Aquaculture | Community | Action | Engagement | Economic Development

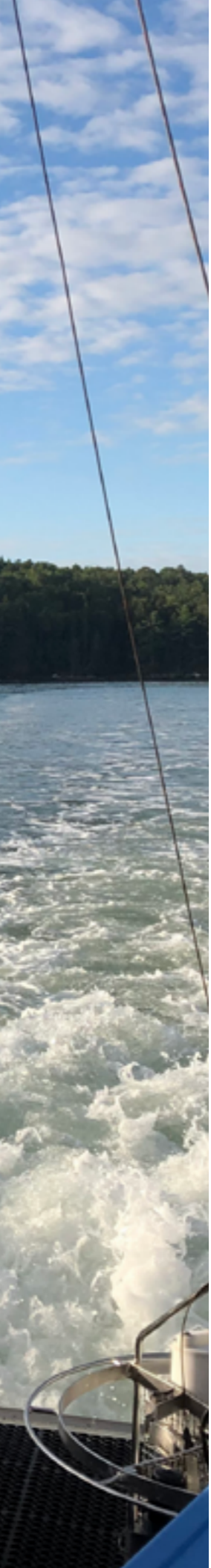
FALL 2019 NEWSLETTER

MAINE EPSCoR

Maine EPSCoR

Building Research Capacity for the State of Maine

THE UNIVERSITY OF MAINE



From the directors

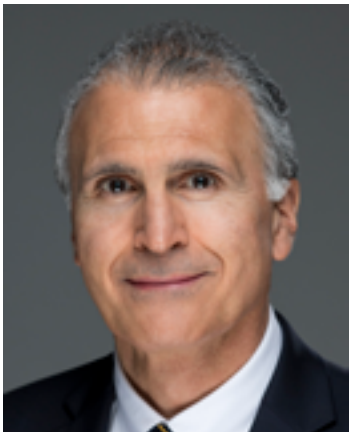
AS THE SUSTAINABLE ECOLOGICAL AQUACULTURE NETWORK (SEANET) completes its final year, several other National Science Foundation (NSF)-awarded grants and activities throughout the state have continued a legacy of positively impacting the state's capacity for research, development, and STEM education.

Maine EPSCoR's newest Track-1 grant, Molecule to Ecosystem: Environmental DNA as a Nexus of Coastal Ecosystem Sustainability for Maine (or Maine-eDNA), is no exception. It has had a strong start, and we aim to continue strengthening collaborations among partner institutions, while conducting highly impactful research, education, and outreach of benefit to Maine.

In this newsletter, you'll learn more about:

- The effects SEANET has had, and will continue to have on the state, through its transition to the Aquaculture Research Institute.
- Some of the education and workforce development initiatives that continue to advance STEM education.
- The historical impact of Maine EPSCoR research and collaborations on the state of Maine and how Maine-eDNA aims to continue this trend.

Thank you for your interest in the work highlighted in these pages. We are happy to present the Fall 2019 Maine EPSCoR Newsletter.



KODY VARAHRAMYAN, PH.D.
Vice President for Research and Dean of the Graduate School, UMaine

SHANE MOEYKENS, PH.D.
Director of Maine EPSCoR

MAINE EPSCoR

What is Maine EPSCoR?

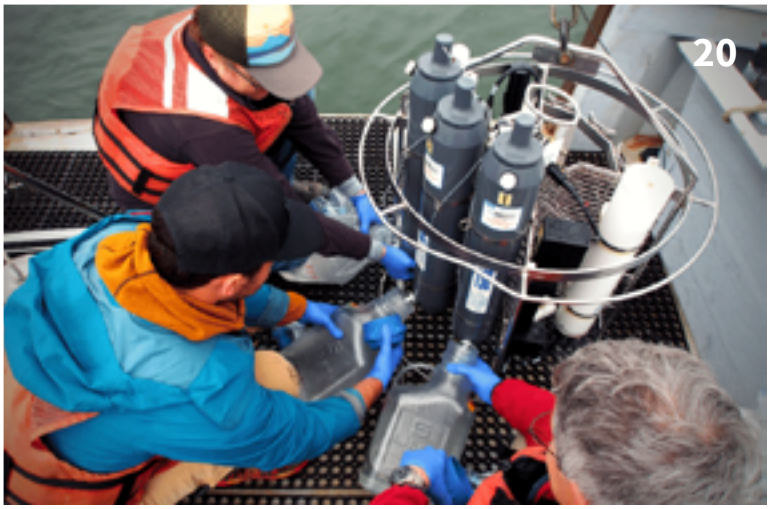
The Established Program to Stimulate Competitive Research (EPSCoR) was initiated at the National Science Foundation in 1978, and now encompasses EPSCoR programs at several other federal agencies.

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 under-represented minorities in science, technology, engineering and mathematics (STEM) disciplines.

ON THE COVER:

Maine-eDNA student Rachel Presley collects a sample during one of the first field-research excursions of the grant.

Cover photo by Jeremy Rich.



Contents

Maine EPSCoR Track-1 Grants Provide Foundation for Leading Research Centers to Grow

BY LIZ THERIAULT

National Science Foundation EPSCoR Research Infrastructure Improvement Program Track-1 awards may have an active funding period of only three to five years, depending on the particular award and the decade, but the impact of Track-1 funding in Maine has sparked exponential growth of the supported research centers and institutes for decades following expiration of the initial funding. Since 1980, Track-1 awards have helped establish four research centers and three institutes in various STEM fields at the University of Maine campus. These research organizations continue to receive external funding for new research projects, faculty hires, publishing reputable articles, and training Maine students to enter the workforce every year. This year-over-year cumulative impact to Maine's research and development capacity will continue to help shape Maine's future.

ADVANCED STRUCTURES AND COMPOSITE CENTER

In 1996, an NSF EPSCoR Track-1 award (1996-1999), titled "Structural Composites Semi-Works and Testing Facility at the University of Maine & Improving Research Capacity in Cold-water; Marine Aquaculture at the University of Maine," was received by the University of Maine to establish the Advanced Engineering Wood Composites Center, now known as the world-leading Advanced Structures and Composites Center (ASCC). The original 30,000 square-foot building officially opened in 1999 with the goal of becoming a unique facility for ground-breaking wood and bio-based composites, and advanced materials development, and it did just that.

In the two decades following 1999, the ASCC has grown both physically in size and in the level of external funding. The facility has grown from 30,000 square feet to an expansive 100,000 square feet in order to house the technology and resources needed for advanced wood composites manufacturing and structural testing. In addition, a wind-wave basin, an offshore wind lab, wind-blade-testing equipment, and an advanced manufacturing lab were built and are all housed under the same roof. Each of these resources has individually produced hundreds of research projects that have translated to 544 published articles, 36 patents and dozens of distinguished state and national awards, such as the American Society of Civil Engineers 2011 Charles Pankow Award for Innovation, a White House 2015 Transportation Champion of Change designation, and the Windpower Engineering and Development 2017 Innovator award.

Since 1980, on the University of Maine campus, Track-1 grants have helped establish four research centers and three institutes in various STEM fields.




Top: Barrows Hall, the building that houses FIRST; Advanced Structures and Composites Center.
Bottom: FBRI research center in Old Town, Maine; Senator George J. Mitchell Center for Sustainable Solutions. Photos by University of Maine

Since its inauguration, the ASCC has provided hands-on employment and research opportunities for over 2,300 graduate and undergraduate students. The ASCC is known for its worldwide clientele and partnerships with over 500 highly reputable organizations, such as NASA, U.S. Department of Transportation, U.S. Department of Energy, U.S. Army, U.S. Department of Agriculture, and more. These collaborations have resulted in over $322.9 million in externally funded research and development since the completion of the Track-1 award, with external support tripling in the last five years.

FRONTIER INSTITUTE FOR RESEARCH IN SENSOR TECHNOLOGIES

When the ASCC's Track-1 award ended, a new NSF EPSCoR Track-1 award, titled "University of Maine Research Infrastructure to Enhance Maine's High-Technology Industries (Biosensors) & Intelligent Spatial Technology Institute (ISTI)," was received. This Track-1 ran from 2000 to 2003 and provided funding to bolster UMaine's already-existing Laboratory for Surface Science & Technology (LASST).

When LASST was founded in 1980, its goal was to

overcome existing scientific and engineering barriers in the way of successful commercialization of biosensors. Funding from an EPSCoR Track-1 award built on this original foundation, expanding the research capacities of the lab, and providing the means to conduct theory, design, and fabrication of sensor elements, as well as the characterization and testing of prototype sensor arrays. This research capacity expansion led to pioneering research in genetics, proteomics (the study of proteins produced by cells), oceanography, aerospace technology, optics, dermatology, materials science, paper coatings, food science, and homeland security.

A notable outcome from LASST was the manufacturing of the first Maine-made technology to be sent into space. In December of 2016, a team of LASST researchers sent a wireless leak-detection system to the International Space Station. This technology has been used to monitor the structural integrity of deployable space habitats, such as those that may be used by astronauts when attempting to set up camp on the moon, other planets, or asteroids.

Following the end of the Track-1 award, LASST received $30.4 million in additional funding from organizations such as the U.S. Department of Energy, the U.S. Environmental Protection Agency, and the National Institute for Health. Over 660 students have worked at LASST since 2003, and the research conducted there has led to 43 patent applications, more than 390 publications, and four spinoff companies. LASST was renamed in March 2019, becoming the Frontier Institute for Research in Sensor Technology (FIRST).

FOREST BIOPRODUCTS RESEARCH INSTITUTE

In 2006, an NSF EPSCoR Track-1, titled "Investing in Maine Research Infrastructure – Sustainable Forest Bioproducts," was awarded. This Track-1 award led to the formation of the Forest Bioproducts Research Institute (FBRI) at the University of Maine in 2010. This institute was established with the mission to integrate new and existing research capabilities to facilitate and advance the understanding of the production of forest-based bioproducts, such as advanced materials, chemicals, and fuels that are beneficial to the economy and ecology of the U.S.

The institute works to create newer and greener chemicals, plastics, and nanotechnologies to decrease the ecological footprint of society by using renewable resources such as fuels and chemicals made from wood biomass, plant materials, and organic wastes. These raw materials provide alternative practices to decrease the dependence on nonrenewable and rapidly decreasing resources.

Since the expiration of the Track-1 in 2009, FBRI has received another $40.3 million of external funding, and has continued to work on reducing the United States' consumption of fossil fuels and advancing forest bioproduct usage efforts. The research projects that FBRI pursued since 2009 have supported more than 290 graduate students and have resulted in 11 patents and 845 publications.

SENATOR GEORGE J. MITCHELL CENTER FOR SUSTAINABILITY SOLUTIONS

The Senator George J. Mitchell Center for Sustainability Solutions was founded with funding from an NSF EPSCoR Track-1 award, titled "Maine EPSCoR's Sustainability Science Initiative" (2009-2014). At the start of the award, the Mitchell Center was created with the goal of strengthening university and stakeholder partnerships on key research issues, with a focus on creating stronger connections between knowledge and action. The Mitchell Center sought to address diversity, increase workforce development, foster external engagement, build cyberinfrastructure, and cultivate sustainability practices.

With funding from the NSF Track-1 award, the Mitchell Center was built as a home for partnerships and collaborations, to stimulate and engage partner institutions and stakeholders across the globe. Research activities led by this center have generated $32 million in external awards since the end of the Track-1 award in 2014. Over 800 students have worked with the Mitchell Center on projects relating to forestry, agriculture and food systems, climate and energy, freshwater resources, urbanization and infrastructure, coastal systems, and cooperation science, leading to 380 publications.

The ASCC, FIRST, FBRI, and Mitchell Center all serve as successful examples of interdisciplinary research capacity that EPSCoR Track-1 awards have brought to the state of Maine. Even after initial NSF EPSCoR support ends, these centers and institutions continue to generate hundreds of millions of dollars in external funding, further growing and broadening the state's research capacity, while serving the needs of our nation's stakeholders and community members. ■

SEANET researchers and industry members work together to answer aquaculture's most pressing questions

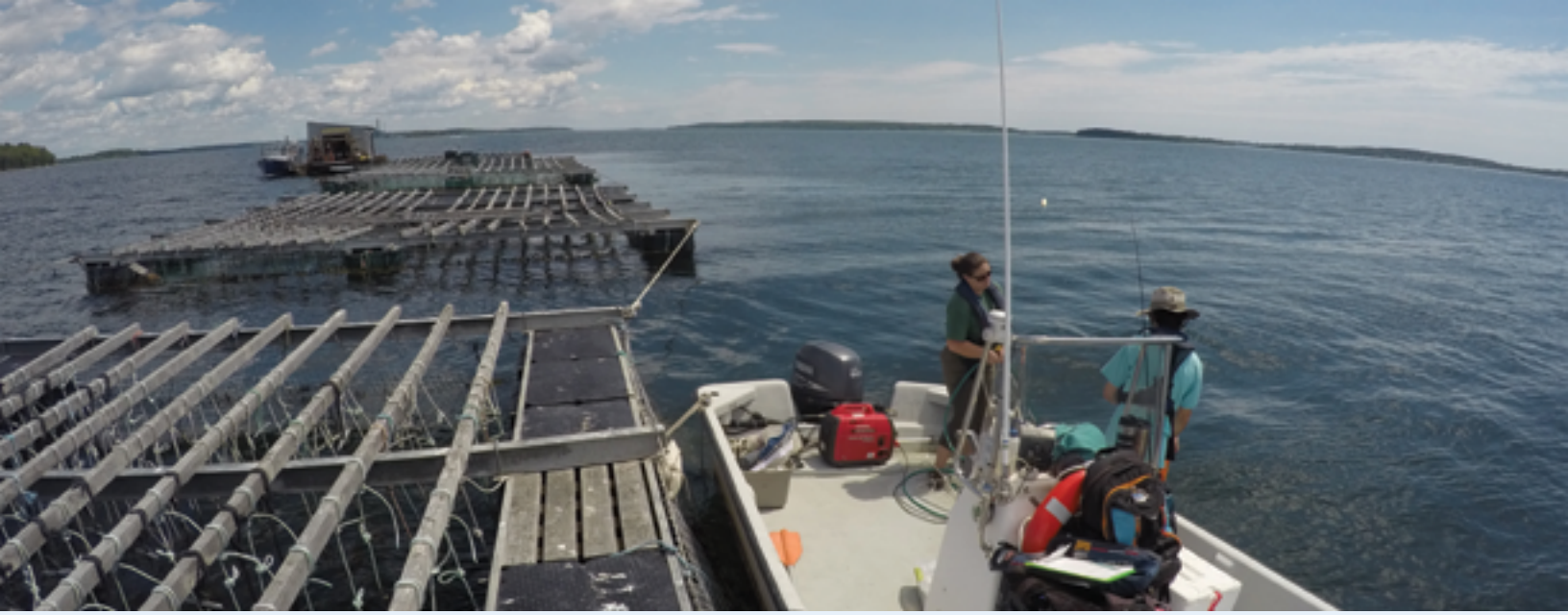
BY LIZ THERIAULT

MUSSELS AND KELP aren't the only things growing along the coast of Maine. Beyond its produce, the aquaculture community is seeing the development of new relationships and collaborations between the research and commercial industries of Maine. Researchers from the Sustainable Ecological Aquaculture Network (SEANET) and members of commercial industry are combining their time, talent, resources, and questions to seek the most valuable and sustainable aquaculture practices.

Bangs Island Mussels is an aquaculture farm off the coast of Portland, Maine, growing fresh sugar kelp and blue mussels that can be found in many local restaurants in Portland and across the nation. Matt Moretti runs the business with his father, Gary, in the waters of Casco Bay. Their central mission is bringing the highest-quality farm-raised products to the market, but Moretti has always had his eye on the research side of aquaculture. To Moretti, these connections with research are a way to push Maine's commercial aquaculture industry into the limelight, and give it the information and support it needs to continue to thrive.

"I see collaborations with researchers as a motivating economic force that grows our industry in Maine through innovation. These collaborations can do a lot of good, both for the economy and for the environment," Moretti says.

"We farm, and that is our main focus, but we always want to inform our decisions using real data," Moretti



Bangs Island Mussels facilities, where mussels are grown.

says. The relationship between Moretti and the Maine research community formed early after Moretti and his father purchased Bangs Island Mussels from its original founders. Moretti sees collaborations between researchers as a way to foster economic growth and beneficial practices that can help his business and the industry as a whole, and hopes his farm can serve as an inspiration. "We are becoming an example for others to look at, and our methods and our practices can help drive the industry forward as people see what we're doing and see it being successful," says Moretti. "Hopefully they'll adopt some of those practices as well, or maybe adapt them to their own sites and uses. If we can set a positive example, I think that will help move the industry forward."

Carrie Byron, assistant professor of Marine Sciences at the University of New England and a SEANET researcher, is currently studying Maine's carrying capacity for sustainable aquaculture. Her work involves looking at what organic particles in Maine's coastal waters mussels are eating while also looking at environmental factors and stressors such as temperature and food sources to uncover what elements result in the most robust mussels. Mussels filter feed particles of organic matter and nutrients that are floating in the water around them.

Byron was a member of the SEANET Committee which developed the Social-Ecological Systems Framework. This framework, which has been modified from earlier work done by Elinor Ostrom and her colleagues, looks at the interactions between resources (e.g., mussels, clams, oysters, etc.), the environment, governance and policies, and users of resources (e.g., fishermen, aquaculturists). The SEANET Committee members used the framework to inform the creation of four research questions that guide research across all of the SEANET projects. The SES-lens informs how Byron approaches her research, helping her to look at her questions with a holistic view.

Byron works closely with Adam St. Gelais, an assistant research scientist at the University of New England, who uses the tissue of the mussels with his students in the classroom to understand the biophysical parameters of the sites where the mussels are being grown.

"We look at them for health and condition respectively," St. Gelais says. "At the same time, you can look at where they were grown just by looking at the tissues and you can trace the production and see how they are investing their energy. Then you can compare that over time with the environmental variables and look at when the mussels are theoretically most robust and happy and healthy and see how they are responding to stressors such as high temperatures or lack of food, or just how harvesting and moving them around might impact them."

St. Gelais, Byron and Moretti started working together on a smaller-scale project a few years ago. More recently, SEANET, an NSF EPSCoR-funded project, provided the funding for the three to establish research goals and cement their partnership. With the financial boost from SEANET, the team was able to purchase additional equipment such as environmental sensors that were needed to make the research more viable. "There were a few things that we could do preliminarily," Byron says. "But SEANET really is what gave us a big push forward and formalized that research relationship with [Bangs Island Mussels]."

This partnership also fostered a change in thinking which Byron finds critical in her research. Instead of focusing on the impact that commercial aquaculture farming has on the environment, Byron and her team

Photos by Adam St. Gelais

focus on how the environment affects the longevity, health, and sustainability of aquaculture products. A collaboration between researchers and an aquaculture businessman was a perfect way to study those impacts, because a well-informed tide could raise all boats.

"That's where one of my major messages is, trying to shift our way of thinking. The way a farmer thinks about the system is almost a [180-degree shift] from the way a research scientist thinks about the system," Byron says. "Let's take it from the farmer's point of view. They want to know where the best-growing space is, how is the environment going to impact their product, and I think if we take that mindset, it is much more positive and inviting and there are additional, interesting questions to be addressed."

Byron went on to say that even though she strays from the traditional path of question asking, there is not a large difference from her work and research that focuses on the impact of industry on the environment. Scientists tend to want to look at how farms impose conditions on the environment and how to mitigate those effects, while farmers want to understand the best growing locations and how the environment will impact their product. "In the end, we are still talking about interactions, it's just a matter of mindset and how you frame it," Byron says. "The bottom line is recognizing that these farms are part of the environment, they are not isolated, separate systems, and that's why this farm is an amazing laboratory to work in — because it's part of that environment."

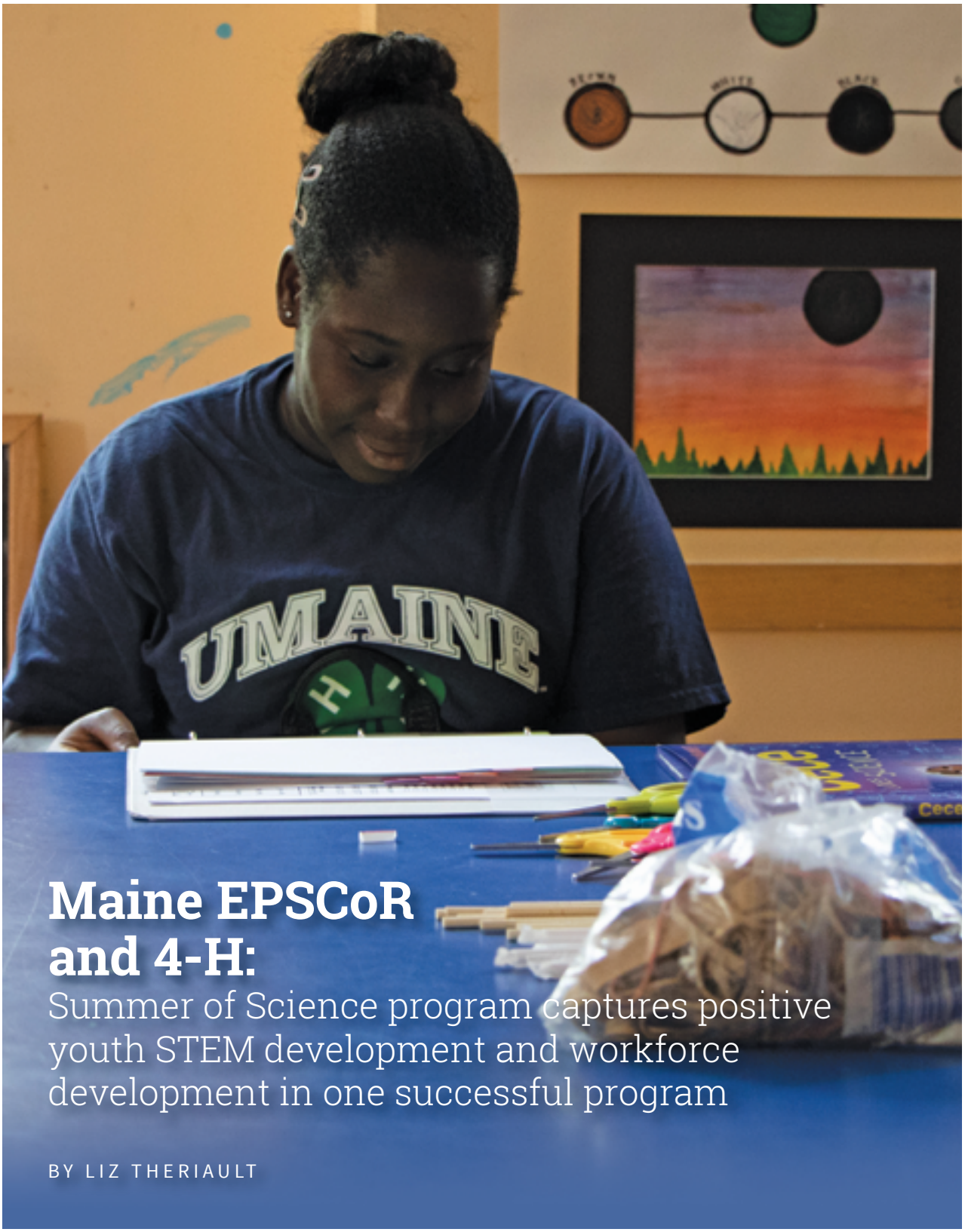
This shift in question asking ties in with the needs of the commercial industry. Moretti provides labor, materials, machinery, and access to his farms, and in turn gets answers to important management questions that help his business be a sustainable force in the industry.

"Partnering with SEANET and these different research institutions has really allowed us to do that in a real way, rather than just as an anecdotal, observational kind of way," Moretti says. "It's given us the tools that we need that we could not afford, and access to expertise that we did not have in-house to acquire data and have it analyzed by professionals, and help that guides our trajectory for the future and our current practices."

Moretti hopes aquaculture research will evolve into informative aquaculture education for the public surrounding economic and ecological benefits to combat critical arguments that are frequently made by opponents of aquaculture farming. "[The collaboration has] been very important for us and, more so than the money to buy materials, it's the relationships that we've built with researchers, the ongoing discussions, and the informal chats that are at least as important as the actual money for the equipment that we've acquired and have been able to use," says Moretti.

Collaborations between aquaculture researchers and their commercial counterparts uncover deeper understandings for both parties. For researchers, it produces peer-reviewed manuscripts and presentations at conferences, and opens up material for future research. For farmers or stakeholders in the commercial industry, it produces management practices that will benefit their farms and have an impact on overall profitability and their bottom lines.

"It's all about [getting] the best growth possible. If we can identify certain conditions or certain types of organic particles that promote better growth, then we can try to select and target those conditions," said Byron. "If we can identify conditions that are adverse to growth, then we can try to avoid them, and I think that is really what [the farmers] are after, just learning more about what promotes good growth and nutrition for their mussels." ■



Maine EPSCoR and 4-H:

Summer of Science program captures positive youth STEM development and workforce development in one successful program

BY LIZ THERIAULT

Elaine, a Summer of Science Teen Teacher, reviews curriculum materials before a lesson at the Portland Boys and Girls Club begins.
Photo by Liz Theriault

OUTREACH PROGRAMS that bring STEM education to Maine's youth while also providing workforce development opportunities for high school and undergraduate students are few and far between. In order to promote the development and accessibility of programs like these, Maine EPSCoR partnered with University of Maine Cooperative Extension 4-H to bolster their 4-H Summer of Science program. By doing so, this partnership has significantly broadened Maine's capacity to bring positive youth development practices to young people throughout the state.

Throughout the summer, college interns and teen teachers bring STEM-related experiments, lessons, and activities to Maine youth summer camps, summer meal sites, and local communities throughout the state.

Various research has shown trends in which students of all grade levels are affected by a phenomenon known as a summer learning loss, or "summer slide," where students return to school after the summer with lower achievement levels in math and reading than they had at the end of the previous school year. One way to combat this is participation in summer schooling programs, but these can be costly and therefore children from lower socio-economic standings are often disadvantaged.

But the 4-H Summer of Science program brings STEM education to students, counties, and communities all around the state at no cost to them.

"We specifically try to partner with audiences that may not have easy access to enrichment programs and we provide it at no cost," said Sarah Sparks, the 4-H science youth development professional at UMaine Extension. "We want to help kids keep learning through the summer and have positive experiences in particular with science education so that they can see that STEM is for everyone."

Seven years ago while working on other 4-H projects, Sparks was contacted by Portland Public Schools inquiring if she could bring STEM education activities to their summer nutrition program. From this original partnership, Sparks was inspired to bring STEM education activities to more Maine children across the state, thus commencing the 4-H Summer of Science program. Since the first year, the 4-H Summer of Science program has gone from bringing STEM education to a single Maine community to traveling to 50 different sites around the state.

Since the first year, the 4-H Summer of Science program has gone from bringing STEM education to a single Maine community to traveling to 50 different sites around the state.

When 4-H Summer of Science reaches more communities, it kindles a love for science in more children.

"We had one [child] come to our program, who wanted nothing to do with it and wanted to leave," said Sparks. "Then the interns convinced him to stay and at least give it a try, and by the end of the session, he was having so much fun and had so much interest in building his particular project, that he didn't want to leave. And he kept coming back to the rest of the sessions we were piloting."

4-H Summer of Science provides a safe space for Maine children to develop positive relationships with caring adults, which influences their overall well-being. Beyond Maine children, the program also grows life skills and workforce skills of the teen teachers and college interns that bring the STEM activities to camps and sites around the state.

"We have teens that work in our program that show increased confidence and leadership ability as a result of acting as teen teachers, and we are helping them build those skills they need to enter the workforce," said Sparks. "We have also had a couple of interns who have decided that they want to become teachers as a result of participating in this program. They changed their pathway as a result of their 4-H Summer of Science internship specifically to STEM education."

Those two interns are Kristin Benson and ZimZim Mohamed, veteran Summer of Science interns and students at the University of Southern Maine. Benson began her college career studying communication and anthropology, but now, as she enters her senior year, she is studying environmental studies and education.

"[The switch] really came from this program because I love doing it," said Benson. "I really enjoy bringing STEM to kids and getting them interested at a young age."

Mohamed graduated with a Bachelor of Science in biology from the University of Southern Maine. But after time as a teen teacher, and three years as a college intern, Mohamed has started graduate school to study education.

"I went on the teaching track because of 4-H," said Mohamed. "I was a biology major thinking of going into research when I started, but while doing this program I realized the teaching part of science is what I really want to do, especially focusing on young kids."

According to the U.S. Department of Education, Maine saw a shortage of math and science teachers in the

Kristin (right), a Summer of Science Intern, helps children at the Portland Front Street Community Center work through that week's summer of science lesson plan. Photo by Liz Theriault

2017-18 school year. With funding from Maine EPSCoR, the 4-H Summer of Science program is able to hire teen teachers and college interns and give them the skills and exposure needed for a career in STEM education.

At the beginning of every summer, the Summer of Science interns attend a 4-H Summer of Science Positive Youth Development training where they learn about teaching and learning models, the socio-economic factors that can impact a child's attitude and ability to learn, and team building exercises focused on communication and problem-solving.

Beyond the funding for teen teachers and college interns, Maine EPSCoR also provides funding for materials and resources, as well as the inspiration for each year's Summer of Science lesson themes.

This summer, Summer of Science is bringing engineering to Maine kids through activities all about ocean literacy, through the lens of pirates. The teen teachers and college interns will bring lessons about density, kinetic energy, engineering design, ocean literacy and more through the pirate adventure storyline.

"For the past several years we have been fortunate to partner with EPSCoR in the SEANET project, and so the theme has tied back into marine science and ocean literacy. This year's theme is framed around pirates, and all six activities are tied into ocean literacy and engineering," explained Sparks. "This year we have added a storyline to go with the [curriculum] that we haven't had in the past because that captures kids' imaginations. And with help from EPSCoR, we were able to purchase new books to go with all of our experiments to add a literacy component that complements the science lessons."

Moving forward, other states may start to see similar programs to Maine's Summer of Science. Since publishing in a peer-reviewed journal article, and after presenting their program at various national conferences, other 4-H offices in different states across the country have approached Sparks and the Maine 4-H office about creating their own Summer of Science programs.

"Other 4-H states have come to us and asked us to train staff in other states," said Sparks. "With our partnership with EPSCoR and our model, we have been able to build and reach so many kids at different levels from elementary students that are participating in the program to teen teachers to the undergraduate college students. As a result of sharing the model, our program has received some national recognition."

Funding from Maine EPSCoR has increased the 4-H Summer of Science program's ability to spread positive STEM education to Maine children, as well as create meaningful workforce development for Maine's STEM labor force.

And Sparks says the Summer of Science program has no plans on slowing down.

"It's about impacting the lives of the people in the communities that we work with, and so if we can continue to do that, then we are reaching our biggest goals," said Sparks. ■

Faculty Spotlights

BY OLIVIA SHIPSEY

CARRIE BYRON

Date of Hire: September 2014
Title: Assistant Professor in the Marine Science Center at the University of New England
Theme: SEANET-Carrying Capacity Co-Lead, New Faculty Hire
Post-doctoral scholar, Ecosystem Modeling, Gulf of Maine Research Institute, 2012
Ph.D., University of Rhode Island, 2010
M.S., University of Massachusetts-Boston, 2007
B.S., University of Wisconsin-Madison, 2001

Dr. Carrie Byron is a researcher and assistant professor at the University of New England's Marine Science Center in Biddeford, Maine. As an assistant professor, Dr. Byron teaches classes, advises student research projects, and serves on various committees. Dr. Byron teaches MAR 350, a marine ecology course that exposes undergraduate students to fundamental ecological concepts through the contexts of the marine ecosystem. She has also instructed MAR 590, a thesis and research course that allows her to assist graduate students with their marine science thesis research.

Her research and teaching areas include aquaculture, fisheries, and coastal management. Byron received a grant through ME EPSCoR to study the carrying capacity of Maine's ecosystems. She believes that understanding the limits of what Maine's environment can support is essential to informing conversations and management decisions that work toward sustainability. Her current research looks at ecological and social carrying capacity for aquaculture, modeling food-web dynamics, detrital contribution to bivalve shellfish nutrition and estuarine food webs, and uses of stable isotopes and lipids to characterize food-web interactions.

Byron also acts as the head of the University of New England's Byron Marine Ecology Lab, located in the Arthur P. Girard Marine Science Center at the mouth of the Saco River. Dedicated to understanding food-web dynamics in the coastal ocean, the lab focuses on monitoring the health of Maine's local waters through collaboration with industry partners in blue-mussel aquaculture and kelp aquaculture. Graduate and undergraduate student members of the lab attended and presented their research at the largest aquaculture conference in the world, the World Aquaculture Society's Aquaculture 2019 meeting in New Orleans, Louisiana. ■

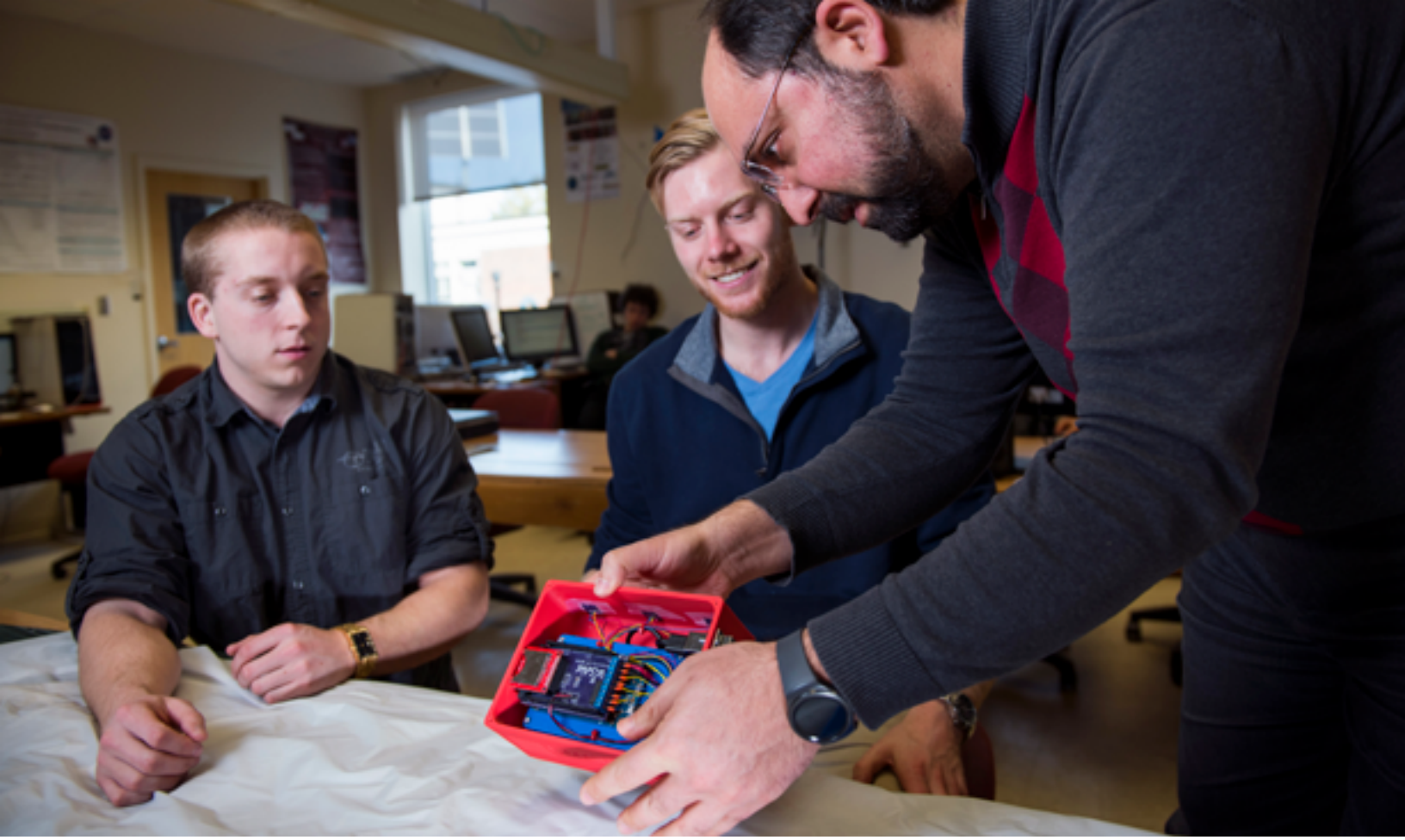
KIM HUGUENARD

Date of Hire: September 2014
Title: Assistant Professor of Civil and Environmental Engineering at the University of Maine
Theme: SEANET-Aquaculture in a Changing Environment, New Faculty Hire
Ph.D., Coastal and Oceanographic Engineering, University of Florida, 2013
M.S., Coastal and Oceanographic Engineering, University of Florida, 2009
B.S., Civil Engineering, University of North Florida, 2008

Dr. Kim Huguenard is a researcher and assistant professor of civil and environmental engineering at the University of Maine. As a professor, Dr. Huguenard teaches CIE 450, Open Channel Hydraulics, which looks at uniform and non-uniform flow in open channels, gradually and rapidly varying flow, computational methods for flow profiles and open channel flow structures. She also teaches CIE 558, Coastal Engineering, which is an introduction to the principles of coastal engineering problems in lakes, river mouths, inlets, estuaries, and other coastal areas.

Her research interests and teaching areas include aquaculture engineering, coastal and ocean engineering, estuarine hydrodynamics, and nearshore processes. Huguenard received a grant through ME EPSCoR to study the relationship between Maine's ever-changing environment and aquaculture. Her current projects include work on the abatement of wave action by kelp farms. Since coastal cities are vulnerable to infrastructure damage, beach erosion, and flooding, soft structures such as kelp farms can help combat this by increasing coastal vegetation. This research includes developing a 3-D fluid-structure-interaction model that simulates interactions between kelp farms and waves. Huguenard found a sustainable and resilient option that adapts to climate change through floating kelp farms.

In 2016, Huguenard conducted four tidal-cycle surveys along the Damariscotta River to learn about the impact of environmental change on material transport. The data collected will be used to understand how transportation patterns of plankton, suspended sediment and pollutants have changed, as well as inform predictions of future environmental change. This research impacts carrying capacity estimates and helps inform future decisions on siting location and optimal growing locations. ■



Ali Abedi with graduate students

NASA EPSCoR brings space research to Maine

BY LIZ THERIAULT

WHEN THINKING OF THE STATE OF MAINE, it's easy to picture lighthouse tourism, lobster-fishing boats, and paper-mill towns. But organizations such as the Maine Space Grant Consortium, paired with institutions like the University of Maine, are working hard to add space-age technology and aerospace research to that list. Much of this renown is due to the impact of EPSCoR — the Established Program to Stimulate Competitive Research in the state of Maine. You may not know it, but researchers, faculty members, and students at the University of Maine are leading the way, conducting instrumental space research and creating tools that were deployed on the international space station.

The Maine Space Grant Consortium (MSGC) is located in Augusta, Maine, and is funded by NASA's National Space Grant College and Fellowship Program, otherwise known as Space Grant. This program was initiated by Congress in 1988 to "contribute to the nation's science and engineering enterprise."

The MSGC works to build research and infrastructure capacity that benefits the interests of both the state of Maine and NASA. They do this by providing competitive federal funding for faculty researchers in Maine and organizations that are partnered with minority serving institutions. The MSGC also does outreach to Maine's schools and supports programs, internships and scholarships for students ranging from elementary to graduate level.

These missions are accomplished through strong partnerships with undergraduate and graduate

institutions, not-for-profit research laboratories, state agencies, and technology firms in addition to science and education organizations. MSGC supports a large hub of the space-research activities happening in Maine through funding for programs, such as Faculty Research Seed Grants for researchers at institutions in need of support for preliminary research activities.

MSGC also partners with NASA EPSCoR, which ties in EPSCoR's values of funding pivotal research, building capacity, and developing the STEM workforce in historically underfunded areas to increase a state's competitiveness for research. Paired with the Maine Space Grant Consortium, NASA EPSCoR provides additional funding to researchers in Maine focusing on the study of space.

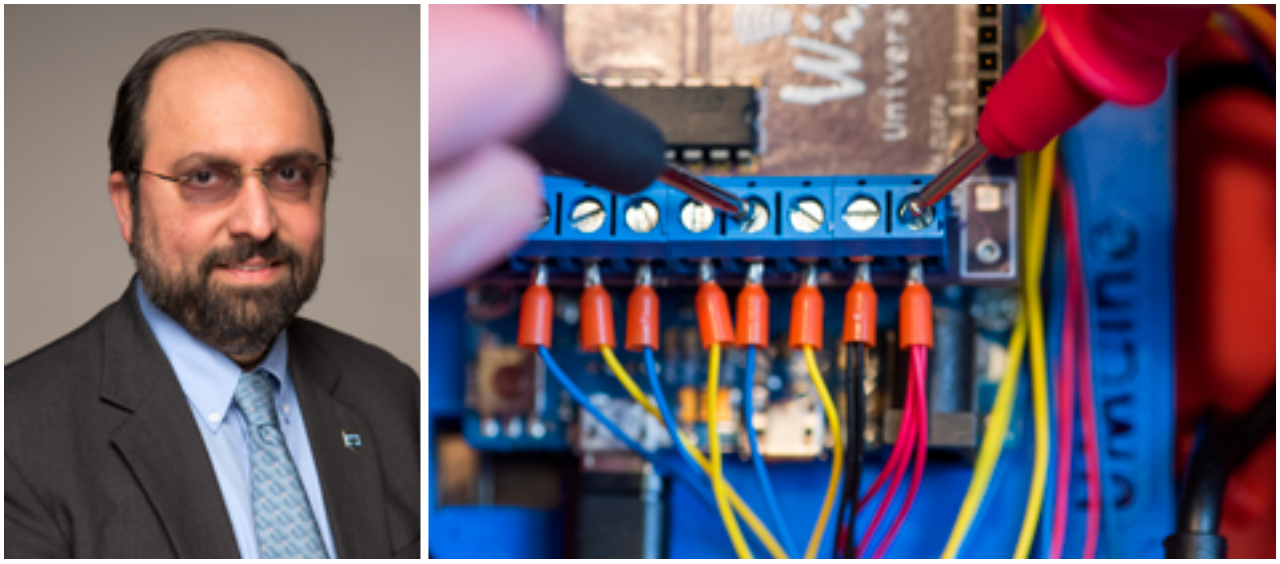
Funding from both MSGC and NASA EPSCoR supported a project headed by Dr. Ali Abedi that resulted in the development and creation of the first Maine-produced technology that has been sent into space. Abedi, along with his cohort of students at UMaine, created these devices using wireless sensor technology that attaches to and monitors the structural integrity of deployable space habitats used by astronauts when attempting to set up camp on our moon, other planets, or asteroids.

Dr. Abedi received his Ph.D. at the University of Waterloo in Ontario, Canada before bringing his wireless-technology expertise to the University of Maine at Orono. "I found UMaine to be one of the worldwide leaders in sensor technology," said Abedi. "With LASST, the Laboratory for Surface Science and Technology, and electrical and computer engineering departments, ... I felt my expertise in wireless communication could be a very good match." This research center was restructured and renamed FIRST, the Frontier Institute for Research in Sensor Technologies, in January 2019.

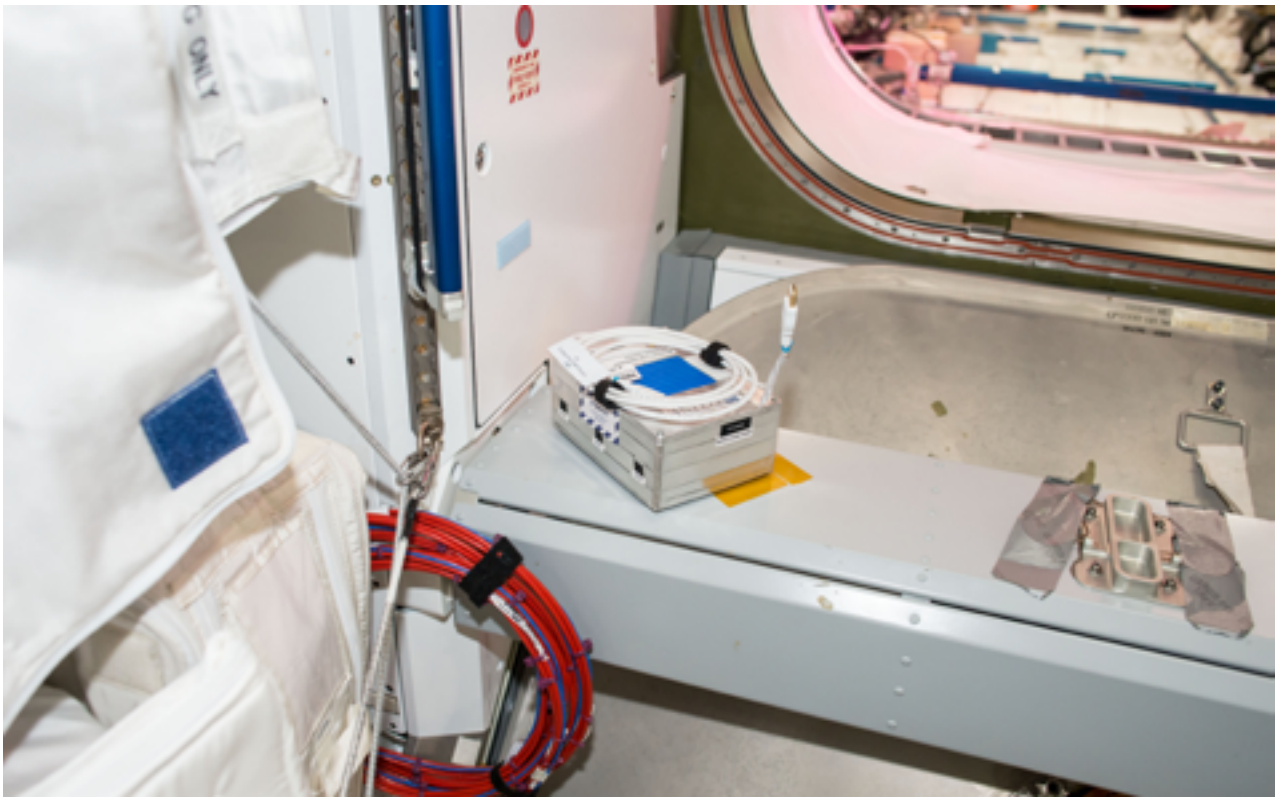
Dr. Abedi holds many titles at UMaine, including Professor of Electrical and Computer Engineering, Assistant Vice President for Research, and Director of the Center for Undergraduate Research. Abedi began his relationship with the MSGC during his early research years, with seed grants for projects and travel grants to present his research at NASA centers. After completing these initial seed grant projects, Abedi received a $1.5 million NASA contract (including $360,000 of UMaine cost-share) to help create a functioning inflatable habitat for extended-duration space missions.

Astronauts currently live in the International Space Station for long periods of time in order to conduct research. The space station is 32,300 cubic feet of pressurized space, spans roughly the length and width of a football field, includes interior space equivalent to six bedrooms, and orbits the Earth. In order for humans to travel further and explore more distant places such as the moon, asteroids, or other planets, they need a structured habitat where they can safely live.

"You can either transport building materials, or try [to build] with materials [that are already] on other planets, or you can think about inflatable ideas," said Abedi. One of NASA's inflatable habitats is currently housed in the Wireless-Sensing (Wise-Net) Lab at UMaine. The habitat is a 42-foot donut-like structure made of a material that is similar to nylon tarp, with a 10-foot-tall interior you can walk inside of. "The idea was that an inflatable habitat can be folded into a very tiny space, and then it goes up into



Ali Abedi, Professor of Electrical and Computer Engineering, Assistant Vice President for Research, and Director of the Center for Undergraduate Research. Right, detail image of the UMaine leak-detection system. Photos courtesy of the University of Maine.



The UMaine leak-detection system inside the International Space Station. Photo courtesy of NASA

space and you pop it up. You can get a lot of volume with little mass."

However, when using an inflatable habitat, the risk of rips or holes becoming detrimental to the structural integrity of the habitat is imminent at all times. Think about flat snow-tubes or pool floats when they get the smallest of holes. Then imagine this is your house, and you are living on the moon — and the air inside is the only oxygen you have. This is a big problem.

To address this, wireless sensors that Abedi and his team invented work to monitor the structure's walls during the various stages of setup and after inflation is complete and the habitat is ready to live in. The sensors must monitor the inflation of the structure, identify any impacts on the habitat's walls from space debris, and locate any rips or damage that could release crucial oxygen storage into space.

The wireless sensor system begins its work when the habitat inflates on another planet. "Just imagine when you fold your clothes in your luggage and then go on a trip," explained Abedi. "If they are a plastic or sticky fabric, they will stick to each other as you unfold them. The inflatable habitat is folded for several months until it reaches its destination, and when it's getting unfolded you need to make sure it doesn't stick or burst, so you need to monitor its inflation.

"Once it's inflated, in other places in space, there is no atmosphere like we have here to protect from radiation, micro-meteorites, or space-debris impacts," said Abedi. "So we need to have a continuous monitoring of the structure."

The structural-integrity-monitoring system was the first of three different sensor systems Abedi developed for inflatable space habitats. After inflation, the structure faced different problems that required both impact-localization sensors and sensors that detect any leaks in the walls. The localization sensors work to monitor the location of any impacts, and if an impact were severe enough to puncture or damage the habitat, the leak detection sensors would notify the astronauts so they could find and repair any hole or rip.

Five organizations, including universities and companies, received funding from NASA EPSCoR to work on sending a payload to the space station, but only two — one being Abedi and his team at UMaine — were able to build the wireless leak-detection sensor system and complete the rigorous process of getting their technology NASA-flight-certified by the deadline.

"In December of 2016 we launched a wireless leak-detection system into space from a Japanese space agency platform at the Tanegashima Space Center, and it went to the International Space Station. We sent three boxes that were operational in early 2017. We got them back in [the summer of] 2017," said Abedi. "[The] three boxes had multiple ultrasonic sensors on them, and they were actively trying to listen for tiny leaks while also trying to map the background noise and interference."

The sensors are tiny devices that detect ultrasonic waves. "The data will come in [from the sensor], become digitized, and then you can transmit the data [using radio waves], almost like a cell phone, and send back to Earth for processing," said Abedi. "You've heard the hiss sound that comes from a leaking balloon or a bicycle tire with a hole. The sensors are listening for that type of hiss sound, but we can't hear it because it is ultrasonic. The ultrasonic sensors can hear it, and then try to figure out the direction of the signal in order to determine the location."

Using a system of algorithms, the sensors triangulate the location of the leak by detecting the frequencies generated by the air, or the "hiss" sound that escapes into space. The data is collected quickly and accurately, using a low-cost system that is lightweight enough to effectively travel to space.

After a long journey back and forth from the space station, these three sensor boxes have each found a final home for display — one in Dr. Abedi's lab, one at the California-headquartered SpaceX company, and one in the lobby of the Emera Astronomy Center at UMaine.

During this project, Abedi had a team of both undergraduate and graduate students aiding him. While working on the sensors, Abedi had 15 master's and Ph.D. students and 30 undergraduate students in the lab with him, many of whom have gone on to work in higher education and/or space-related science and engineering fields.

"To give you a few examples, some of my students are now professors at universities. Some of them are working in industry, such as one of my students who is from Old Town, Maine. He worked for me when he was a high-school student in the summer, and then he got his bachelor's and master's degrees in electrical engineering, and now he works at the SpaceX company in California. Another student works at the NASA Goddard Center in Maryland," said Abedi. "UMaine has a lot of talent. We have an excellent undergraduate student body. We have very talented graduate students who are very diverse, from Maine, from others states, and from other countries all over the world."

Abedi explained that funding from EPSCoR allows the students at UMaine to flourish and pursue their research ideas, leveraging UMaine's strong infrastructure — capacity that was built in no small part due to past EPSCoR support. "The Maine EPSCoR office has been very instrumental helping us with seed grants and putting us in competition with big-name schools in places like Massachusetts and California," said Abedi. "The results, in my opinion, are very interesting to see. You get a first-generation college student from Rumford, Maine, and you put him on a project to build something that actually goes to the space station and now that person works for NASA. That story goes back to his high school and everybody gets inspired and [realizes they can do the same]."

The structural integrity monitoring system was the first of three different sensor systems Abedi developed for inflatable space habitats.

Abedi's influence on the UMaine community extends beyond the mentoring and research opportunities he provides to students through his partnerships with other UMaine departments and faculty. A 10-year collaboration between Abedi's wireless sensor technology and the UMaine psychology department resulted in technology that helps people with PTSD, Alzheimer's disease, athletes with concussions, and other individuals with traumatic brain injuries. "We implemented sensors in a fitted sheet. The individual takes it home, puts it on their mattress, and they sleep on it. The sensors are wireless. You don't see them and they are not touching your body, but they take all of your sleep data and map your brain activities," said Abedi. This, Abedi explains, is just one example of how space research can still affect and benefit those on Earth and in Maine.

Efforts from Abedi, the MSGC, and NASA EPSCoR create valuable benefits for the state of Maine and the nation. Investments in research and infrastructure at places like UMaine increase potential for the growth of future industries that could contribute to Maine's economy. Maine is well known for its forestry, tourism, paper mills, and seafood, but the innovative research going on at places like MSGC and UMaine is pushing Maine to the forefront of biotechnology, remote home and health care, space-age technology, and more. Research and development investments in fields such as space studies are vital for our home state and the opportunities are as limitless as the stars. ■

SPLASH Summer Interns

BY LIZ THERIAULT

MAINE IS A STATE OF INNOVATORS AND ENTREPRENEURS. Since the state began investing in research and development to bolster its economic competitiveness, new and emerging industries have sprouted into the Pine Tree State. One of these industries is aquaculture. As the industry grows, innovators and entrepreneurs need to find their place within the changing landscape. How does Maine's future workforce — the students who are still working through high school, college, and their graduate schooling — connect their ideas and passions with knowledge and skills sufficient enough to gain a career in aquaculture?

SPLASH, a workforce development and internship program at the Maine Aquaculture Innovations Center (MAIC) in Walpole, Maine, may have the answer to that question.

In Summer 2019, Christopher Davis of the Maine Aquaculture Innovations Center (MAIC) and Anne Langston of the Maine Aquaculture Research Institute (ARI) brainstormed, created, and organized a hands-on aquaculture summer internship that would directly connect Maine high-school students with Maine aquaculture farmers.

The MAIC is a center dedicated to advancing both environmentally and economically sustainable aquaculture opportunities in Maine through research, education, and workforce practices. The SPLASH internship, as one of their most recent endeavors, combines all three of these features into one cohesive summer experience.

"Interns are placed with a farm and spend most of their time on the program working on a farm, getting very real everyday practice," explains Langston. "Then one day every week they spend time with myself and [Davis], where they get exposure to a range of different knowledge."

From Monday through Thursday, the four high-school students selected for this internship work on various aquaculture farms based out of the Damariscotta River estuary, gaining real experience harvesting oysters and making network connections with Maine aquaculture farmers. Then, every Friday, the interns get lessons to pair with their labor. These topics range from aquaculture species, water safety, and how to be professional in a work environment.

"You're going into a profession, and even though you are wearing the dirtiest clothes you have, because you're going to look filthy, it's still a professional environment and you have responsibilities to the business and the program, so there is some mentorship there," says Langston. "Not only are we exposing them to empirical knowledge in terms of doing, condense research, like, 'This is how you grow oysters,' but there is also the tacit knowledge that comes from just meeting people and hearing about their own experiences."

On top of their daily work, these high-school students were also administered electronic curriculum through iBooks, an EPSCoR-funded development

Left to right: Aaron French, UMaine graduate student; Misha Curtis, SPLASH intern; Chris Davis, executive director of the Maine Aquaculture Innovations Center; Aria Ton, SPLASH intern; Anne Langston of the Maine Aquaculture Research Institute.
Photo by Liz Theriault

created by the MAIC to read on their own time. These iBooks are loaded with new, consistent, and up-to-date resources such as references, photos, videos, and lessons in order to enhance the interns' daily workforce and education experiences.

The interns participating in this summer's experience all come from Lincoln Academy, a school in a town right off the Damariscotta River, with easy access to the growing aquaculture industry in Maine.

"We have some students who have a home in a community that has a long-term working-waterfront heritage," says Langston. "They are interested in continuing that working-waterfront tradition, and aquaculture is a new opportunity to do that."

On the other hand, some students, such as Aria Ton, have had no experience and very little exposure to aquaculture before this internship. Ton, a new student to Lincoln Academy originally from San Francisco, California, applied for the internship after falling in love with marine biology because of an oceanography course she took her junior year. This summer, she works at Glidden Point Oyster Farms.

"I was surprised by the amount of work that went into harvesting even just one oyster. I was oblivious to the work that goes into growing them," says Ton. "I've learned how much handling goes into each oyster before they are market size, and I didn't realize it would be that much."

As Ton enters her senior year, she hopes to go to school for marine biology, and the hands-on experience and network-exposure opportunities this internship has provided this summer will help kick start her way into a career.

"Part of this [experience] is also about hearing people's own career pathways, and learning how people ended up in the same place [on the farms], by taking opportunities as they come, and not being afraid to try something new," says Langston. "That opens their eyes to how they can make the most of their college experience."

As the internship prepares students for their college experiences, it also prepares Maine's future workforce to meet the demands of the growing aquaculture industry. The SPLASH internship program provides Maine's high-school students with the first set of skills and experiences they need to fill the roles of aquaculture workers and farmers.

"As you see a sector grow, you have key leaders, entrepreneurs, and innovators… and then in the next phase of growth you suddenly have lots of new companies, and as those companies get bigger, you need more people in that company," explains Langston. "Maine is really good at training entrepreneurs and innovators, and that's good, but sometimes you need people who need to do the work every day. There is a very particular base of knowledge they need, and this internship can help fill those gaps."

As the summer came to a close, Langston hoped to continue the program for years to come. The SPLASH internship started as an idea between Langston and Davis, made possible through funding from Maine EPSCoR.

"The funding that we have through Maine EPSCoR allows us to test ideas like this," says Langston. "The funding allows us to test an idea, collect information about the idea, and help us find something to carry on into the future."

And the horizon is bright for the future of the SPLASH program. Since this was the internship's first year, Davis and Langston took on only four students, and worked with four farms. However, others farms not involved this year have already reached out to Langston expressing their interest in hosting an intern next year.

"I am surprised at the excited feedback we have had from other companies that are not currently part of this program," says Langston. "It gives us a reason and energy to find funding to do it again."

There are many pathways that current Maine students can take to find a career in aquaculture, but with the help of the SPLASH internship, these four students have had a summer of experience, knowledge, and networking under their belt to make navigating the right path for them a little easier.

"It's going to be an important cog in the engine that continues to drive the sector forward," says Langston. "The entire coastline of Maine has got this incredible heritage and it's incredibly important to keep our eye on the ball in order to keep that heritage alive for the next generation." ■

Maine EPSCoR's new Track-1 Grant,

Maine-eDNA, is now underway

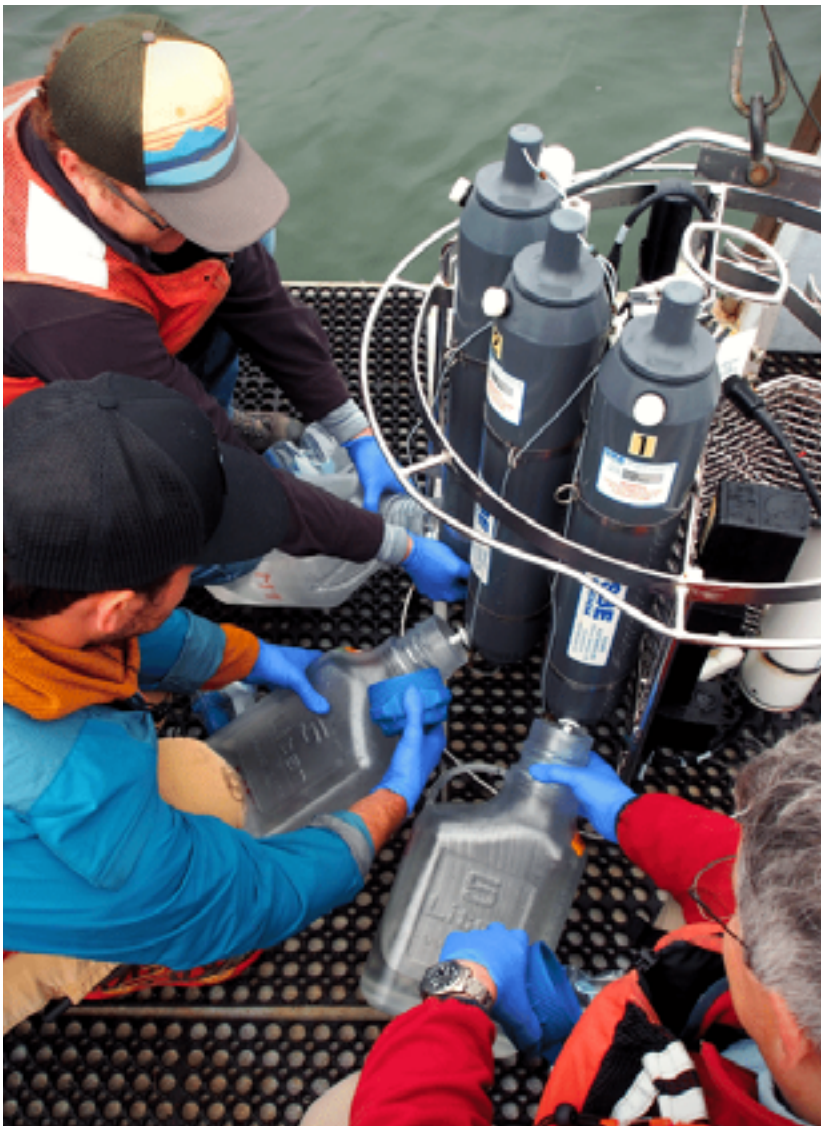
BY MARCELLA SILVER

Over the past two years, researchers and staff members from the University of Maine, the Bigelow Laboratory for Ocean Sciences, and other collaborators worked hard to create and submit a $20 million grant proposal to the National Science Foundation (NSF) EPSCoR program. In August 2019, the partnering institutions were officially awarded their Track-1 project: Molecule to Ecosystem: Environmental DNA as a Nexus of Coastal Ecosystem Sustainability for Maine (or Maine-eDNA).

According to the University of Maine's official press release, the 5-year initiative "aims to revolutionize environmental monitoring, ecological understanding and sustainability of coastal ecosystems."

Dr. Kody Varahramyan, the University of Maine's Vice President for Research and Dean of the Graduate School, is the Principal Investigator (PI) of Maine-eDNA. "The Maine Environmental DNA (Maine-eDNA) initiative represents a multi-institutional partnership that will position Maine as a national leader in the understanding and sustainable use of coastal ecosystems, and in addressing the statewide workforce needs in critically important areas, including biotechnology, ecology, environmental and data sciences," Dr. Varahramyan stated in the press release.

The Co-PIs on the project include: Dr. Kate Beard and Dr. Michael Kinnison (both from the University of Maine), Dr. Heather Leslie (director of the University of Maine's Darling Marine Center), and Dr. David Emerson (Bigelow).



Maine-eDNA researchers collect samples during one of their first days spent out in the field.

Maine EPSCoR Director Dr. Shane Moeykens serves as the associate project director.

Over the last several months, the team has worked together to develop a Strategic Plan that was recently accepted by the NSF, pull together resources, including graduate and undergraduate student support, and even start field sampling and data collection. Two research expeditions have occurred so far. One took place in the Damariscotta River and the other in the Damariscotta Lake.

Maine-eDNA research will not only strengthen the lead institutions and their partnerships but also apply big data and team science studies to the overall collaborative efforts. In addition, this research has the capacity to create impactful education and outreach activities that will establish connections with the state's rural and Native American populations. As with previous Track-1 grants, this project will develop new professional development opportunities for teachers and environmental professionals while strengthening ties with key stakeholders and state resource managers. Overall, the project aims to positively impact the research capacity of the state.

Visit umaine.edu/edna to learn more about the Maine-eDNA project and the amazing personnel involved with achieving these key objectives. ■

Maine-eDNA consists of three thematic goals:

1.) SUSTAINABLE FISHERIES: Employ eDNA-based ecological inference to understand population and community processes and consequences of fisheries recovery and recruitment dynamics of invertebrates and macroalgae.

Theme Leads: Michael Kinnison, Heather Leslie, and Nichole Price

2.) HARMFUL AND SHIFTING SPECIES: Employ eDNA-based ecological inference to understand population and community processes governing emergence and controls on harmful blooms and broader species range shifts.

Theme Leads: David Emerson, Peter Countway, and Damian Brady

3.) MACROSYSTEM EDNA INTEGRATION: Leverage the team science and Big Data integration capacity of Maine-eDNA to understand community dynamics and stability across the full coastal gradient and taxonomic scope, from microbes to whales, as well as studies of how communication shapes team science processes and outcomes in the context of eDNA research.

Theme Leads: Kate Beard, David Emerson, and Bridie McGreavy

MAINE EPSCoR

5717 Corbett Hall, Room 444
Orono, ME 04469-5717

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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.

Maine-eDNA personnel group photo from the 2019 Strategic Planning meeting.

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Maine EPSCoR

Fall 2019

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