MAINE EPSCoR

at the University of Maine

2020 Annual Report

MAINE EPSCoR

Contents

Maine-eDNA (page 2) is an NSF EPSCoR Research Infrastructure Improvement (RII) Track-1 program, which supports research-driven improvements to the state's research and development enterprise. If you would like to learn more about how historical Track-1 projects have impacted the state through the creation of research centers, turn to page 29.

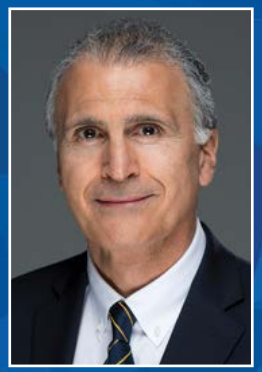
Leveraging Intelligent Informatics and Smart Data for Improved Understanding of Northern Forest Ecosystem Resiliency (INSPIRES) (page 6), **Genomic Ecology of Coastal Organisms (GECO)** (page 10), **Single Cell Genome to Phenome** (page 12), **and The Visual Experience Database: A Large-Scale Point-of-View Video Database for Vision Research** (page 14) are NSF EPSCoR RII Track-2 Focused EPSCoR Collaborations (FEC) awards, which create interjurisdictional collaborative teams in order to tackle complex projects.

Advanced Control Strategies for Floating Offshore Wind Farms (page 16) **and Diffuse Optical Imaging for Early Detection of Diabetic Polyneuropathy (DPN)** (page 18) are NSF EPSCoR RII Track-4 awards, which allow for an investigator and their graduate student or postdoctoral fellow to visit state-of-the-art research centers in order to collaborate and further their expertise.

In this report, you will also learn about the funding and award opportunities provided through:

Photographs of students and others not wearing masks were taken prior to the coronavirus pandemic. *The University of Maine and University of Maine at Machias follow federal and state Centers for Disease Control and Prevention health and safety guidance, which includes social distancing and use of face coverings for the start of the 2020–21 academic year.*

From Maine EPSCoR Leadership



Kody Varahramyan
Vice President for Research and Dean of the Graduate School

Shane Moeykens
Director of Maine EPSCoR

Amidst challenges associated with the COVID-19 pandemic, National Science Foundation (NSF) EPSCoR-funded research and activities across the state have proven themselves to be resilient. Over the past year, Maine EPSCoR (Established Program to Stimulate Competitive Research) has had the great pleasure of participating in and supporting some of the state's most innovative research. These efforts have made important social, economic, and educational impacts on the state of Maine. The achievements and discoveries highlighted in this annual report only graze the surface of what has been accomplished, and of what is surely yet to come.

Maine EPSCoR's current Track-1 grant, Molecule to Ecosystem: Environmental DNA as a Nexus of Coastal Ecosystem Sustainability for Maine (or Maine-eDNA) has completed important first steps in establishing protocols and baseline data while conducting initial sampling and analysis in summer and fall 2020. While COVID-19 has brought extensive challenges to many programs and projects supported by NSF EPSCoR, Maine-eDNA and several other EPSCoR grants throughout the state have showcased their ingenuity.

The faculty, students, and staff mentioned within these pages have exhibited perseverance through this year's challenges, and deserve our recognition. We are also thankful for those who have continued interest in our work. We hope this annual report showcases our enthusiasm for the future, and provides you with a first-hand look at some of the most exciting research taking place in the beautiful state of Maine. Thank you.

RII Track-1:

Molecule to Ecosystem: Environmental DNA as a Nexus of Coastal Ecosystem Sustainability for Maine (Maine-eDNA)

July 2019 – June 2024

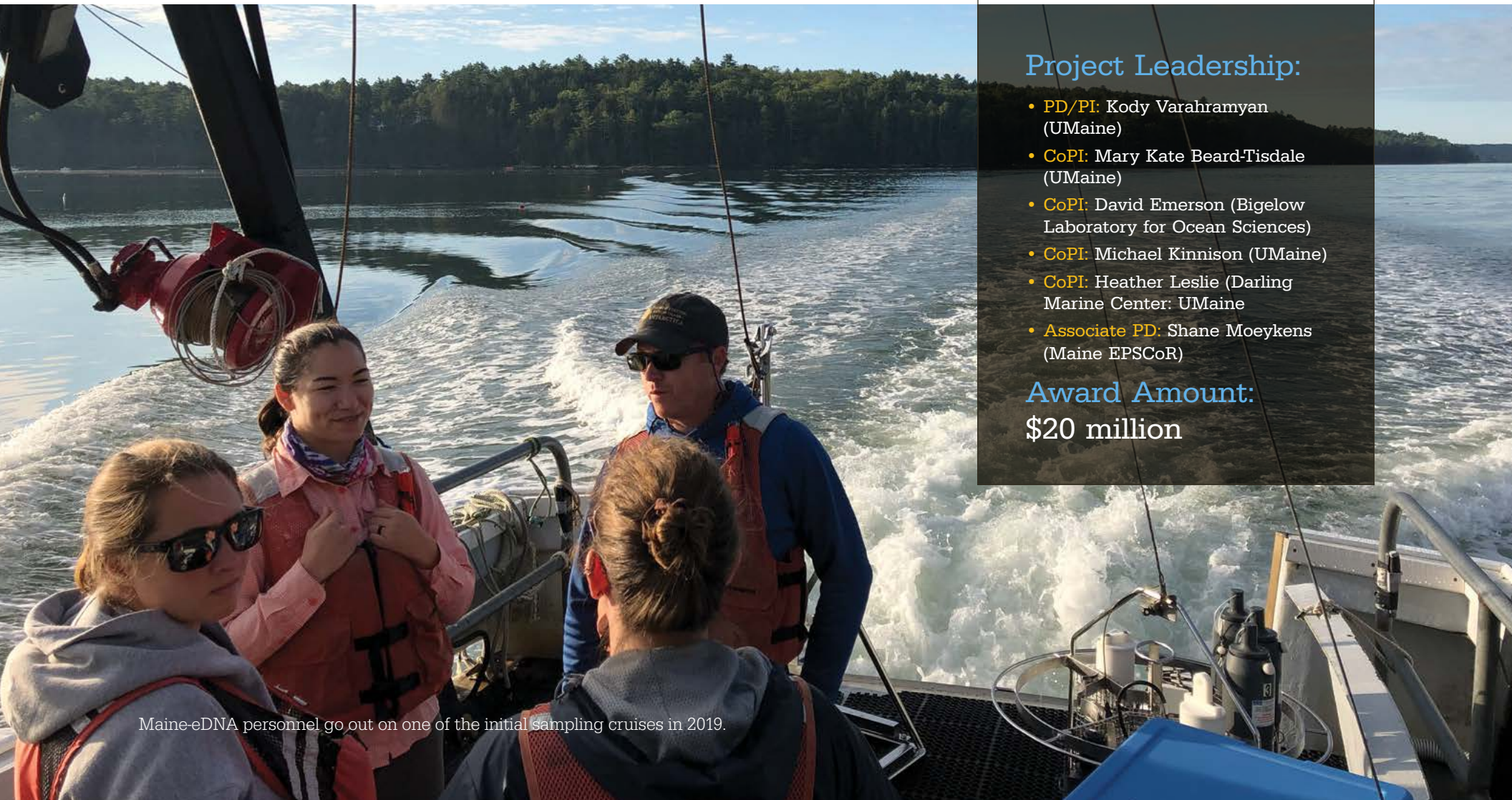
NSF EPSCoR Research Infrastructure Improvement (RII) Track-1 programs are five years in length and support research-driven improvements to the awarded jurisdiction's physical and cyber infrastructure and human capital development in order to improve future research and development competitiveness.

Project Leadership:

- PD/PI: Kody Varahramyan (UMaine)
- CoPI: Mary Kate Beard-Tisdale (UMaine)
- CoPI: David Emerson (Bigelow Laboratory for Ocean Sciences)
- CoPI: Michael Kinnison (UMaine)
- CoPI: Heather Leslie (Darling Marine Center: UMaine
- Associate PD: Shane Moeykens (Maine EPSCoR)

Award Amount:

$20 million



Maine-eDNA personnel go out on one of the initial sampling cruises in 2019.

All organisms leave traces; whether they be pawprints, fingerprints, or DNA. We are able to track pawprints through the woods to find animals or collect left-behind fingerprints at crime scenes, but what about DNA? Or, more specifically, DNA from organisms that live in bodies of water?

In August 2019, the University of Maine, Bigelow Laboratory for Ocean Sciences, and other collaborators were awarded a $20 million grant from the National Science Foundation (NSF) EPSCoR program to develop efficient ways to collect the DNA of those organisms. The Maine EPSCoR Track-1 Grant: Molecule to Ecosystem: Environmental DNA as a Nexus for Coastal Ecosystem Sustainability for Maine (or Maine-eDNA), is collecting, identifying, and linking the genetic fingerprints of marine ecosystems back to specific species.

Environmental DNA (eDNA) is the genetic material left behind by organisms in their environments as a byproduct of their natural life and death processes. For some microbes, eDNA can come from the whole living organism. For larger organisms, eDNA typically comes from shed skin cells, gametes or waste products. Samples collected by Maine-eDNA researchers typically look like a bottle of water—providing the state of Maine with a safer, more accessible and sustainable alternative to previous collection methods, such as nets, trawls, or divers.

The vision of the five-year initiative is to: "Make Maine 'the DNA Coast' – a world leader in eDNA-based partnerships, understanding, and sustainability of coastal marine and freshwater ecosystems." The program aims to aid in monitoring coastal systems and improving outcomes, such as healthy fisheries and aquaculture. With the funding provided from the Maine-eDNA grant, students, scientists, agencies, industries, and community members will collect water samples from around the state to create an expansive understanding of how species interact to make ecosystems function.

Dr. Kody Varahramyan, the University of Maine Vice President for Research, Dean of the Graduate School, and Principal Investigator of Maine-eDNA stated: "the Maine Environmental DNA 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."

During the 2019-2020 season, the Maine-eDNA team worked diligently to develop plans and procedures while achieving first-year goals and gathering baseline data amidst challenges, mostly emerging from the COVID-19 crisis. The team's characteristic adaptability suggests these challenges will be experienced as temporary delays, not fundamental changes to scope.

In support of the Maine-eDNA grant, the eDNA Service Center was fully functional within UMaine's Coordinated Operating Research Entities (CORE) program in early 2020. This Center will be fully operational as of fall 2020, and serves as a key subcomponent of the Maine Center for Genetics in the Environment. As designed, the eDNA Service Center will perform the majority of ddPCR and qPCR testing for Maine-eDNA, as well as genome sequencing work.

While there were a number of delays in spring 2020 with Maine-eDNA due to COVID-19 restrictions, most Year 1 objectives have been fully satisfied. Maine EPSCoR's Educational Program Manager, Laurie Bragg, collaborated with partner agencies and institutions to determine what program-funded Workforce Development and Diversity activities were able to safely occur in fall 2020, and is working to replace any identified gaps with newly developed, virtually-hosted programs. NSF EPSCoR has stressed the importance of not curtailing educational outreach with underrepresented communities due to COVID-19 restrictions, and Maine EPSCoR is advancing new programming with this guidance as a central focus.

Research updates:

Project personnel developed new eDNA tools and field/lab protocols, identified sampling sites, recruited graduate researchers, and built essential connections with Maine stakeholders. Discoveries that will impact upcoming research were made. For example, researchers analyzed data from juvenile salmon and found a previously undescribed eDNA breakout window, where detection and quantification were initially lower near the source and peaked at a distance downstream before declining again. These findings indicate eDNA detection may not be higher when a sample is collected closer to the source, but rather a certain distance away. This insight was used to optimize eDNA survey designs for detecting extremely rare organisms.

Maine-eDNA Leadership met in August 2019 to develop their Strategic Plan.

Researchers were also able to engage a number of stakeholder groups, including governmental, commercial, and nonprofit entities, to provide information and project plans, and learn about community needs and requirements for the resulting work. For example, the Highland Lake Association and the Maine Department of Environmental Protection approached project personnel regarding Harmful Algal Blooms (HABs) that are occurring in Highland Lake. Researchers were able to discuss this challenge and its potential implications with these entities, thus engaging community members in citizen science.

Maine-eDNA personnel were also able to develop standard sampling protocols for the entire Maine-eDNA program, which are providing a solid foundation for subsequent macrosystem analyses. A code library and web-based eDNA tool, with an easy-to-use map interface for exploring sampled sites and associated sequence data, were created. These protocols, refinements, and tools all play an important role in conducting team science research.

Overall, Maine-eDNA personnel have worked effectively to complete important Year 1 goals and objectives, and demonstrated their ability to collaborate creatively in order to overcome difficult challenges, such as COVID-19. Researchers and staff are optimistic and excited about the implications of these accomplishments, and what their potential impact will be in future years of the program. ■

Maine-eDNA Year One At a Glance in FY20:

25 faculty participants

13 undergraduate students supported

11 graduate students supported

3 journal publications

$14,563,453

in submitted grant proposals

RII Track-2 FEC:

Leveraging Intelligent Informatics and Smart Data for Improved Understanding of Northern Forest Ecosystem Resiliency (INSPIRES)

August 2019 – July 2023 (estimated)

NSF EPSCoR RII Track-2 Focused EPSCoR Collaborations (FEC) awards build interjurisdictional collaborative teams of investigators in scientific focus areas consistent with NSF priorities. Projects are investigator-driven and must include researchers from at least two eligible jurisdictions with complementary expertise and resources necessary to tackle those projects.

INSPIRES

Project Leadership:

- PI: Aaron Weiskittel (UMaine)
- CoPI: Mary-Kate Beard-Tisdale (UMaine)
- CoPI: Scott Ollinger (UNH)
- CoPI: Ali Abedi (UMaine)
- CoPI: Anthony D'Amato (University of Vermont)

Award Amount:

$3 million (to date)

Compiling data to better assess, understand and forecast complex forest landscape changes is the goal of a four-year, multidisciplinary regional project led by the University of Maine. The project, "Leveraging Intelligent Informatics and Smart Data for Improved Understanding of Northern Forest Ecosystem Resiliency (INSPIRES)" was awarded $6 million from the National Science Foundation, with $3 million contingent on project progress and availability of funds.

The project combines the expertise and facilities from the University of Maine, the University of New Hampshire, and the University of Vermont to build a digital framework that integrates, analyzes and visualizes complex data streams across the region's vast forest.

"Forests are changing rapidly, while the technology to better monitor them is, too," says Aaron Weiskittel, professor of forest biometrics and modeling and Irving Chair of Forest Ecosystem Management at UMaine, who is leading the project. "I hope this project can help support and sustain northern New England's unique working forests, which many rural communities rely on for their livelihoods."

The project builds on expertise and facilities across the three universities to integrate emerging computational, monitoring, remote sensing and visualization technologies into a digital framework. The framework will create a natural laboratory for scientific experimentation by providing comprehensive spatial and temporal measurements of the forest that can be readily accessed by scientists, land managers, and policymakers. In addition, INSPIRES aims to strengthen workforce development and broaden participation in STEM education, particularly among students with diverse backgrounds, skills and interests. In order to achieve its goals, INSPIRES draws from a variety of established programs and disciplines, including data science, ecology, electrical engineering and communications.

Faculty and students from the three institutions have begun collaborating on the development of a virtual, regional Complex Systems Research Institute that will facilitate ongoing analysis of natural ecosystem integrity and resilience from multiple scientific perspectives. The institute will include large-scale simulations

Researchers will use advanced technologies like wireless sensors and remote sensing to better monitor the forest, while researchers back in the lab develop new methods to handle this big data.

from alternative futures such as climate variability, atmospheric pollution, land use, and changes in regulatory policies.

Working with nearly 28 million acres of forests across three states (Vermont, New Hampshire, and mostly Maine), Weiskittel and his team (Co-PIs: Kate Beard & Ali Abedi, UMaine; Scott Ollinger, UNH; and Anthony D'Amato, UVM) aim to develop comprehensive monitoring and harness the big data revolution. The INSPIRES project focuses on three areas: developing ecological sensors, working with K-12 educators (like those in highly forested rural Maine), and leveraging new technology, statistical methods, and computer science with an ever-changing and highly dynamic ecosystem like the forest.

The forest is one of Maine's most important economic resources. The forest industry directly adds ~5% to the state's GDP; one of the highest contributions of any state in the U.S. With the addition of tourism and hunting, Maine quickly becomes one of the most forest-reliant states. In addition, many Mainers view the forest as a vital piece of their heritage. However, the forest, inherently dynamic and visible, poses many challenges for modern foresters.

Forestry, itself, is in a state of transition due to expanding global markets, changing workforce development, ongoing mill closures, past/pending pest outbreaks (e.g., spruce budworm), technological advancements, and a younger generation of foresters. Maine may be well positioned as the new generation becomes interested in the forest, green-collar jobs, and an emerging carbon economy. Governor Janet Mills has proposed that the state of Maine will be carbon neutral by 2045. This positions Maine as a potential leader in this industry, sustaining the heritage of its citizens within a future circular economy reliant on the sustainable management of extensive yet dynamic natural resources.

INSPIRES proposes to address these multi-dimensional challenges by balancing Maine's most important resources, landowners, workforce, and heritage on the frontlines of climate change. Researchers are using advanced technologies like wireless sensors and remote sensing to better monitor the forest, while

researchers back in the lab develop new methods to handle the resulting big data. In other words, the former provides the necessary data and the latter turns this data into readable information through interpretation and identifying key cycles that can help improve the ecological models used to forecast future conditions.

"Sensors are often hardwired to take data at regular and fixed intervals," says Weiskittel. "Can we develop smarter technology that learns from itself and tells the sensor when to collect data at ecologically important intervals?"

"Machine learning methods developed in this project not only process data, but also provide us new data on quality of wireless communication channels, helping the researchers to design a network that can last a long time in the forest without the need for daily change of batteries," said Co-PI Ali Abedi.

INSPIRES then goes a step further with ecological modeling, forecasting, and projecting a future forest under alternative scenarios. With so many different types of data, it is essential to come up with a common platform to understand key metrics. Weiskittel and his team have been working on these metrics within a broader vision akin to a real-time dashboard for the forest with a prototype version released in spring 2020: https://forestapp.acg.maine.edu/.

But what would a Digital Forest look like? Weiskittel describes his vision as an online interface (or "Digital Forest Big Data" framework) that anyone can log in to. This application would look and behave similarly to Google Earth, but the information would pertain specifically to Maine's forested regions, which take up approximately 90% of the state's entire land area.

With Weiskittel and his team spending a lot of time looking at vulnerability, one of the uses of this future forest app would allow a landowner to zoom in on a specific location in order to monitor spruce budworm defoliation or vulnerability. Landowners and researchers could also monitor for Canada lynx or carbon. Thanks to the application, new possibilities for identifying "hot spots" of vulnerability may arise. Through spatial and ground data, the landowner would also be able to see a forty-year history of Maine's forest, look at drivers, balance trade-offs, and address emerging trends.

The INSPIRES project also aims to extend its reach with an educational component. The goal is to develop better curriculum materials and course content for middle school and high school students that teaches how to interpret graphs, take measurements, and build other skills, such as quantitative reasoning.

The University of Maine has a long history of bringing various people from different fields of research together to face issues that are relevant to Maine. With Governor Mills' statement of carbon neutrality, INSPIRES plans to help achieve this goal by changing forest management and developing new relevant technology to help managers.

"That's what excites me—bringing people together to work on something that can help the entire state," Weiskittel says. "Moving this forward is critical, given the importance of our region's forests. It's particularly important that we do so with the goal of a low-carbon economy."■

"I hope this project can help support and sustain northern New England's unique working forests, which many rural communities rely on for their livelihoods."

—Aaron Weiskittel

RII Track-2 FEC:

Genomic Ecology of Coastal Organisms (GECO): A Systems-Based Research and Training Program in Genome-Phenome Relationships in the Wild

August 2018 – July 31, 2022 (estimated)

NSF EPSCoR RII Track-2 Focused EPSCoR Collaborations (FEC) awards build interjurisdictional collaborative teams of investigators in scientific focus areas consistent with NSF priorities. Projects are investigator-driven and must include researchers from at least two eligible jurisdictions with complementary expertise and resources necessary to tackle those projects.

Project Leadership:

- PD/PI: Adrienne Kovach (UNH)
- CoPI: Serita Frey (UNH)
- CoPI: Brian Olsen (UMaine)
- CoPI: Benjamin King (UMaine)
- CoPI: Kristina Cammen (UMaine)

Award Amount:

$1,998,863 (to date)

Since August 2018, the scientists on the GECO project have been working to increase our knowledge of genome to phenome relationships. According to Benjamin King, an Assistant Professor of Bioinformatics at the University of Maine (UMaine), genomes are the "blueprint" of genetic material within an organism and phenomes are the physical, behavioral, and molecular characteristics of an organism that result from the interaction of the genome and the environment. "Phenotypes can appear as feather plumage or the morphology of the beak of a bird," says King.

The team's main goal has been studying the interaction between genotypes and the organism's environment. The Universities of New Hampshire and Maine combined their complementary research expertise in disciplines such as genomics, bioinformatics, marine ecology, ornithology, and ecological evolutionary dynamics, in order to start this Research and Infrastructure Improvement Track-2 Focused EPSCoR Collaborations award (RII Track-2FEC). Adrienne Kovach from the University of New Hampshire (UNH) acts as the Principal Investigator, with Serita Frey (UNH), Brian Olsen (UMaine), Benjamin King (UMaine) and Kristina Cammen (UMaine) as Co-Principal Investigators.

The award has continued in its other goal, which is the creation of a research and training program in the Genomic Ecology of Coastal Organisms (GECO) and has done so through the integrated study of six species of tidal marsh sparrows. The coastal area these birds call home is dynamic, and acts as a natural laboratory for studying how these six species have adapted and co-evolved. Their unique adaptations, paired with this environment, provide the perfect case study for achieving the project's research and training goals with regard to better understanding genome to phenome relationships.

While the first complete field season in 2019 was an overall success, the 2020 field season had to be adapted, due to COVID-19 restrictions. Some areas previously used for the field season had to be postponed for the year and replaced with areas that could be safely utilized and accessed by researchers.

Photo taken prior to COVID-19.

The team has chosen to focus on the smaller projects that could be safely and effectively handled despite restrictions, yet still have an impact on the project's research objectives as a whole.

As a result, several studies have safely commenced and grown. One investigation has made significant progress in assessing how the studied birds may use their bills to regulate their body temperatures. In this project, researchers capture the birds and observe them in warm temperatures, while monitoring how their bills blush. Other studies focus on color, plumage, size, and diet. After gently taking blood samples, the birds are released.

There are several different types of sparrows that live in tidal marsh zones that migrated from different areas but developed similar adaptations over time. For example, all of the sparrow species being studied have larger bills than those who live in non-tidal zones. In addition, it appears that many have also adapted to handle salt, and have learned how to nest safely in places that experience high tides. By watching and observing, the researchers have explored how different species may have evolved similar adaptations over time. In addition, the researchers may be able to use this information to help better predict what kinds of adaptations or evolutions may develop in the future. For example, new bird species migrating to tidal regions will likely develop new bills, a new diet, or ways of digesting food over time.

Genomic scientists have been studying the biological data collected. While some of these species have already had their genomes characterized, some have not. Over the past year, the team has developed draft genotypes from six different species. The next step is improving and validating these genotypes.

"It's sort of like dumping out a puzzle box," UMaine researcher and Co-PI Brian Olsen explains. "We have to find out which sequences go in which order, one piece at a time."

The project was evaluated by the American Association for the Advancement of Science (AAAS) last year and received positive feedback and a favorable review. In addition, the team held a virtual all-hands meeting this summer and was able to flesh out a complex mentoring plan, so that everyone on the project had a chance to articulate how certain aspects of the research could enhance their learning experience. Five undergraduate students have also signed up to work with the project on their capstone theses, in addition to the six Ph.D. students that have already been involved.

Olsen has also been leveraging the project's collected data to develop new lessons that will be integrated into undergraduate courses across Maine and New Hampshire. The data are also being incorporated into an ongoing project, which Olsen and PI Adrienne Kovach are involved with, known as the Saltmarsh Habitat & Avian Research Program (SHARP). GECO project researchers can utilize a decade's worth of data that has already been captured by SHARP.

Overall, the project has made significant progress in its formative years. Its unique approach to studying and interacting with wild populations in their environment has yielded highly valuable information that will be essential to achieving the project's upcoming goals. Each team that participates in the project, whether based in genomics, pedagogy, or evolution, has ties to both UNH and UMaine, which not only bolsters their collaborative efforts, but also allows for the effective sharing of expertise and knowledge. This collaboration is resulting in new ways of thinking about genotypes, the environment, and the complex ways in which their interactions bring about phenotypes. ■

RII Track-2 FEC:

Single Cell Genome-to-Phenome: Integrating Genome and Phenome Analyses of Individual Microbial Cells in Complex Microbiomes

August 2018 – July 2022 (estimated)

NSF EPSCoR RII Track-2 Focused EPSCoR Collaborations (FEC) awards build interjurisdictional collaborative teams of investigators in scientific focus areas consistent with NSF priorities. Projects are investigator-driven and must include researchers from at least two eligible jurisdictions with complementary expertise and resources necessary to tackle those projects.

Project Leadership:

- PI: Ramunas Stepanauskas (Bigelow)
- CoPI: Beth Orcutt (Bigelow)
- CoPI: Nichole Poulton (Bigelow)
- CoPI: Kai Zeirvogel (University of New Hampshire)
- CoPI: Duane Moser (Desert Research Institute: Nevada)
- Senior Personnel: David Emerson (Bigelow):
- Senior Personnel: Julia Brown (Bigelow)

Award Amount:

$2,994,002

Bigelow | Laboratory for Ocean Sciences

Photo taken prior to COVID-19.

Much of the biological diversity on our planet is made up of single-celled organisms, such as bacteria. These types of microbes exist in many diverse environments, including the ocean, which makes up most of the earth's hydrosphere. However, there is relatively little known about these organisms, especially in regard to their individualized genomes and activities. This means the potential bioenergy and pharmaceutical applications of such organisms are yet to be discovered.

The Bigelow Laboratory of Ocean Sciences, located in East Boothbay, Maine, partnered with the University of New Hampshire (UNH) and the Desert Research Institute (DRI) in Nevada to identify the activities associated with these single-celled organisms. Their EPSCoR Track-2 grant, titled "Single Cell Genome to Phenome," proposes to do this by specifically focusing on tying cell-specific genomes to their expressed functions.

According to David Emerson, one of Bigelow's senior personnel on the project, there is a significant amount of unknown diversity in the ocean's ecosystems, especially at the subtidal, subsurface, and mesopelagic zones. "It's difficult to tie specific activities to various groups of microbes," says Emerson. "We can generally identify who is there, but not who is doing what. Through the coupling of these activities to single cells, we can identify which cells are actually active and then sequence their genomes on a single-cell basis."

The research team is developing a new analytical pipeline for linking phenotype information to genomes of single microbial cells. Each case study of genome-to-phenome linkage in this project will answer important ecological questions and help advance research programs.

Over the past year, the team has faced some setbacks and postponements, specifically in relation to the COVID-19 pandemic. However, the bulk of their work for this year, which was meant to consist of data analysis anyway, was able to proceed. Labs were able to host critical work done by one scientist in each lab space. Others conducted their research from home.

Researchers on the projects have paid particular attention to microorganisms from the ocean, conducting measurements on respiration rates while also analyzing genomes and gene expression of the same, individual cells. According to PI Ramunas Stepanauskas, this novel technology is used to find out how much oxygen and carbon each microorganism consumes, and what metabolic processes and genetic features contribute to this consumption under various environmental conditions. That, paired with gene expression, will create a "blueprint" of the organism, which can then be used to look for how they impact their environment.

Since the start of the project, the research team conducted six experiments in the Gulf of Maine in order to study the impact of seasons on the myriad bacterial types that inhabit each drop of seawater. In addition, this Gulf of Maine study and experiments with pure microbial cultures in the lab enabled the optimization of a new research technology. In 2019, another series of experiments were conducted on water-column and ocean-crust microbes in the Pacific Ocean. Currently, planning is underway for an expedition to Death Valley, California, where the researchers will study deep terrestrial subsurface microorganisms. Although the COVID-19 pandemic has made field studies challenging, the team hopes to be able to conduct this expedition in April 2021. ■

RII Track-2 FEC:

The Visual Experience Database: A Large-Scale Point-of-View Video Database for Vision Research

August 2019 – July 2023 (estimated)

NSF EPSCoR RII Track-2 Focused EPSCoR Collaborations (FEC) awards build interjurisdictional collaborative teams of investigators in scientific focus areas consistent with NSF priorities. Projects are investigator-driven and must include researchers from at least two eligible jurisdictions with complementary expertise and resources necessary to tackle those projects.

Project Leadership:

- PI: Michelle Greene (Bates)
- CoPI: Benjamin Balas (North Dakota State University)
- CoPI: Paul MacNeilage (University of Nevada)
- CoPI: Mark Lescroart (University of Nevada)

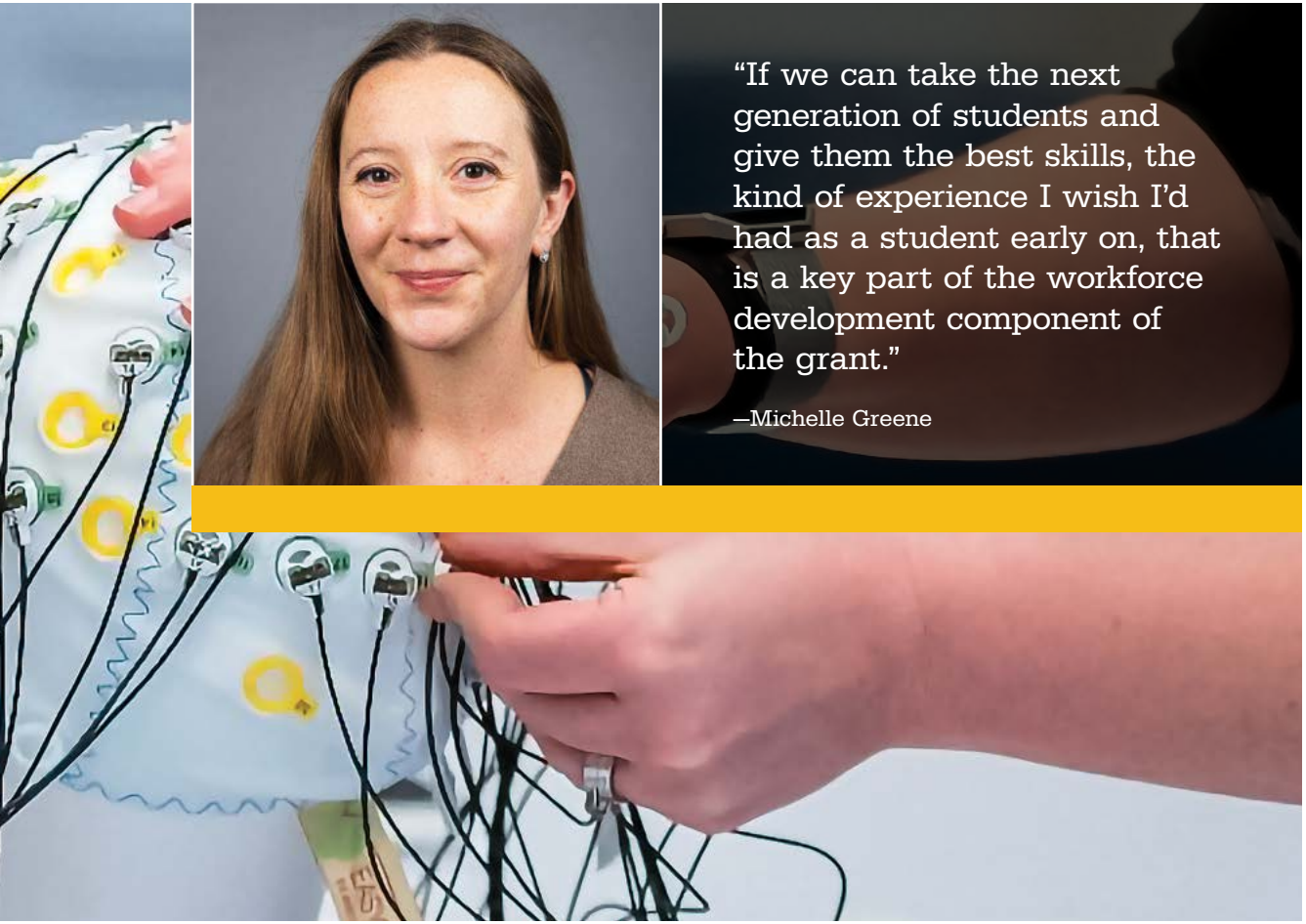
Award Amount:

$2,004,695 (to date)

Student researcher Hanna De Bruyn '18 (far left) works with Assistant Professor of Neuroscience Michelle Greene to prepare an EEG test in March 2018. (Phyllis Graber Jensen/Bates College)

Bates College received a four-year, $3.97 million grant from the National Science Foundation in order to create a groundbreaking Visual Experience Database (VED) to support research in fields that rely on the analysis and recognition of images, such as neuroscience, cognitive science, and artificial intelligence. The project, which is the largest federal grant to ever be awarded to Bates, is titled "The Visual Experience Database: A Large-Scale Point-of-View Video Database for Vision Research" and is led by Michelle Greene, an assistant professor of neuroscience at Bates who specializes in researching how the brain makes sense of what it sees. The co-principal investigators are Benjamin Balas (neuroscientist and associate professor of psychology at North Dakota) and Paul MacNeilage and Mark Lescroart (neuroscientists and assistant professors of psychology at the University of Nevada).

The project is working to create an expansive gallery of videos that depict what, and how, people see as they go about daily activities. Current artificial intelligence (AI) systems that recognize visual content require millions of training examples in order to achieve optimal performance. However, the databases used to train such systems often take photos and videos from the internet, which do not necessarily represent the actual content people see on a daily basis. This creates substantial biases within the AI systems that can have serious implications.



"If we can take the next generation of students and give them the best skills, the kind of experience I wish I'd had as a student early on, that is a key part of the workforce development component of the grant."

—Michelle Greene

The VED created by this project will contain over 240 hours of video shot from the diverse perspectives of a wide variety of observers engaged in common, everyday activities such as shopping, eating, or walking. By enlisting diverse observers local to each of the three participating institutions, the project will record how changes in environment, age, and task affect the act of looking.

Innovation in artificial intelligence, in particular, stands to benefit from the VED. Model systems in computer vision "are very data-hungry," said Greene in a release from Bates. "They tend to require tens of millions of images, and have been downloading these tens of millions of images from the internet. We will now give them tens of millions of images that are more representative of daily-life experience."

The primary goal of this project is to make the database open and accessible to the public. Project personnel will release a suite of software tools for using the database and implement a "Big Data Skills" workshop in basic computer programming skills to help grow a workforce that is prepared for a variety of scientific occupations. By making the database open to the public, the project will enable scientists, historians, and even artists to benefit from the VED.

Undergraduates at all three schools, including 28 at Bates over the four-year grant period, will participate in the research. Among other roles, these students will serve as videographers, creating assets for the VED.

"If we can take the next generation of students and give them the best skills, the kind of experience I wish I'd had as a student early on, that is a key part of the workforce development component of the grant," Greene said. ■

RII Track-4:

Advanced Control Strategies for Floating Offshore Wind Farms

October 2018 – September 2021 (estimated)

NSF EPSCoR RII Track-4 awards provide opportunities for non-tenured investigators to further develop their individual research potential through extended collaborative visits to the nation's premier private, governmental, or academic research centers. During these visits, the EPSCoR Research Fellows learn new techniques, develop collaborations, benefit from access to unique equipment and facilities, and/or shift their research toward transformative new directions. These benefits to the Fellows are expected to improve the research capacity of their institutions and jurisdictions more broadly.

Project Leadership:

- PI: Andrew Goupee

Award Amount:

$96,275

Clean energy from solar, wind, and water are necessities for a sustainable future. But sometimes, sustainability isn't just about what is good for the environment, but what is economically feasible for countries and regions that invest, manufacture and export the technology required to produce that clean energy.

Andrew Goupee, an Assistant Professor of Mechanical Engineering at the University of Maine, has been working on improving that economic feasibility through his research in offshore wind turbines. In the summer of 2019, Goupee and his graduate student, Eben Lenfest, traveled under their awarded EPSCoR Track-4 grant to the National Renewable Energy Laboratory's (NREL) National Wind Technology Center (NWTC) in Boulder, Colorado, which is one of the premier wind energy, water power, and integration research facilities in the United States. There, Goupee and Lenfest learned new techniques, developed key collaborations, and expanded their understanding of the specific control systems needed to maintain an efficient offshore wind turbine.

Conventional offshore wind turbine practices exist in areas of shallow water where fixed-bottom technologies can be employed. The state of Maine is poised with an expansive natural resource in offshore wind, but local coastal waters are too deep for conventional technologies. To combat this, Goupee, Lenfest and other researchers at UMaine are developing new, offshore wind technologies that are compatible with deepwater locations. While this practice would allow for high levels of energy capture, it also presents challenges in terms of motion instabilities that increase structural loads on the turbine.

Goupee's specific research aims to develop a more resilient and effective control strategy that would enable offshore wind turbines to harness more energy and reduce fatigue loads, thus extending their service lives. Goupee recognizes that despite his extensive knowledge in offshore wind turbines he gained from working at the UMaine Advanced Structures and Composites Center for ten years, he was no controls guru.

Photo taken prior to COVID-19.

"When I worked as staff at the composite center, I was their go-to numerical model person, so when you design a wind turbine and want to know what's going on, you use these fairly sophisticated pieces of software that simulate what goes on in everyday application or extreme events, to help you understand the behavior of the system so that you can design it properly," explains Goupee. "Since moving away from the center and taking on a faculty role, where I do grading and lectures, I was pretty out of touch with the current software. But [in Colorado], I got to dive into the latest software called OPEN-FAST, and I got to spend a lot of time coming up to speed." The NWTC also provided Goupee and Lenfest opportunities to expand their network and learn new skills.

"Some of the techniques we developed are a natural fit for the research we do," says Goupee. "One example is wind turbine power regulation controls, which is challenging because standard wind turbine controls can destabilize the floating platform. We are developing a framework to understand this behavior and then tune them for the improved energy capture and platform motion performance."

Goupee and Lenfest have also jumped on new opportunities to expand their funding and take on new projects related to their research. Experts and collaborators at the NWTC worked with Goupee to aid in submitting proposals for awards from the U.S. Department of Energy, NASA, and Advanced Research Projects Agency-Energy (APRA-E). Since submitting those proposals UMaine has secured over $2 million in funding to progress floating wind turbine controls related research.

"We put in a pile of proposals and several of them have been funded, two from ARPA-E, which is all about controls and code design for floating offshore wind turbines," says Goupee. "With this EPSCoR Track-4 experience, we gained enough knowledge to help inject that into our proposals."

The Track-4 grant funds two summers worth of travel, and thus, Goupee and Lanfest intend to return to the NWTC to continue their collaborations and expand their knowledge on floating offshore wind turbine control systems once travel restrictions related to COVID-19 allow. ■

RII Track-4:

Diffuse Optical Imaging for Early Detection of Diabetic Polyneuropathy

October 2018 – September 2021 (estimated)

NSF EPSCoR RII Track-4 awards provide opportunities for non-tenured investigators to further develop their individual research potential through extended collaborative visits to the nation's premier private, governmental, or academic research centers. During these visits, the EPSCoR Research Fellows learn new techniques, develop collaborations, benefit from access to unique equipment and facilities, and/or shift their research toward transformative new directions. These benefits to the Fellows are expected to improve the research capacity of their institutions and jurisdictions more broadly.

Project Leadership:

- PI: Karissa Tilbury

Award Amount:

$162,450 (to date)

You may remember the days in elementary school where teachers would roll out a clunky projector and use transparent sheets, cameras, and light to teach math, science, or more. What if there was a projector-type machine that uses the same basic tools, but instead of teaching fifth graders, it's used for looking into the layers of your skin?

Karissa Tilbury, Assistant Professor of Chemical and Biomedical Engineering at the University of Maine, has dedicated her time to developing low-cost biomedical optic techniques to expand accessibility for instrumental technology. Tilbury and her graduate student, Wyatt Austin, spent the summer of 2019 at the Biomedical Optic Technologies (BOT) Lab at Boston University under their awarded EPSCoR Track-4 grant, where the pair collaborated with researchers there to build a spatial frequency domain imaging system (SFDI).

This is where the resemblance to old-school projectors occurs. Essentially, an SFDI is composed of a number of LEDs, cameras, and projector screens that result in a noninvasive technique that allows users to peer into different layers of skin.

"Multiple images at different wavelengths are captured and processed to extract tissue scattering and absorption properties which can be used to map oxy- and deoxyhemoglobin levels," says Tilbury.

The practical approach of SFDI allows those who are at risk for or suffering from polyneuropathy, or damage to peripheral nerves in different areas of the body from diabetes, to take proactive detection measures.

"Current approaches for detecting neuropathy in diabetics use a tuning fork or a filament test, where a doctor applies a vibrating tuning fork or a filament to your skin and asks if you can feel it or not," explained Tilbury. "That is very subjective, not very quantitative, and you can imagine that there is a lot of anxiety and doubt. But with [the SFDI] technique, we are upstream of current practices and can detect changes in different layers of the skin before it gets to the point where a patient can't feel the tuning fork"

Working with collaborators at the BOT lab at Boston University allowed Tilbury and Austin to advance their understanding on SFDI technologies and bring it back to Maine, where an accessible SFDI machine could be vital for the older and more rural population.

"The reason SFDI is so powerful is that it is very low-cost. You could build a system for probably about $1,000 if you wanted to," said Tilbury. "It's attractable, it's obtainable, and it's a strong educational tool and great for lower resource settings."

Tilbury has plans to return to Boston University to finish out the Track-4 Grant once COVID-19 related travel restrictions are lifted. Tilbury hopes to gain more advances in her research, while also gaining insights to smaller, day-to-day practices, such as organizational structures and lab meetings, that she can apply to her own lab at UMaine. ■

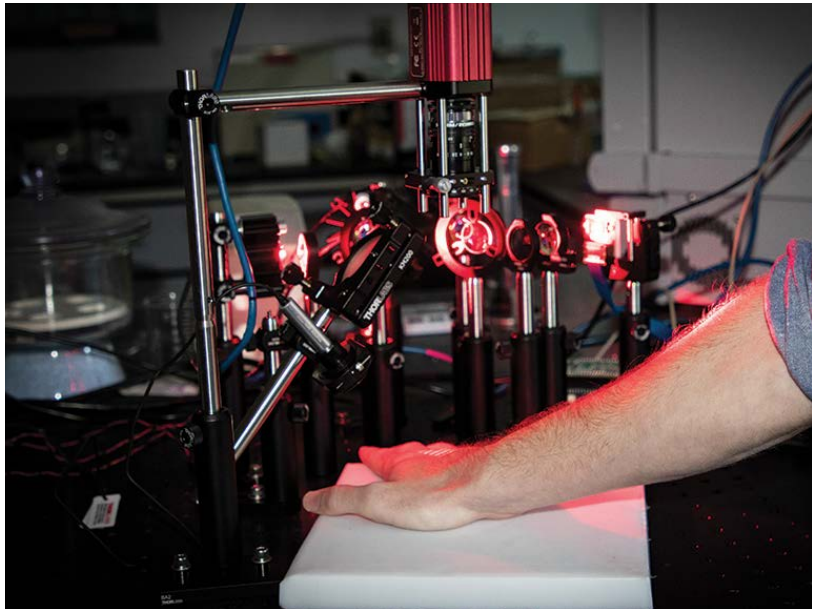
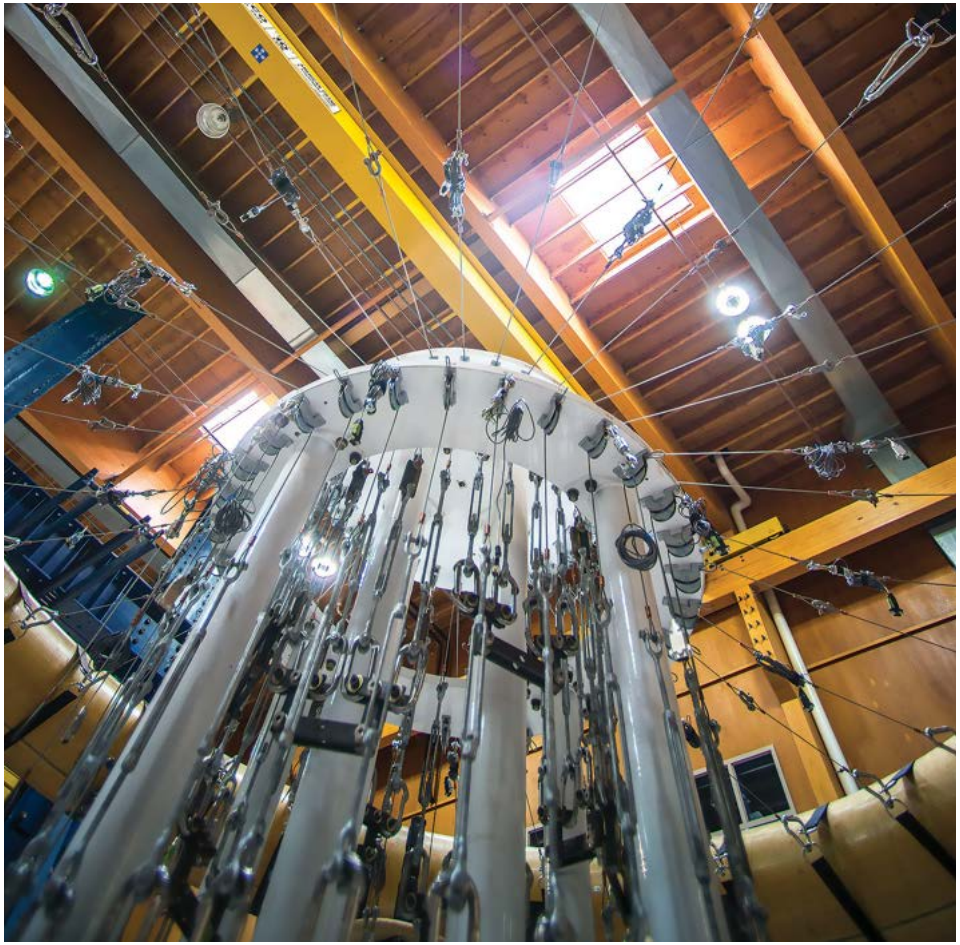


Photo taken prior to COVID-19.

Maine Space Grant Consortium & Maine EPSCoR

NASA EPSCoR

Director: Terry Shehata



Since the early 2000s, Maine's NASA EPSCoR program, through the Maine Space Grant Consortium (MSGC), has invested in a variety of research sectors, including biomedical science, advanced materials science, high-performance propulsion systems, remote sensing applications, marine science, and climate science.

The primary goal of the program is to create a workforce developed through new science in areas that not only align with the interests of NASA, but also the state's aerospace-related activities. Maine's NASA EPSCoR program receives $125,000 per year under the NASA Research Infrastructure Development (RID) program over the course of three years (with renewals every three years). This helps Maine researchers establish relationships with NASA researchers. RID funds support small-scale research intended to generate data for larger research proposals.

In addition, each year the national NASA EPSCoR Research Competition awards $750,000 over three years to support meritorious research projects that align with NASA's needs. Annually, Maine NASA EPSCoR solicits research proposals for this competition, and following an external review process, one proposal is submitted to NASA EPSCoR. If selected, NASA EPSCoR issues an award to the state NASA EPSCoR program, which in turn issues a subaward to the institution of the Science-Principal Investigator.

In the last year, Maine's NASA EPSCoR has seen some important achievements. For example, two projects received funding, one under the Maine NASA EPSCoR Research Competition and the second under the Maine NASA EPSCoR RID Program.

Maine NASA EPSCoR Research Competition Award:

Multi-Scale Remote Sensing Approaches for Forest Health Assessment

September 2019 – August 2022 (estimated)

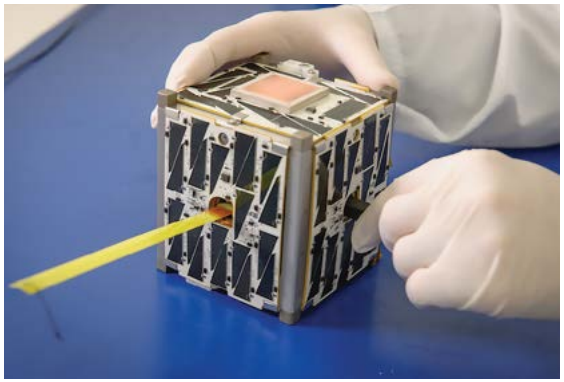
Maine's NASA EPSCoR program, through the Maine SpaceGrant Consortium (MSGC), has invested in a variety of research sectors, including biomedical science, advanced materials science, high-performance propulsion systems, remote sensing applications, marine science, and climate science. The primary goal of the program is to create a workforce developed through new science in aerospace-related activities.

Project Leadership:

- PI: Parinaz Rahimzadeh (UMaine)
- CoPI: Aaron Weiskittel (UMaine):
- CoPI: Wilhelm Friess (UMaine)
- CoPI: Daniel Hayes (UMaine)
- CoPI: Peter Nelson (UMaine Fort Kent)

Award Amount:

$750,000



Multi-Scale Remote Sensing Approaches for Forest Health Assessment

Almost one-third of U.S. economic and cultural well-being strongly depends on a healthy forest land-base and its sustainable management. The Northeastern U.S. is the most heavily forested part of the country, with Maine being the most forested state at 89%. The forests of this region provide numerous products and services for rural livelihood, wildlife, and the environment. Sound, scientifically based management of this resource requires a significant investment in forest inventory and health-monitoring.

Recent advances in remote sensing (RS) technology are revolutionizing the way in which forests are measured and monitored. The focus of this research is on providing more detailed, finer-resolution, accurate, and near-real-time data on forest tree species identification and forest tree decline detection and damage assessment using optical air- and space-borne hyperspectral and multi-spectral data. The goal is to address information needs for precise pest/pathogen control for current outbreaks in Northeastern forests, as well as for early intervention and host tree protection. This information can also be used for pest risk prediction, estimation of economic impacts of outbreaks, quantifying wood supply losses, identifying changes in wildlife habitat, and as inputs for landscape-scale forest succession and disturbance simulation models.

Maine NASA EPSCoR RID Award:

Earthshine CubeSat Proof-of-Concept

July 1, 2020 – June 30, 2021

Maine's NASA EPSCoR program, through the Maine SpaceGrant Consortium (MSGC), has invested in a variety of research sectors, including biomedical science, advanced materials science, high-performance propulsion systems, remote sensing applications, marine science, and climate science. The primary goal of the program is to create a workforce developed through new science in aerospace-related activities.

Project Leadership:

- PI: Daniel Martínez (University of Southern Maine)
- CoPI: Ashanti Maxworth (USM)
- CoPI: Asheesh Lanba (USM)

Award Amount:

$100,000

Earthshine CubeSat Proof-of-Concept

This project's main goal is to develop and deliver a proof-of-concept 1U CubeSat (a type of miniature satellite) with environmental sensors and an imaging system whose ultimate orbital mission will be to photograph the moon and transmit images to a primary ground station. To achieve this goal, PI Daniel Martinez will work with USM colleagues and partners from Espace Inc, Sonoma State University, and Arizona State University to construct a ground station and control room on USM's Portland Campus and a new, portable ground station on USM's Gorham campus for balloon and satellite communications. This will also include the design and creation of the 1U CubeSat, a physical engineering test unit, as well as sensor and instrument characterization, design, and integration in addition to balloon launch testing. This proof-of-concept project will be used to prepare for a launch-ready Earthshine spacecraft, whose science mission will be to photograph the moon and transmit images to a primary ground station.

According to Terry Shehata, projects, such as those described above, build an important foundation for both the academic and private sectors that can potentially bolster the state's economy. In early 2018, the MSGC convened a two-day workshop with industry, education, government, and space-sector experts to discuss the potential for developing a new space economic cluster in Maine, with a spaceport (SpacePort Maine) as its foundation. These experts (including representatives from NASA and the FAA's Office of Commercial Space Transportation) agreed that Maine may be poised for a major role in the global nanosatellite market.

Maine offers an ideal geographic location for launching small satellites into polar orbits and is also the home of two former military air bases, which would accelerate the development process. Some Maine companies are already supporting the aerospace supply chain, and educational opportunities, such as the University of Maine Aerospace Engineering Initiative, are preparing students for careers in aerospace.

"The idea of the spaceport is really a unifying vision for the state's economy," says Shehata. "We can create job opportunities for our new graduates and motivate them to stay here." In 2019, the MSGC has conducted a feasibility study for developing such a spaceport through the Maine Technology Institute's (MTI) Cluster Initiative Program (CIP). This study has involved conducting a market analysis, interviewing key stakeholders, and the assessment of existing resources. According to Shehata, the results have been promising.

In January 2020, a bill to create the Maine Space Port Leadership Council in order to develop the strategic investment plan for creating a new space port was submitted to the Maine state legislature. The bill includes steps for investments in private and public sectors, with the Spring of 2022 as an end date for securing bond issues.

While major bills have been put on hold by Maine legislature due to the COVID-19 pandemic, the bill was supported unanimously prior to the legislative session going on hold in spring 2020. However, Shehata states that outside funding has been secured, as described in the bill, and that the Maine Space Port Leadership Council began its work in fall 2020.

"We're implementing our vision, step by step," says Shehata. ■

According to Terry Shehata, projects build an important foundation for both the academic and private sectors that can potentially bolster the state's economy.

DOE Implementation Grant:

Harsh Environment Materials and Fabrication Techniques for Wireless Sensor Applications

September 2019 – September 2021

The DOE Implementation Grant:
Mauricio Pereira da Cunha, a professor of electrical and computer engineering, and Robert Lad, a professor of physics, are leading a two-year, $750,000 project funded by a Department of Energy (DOE) EPSCoR Implementation grant; one of only nine that were awarded in 2019.

Project Leadership:

- PI: Mauricio Pereira da Cunha
- CoPI: Robert Lad
- Research Associate: Luke Doucette

Award Amount:

$750,000

Photo taken prior to COVID-19.

Imagine gas turbine engines, like those found on airplanes, or nuclear or coal power plants that experience high temperatures with corrosive and erosive conditions. These engines and power plant systems operate at temperatures capable of melting the metal they are made out of. They require careful structural design, advanced cooling techniques, and temperature monitoring to allow the metal to expand and contract as necessary for the engine to function safely.

Without advanced methods to effectively monitor these temperatures and the strain imposed on the materials involved, the risks and costs involved in the design and operation of components and systems can be prohibitive. Nobody wants a gas turbine engine or a power plant component to fail under operation. Such catastrophic events result in excessive costs, and more important, pose unacceptable threats to structures and safety.

This is a significant problem that an interdisciplinary team at the University of Maine is currently tackling. Mauricio Pereira da Cunha, a professor of electrical and computer engineering, and Robert Lad, a professor of physics, are leading a two-year, $750,000 project funded by a Department of Energy (DOE) EPSCoR Implementation grant; one of only nine that were awarded in 2019.

The goal? Create a wireless nanotechnology that is able to withstand extreme temperatures up to 1000°C (1800°F) and over 50,000 times the force of gravity on earth, while being packaged in a way that protects the performance of the device, and tiny enough to place on small components — down to 1 mm by 2 mm to be precise. That's roughly the size of a grain of rice.

"Temperature and strain have to be monitored in order to properly design parts aimed to operate in high-temperature, harsh environments, or predict and detect damage or malfunctions," Pereira da Cunha says. "The ability to do so remotely, thanks to wireless technology, has a lot of advantages. It can be placed on moving parts, like a rotating blade in a gas or steam turbine, or a moving part on a belt furnace of a production line or process, for example." This goal may seem insurmountable, but Pereira da Cunha and Lad have been researching and developing this type of technology for about two decades. Their combined expertise has helped make the University of Maine a go-to research hub for harsh environment technology needs, due to the worldwide forefront of patented technology created at UMaine.

The activities generated from past projects resulted in the creation of Environetix Technologies, a custom wireless sensor technology company, located in Orono, Maine, which has employed about 20 people since its creation in 2009. Environetix is one of seven different sensor-based companies that have spun out of research originally conducted at the University of Maine's interdisciplinary Frontier Institute for Research in Sensor Technologies (FIRST), which was previously known as the Laboratory for Surface Science and Technology (LASST). These spinoff companies have created hundreds of high-paying jobs throughout the years, providing local hiring opportunities for many talented scientists and engineers graduating from UMaine.

Together with the University of Maine, Environetix has generated services and manufactured products for the U.S. Air Force, the Department of Defense, and the DOE. An important aspect of the past, current and future work in this area is the mentorship and hands-on training opportunities available to students, engineers, and technical personnel working on these projects. In particular, the group working on this DOE EPSCoR-funded project will learn skills in advanced electronic device fabrication, materials analysis, and other laboratory techniques that are directly transferable to meeting the needs within several industries, including semiconductor and biomedical companies based in Maine.

While the challenge of producing a material that is able to retain its conducting and insulating functions under extreme conditions is indeed a difficult task, these two scientists and their expanding team of researchers have the experience and inspiration necessary to achieve it. They are also passionate about involving more scientists from a variety of disciplines in order to look at the challenge from as many vantage points as possible.

Research activities have benefitted from the established capabilities within FIRST. The development of this complex technology includes thin film deposition, clean room microfabrication, nanoscale materials analysis using microscopies, spectroscopies and diffraction; high-temperature thermal processing; and testing of prototype sensor component materials and sensor devices.

Prototypes of this technology have already been placed at the University of Maine steam plant, the Penobscot Energy Recovery Center, and Longview Power Plant in West Virginia, and also tested in gas turbine engines from General Electric and Rolls Royce. At these types of facilities and applications, the wireless sensor technology will not only improve safety and lower maintenance costs, but also help manufacturers to operate their systems and engines more efficiently, thus reducing fuel usage and the emission of polluting gases. This can be achieved through the sensors' ability to provide real-time data for parameters such as temperature, strain, pressure, corrosion and gas concentration. For the current project, new developments are planned to broaden the scope of applications and the technology's efficiency.

The applications for this type of technology go beyond power plants and turbine engines. This nanotechnology could easily be applied to ceramic, steel and other metal production, space exploration, oil exploration, the transportation industry, complex engine systems, and other advanced manufacturing processes that involve extreme conditions that could benefit from the ongoing and future scientific and technological advances made at the University of Maine.

"We have the ability to further flourish and expand this technology to new applications, also continuously increasing its impact," Pereira da Cunha says. "We are seeking additional collaborators and funding to make sure this research and development effort continues to benefit the state of Maine, the U.S., and the world." ■

IDeA in Maine

Institutional Development Awards from the National Institute of General Medical Sciences

July 2019 – June 2024

Maine's IDeA program bolsters the state's research capacity by supporting biomedical research and training in laboratories and academic institutions. Maine IDeA consists of two funding programs: the Centers of Biomedical Research Excellence (COBRE) and Institutional Development Award Networks of Biomedical Research Excellence (INBRE).

The IDeA program focuses on states like Maine that have historically had lower levels of NIH funding. With this funding, Maine's scientists are learning more about heart disease, cancer, chronic pain, aging, neurodegenerative diseases, diabetes, and regeneration. ■

Photos taken prior to COVID-19.

Impacts:

- $213 Million in IDeA research funding awarded in Maine since 2001
- $165 Million in additional funding secured to date as a result of IDeA-funded research
- More than 272 New Jobs created in Maine by the IDeA program
- 3 Centers of Biomedical Research Excellence conducting cutting-edge research with human health impacts
- 1 Center for clinical and translational research infrastructure to support healthcare in Maine, Vermont, and New Hampshire
- 1 IDeA network of biomedical research excellence, a statewide partnership to strengthen Maine's research capacity

Maine IDeA Network of Biomedical Research Excellence

Institutions include: Bates College, Bowdoin College, Colby College, College of the Atlantic, The Jackson Laboratory, Southern Maine Community College, University of Maine, University of Maine at Farmington, University of Maine at Fort Kent, University of Maine at Machias, University of Maine at Presque Isle, University of Maine Honors College

Maine's INBRE program aims to strengthen the state's capacity to conduct innovative biomedical research while supporting students, young faculty, and research infrastructure. The Mount Desert Island Biological Laboratory (MDIBL) founded Maine INBRE 18 years ago with a network of 12 additional educational and research institutions.

The INBRE Project Leaders met with the External Advisory Committee to discuss their research programs in March 2019 at Southern Maine Community College.

Accomplishments:

- Provided Maine with $86 million in direct research and training funding since 2001
- Provided more than 2,400 Maine students hands-on biomedical research training
- 65% increase in science majors over the past 5 years
- Created and sustained over 100 jobs in Maine's research and educational sectors
- Created an outstanding model for public-private partnerships
- Together with other Maine IDeA programs, allowed Maine research and educational institutions to successfully compete for 1,872 federal research grants, bringing tens of millions of dollars into Maine

Defense Established Programs to Stimulate Competitive Research

DEPSCoR

As part of the FY20 defense appropriations bill, Congress tasked the Basic Research Office with managing the Defense Established Program to Stimulate Competitive Research (DEPSCoR). DEPSCoR is a capacity building program that is designed to strengthen the research infrastructure at institutions of higher education in underutilized States/Territories. In order to achieve its congressional mandate, the Basic Research Office developed three major thrusts for DEPSCoR — 1: augment funding to an existing tri-Service program, 2: solicit applications for a stand-alone collaborative competition, and 3: outreach meetings.

These objectives will help build the national infrastructure through increasing the number of university researchers and enhancing the capabilities of IHE to perform competitive science and engineering research relevant to the mission of the DoD and national security priorities. Maine is among the states eligible for future DEPSCoR funding. ■

Objectives:

- Enhance the capabilities of institutions of higher education (IHE) in eligible states and territories to develop, plan, and execute science and engineering (S&E) research that is relevant to the mission of the Department of Defense (DoD) and competitive under the peer-review systems used for awarding Federal research assistance.
- Increase the number of university researchers in eligible states/territories capable of performing S&E research responsive to the needs of the DoD.
- Increase the probability of long-term growth in the competitively awarded financial assistance that IHE in eligible states/territories receive from the Federal Government for S&E research.

MAINE EPSCoR

NSF EPSCoR supported Centers by the **NUMBERS** *(2000–2020)*

$500,000,000+ of new R&D funding

14 spin-off companies created

4,692 graduate and undergraduate students supported

2,612 Publications

104 patents

Since 1980, NSF EPSCoR funding has supported the development and implementation of 10 Track-1 grants in Maine. These grants have driven the growth of the STEM workforce, increased state competitiveness, and improved the capacity and infrastructures needed to advance research and development in the state, including funding five research centers, three institutes, and 11 laboratories at the University of Maine. Even more important than the initial NSF EPSCoR financial support received during the lifespan of a Track-1 grant are the longer-term outcomes delivered by these centers and institutes after expiration of their initial NSF EPSCoR funding. For example, considering four research centers (the Advanced Structures and Composites Center, the Frontier Institute for Research in Sensor Technology, the Forest Bioproducts Research Institute, the Senator George J. Mitchell Center for Sustainability Solutions, and the Aquaculture Research Institute) that either were started by Track-1 grants or expanded early in their life with NSF EPSCoR support, the importance is clear. From 2000-2020, these centers have contributed to the research enterprise at UMaine. ■

Maine EPSCoR
Corbett Hall
University of Maine
Orono, ME 04469

Follow us on social media:

@MaineEPSCoR

@MaineEPSCoR

@maineepscor

Maine EPSCoR

Photographs of of students and others not wearing masks were taken prior to the coronavirus pandemic. *The University of Maine and University of Maine at Machias follow federal and state Centers for Disease Control and Prevention health and safety guidance, which includes social distancing and use of face coverings for the start of the 2020–21 academic year.*