Vermont EPSCoR was awarded a new Research Infrastructure Improvement (RII) Track-1, $20M award on June 1, 2016 for research on Lake Champlain Basin Resilience to Extreme Events (BREE). The research will inform public policy and support economic and workforce development. Research questions examine what makes some parts of the Lake Champlain Basin and its watersheds resilient in the face of extreme weather events, increasingly common in a warming Vermont, while other parts fail to recover and rebound. The award from the National Science Foundation will help answer those questions, providing much needed information to decision-makers as they govern the basin and develop policies that reach far into the future. The five-year project will support research teams from UVM and colleges across the state that will collect data from sensors in streams, soil, and the lake. Research teams will also gather information on land use, economic impacts of poor water quality, and more. Seven social and ecological computer models that are calibrated our collected data will be linked together. The resulting integrated model will used to test impacts of management scenarios on Lake Champlain water quality, and can identify strategies for preserving infrastructure, environmental health and drinking water quality as Vermont’s landscape continues to change and the climate continues to show a rise in extreme precipitation.

- The project will be undertaken by a diverse group of scientists and stakeholders working together with Vermont EPSCoR. In addition to UVM, other partner institutions include Johnson State College, Lyndon State College, Castleton State College, Middlebury College, Saint Michael’s College, and Dartmouth College. Also participating in the project will be key stakeholders, including the Lake Champlain Basin Program and the Vermont Agency of Natural Resources and partners from Quebec and Lake George, NY.

- Since June 2016, BREE has engaged 208 Vermont participants, which includes 22 new jobs and 35 Private sector awards. Partners from six Vermont institutions (University of Vermont, Saint Michael’s College, Middlebury College, Castleton University, Lyndon State College/NVU-Lyndon, and Johnson State College/NVU-Johnson), are also major stakeholders.

- NSF made the award to Vermont EPSCoR partly because both natural and social scientists work together across disciplines on the project in creating their predictive models.

- The BREE award was announced at the White House Water Summit on World Water Day, March 22, 2016.

- A key element of the award is work performed by the Vermont EPSCoR Center for Workforce Development and Diversity at Saint Michael’s College (CWDD), which offers research opportunities to Vermont high schools, middle schools and undergraduates from across Vermont, including the Community College of Vermont and a new partnership with Landmark College.

- Scholarships are available to Abenaki students and first-generation college students who are seeking science, technology, engineering or mathematics (STEM) majors.

- Girls are supported through the Vermont Works for Women, Rosie’s Girls Program.

- Small businesses are able to participate through pilot awards and funding from the Small Business Innovation Research Phase (0) program and support through Launch VT.
**SOME RECENT IMPACTS INCLUDE:**

- The BREE Policy and Technical Advisory Committee (PTAC) convenes two meetings per year during which time BREE researchers and invited speakers shared data and results, posed questions and sought advice from some of our region’s leading experts in water quality. PTAC members are from the Environmental Protection Agency, United States Department of Agriculture, representatives from the Vermont Agencies of Natural Resources, Food, Agriculture & Markets, and Transportation, regional and municipal planners, the Lake Champlain Basin Program, as well as representatives from Quebec and the International Joint Commission.

- Saving Our Waters, a television series including three thought-provoking short documentaries covering steps toward keeping our waterways clean – the impacts of phosphorus and other contaminants and using the science behind the issues to derive solutions that have positive impact on our communities, was produced by VT PBS with major funding by VT EPSCoR and won a 2018 New England regional Emmy in the Outstanding Environmental category.

- Vermont PBS hosted multiple town hall meetings in three of the communities most affected by watershed issues. Over 200 community members attended the Town Meetings in Burlington, St. Albans and Rutland. The videos of these in-depth conversations may be seen on PBS and by visiting the website [https://www.vermontpbs.org/water/](https://www.vermontpbs.org/water/)

- In early May of 2017 the UVM EPSCoR lake Ecological team deployed two high-frequency water quality monitoring platforms (buoys) in St. Albans Bay. These water quality platforms allow for real-time high-frequency monitoring of St. Albans Bay to better understand the drivers of nutrient dynamics and cyanobacteria blooms.

- Dr. Carol Adair, BREE Ecological Systems Co-Leader, directed the installation of a new cutting-edge sensor network in the Hungerford Brook watershed in June 2017. The team installed the sensors in several different riparian areas to study what makes those areas effective water filters. Learning this information will enable researchers to maintain the processes when and where the riparian areas fail to filter water after an extreme event or in a riparian area that fails to remove pollution.

**WORKFORCE DEVELOPMENT**

The VT EPSCoR Center for Workforce Development and Diversity (CWDD) located at Saint Michael’s College integrates students and teachers into BREE research while increasing the diversity of participants including students who are under-represented in STEM research: veterans, economically disadvantaged, first generation, minorities and disabled. The CWDD continues to broaden participation in STEM through scholarships to Native American and first generation Vermont students pursuing a STEM major.

Between 2003 and 2018, VT EPSCoR provided funding to 96 graduate students and 17 Post-doctoral associates. Ten of these graduate students have been located in the Vermont Center for Emerging Technologies (VCET) as MBA or Ph.D. students working with start-up companies. VT EPSCoR is increasing the number of highly trained graduates in Math, Science, and Engineering. The VT EPSCoR Center for Workforce Development and Diversity (CWDD) located at Saint Michael’s College integrates students and teachers into BREE research while increasing the diversity of participants including students who are under-represented in STEM research: veterans, economically disadvantaged, first generation, racial minorities, and disabled. In 2018-2019, 19 undergraduate students received summer research funding through the CWDD, 34 high school students participated in research, and 17 high school teachers received research stipends. The CWDD continued to broaden participation in STEM through scholarships to Native American and first generation Vermont students; five $5,000 scholarships were awarded for the 2018-19 academic year to Vermont students pursuing a STEM major. A total of 46 scholarships have been awarded over the last 7 years.

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Faculty from the Department of Biology (Sara Helms Cahan, Brent Lockwood) and the Department of Biomedical and Health Sciences (Seth Frietze) at UVM have received a $4,771,722 Track-2 award to build a cross-jurisdictional research network with colleagues in Rhode Island (James Waters, Providence College and Heather J. Axen, Salve Regina University) and at the University of Kentucky (Nicholas Teets). In line with the program’s theme of “Genome to Phenome”, the team will be investigating how the genotype and environment interact to determine resistance to temperature stress, using the fruit fly model organism *Drosophila melanogaster*.

The research team brings together scientists with diverse and complementary expertise, from cellular epigenetics to physiology to evolutionary biology, providing multiple opportunities for productive collaboration. At UVM, research will focus on the molecular genetic processes that allow early temperature signals to be translated into changes in gene expression later in life. Students and post-doctoral trainees will learn how to generate and analyze large data sets with advanced computational methods, and identify candidate mechanisms that they will experimentally manipulate using a wealth of functional genetic tools available in the fruit fly. The project will build a strong, sustainable connection between flagship universities and smaller, undergraduate-focused institutions that can struggle to support scientific research without the support of colleagues and established infrastructure.

As part of the project’s mission, the team will also be developing outreach activities to broaden STEM participation to underserved communities in Vermont and beyond. These include an intensive summer research program for undergraduates, and weeklong summer workshops to introduce the exciting field of Genetics to high school students.
Norwich University Professor of Earth and Environmental Science Laurie Grigg has earned a RII Track-4 Award for $132,000 through the National Science Foundation’s Established Program to Stimulate Competitive Research (EPSCoR) to support her research on paleoecological insights into the impacts of climate change on Vermont lakes.

Grigg and recent Norwich University undergraduate, Irene Magdon, have been working with Dr. Bryan Shuman at the University of Wyoming since July 1, 2018 and will finish up in early January, 2019. The first few months of work was spent logging, describing, and sampling a set of cores from Twin Ponds which is located in Brookfield, VT. The cores were taken by Grigg and Shuman, through the ice in the winter of 2014. The facilities and equipment available at the Shuman Lab in Wyoming have enabled Grigg and Magdon to collect a range of paleoenvironmental data in a relatively short amount of time, including magnetic susceptibility, loss-on-ignition, and core density. This baseline of sediment data has informed further sampling and analysis of macrofossils, pollen, organic carbon and nitrogen isotopes and the submittal of 10 samples for radiocarbon dating. Grigg and Magdon have been able to work with the Stable Isotope Facility at the University of Wyoming to develop a method for sample preparation that will be used in future studies.

The preliminary results on the paleoproductivity of the lake show a general increase through time in the remains of the zooplankton, Daphnia, as well as, shorter fluctuations that vary alongside percentages of organic carbon. This correlation suggests time periods in the past of increased phytoplankton abundance. Once the isotope measurements are complete, the source of organic carbon and the types of productivity should be apparent. Ongoing fossil pollen analysis will be the basis for independent climatic reconstructions that will be used to assess the relationship between productivity and climate. Additional climatic reconstruction will be provided by the ongoing work by Shuman and his graduate student on the use of compound-specific hydrogen isotopes and branched GDGTs to reconstruct temperatures from a different Twin Ponds core. In addition, to collecting a whole lot of data, Grigg has been meeting weekly with Shuman and his graduate students to discuss issues in Holocene paleoclimate and is working with Shuman and another co-author on a manuscript from previous work. Grigg and Magdon will use the remaining time in Wyoming to finish pollen analysis, isotope preparation, learn new methods to analyze the data, and will submit an abstract to northeast Geological Survey of America meeting in March, 2019.
During the summer of 2018, Assistant Professor Matthew White of the UVM Department of Physics and Materials Science Program and one graduate research assistant traveled to Golden Colorado to spend three months working with global leaders in perovskite solar cells at the National Renewable Energy Laboratory (NREL). Three UVM undergraduate physics majors joined them, with travel supported by the UVM Clean Energy Fund. The team used Pulsed Laser Deposition (PLD) to construct digital alloy oxide films with precise energy band and doping gradient control. These digital alloys were used as electron-selective contact layers for perovskite solar cells to simultaneously maximize the charge collection efficiency and prevent carrier recombination, improving both the short circuit current and open circuit voltage, as seen in the solar cell J-V curves below. Doing so requires precise, sub-monolayer control of both isovalent substituent (Mg) and dopant (Ga) concentration in an intrinsic ZnO host matrix. PLD offers an ideal tool for digital alloy fabrication as the laser pulses occur on the order of 1 to 10 per second, each depositing a small fraction of a monolayer of material. By switching targets between laser pulses, we fabricated such digital alloy gradient thin films. The tools necessary to fabricate and characterize such advanced nanomaterials are only available at NREL. A publication entitled “Digital alloy contact layers for solar cells” is currently in preparation summarizing the results of our summer research. An additional publication entitled “Nonlinear impedance spectroscopy of organic MIS capacitors and planar heterojunction diodes”, based on our preparatory work during spring 2018, was published in Organic Electronics.[1] The work was also presented at the Materials Research Society Fall 2018 meeting in Boston, MA.

Vermont NASA EPSCoR fosters research collaborations among faculty and students at the University of Vermont, Vermont Technical College, Norwich University, Saint Michael’s College, Middlebury College, and Champlain College as well as local industry. The Research Infrastructure Development (RID) Program provides Small-Scale Grants and Pilot Grants for faculty researchers engaged in projects that are aligned with NASA research priorities. These awards are selected through a competitive, peer-reviewed process. In addition, Vermont NASA EPSCoR also competes at the national level in Research Group Competitions for multi-year, large scale investigations.

Since 2007 Vermont has received nine national NASA EPSCoR Research Group Awards, each of these being three-year grants valued at $750,000. The most recent project was awarded in November 2017 entitled “Critical Gas-Surface Interaction Problems for Atmospheric Entry” (see Fig. 1); the multidisciplinary research team was comprised of engineering and physics researchers at UVM and Norwich University. Vermont NASA EPSCoR Research Group Awards since 2007 have led to three patents issued in 2013, 2014 and 2016 with one additional patent application that has received a preliminary, favorable international recommendation in 2018.

At the local level, RID funding provides “small-scale” or “pilot” grants as seed funding to researchers to initiate projects relevant to NASA priorities. One recent example is “Modeling of Melted Volcanic Ash and Sand Particle Impingement on Gas Turbine Engine Surfaces“ awarded to a professor of mechanical engineering at UVM is collaborating with researchers at NASA’s John Glenn Research Center. This project aims to better understand the impact of airborne particles on the performance of gas turbine jet engines operating in desert climates. RID funding also supports travel by researchers to NASA centers and workshops for the purposes of initiating new research projects or fostering existing ones. In 2017, RID funding supported three Vermont physics researchers to attend the NASA Fundamental Physics workshop at NASA JPL (Fig. 2). This group of researchers subsequently leveraged this opportunity in 2018 and were selected to represent Vermont in the national NASA EPSCoR Research Competition.

Finally, NASA EPSCoR also provides support for small business innovative research grants, including the SBIR Phase 0 competition that is coordinated with the VT EPSCoR Program. Among the most recent awardees was Benchmark Space Systems Inc., who were notified in November 2018 that they were the recipient of a SBIR Phase I award from the Air Force Research Laboratory.

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A research team at the University of Vermont uses innovative approaches to study animal disease biosecurity. Awarded a five-year, $7.4 million award from the USDA National Institute for Food and Agriculture’s Agriculture and Food Research Initiative (AFRI) (Award #2015-69004-23273) in 2015, the multi-disciplinary team leverages existing Vermont EPSCoR funded infrastructure. Dr. Julie Smith, D.V.M, Ph.D., a research associate professor in the Department of Animal and Veterinary Sciences at the University of Vermont, leads the effort that brings together researchers and practitioners from several institutions to understand how to influence those involved with animal agriculture to implement practices that can reduce the impact of new or emerging diseases to U.S. livestock populations.

• Emerging diseases of socio-economic importance have food security, perceived food safety, and domestic and international trade implications for the marketing of animals or animal products. Understanding the human behavioral dimensions of the introduction, spread, identification, reporting, and containment of diseases of livestock is critically important for developing effective strategies to sustain a productive and secure food animal sector.

• Experts in animal science and veterinary medicine, agricultural economics, public policy and decision science, anthropology, adult education, and risk communication come together to lead this USDA funded Coordinated Agricultural Project (CAP).

• This inter-disciplinary applied research and outreach project focuses on enhancing biosecurity practices and strategies to reduce the impact of incursions of new, emerging, or foreign pests or diseases in our livestock industries, primarily dairy, beef, and swine.

• Through engagement with project activities, stakeholders in U.S. livestock are encouraged to implement practices and policies that collectively reduce the impact and threat of new, emerging, and foreign pests and diseases. Educational resources, lab and experimental games, simulations of livestock industries at the state and county levels, and messages developed and tested during the project will be made available beyond the end of the funding period.

• The UVM Social Ecological Gaming and Simulation Laboratory (SEGS Lab: www.uvm.edu/~segs), established with funding from the National Science Foundation’s Experimental Program to Stimulate Competitive Research (EPSCoR), leads this dimension of the project under the leadership of project Co-PIs Scott Merrill, Asim Zia and Christopher Koliba. The SEGS lab combines experimental, “serious” gaming and computer simulation approaches for bringing the dynamics of human decision-making into models of ecosystem-level problems, enabling researchers to determine how farmers and producers would react to disease outbreaks without exposing animals to new infectious threats.

• To achieve project objectives UVM researchers are collecting social-behavioral data using realistic experimental game environments. These data, along disease characteristics, economic cost-loss functions, and supply chain dynamics, are integrated into simulation models to provide digital decision support tools to help reduce the impact of livestock disease.

• “The SEGS lab is placing farmers and producers into simulated environments to see how they react to different situations,” said Scott Merrill, a research assistant professor in UVM’s Department of Plant and Soil Science and the lab’s managing director.
Vermont Genetics Network (INBRE)

The Vermont Genetics Network (VGN) is in its third phase of funding with a five-year $17.8 million award from the IDeA Networks of Biomedical Research Excellence (INBRE) program of the National Institute of General Medical Sciences (NIGMS) at the National Institutes of Health (NIH). The mission of VGN is to build human and physical infrastructure in Vermont for biomedical research. At the lead institution, the University of Vermont (UVM), we have developed a state-of-the-art facility in our Proteomics Core to provide to researchers across Vermont the resources they need to carry out world class research and compete for federal funding. To address workforce development and its diversity, we build cultures of research by supporting faculty and student research at our Baccalaureate Partner Institutions: Castleton University, Northern Vermont University, Middlebury College, Norwich University, Saint Michael's College and Green Mountain College. We also work with students in college lab classes throughout Vermont in order to bring state-of-the-art research resources into their education, including at the Community College of Vermont and Landmark College.

In the current year, VGN impacts STEM employment in Vermont by supporting faculty and staff members at UVM and BPIs: 4 full time faculty at UVM and Norwich University, 2 part time faculty at UVM and 24 at BPIs, and 5 full time staff at UVM and Norwich University. Since 2005, VGN has funded 30 graduate students, 114 project, 82 pilot awards and 38 small awards to BPI faculty members, 201 student research awards to BPI undergraduate students and use of facility awards to 12 UVM faculty members. Our students’ careers in medicine, biomedical research and STEM teaching have been influenced by opportunities made possible by VGN. The principal investigator is Rex Forehand, PhD (Rex.Forehand@uvm.edu). To learn more, visit: http://vgn.uvm.edu/

Vermont Center for Immunology and Infectious Diseases (COBRE)

The Vermont Center for Immunology and Infectious Diseases (VCIID) is designed to integrate the studies of immunology and infectious disease since the primary function of the immune system is a defense against infection. Microorganisms interact with two fundamental components of the immune system, the evolutionary older innate immune system using largely invariant nonpolymorphic receptors, and the newer adaptive immune system that uses highly polymorphic receptors. Center investigators are examining genes that regulate the pathogenicity of infectious organisms as well as how the immune system responds to these agents. Some of the findings will lead to better vaccine development.

The goals of the VCIID COBRE are to build a robust and vibrant center that supports and mentors talented young faculty, recruit additional faculty, provide a dynamic seminar series, and expand core facilities in proteomics and microarray. The Center also provides support for students, postdoctoral fellows, and retreats. A special emphasis is placed on promoting an atmosphere that fosters stimulating discussions between basic and clinical scientists. These interactions will also include the state health department in an effort to directly improve the health of Vermonters. The VCIID COBRE program centers around a 5-year award from the IDeA program of the National Institute of General Medical Science of the NIH. The principal investigator is Dr. Ralph Budd (Ralph.Budd@med.uvm.edu). To learn more, visit: http://www.med.uvm.edu/vciid
Vermont Center on Behavior and Health (COBRE)

An $11.7 million COBRE research grant from the National Institute of General Medicine (NIGMS) and the National Institute on Drug Abuse (NIDA) supports the development of the Vermont Center on Behavior and Health (VCBH) at the University of Vermont. The COBRE is currently in its second five-year phase and supports research on addressing and better understanding the unhealthy behaviors that negatively impact health.

This grant supports research projects led by five outstanding UVM junior faculty that include studies of breast cancer incidence in high-risk women; improving linkage to care after ocular telehealth screening in diabetic adults; smartphone-based financial incentives to promote smoking cessation in pregnant women; the effects of stress on capillary-to-arteriole communication in the brain; and improving smoking cessation in socioeconomically disadvantaged young adults.

The VCBH integrates an interdisciplinary group of accomplished senior scientists, promising junior investigators, and distinguished advisors and collaborators to establish a center of excellence focused on understanding the mechanisms underpinning vulnerability to unhealthy behavior patterns and developing effective behavior-change interventions. The Center, led by UVM faculty members Stephen Higgins, Ph.D., and Philip Ades, M.D., has already made considerable progress in this area. Higgins and the UVM COBRE faculty and collaborators have published an impressive 185 peer reviewed publications in the area of behavior and health in the past five years. They have also garnered nearly $60 million in additional external grant funding. COBRE PI and Director is Stephen Higgins (stephen.higgins@uvm.edu). To learn more, visit: http://www.med.uvm.edu/behaviorandhealth

The Translational Global Infectious Disease Research Center (TGIR): a Center of Biomedical Research Excellence (COBRE)

We are pleased to announce the receipt of a $12.3 million award for the Translational Global Infectious Disease Research Center (TGIR), a Center of Biomedical Research Excellence (COBRE) at the University of Vermont Larner College of Medicine. The TGIR-COBRE will aspire to decrease the burden of global infectious diseases, particularly in low-income countries, and has two major objectives. The first is to develop institutional strengths in global infectious disease research. The second is to develop the research careers of outstanding junior faculty in this field, under the mentorship of scientific advisors from three UVM colleges and five departments. A particular focus will be to train biomedical and quantitative data scientists so that these two traditionally distinct groups of investigators can collaborate and communicate effectively in the new era of big data. By leveraging existing strengths at the University of Vermont, the TGIR-COBRE will bridge the gap between the biologic and quantitative data fields of biomedical research to create a robust, well-organized academic home for the COBRE junior faculty and their mentors, as well as other faculty interested in global infectious diseases.

Effective responses to infectious disease burden and threats must capitalize on new technologies and analytical tools. The TGIR-COBRE will create a strong backbone of translational research in global infectious diseases. This backbone will incorporate the human immunology, clinical trials platforms and biorepositories of the UVM Vaccine Testing Center (VTC), in addition to other existing Infectious Disease research strengths. It will also incorporate the substantial expertise in complex systems and mathematical/computational modeling that exists within the UVM College of Engineering and Mathematical Sciences (CEMS). COBRE PI is Beth Kirkpatrick (Beth.Kirkpatrick@med.uvm.edu). To learn more, visit: http://www.med.uvm.edu/tgircobre/home
and clinical scientists. These interactions will also include the state health department in an e
receptors, and the newer adaptive immune system that uses highly polymorphic
program of the National Institute of General Medical Science of the NIH. The principal investigator is Dr. Ralph
pathogenicity of infectious organisms as well as how the immune system responds
receptors. Center investigators are examining genes that regulate the
http://vgn.uvm.edu/
research and STEM teaching have been influenced by opportunities made possible by VGN. The principal
students and use of facility awards to 12 UVM faculty members. Our students’ careers in medicine, biomedical
UVM and Norwich University. Since 2005 VGN has funded 31 graduate students, 104 project, 69 pilot awards
infrastructure in Vermont for biomedical research. At the
Sciences (NIGMS) at the National Institutes of Health (NIH).

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