Co-op. The parents on the water are coming in and asking questions of their kids, of the teachers, and of us. They’re learning about aquaculture in a non-threatening way, with their children — rather than top-down, from officials coming in and telling them what to do. It’s definitely been a good entry point in terms of conversation.” The Hurricane Island program has additional community benefits; rigorous water quality testing undertaken by the Foundation may soon open parts of Vinalhaven to legal shellfish harvesting for the first time in years.

“Before SEANET, we really weren’t doing anything with aquaculture,” says Page. “Because of the success of this program, we sat down as an organization and really committed ourselves to aquaculture education going forward. We’ve found that this is a great niche for us to be in, and a great role for us to play. The connections that we’ve made — with fishermen, kids, educators up and down the entire coast, plus of course with the Department

of Marine Resources — have become embedded in the fabric of who we are.”

The Hurricane Island Foundation has also collaborated with other SEANET seed grant recipients, including the Island Institute and Herring Gut Learning Center. Page explains, “The collaborations have been really significant for us. We work pretty synergistically now in terms of supporting one another; there’s not a competitive feeling to it. We’re committed to continuing to work together.”

SEANET was established through a \$20 million grant awarded by the National Science Foundation (NSF) to the Maine Established Program to Stimulate Competitive Research (EPSCoR) at the University of Maine. SEANET forms partnership with organizations, institutions, students, researchers, communities, and professionals statewide, mobilizing the collective capacity of Maine’s marine science resources. Together, SEANET and its partners are ensuring that Maine remains a key player in the aquaculture industry for years to come, paving the way for greater economic growth that is both sustainable and environmentally responsible. ■



Brunswick High School students attend mud school! Students learned proper techniques for walking on clam flats as part of their field research training.

A dynamic splash of water in shades of blue and white, creating a sense of movement and freshness. The water droplets and ripples are captured in mid-air, with some droplets appearing as bright white highlights against the darker blue background.

Water-Palooza

Students present action plans at Water-Palooza

BY MOLLY JOYCE

ME EPSCoR Student Writer

IN EARLY SPRING 2017, college students from across the state of Maine gathered at the Maine Student Water Challenge Water-Palooza to present and discuss various approaches they had developed with the shared idea of solving water-related problems that face their communities.

Maine Campus Contact (MCC), with support from Maine EPSCoR, provided 41 college students throughout the state with stipends to participate in MCC's very first Maine Student Water Challenge.

For the challenge, students were tasked with developing action plans in response to water-related issues facing their communities. The students were able to use a variety of methods to create their plans that were related to ocean research, water quality, aquaponics, or aquaculture. The 41 students from 11 different campuses were divided into teams of two to four people. Students did research on a chosen water issue, wrote a research paper, and created an action plan describing how they would reach out to a school or a local community to implement those action plans. The students then gathered and presented their plans at the Water-Palooza.

"The most significant topics we were running into were conservation efforts with lakes, and how maintaining lake water quality seemed difficult," says Water Challenge participant, Andrew Purgiel, an engineering student at the University of Maine. By participating in the Maine Water Challenge, Purgiel was able to get experience creating a curriculum, which was a completely unexplored area for him.

Several groups were able to put their plans into action. The team working at Husson University created an action plan to make a rain garden and are currently in the process of working with the university's facilities manager in order to bring the garden to fruition.

By having the freedom to be innovative, students were able to take what they've learned in the classroom and apply it to issues facing their communities. "The Water-Palooza gave my team and me a chance to share ideas, gain new knowledge, and pushed us one step further on our plan to create a rain garden at our school's campus," says Serian Williams, a student at Husson University. According to Williams, "The rain garden is still in the works, and is heading in a positive direction."

Also present at the Maine Student Water Challenge was University of Southern Maine professor and SENCER (Science Education for New Civic Engagements and Responsibilities) trainer, Rob Sanford. Sanford presented a tailored SENCER training for the students participating in the Water-Palooza, emphasizing how each student could apply their educational background to becoming a community partner. According to Sanford, "the Water-Palooza was a great example of an intersection between research, student learning, and civic engagement. It also marked an intersection between colleges in Maine, Maine Campus Compact and SENCER." ■



Students Engage

BY MOLLY JOYCE
ME EPSCoR Student Writer

Students with disabilities engaged through research of the invasive European green crab

IN THE SUMMER OF 2016, the University of Maine Center for Community Inclusion and Disability Studies (CCIDS), with funding from the Maine Established Program to Stimulate Competitive Research (EPSCoR), partnered with the Community Environmental Health Laboratory (CEHL) at MDI Biological Laboratory to initiate a workforce development initiative that provided opportunity-based learning on a hands-on level for middle and high school students with disabilities from the coastal and Hancock County region.

As a part of EPSCoR's outreach and workforce development initiatives that educate and encourage students to explore the field of aquaculture and water conservation, EPSCoR collaborated with CCIDS and CEHL to engage students with disabilities as citizen scientists to help survey the invasive species in the area.

Participating students were offered paid internships and received training in the identification of invasive species, specifically European green crabs. Janet May, the Coordinator of Transition and Adults at CCIDS, served as the lead on this initiative. "We wanted the kids to

understand that the data we collected and wrote down went somewhere," May says. "We wanted them to understand that there were other people in other parts of the state doing similar work, and that the work itself mattered."

The students conducted their green crab census work at Hadley Point Beach on Mount Desert Island over five Saturdays spanning June and July. Racing against the tide, they searched for green crabs to observe and record in their study. "The students would compare notes on what type of crab they found, what the crabs looked like, and any other things that might be found around low tide — which was part of the excitement as well," according to May.

The students followed specific surveying protocol, targeting a specific area of the beach by tossing out a quadrat in a transverse line.

"We started out laying transects and digging in the sand for green crabs, and then the students started building different ways to corral the crabs they found until they could measure them," Anna Farrell, Program Coordinator at CEHL says. "When we discussed why we were studying green crabs in relation to the eelgrass, [the students] asked insightful questions about the eelgrass, started hunting for blades washed up on the shoreline, and created stories about monster green crabs."

Dr. Jane Disney, Senior Staff Scientist and Director of CEHL, and Farrell trained the student interns on the scientific protocol used by the Department of Marine Resources for green crab surveys. CEHL also developed pre- and post-project surveys to gauge student learning. "They were incredibly dedicated to the effort," Disney says of the students. "They helped document that the green crab populations are in decline in the upper bay, which bodes well for eelgrass habitat and all of the marine life that depend on that habitat for survival."

Disney's research at the MDI Biological Laboratory has involved studying and restoring eelgrass populations in Frenchman Bay. Because the invasive European green crab has proved to be problematic for the eelgrass beds, Disney and her team have been working to get a handle on the number of green crabs in areas around Frenchman Bay in order to inform their eelgrass restoration efforts.

In addition to the opportunity to gain paid, hands-on worksite experience, "the kids became friends, and that was a really cool benefit," May says. CCIDS hopes to continue providing hands-on research opportunities for students throughout the state, and according to May, "Just knowing what we know about the importance of kids having early work or internship opportunities, I would love to continue this in a hands-on kind of way." ■

Cilantro, basil and kale, oh my!



Vine Street School grows Tank to Table aquaponics program

BY ANDREA LITTLEFIELD

VINE STREET SCHOOL in Bangor harvested fresh herbs and greens grown in the lobby aquaponics tank for students and parents to take home for the holidays.

Aquaponics is the combination of aquaculture — fish or other aquatic animals being raised — and hydroponics — plants being grown in water.

The Tank to Table program, which has existed for about a year, is the brainchild of Jessica Muhlin, Caroline Noblet and Ryan Weatherbee, parents of students at Vine Street School.

The group received a seed grant from Maine EPSCoR at the University of Maine to set up the tank.

Noblet, an assistant professor in the School of Economics at UMaine, works with the Sustainable Ecological Aquaculture Network (SEANET) program and suggested the opportunity to the group whose children were in the same class.

Weatherbee is a research associate at the Satellite Oceanography Lab at UMaine and Muhlin is an associate professor of marine biology at Maine Maritime Academy.

The group approached first-grade teacher Annmarie Dionne with the idea.

“It’s been amazing,” says Dionne. “It’s really been great for the whole school.”

Principal Lynn Silk has championed the project, welcoming the aquaponics unit into the main lobby of the school and setting aside a STEM room where students can experiment and explore.

Although it’s taken some time to see the fruits, and vegetables, of its labor, the group is pleased with the results.

“We’ve been experimenting with planting lots of different things,” Muhlin says. “Kale seems to do really well. I think, in general, leafy greens and herbs do great. Consistently, most of the aquaponics literature I’ve read agrees with that assessment.”

The group coordinated the tank project with the existing curriculum. When the children studied cycles, specifically the water cycle and the ocean cycle, it made sense to include that type of lesson in connection with the tank.

The school also has welcomed guest speakers to talk about various aspects of aquaculture as well as STEM-related careers.

Speakers have included Sebastian Belle, director of the Maine Aquaculture Association; Kim Huguenard, assistant professor of civil and environmental engineering at UMaine; Michael Pietrak, research associate with the USDA Agricultural Research Service at the National Cold Water Marine Aquaculture Center; Muhlin; and Dana Morse, Maine extension associate at Maine Sea Grant.

The group has connected with several community organizations, including the Challenger Center, Maine Discovery Museum, University of Maine Cooperative Extension 4-H and the Maine Science Festival. And it’s looking at ways to fund a larger community project.

The organizers’ children soon will be graduating from Vine Street and they invite more parents, teachers and community members to continue growing the program.

The Tank to Table team hopes its experience provides an example of positive school engagement. Members say they plan to continue supporting STEM learning in school. ■



IMPACT

When aquaculture grows, so does its economic impact

BY ANDREA LITTLEFIELD

FARMING OF FINFISH, SHELLFISH AND PLANTS in fresh and saltwater is the fastest-growing food production sector in the world and it's growing in Maine, too.

From 2007 to 2014, the total economic impact of aquaculture in Maine — including sales revenue, full- and part-time jobs and labor income — nearly tripled from \$50 million to \$137 million. In 2014 alone, aquaculture businesses in the state reported \$73 million in sales revenue.

That's according to a new survey done by the University of Maine Aquaculture Research Institute, in partnership with the Maine Aquaculture Innovation Center, Maine Aquaculture Association and the UMaine School of Economics to assess the economic impact of aquaculture in the state.

A total of 71 of the approximately 107 aquaculture businesses responded to the 2015 Maine Aquaculture Economic Impact Survey.

The industry in the state employs 1,078 people, with 70 percent of those employed in year-round, full-time positions, according to the survey.

"This report highlights the often underestimated economic impact of the aquaculture sector to Maine, and illustrates the recent growth of this sector," says Chris Davis, executive director of the Maine Aquaculture Innovation Center (MAIC).

Prospects for area aquaculture farmers to help supply the country with seafood are promising, as the U.S. imports 91 percent of its seafood, according to the National Marine Fisheries Service.

Maine's coastline and marine resources represent unique assets and aquaculture business owners expressed optimism about opportunities to grow — 73 percent of respondents predicted as much as a 51 percent increase in sales revenue by 2020.

For a considerable percentage of respondents, aquaculture is a relatively young enterprise.

Forty-five percent of the respondents indicated they

had been in business since 2009 — 24 percent began operations in 2012 or later and another 21 percent began operations between 2009 and 2011. Fourteen percent had been in business 21 or more years.

Respondents reported that in 2014, the top three selling aquaculture species were Atlantic salmon, blue mussels and Eastern oysters.

For more than 40 years, the University of Maine has provided educational opportunities and conducted research related to aquaculture, at both the UMaine campus in Orono and at the Darling Marine Center, the university's marine laboratory in Walpole.

And in 2014, the National Science Foundation awarded its largest-ever aquaculture research grant to UMaine and its partners. The purpose of the five-year, \$20 million award was to expand Maine's research capacity across institutions and disciplines. It led to the creation of SEANET, the Sustainable Ecological Aquaculture Network.

"The university anticipates that the outcomes, impacts and new capacity that emerges from the SEANET project will be integrated in the Aquaculture Research Institutes's work plan and that this network of researchers and educators will help establish Maine as a leader in the science and education needed to build long-term sustainability in this important food system," says Paul Anderson, SEANET research network director and ARI director.

In 1988, the Maine Legislature established the Maine Aquaculture Innovation Center to assist with developing economically and environmentally sustainable aquaculture opportunities in the state. MAIC supports 20 ongoing research projects and manages two incubation facilities dedicated to aquaculture based at the University of Maine Center for Cooperative Aquaculture Research in Franklin and at the Darling Marine Center.

To read the report, visit umaine.edu/aquaculture/economic-impact-report. ■



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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.



SEANET graduate students attend an aquaculture bootcamp lead by Chris Davis of the Maine Aquaculture Innovation Center at the Darling Marine Center in Walpole.

Maine EPSCoR

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