MAINE EPSCoR

Annual Report

2018–19

MAINE EPSCoR

National Science Foundation (NSF) EPSCoR (the Established Program to Stimulate Competitive Research) promotes a wide variety of research through the support of grants and programs that promote scientific progress throughout the nation. Here in Maine, several types of grants have been awarded and are ongoing.

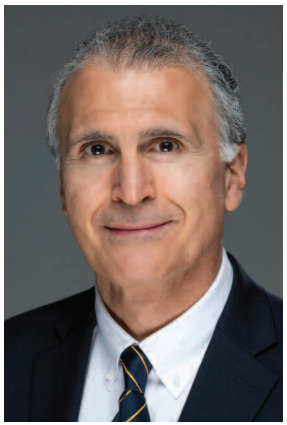
Contents

From Maine EPSCoR Leadership

Over the past year, Maine EPSCoR has had the great pleasure of participating in and supporting some of the state's most innovative research. The scientists, faculty, students, and staff involved with 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.

As Maine EPSCoR's current Track-1 grant, the Sustainable Ecological Aquaculture Network (SEANET) completes its final year by delivering its most significant findings yet, several other grants awarded by the National Science Foundation (NSF) throughout the state are just getting started. This report will review these exciting new projects and their initial outcomes. In addition, we'll take a look at what some of the state's longest EPSCoR funded initiatives (such as NASA EPSCoR) have been up to, while announcing the newly reauthorized Defense Established Program to Stimulate Competitive Research (DEPSCoR).

Thank you for your interest in the work highlighted in these pages. We are delighted to present the 2018–19 Maine EPSCoR Annual Report.



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

Shane Moeykens
Director of Maine EPSCoR

RII Track-1:

Maine EPSCoR: The Nexus of Coastal Social-Environmental Systems and Sustainable Ecological Aquaculture (SEANET)

August 2014 – December 2019

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); Associate PD, Shane Moeykens (Maine EPSCoR); and Co-PIs, Barry Costa-Pierce (UNE), Teresa Johnson (UMaine), and Peter van Walsum (UMaine)

Award Amount:
$20 million

SEANET's study of sea vegetables, such as the Alaria pictured here, has been key to understanding the various uses of sea vegetables and how they may be effectively processed.

In Maine, there has been a growing interest in aquaculture: the farming of finfish, shellfish, and sea vegetables. Maine EPSCoR's Track-1 award, the Sustainable-Ecological Aquaculture Network (SEANET), has investigated, developed, and responded to current trends in aquaculture, while examining Maine's marine social-ecological systems (SES) through the lens of sustainable aquaculture. Over the past five years, SEANET has created synthesis tools and products, informed best management practices through innovative technologies, built public support through workforce development innovations, and contributed significantly to the science of climate resilience.

Research Updates

SEANET researchers from multiple disciplines have worked together to address some of the state's most prominent concerns regarding the expanding aquaculture and sustainable seafood industry in Maine. Since Year 5 is the last year of the award, the dissemination of key results and transitioning SEANET to the University of Maine's Aquaculture Research Institute (ARI) have been high priorities.

Dr. Damian Brady, Associate Professor of Marine Science at the University of Maine, and Dr. Kate Beard, Professor of Computing and Information Science at the University of Maine, led a team of researchers studying the overall carrying capacity of the coast in regard to aquaculture. Their findings are being used to inform coastal planning and preparedness strategies. The team used buoys to monitor parameters, such as pH, dissolved oxygen, and nitrogen, to gauge the health of estuarine systems across the state. This information, paired with hydrodynamic models and remote satellite data, provided new evidence for the temperature-regime shifts taking place on the coast. The collected data also suggest that the warming water may expand the potential habitat for oyster aquaculture in the state. A new interactive tool[1] was also created as a result of this research, and can be used to predict production carrying capacity estimates for key aquaculture species along the coast; an approach that can be applied to any coastal region.

Dr. Ian Bricknell, Professor of Aquaculture at the University of Maine, and Dr. Shane Moeykens, Director of Maine EPSCoR, led a team of researchers in better understanding Maine's changing coastal environment, and how key species may react to these changes. Team members have worked on a broad spectrum of research, from developing a storm-visualization tool to better inform the public about dangerous storm events to studying invasive species, such as green crabs, and troublesome parasites, such as sea lice. This research has also generated critical data for assessing the impact of ocean acidification (the ongoing decrease in pH of the Earth's oceans) on the state's aquacultured species.

1. shellgis.com/examples/TFWMidMaine.html

In Year 5, Moeykens advised a commercialization project with the Maine Aquaculture Innovation Center (MAIC) for small data buoys. With participation from undergraduate mechanical engineering students at the University of Maine, as well as financial support from the Maine Technology Institute (MTI), a low-cost prototype was created. If such buoys are commercialized, small aquaculture farms would be able to collect important environmental parameters, potentially leading to higher productivity and lower operating costs.

Dr. Denise Skonberg, Associate Professor of Food Science at the University of Maine, and Dr. Peter van Walsum, Associate Professor of Chemical and Biomedical Engineering at the University of Maine, led a team of researchers in creating new and innovative products and methods for aquaculture. This research team has substantially advanced sea-vegetable farming in Maine. Over the past five years, researchers have found many uses for sea vegetables; as valuable food products and value-added products, and for storm remediations, as kelp lines can help reduce wave energy under storm conditions and sequester excess nutrients. Researchers have also studied drying methods that may preserve the taste and nutrients of sea vegetables, also addressing a primary production bottleneck to the growth of

SEANET's research and collaborations have had lasting industrial impacts, and will continue to inform best practices in finfish, shellfish (such as the oysters pictured here), and sea-vegetable aquaculture.

this industry in Maine. Dr. Balu Nayak, Associate Professor of Food Processing at the University of Maine, worked with Dr. van Walsum and graduate students to design a portable dryer for sea vegetables that may change the farming and processing industry as we know it.

Dr. Teresa Johnson, Associate Professor of Applied Marine Social Science at the University of Maine, and Dr. Caroline Noblet, Associate Professor of Economics at the University of Maine, led a group of researchers in better understanding the human dimensions and economic impacts that aquaculture may have on the state. Studies, including surveys and interviews, conducted over the last few years, have shown how Maine communities view and react to aquaculture, and how the industry may impact real-estate values and local decision-making. These findings continue to identify barriers and opportunities for the aquaculture industry to grow. Low levels of current knowledge among the general public, as well as the influence of the mass media, provide an opportunity for science communication to inform decision-making.

Workforce Development & Diversity

SEANET has contributed to workforce development (WFD) and diversity by extending aquaculture educational resources, facilitating a pathway between researchers and growers, and continues to implement an integrated WFD plan. In Year 5, Maine EPSCoR's Workforce Development and Diversity team had their Summer of Science (SoS) program published in the Journal of STEM Outreach. SoS consists of weekly science sessions taught at over 40 sites across the state for six weeks. There has also been an increase in participation in the Wabanaki Youth in Science (WaYS) afterschool programs, which provide mentoring and training opportunities in the life sciences for Native American youth in Maine.

ME EPSCoR has partnered with the University of Maine's Cooperative Extension group to lead teacher trainings and develop STEM toolkits, which provide experiential learning opportunities for Maine's youth via access to curricular materials that enable science-based learning. In Year 5, the last two curriculum toolkits, "Innovations in Aquaculture Engineering," and "Data Literacy," were completed and piloted with junior-high and high-school students.

The American Association for the Advancement of Science (AAAS) identified ME EPSCoR's workforce development and diversity programs as "outreach of the highest caliber... that deserves national acclaim," in its Year 5 summative review of the project.

Enduring Impacts

SEANET has acted as an information network facilitating the exchange of data and information between industry, government, academia, and the general public. In addition, SEANET brought together disparate organizations around the state for the common purpose of understanding and advancing sustainable aquaculture.

As the only network dedicated to aquaculture research in Maine, SEANET has kept up with the demand for the best available science to support industry in a manner that is viable for Maine's working waterfronts and coastal ecosystems. The SEANET project has been instrumental in moving partner institutions, such as the Downeast Institute (DEI), the University of New England (UNE), and the Aquaculture Research Institute (ARI) forward in new interdisciplinary research directions while still maintaining their core research strengths. The ability to advance interdisciplinary aquaculture science at this level of excellence did not exist before SEANET, but will continue well beyond the life of the grant via the transition of the network to ARI. ◆

Top: Wabanaki Youth in Science (WaYS) students visit the Aquaculture Research Center (ARC) located on the University of Maine campus.

Middle: SEANET researcher Tyler Van Kirk conducts field research with green crabs on the coast of Maine.

Bottom: SEANET, in collaboration with Maine Aquaculture Innovation Center (MAIC), and with help from the undergraduate mechanical engineering program at UMaine, created a prototype of a low-cost data buoy, with the goal of commercialization.

SEANET Year 5 *at a Glance*

46 *faculty* **supported statewide**

30,548
OUTREACH PARTICIPANTS
ACROSS THE STATE OF MAINE

32
GRADUATE STUDENTS
IN 14 DISCIPLINES

216% growth
($23.7M vs. $7.5M)
in science funding from federal & state sources

3 **postdoctoral researchers**

126 *undergraduate* *interns* STATEWIDE

65
COLLABORATIONS

27
papers published

1,091 women and girls involved with STEM

One of SEANET's Land Ocean Biogeochemical Observing (LOBO) buoys, located in the middle Damariscotta River, near the Darling Marine Center (DMC) in Walpole, Maine.

RII Track-2 FEC:

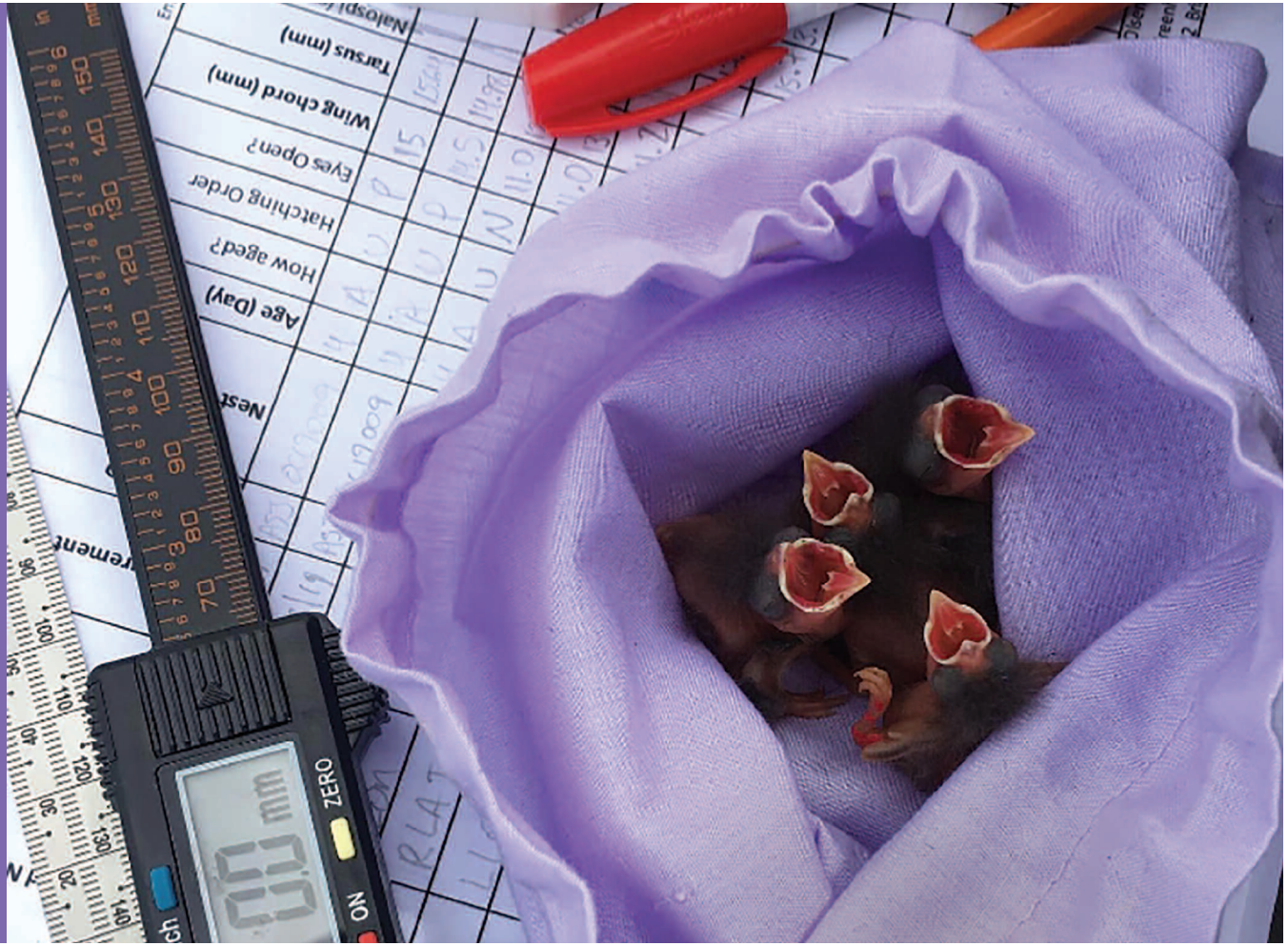
Genomic Ecology of Coastal Organisms (GECO): A Systems-Based Research and Training Program in Genome-Phenome Relationships in the Wild

August 2018 – July 31, 2022 (estimated)

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: Adrienne Kovach (UNH)
Co-PIs: Serita Frey (UNH), Brian Olsen (UMaine), Benjamin King (UMaine), Kristina Cammen (UMaine)

Award Amount:
$1,998,863 (to date)



GECO field researchers observe and take measurements of new sparrow hatchlings. (Photo by Mackenzie Roeder)

Our understanding of genome-to-phenome relationships is incomplete. 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. "Another example would be a species that evolved to have a certain phenotype in how they appear, so they can camouflage themselves."

Scientists are still wondering how the interaction between genotypes and the organism's environment is caused and constrained. In August 2018, the University of New Hampshire and the University of Maine combined their complementary research expertise in disciplines such as genomics, bioinformatics, marine ecology, ornithology, and ecological evolutionary dynamics, in order to begin a new Research and Infrastructure Improvement Track-2 Focused EPSCoR Collaborations award (RII Track-2 FEC). 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.

"We're working with wild populations in their home environment and we're merging ecology and genomics."

— Kristina Cammen

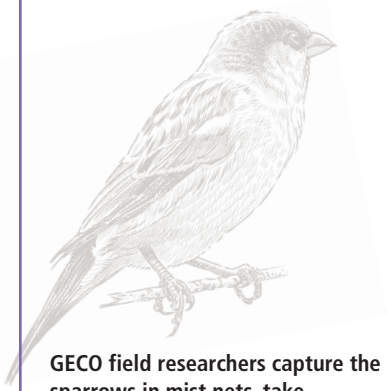
The award specifically addresses this lack of knowledge through the creation of a research-and-training program in the Genomic Ecology of Coastal Organisms (GECO) and the integrated study of six species of tidal marsh sparrows. The coastal area these birds call home is dynamic, and acts as a natural 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 in regard to better understanding genome to phenome relationships.

The project has already started its first field season, with graduate student- and technician-led field teams located from the coast of Virginia all the way up to Downeast Maine. Field researchers spent their early summer mornings capturing individual birds with mist nets, taking biological samples, and releasing the birds back into the wild. The researchers also monitor nests for success rates by noting the number of fledglings produced. Over the next few years, they'll document how many return. Altogether, the researchers expect to identify the genotype of nearly 1,000 individual birds.

Genomic scientists will study the biological data collected. While some of these species have already had their genomes characterized, four have not. According to King, the characterization of these genomes will be one of many major accomplishments that result from this project. Co-PI Cammen added that an associated accomplishment from the project will be the training of six Ph.D. and three postdoctoral researchers.

Co-PI Olsen has been working with Michelle Smith, an Associate Professor of Ecology and Evolutionary Biology from Cornell University, to use the project's collected data to develop new lessons that will be integrated into undergraduate courses across Maine and New Hampshire. The collected data are also being incorporated into an ongoing project, which Olsen and Kovach are involved with, known as the Saltmarsh Habitat & Avian Research Program (SHARP). Project researchers can utilize the decade's worth of data that has already been captured by SHARP.

"Our study is unique in its approach to understanding this big challenge," Cammen says. "We're working with wild populations in their home environment and we're merging ecology and genomics." 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, which will result in new ways of thinking about genotypes, the environment, and the complex ways in which their interactions bring about



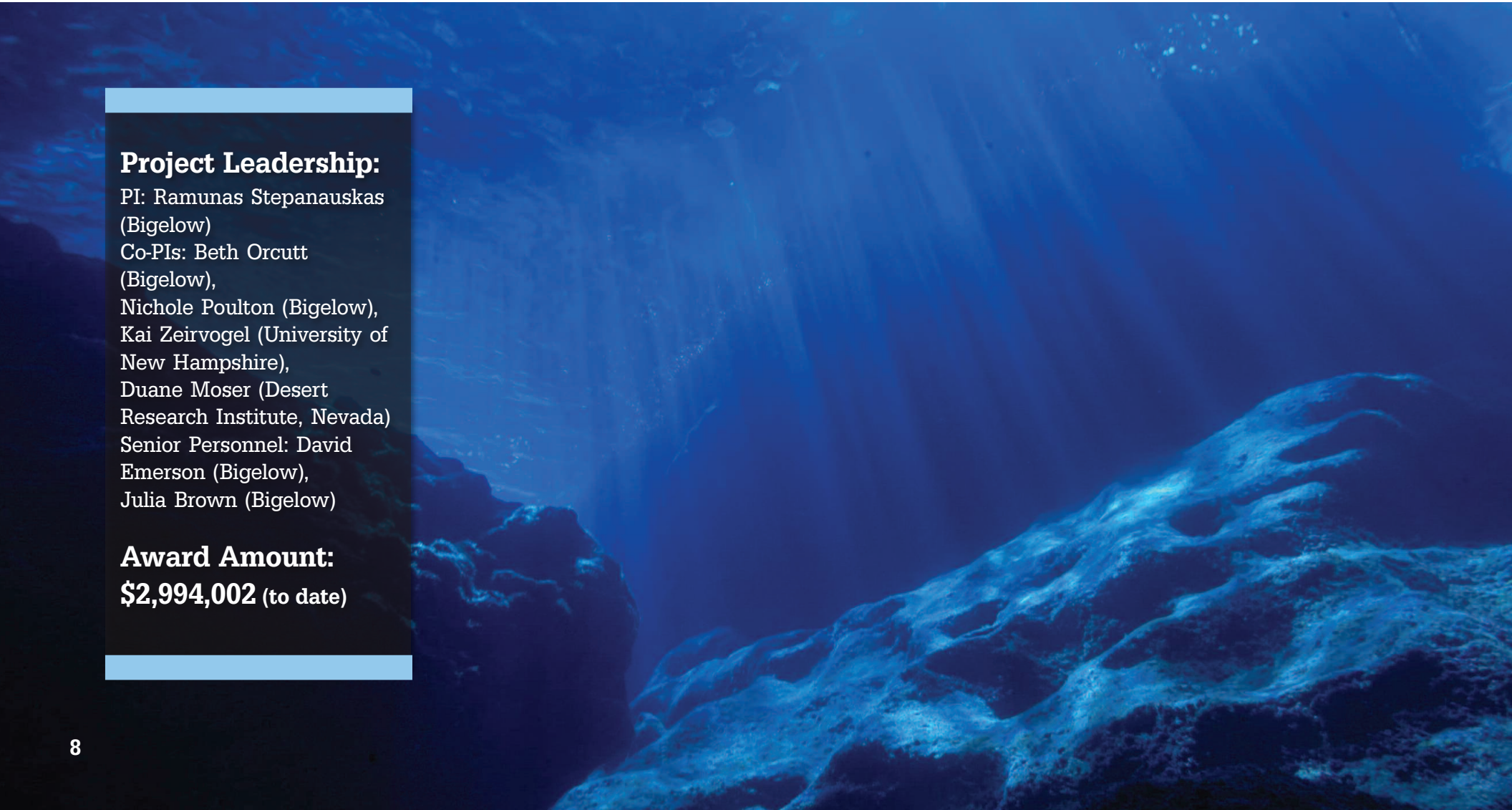
GECO field researchers capture the sparrows in mist nets, take biological samples, and observe the individuals before releasing them. (Photo by Mackenzie Roeder)

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)

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)
Co-PIs: Beth Orcutt (Bigelow),
Nichole Poulton (Bigelow),
Kai Zeirvogel (University of New Hampshire),
Duane Moser (Desert Research Institute, Nevada)
Senior Personnel: David Emerson (Bigelow),
Julia Brown (Bigelow)

Award Amount:
$2,994,002 (to date)

Most 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.

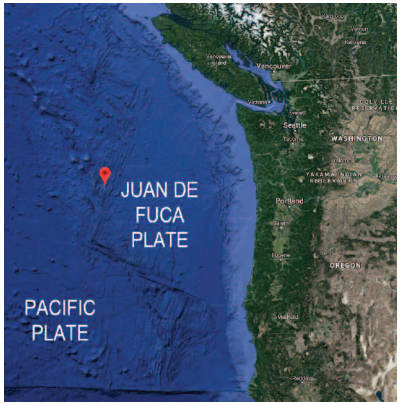
The Bigelow Laboratory of Ocean Sciences, located in East Boothbay, Maine, has partnered with the University of New Hampshire (UNH) and the Desert Research Institute (DRI) in Nevada to identify the activities associated with these single-celled organisms. Their EPSCoR Track-2 grant, titled "Single Cell 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 specific 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 single microbial cells. Each case study of genome-to-phenome linkage in this project will answer important ecological questions and help establish ongoing research programs.

The project officially began in the fall of 2018, and over the past year, significant training has taken place. In addition, Bigelow Senior Research Scientist Beth Orcutt led an international team of scientists, including many early-career students, on a research cruise to examine microbial activity deep below the seafloor in the northeastern Pacific Ocean. Orcutt and her team applied new techniques to research the microbial activity taking place deep in the crust of the Juan de Fuca oceanic plate – 2.6 kilometers below the surface of the sea. The samples collected will be used to determine how life exists under extremes of pressure and temperature and at the same time makes use of unusual energy sources for life. By leveraging National Science Foundation (NSF) and National Aeronautics and Space Administration (NASA) funding, this project will lead to a greater understanding of the important role these microbes play in shaping the chemistry of the ocean, making it conducive for life, and how changes to these subsea environments could affect all life on Earth.

According to Emerson, the project as a whole is based on these types of discoveries and environmental observations, which cannot be replicated in laboratories. "We're focused on understanding novel metabolic pathways and novel genes that could ultimately be applied to industrial enzymes or have biomedical applications," Emerson says. ◆



Bigelow Senior Research Scientist Beth Orcutt (pictured far left) led an international team of scientists, including one undergraduate, six graduate students, and six early-career scientists and representatives from all three of the grant's jurisdictions (Maine, New Hampshire, and Nevada) on an oceanographic research expedition aboard Research Vessel Atlantis in May 2019 to study the activity of microbes deep below the seafloor in the northeast Pacific Ocean. (Photo by Beth Orcutt)

RII Track-4:

Advanced Control Strategies for Floating Offshore Wind Farms

October 2018 – September 2020 (estimated)

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 (UMaine)

Award Amount:
$96,275

The VolturnUS was originally placed off the coast of Castine, Maine.

The development of clean, renewable energy is not only good for our planet, but also for the economies of the countries and regions that invent, manufacture, and export technologies that harness energy sources, such as solar, wind, and water. Andrew Goupee, an Assistant Professor of Mechanical Engineering at the University of Maine (UMaine), is hoping to be a part of inventing and improving such innovations. More specifically, Goupee is hoping that he and his graduate student, Eben Lenfest, can become experts in control strategies for offshore wind farms through their new Track-4 EPSCoR grant.

In 2015, the US Department of Energy (DOE) released Wind Vision; a report than envisions the future goal of providing 35% of the US's electricity needs through the harvesting of land-based and offshore wind energy by 2050. There are a variety of concerns that arise when dealing with the technical aspects of attaining this goal.

For example, placing offshore wind turbines in water deeper than 60 meters requires floating technology, which presents several challenges. One such challenge involves the wind turbine active blade pitch and generator controllers, which are responsible for power regulation in moderate to high winds. Deepwater locations are desirable because they often experience less competing-use concerns and stronger winds. However, the use of land-based wind-turbine control strategies on floating wind turbines can lead to motion instabilities that increase structural loads and negatively impact energy capture. A more resilient and effective control strategy would enable these offshore wind turbines to harness more energy and reduce fatigue loads, thus extending their service lives. Goupee and Lenfest aim to be a part of this solution.

Setting up a "land-based configuration is fairly straightforward," says Goupee. "On floating systems, the dynamics get all mixed up. There are some unique challenges with these controllers meant to regulate wind turbine power. You have to consider variables such as generator torque and blade pitch. You have to get really creative."

Both Goupee and Lenfest have experience with the Advanced Structures & Composites Center on the UMaine campus, which has given them the opportunity to investigate some of the Center's innovative floating technologies, such as the VolturnUS system. However, the amount of resources in Maine, including expertise regarding control strategies for these floating offshore wind farms, is still quite sparse.

Andrew Goupee (right) and his graduate student researcher, Eben Lenfest, pictured outside the National Renewable Energy Laboratory's (NREL) National Wind Technology Center (NWTC) in Boulder, Colorado.

This specific Track-4 grant has allowed Goupee and Lenfest to travel to the National Renewable Energy Laboratory's (NREL) National Wind Technology Center (NWTC) in Boulder, Colorado, which is the nation's premier wind energy, water power, and integration research facility. The pair of researchers will spend the summers of 2019 and 2020 at the NREL, developing their knowledge, obtaining new skills, creating collaborations, and improving the NREL's FAST.Farm tool (a multiphysics engineering model for predicting the performance and loads of wind turbines within a wind farm).

Upon returning to UMaine, Goupee and Lenfest hope to use their newfound knowledge and expertise to inform new research and curricula for the Department of Mechanical Engineering at the undergraduate and graduate levels. In addition, this research and fellowship experience will aid in the development of improved control strategies that may enhance the cost-competitiveness of deep-water offshore wind, and permit smarter, more economical floating offshore wind turbine designs. Both are essential to meeting the DOE's Wind Vision goal and for advancing the offshore wind industry in Maine.

According to Goupee, reducing the overall costs involved in floating offshore wind turbines, through the research and improvement of these advanced controls, is highly important. "It isn't the whole puzzle," says Goupee, "but it is a key part." ◆

RII Track-4:

Diffuse Optical Imaging for Early Detection of Diabetic Polyneuropathy (DPN)

October 2018 – September 2020 (estimated)

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.

Karissa Tilbury of the University of Maine and her graduate student, Wyatt Austin, recently returned from the first of two visits to the Biomedical Optical Technologies Lab at Boston University, where they gained invaluable knowledge and experience related to the three-wavelength Time Modulated Spatial Frequency Domain Imaging (SFDI) and Laser Speckle Contrast Imaging (LCSI) system they are currently building. "We've forged long-term research partnerships. Most importantly, this summer has forever altered Wyatt's perspective of the state of the art in biomedical optics and likely will shape his future career aspirations," says Tilbury.

The SFDI/LCSI instrument, above, can help with the wide-field imaging of blood flow rates and lead to the improved diagnosis of DPN. "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. ◆

NASA EPSCoR Maine Space Grant Consortium and Maine EPSCoR

Project Leadership:
Director: Terry Shehata (MSGC)

Award Amount:
$125,000 per year, for 3 years (renewed every 3 years)

A Hypersonic Inflatable Aerodynamic Decelerator (HIAD) as it is being developed in the Advanced Structures & Composites Center (ASCC) at the University of Maine. One of NASA EPSCoR's successfully completed projects advanced our understanding of how to better develop these innovative devices.

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, applications that do remote sensing, marine science, and climate science. Perhaps you can see why Maine's NASA EPSCoR program would take interest in some of these sectors, but maybe you're wondering what some of them have to do with space. According to Maine's NASA EPSCoR and MSGC Director, Terry Shehata, this is a common question.

"When we talk about NASA, a lot of people think about space and developing the technology that will be part of the Mars mission, a moon mission, or the space station," says Shehata. "People don't necessarily think about the tech that has been produced as a result of space exploration that we can use here on earth." This idea is particularly true in Maine, where marine science and forest-resource research make great use of remote-sensing data, which is possible because of NASA satellites.

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.

Every year, the national NASA EPSCoR Research Competition awards $750,000 over three years to support meritorious research projects that align with NASA's needs. 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.

Examples of successfully completed RID- and NASA EPSCoR Research-funded projects at the University of Maine include:

"Behavior and Optimization of Hypersonic Inflatable Atmospheric Decelerator Devices for Spacecraft Re-Entry."

William Davids
John C. Bridge Professor of
Civil and Environmental Engineering
University of Maine

The Hypersonic Inflatable Aerodynamic Decelerator (HIAD) is an inflatable spacecraft technology that may give NASA more options for future space missions. The HIAD is nose-cone-mounted to the spacecraft and is designed to help decelerate and protect it during atmospheric re-entry. This project advanced our basic understanding of the load-deformation behavior of HIADs and whether or not they could allow future spacecrafts to carry heavier space exploration tools. This NASA EPSCoR grant resulted in important infrastructure improvements that put UMaine in a position to continue supporting NASA's future efforts.

"Experimental Studies of Potential Biosignatures in Serpentinite-Water Systems."

Amanda Olsen
Earth and Climate Sciences
University of Maine

Serpentine minerals have been found in multiple locations on Mars, some of which were intermixed with potential alteration products, such as clay minerals. Serpentinite rocks are of particular interest in the exploration of Mars, because they are potentially habitable environments. They also contain multiple trace elements whose release may act as indicators of alteration conditions. This project used targeted experiments and modeling to test the hypothesis that aqueous alteration with and without organic compounds will result in chemical signatures of alteration distinct from unaltered serpentine. These altered surfaces may aid in the identification of potentially habitable serpentine environments on Mars.

According to Shehata, these types of projects 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."

Over the past year, 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. Results from the study are expected in September 2019. ◆

"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."

— Terry Shehata

Mars, as pictured through the telescope located at the Maynard F. Jordan Observatory at the University of Maine. One of NASA EPSCoR's successfully completed projects focused on the serpentinite rocks discovered on the surface of Mars.

Defense Established Programs to Stimulate Competitive Research (DEPSCoR)

During the 2018 fiscal year of the National Defense Authorization Act (NDAA), Congress reauthorized a restructured version of Defense Established Programs to Stimulate Competitive Research (DEPSCoR) and appropriated $12 million towards the program.

According to the new program statute, DEPSCoR is meant to:

- 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.

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. ◆

Institutional Development Awards

from the National Institute of General Medical Sciences (IDeA) in Maine

Maine's IDeA program bolsters the state's research capacity by supporting biomedical research and training in laboratories and academic institutions. Maine IDeA is comprised of two programs: the Centers of Biomedical Research Excellence (COBRE) and Maine IDeA Network for 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. ◆

Impacts:

- $195 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 (INBRE)

Sally Molloy, Honors Preceptor and Assistant Professor of Genomics (left), with Emily Illingworth, an INBRE fellow and UMaine alumni, who is currently pursuing a Ph.D. at Johns Hopkins Bloomberg School of Public Health.

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, including:

- 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

MDIBL recently received a grant from the National Institute of General Medical Sciences for $18 million in order to renew a program focused on strengthening biomedical research and training in Maine. This will fund Maine INBRE for another five years.

Maine INBRE Impacts:

- $68 million in direct federal funding since 2001.
- $80 million leveraged in additional federal grants.
- >2,250 students in Maine have received hands-on biomedical research training.
- >100 new jobs created in Maine.
- 65% increase in science majors at participating colleges over the past five years.
- 88% of INBRE graduates pursue advanced degrees/careers in scientific/medical fields.
- 19% of INBRE graduates pursue advanced degrees/careers in Maine.

Thanks to INBRE funding, participating institutions are able to advance novel research while fostering student growth. For example, UMaine Honors students are able to participate in cutting edge genomic and bioinformatic research through INBRE-funded investigations being led by some of the university's most talented researchers, such as Sally Molloy (genomics) and Benjamin King (bioinformatics). For many of these undergraduates, this may be their first experience with hands-on research. The courses, workshops, and mentorships created are a fundamental aspect of building Maine's research capacity. ◆

A History of Impactful Research

Since 1980, NSF EPSCoR has contributed $113.9M to support the development and implementation of Track-1 grants in Maine. These grants have driven the growth of the STEM workforce, increased state competitiveness, and improved the capacity and infrastructure needed to advance research and development in the state, including funding four 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 & Composites Center, the Frontier Institute for Research in Sensor Technology, the Forest Bioproducts Research Institute, and the Senator George J. Mitchell Center for Sustainability Solutions) that either were started by Track-1 grants or expanded early in their lives with NSF EPSCoR support, the importance is clear. From 2000-2018, these four centers have contributed to the research enterprise at UMaine as shown “By the Numbers” on the following page. ◆

MAINE EPSCoR

NSF EPSCoR-SUPPORTED CENTERS

by the

NUMBERS

New R&D Funding

$425,000,000+

500+
Clients & Partners

FISCAL YEARS
2000–2018

47
PRODUCT PATENTS

4,081
GRAD AND UNDERGRAD **STUDENTS**

14 Companies
CREATED

2,163 PUBLICATIONS

Design by Creative Services, University of Maine Division of Marketing and Communications

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