Missisquoi Bay under-ice sampling Winter 2018

Shown right to left: Saul Blocher, Wilton Burns, Natalie Ceresnak, Austin Wilkes and Meagan Leduc.

Photo credit: Dr. Andrew Schroth

Vermont Established Program to Stimulate Competitive Research

VERMONT EPSCoR

Winter 2019

VERMONT EPSCoR

WINTER 2019

Editors:
Arne Bomblies, Ph.D., P.E.
Lillian Gamache

Contributing Writers:
Charlie Brooks
Jory Hecht
Andrew Schroth
Jeff Wakefield
Patrick Clemins
Lillian Gamache
Kevin Coburn

Contributing Photographers:
Charlie Brooks
Steve Exler
Arne Bomblies
Lillian Gamache
Brian Jenkins
Andrew Schroth
Kevin Andrew

Print and Design:
Pawprint & Mail

Address:
334 Marsh Life Science Building
109 Carrigan Drive
University of Vermont
Burlington, VT 05405

Funding:
This material is based upon work supported by the National Science Foundation under Award No. OIA 1556770.

INSIDE THIS ISSUE

From The Director

We are happy to share with you the latest news from Vermont EPSCoR in this 2019 winter magazine.

We have focused on two northern bays in Lake Champlain – St. Albans and Missisquoi – for Ecological Team Co-leader and researcher Dr. Andrew Schroth to provide a snapshot of why these two bays are scientifically interesting and how the Basin Resilience to Extreme Events or BREE researchers are gathering data from them. Dr. Jory Hecht, Postdoctoral Associate, explores how these data help inform policy makers and decision makers through our Policy and Technical Advisory Committee (PTAC) and the Integrated Assessment Model (IAM). As we try in the long term, explains Dr. Hecht, "to understand how we respond to the shocks that extreme events bring to the system and how our responses to them…may affect our resilience to future extreme events…" We also welcome Dr. Clelia Marti, who has joined our team and is contributing to the development of a fully 3D coupled physical and biogeochemical model of Lake Champlain.

Please check in often and follow us on Twitter, Facebook, LinkedIn and our website **www.uvm.edu/EPSCoR**

Best regards,
Arne Bomblies, Ph.D., P.E.
State Director, VT EPSCoR

Our New and Continuing Partnerships

Celebrates and promotes women entrepreneurs and ventures that impact and empower the lives of women and families.

Middlebury College

Offering researchers valuable insights into Lake Champlain processes enhanced by data from the research vessel, David Folger.

BREE
Basin Resilience to Extreme Events in the Lake Champlain Basin

A NSF funded project focusing on extreme events and resilience; building transdisciplinary research and integrated modeling capacity.

Lake Champlain Basin Program

Works in partnership with government agencies from New York, Vermont, and Québec, private organizations, local communities, and individuals to coordinate and fund efforts that benefit the Lake Champlain Basin's water quality, fisheries, wetlands, wildlife, recreation, and cultural resources.

LANDMARK COLLEGE

A leader in creating successful learning strategies for students who learn differently and strengthening the STEM workforce.

VERMONT PBS

Vermont Public Broadcast Station educates, informs, entertains and inspires Vermonters to be lifelong learners and engaged in their community.

The University of Vermont

Home of Vermont EPSCoR and center of RACC interdisciplinary research aligning with its mission to be among the nation's premier small research universities for faculty, post-doctoral associates, graduate students, undergraduates.

Alan Alda Center for Communicating Science
AT STONY BROOK UNIVERSITY

Working to enhance understanding of science by helping train the next generation of scientists and health professionals to communicate more effectively with the public, public officials, the media, and others outside their own discipline. University of Vermont became an Alda Center Affiliate in 2015.

VCET

Vermont Center for Emerging Technologies
Offering select early stage firms substantive business mentoring along with traditional business incubator services and infrastructure.

Saint Michael's College FOUNDED 1904

Home to the VT EPSCoR Center for Workforce Development and Diversity (CWDD), water quality analysis laboratory for total suspended solids and summer internship opportunities for undergraduates and high school students.

UMET UNIVERSIDAD METROPOLITANA SISTEMA UNIVERSITARIO ANA G. MÉNDEZ

The Ana G. Méndez University System (AGMUS) and Universidad Metropolitana
Providing undergraduate summer research internships and an opportunity to present VT EPSCoR research at the annual "Research Symposium for Minority Students" in San Juan, Puerto Rico.

NSF

The National Science Foundation
Where discoveries begin

COMMUNITY COLLEGE OF VERMONT CCV

Providing motivated adults the opportunity to participate in authentic research opportunities leading to continued STEM education or career opportunities.

LTER

University of Puerto Rico at Rio Piedras and the Luquillo Long Term Ecological Research (LTER) Integrating high school teams into Vermont EPSCoR RACC research to learn about climate change and water quality.

Northern Vermont UNIVERSITY

LAUNCHVT

Vermont's statewide business pitch competition.

VSSMF

NORWICH UNIVERSITY

VSSMF (Vermont State Science and Math Fair) and Norwich University Vermont 5th-12th grade students' state-wide science fair competition inspires students and provides opportunities to further their interests in STEM.

1787 Castleton

VERMONT AGENCY OF NATURAL RESOURCES

Promoting the sustainable use of Vermont's natural resources, protecting and improving the health of Vermont's peoples and ecosystems, and promoting sustainable outdoor recreation.

Vermont Technology Council

Vermont Technology Council
A catalyst for the creation of science-and-technology-based business in Vermont.

VERMONT WORKS FOR WOMEN

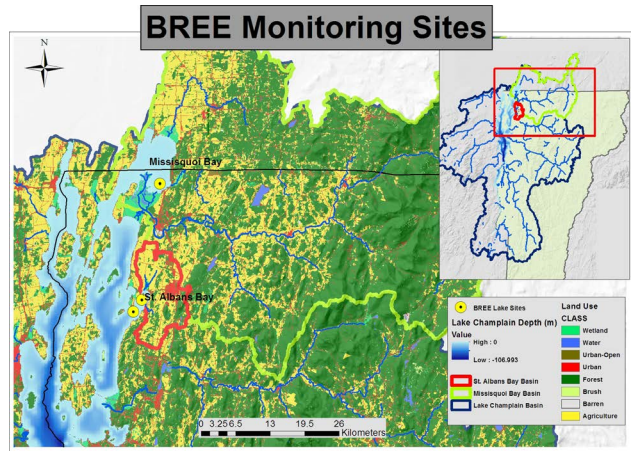
CUTTING-EDGE SENSORS DEPLOYED TO STUDY DRIVERS OF WATER QUALITY IN ST. ALBANS AND MISSISQUOI BAYS, LAKE CHAMPLAIN

by Dr. Andrew Schroth,
Co-Leader Ecological Systems, BREE Research Associate Professor of Geology, University of Vermont

The degradation of water quality in Lake Champlain's Missisquoi and Saint Albans Bays over recent decades is a crisis that has suppressed local real estate prices, compromised citizen-valued recreational resources, and fueled regional and local controversy. Yet this issue has also brought together many actors across jurisdictions, agencies, and sociopolitical demographics to develop strategies to promote water quality resilience and improve conditions within these treasured Vermont resources. Towards this end, in 2017, researchers associated with the University of Vermont, Middlebury College and Vermont EPSCoR deployed a suite of sensors in Lake Champlain's Missisquoi and Saint Albans Bays to monitor water quality dynamics continuously at high frequency (many measurements every day) as part of the Basin Resilience to Extreme Events (BREE) project.

WHY THESE TWO BAYS?

The researchers' goal is to study how water quality in each bay responds to different kinds of extreme weather events such as droughts, heat waves, floods, cold snaps, and large storms. These sites were selected because they bear both important similarities and differences in the factors that impact their water quality. Both sites underwent cultural eutrophication in the second half of the 20th century, shifting from low-moderate nutrient systems with relatively high water clarity to turbid eutrophic systems that experience relatively strong and persistent potentially harmful cyanobacteria blooms (CyanoHABs). These algal blooms occur every year due to high levels of nutrients associated with a legacy of human land use practices in the watershed of each bay. Indeed, previous research from this group and others has suggested that the critical driver of CyanoHAB initiation, severity and duration at both sites is linked to the release of nutrients, particularly phosphorus, from bay sediments. Those sediments have become enriched in phosphorus over time due to the urbanization and the intensification of agricultural practices in the Missisquoi and Saint Albans watersheds over the course of the 20th century through present day.



Map of Missisquoi and Saint Albans Bays with their watershed's outlined in green and red respectively. Location of vertical profiling buoys monitoring and associated equipment identified by yellow circles. Landuse/landcover classification within each watershed is identified by color with agricultural (yellow), urban/developed(red), and forested (green) lands distinguished. Discussed differences in watershed to area ratio, bay connection or lack thereof to the green mountains or Inland Sea are easily discerned from these maps.

These human-induced changes to the landscape have increased nutrient loads delivered by rivers to the lake (relative to what would come into the bays via the rivers from a 'natural' forested watershed). Much of this phosphorus is then deposited in lake sediments, where its concentration in the sediment has built up over time (legacy phosphorus). Then, under warm, calm weather conditions, certain phosphorus bearing minerals in these sediments are prone to dissolve, releasing the phosphorus that was stored in the sediment back into the water (internal phosphorus loading), initiating and sustaining CyanoHABs in both shallow bays.

While the water pollution problem of CyanoHABs due to internal loading of legacy phosphorus is similar between the two bays, and they are also exposed to very similar local weather due to their close proximity and comparable elevation, there are also interesting differences between the two systems that the researchers hypothesize could allow for weather and climate events to impact their water quality differently.

EUTROPHICATION, or hypertrophication, is when a body of water becomes overly enriched with minerals and nutrients that induce excessive growth of plants and algae. This process may result in oxygen depletion of the water body.

TURBIDITY is a measure of the level of particles such as sediment, plankton, or organic by-products, in a body of water. As the turbidity of water increases, it becomes denser and less clear due to a higher concentration of these light-blocking particles.

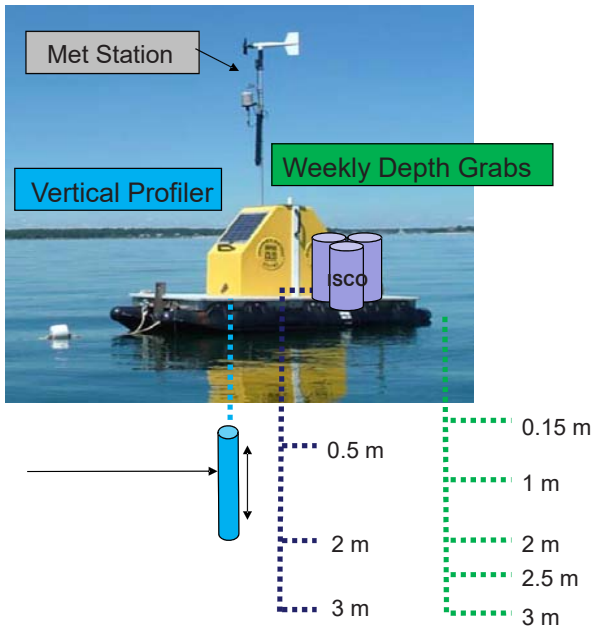
PHYSICAL CHARACTERISTICS OF THE BAYS

Missisquoi Bay has a large watershed to bay area ratio, making it particularly responsive to events that impact river flow. Its watershed also stretches well into the northern Green Mountains, thus connecting the bay to the unique weather patterns that impact the higher elevations of Vermont, even though the bay itself is far from those mountains and near sea level. For example, the melting of a deep high elevation snowpack around Jay Peak has a strong impact on nutrient concentrations and water movement in Missisquoi Bay.

Conversely, the Saint Albans Bay watershed is constrained to the lowlands and foothills of the Champlain Valley, thus to some extent disconnecting this bay from the unique weather of the Green Mountains and their deep snowpack.

Similarly, during Tropical Storm Irene (August 2011), flows and nutrient loads were extreme in the rivers and streams draining the Green Mountains due to the intense and persistent precipitation that occurred at high elevation, coupled with landslides and erosion triggered in steep mountain valley walls. Yet in the lowland watersheds of the Champlain Valley, Irene was nothing more than a typical storm in its delivery of water and nutrients to Lake Champlain. Thus, an event like Irene likely impacted water quality to a greater degree in Missisquoi Bay relative to St. Albans Bay.

Another interesting difference between the two systems is their connectivity to the lower nutrient, mesotrophic waters of Lake Champlain's Inland Sea. While Missisquoi Bay is often isolated from mixing with those waters because of a narrow channel that connects it to the Inland Sea, Saint Albans Bay is fully connected to the Inland Sea across its southwestern border, which is also the dominant summer wind direction. As such, exchange between the Inland Sea and these two water bodies should be quite different over the course of the year, which likely also impacts the extent to which nutrient concentrations and even CyanoHABs may be suppressed by mixing with Inland Sea waters.



Schematic image of the components of each BREE vertical monitoring platform with a picture of one of our systems deployed in (site name depending picture selected) Bay in the insert.

PhD student Wilton Burns, research technician Saul Blocher, and PI Dr. Andrew Schroth hold up an EXO sonde before hooking it up to the water quality monitoring platform in St. Albans Bay.

INSTRUMENTING THE BAYS – BIG DATA

Because of these structural similarities and differences in potential drivers of water quality, the two bays provide an interesting framework for understanding how climate and weather extreme events impact water quality and its resilience, which is an overarching research goal of the BREE project.

To study the bays and their response to different weather events, an array of physical, chemical, and biological sensors were deployed by the research team in 2017. These sensors allow the researchers to capture physical, chemical and biological dynamics and explore their linkages continuously over time at high frequency.

This capability is particularly important in studying the impacts of events on water quality, since many events can be hard to capture using more conventional sampling approaches (researchers occasionally collecting water samples from a boat) for many reasons such as their unpredictable and episodic nature, promotion of dangerous conditions on the water, or their gradual occurrence over long periods of time (e.g. a drought).

MESOTROPHIC LAKES are lakes with an intermediate level of productivity. These lakes are commonly clear water lakes and ponds with beds of submerged aquatic plants and medium levels of nutrients.

THE INLAND SEA is a component of the Northeast Arm-Importantly, these two study sites are within the Northeast Arm, but adjacent to the Inland Sea.

INTERANNUAL: occurring between, relating to, or involving two or more years: occurring or observed in different years.

Thus, having sensors deployed in the lake allow the research community to monitor the system continuously across the seasons and during all events that impact water quality. These data can therefore provide a holistic characterization of water quality dynamics and their drivers across sub-daily to seasonal and even inter-annual timescales.

In Missisquoi Bay, there is one "vertical profiling system" that has been monitoring water quality since 2012. Physical, chemical and biological sensors move vertically through the water column once an hour, taking measurements at 0.5 meter intervals from the lake surface to bottom. This allows researchers to understand how the chemical, physical and biological components of different depths within the water column respond to different events.

In Saint Albans Bay, two similar vertical profiling systems are deployed, located in the inner and outer portions of Saint Albans Bay respectively. At each of the bay's vertical profiling platforms, there are also meteorological stations that continuously monitor and record the weather. Additionally, each platform is equipped with two automated water sampling systems that collect a water sample every day from two locations within the water column; one near the bottom to detect when the sediments are releasing nutrients, and the other near the surface to reveal nutrient concentrations where the algae often reside.

The platforms are deployed in the bays from early May through October, but must be removed before the bay surfaces become frozen in the winter. While deployed, Vermont EPSCoR researchers travel to the buoys once a week to collect additional water, sediment and biological samples, as well as service the sensors and automated water sampling systems.

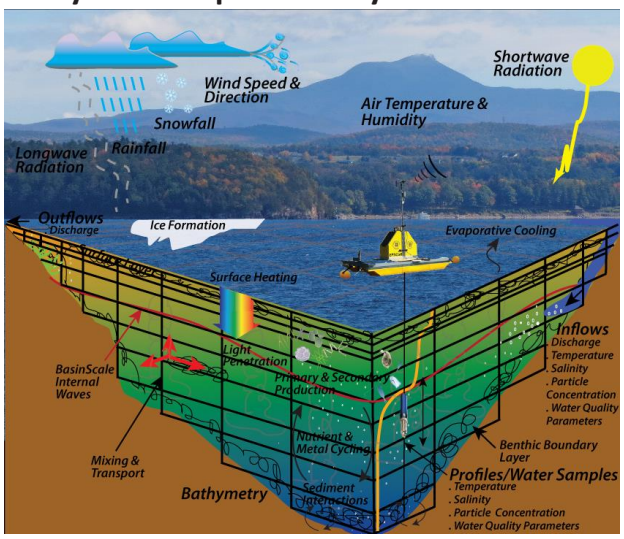
These 'big' sensor data are telemetered (or transmitted) via cell modem every hour back to UVM servers, where the data is then uploaded nightly into a database to undergo rigorous quality assurance/control protocols. The researchers then integrate these data to understand the critical processes that regulate water quality at the sites across time scales ranging from hours to years. By describing these critical processes, researchers can also understand current and future threats to water quality due to changes in the landscape and/or climate.

Lake Model (AEM3D; ELCOM-CAEDYM)
3D coupled Hydrodynamic-Aquatic Ecosystem Model

Processes Simulated

Hydrodynamics: Motions of the water body and the transport and mixing of all simulated constituents due to these motions.

Biogeochemical processes: Primary and secondary production, nutrient and metal cycling and sediment interactions.



Schematic developed by Dr. Clelia Marti illustrating the physical, chemical and biological processes simulated by the new BREE lake model that is under development. This model will be then be embedded within the larger framework of the BREE integrated assessment model to be linked with other component models of the Lake Champlain Basin social-ecological system as illustrated in Panel B.

MODEL DEVELOPMENT

Ultimately, in addition to understanding process, the massive composite of environmental monitoring data collected from BREE sensor arrays at these sites is critical for developing accurate models that can simulate lake coupled physical, chemical and biological processes and project changes under future land-use or climate scenarios.

With the new addition of renowned lake modeler, Dr. Clelia Marti, to the research team, development of new process-based coupled physical, chemical and biological models for both bays is underway. These models will ultimately become embedded in the larger BREE integrated assessment model. This will link the new lake models to regional land use, governance, economic, climate, and watershed models that are being concurrently developed by the rest of the BREE research team. Model integration will allow these diverse component models to 'speak to one another' over time as social and environmental conditions in the Lake Champlain Basin change. This enables researchers to quantify changes in water quality in response to climate warming scenarios, land use or policy directives, as well as responses to specific individual or sequences of extreme events. These integrated model outputs will allow for the research team to better understand conditions within the Lake Champlain Basin social-ecological system that promote resilient water quality across both time and space.

DEVELOPING SCENARIOS TO DETERMINE EFFECTS OF LOCAL ACTION ON CLIMATE CHANGE RESILIENCE

by Dr. Jory Hecht, Postdoctoral Associate, VT EPSCoR

One major component of the BREE project is to identify local strategies for enhancing the resilience of the Lake Champlain basin, especially lake water quality, to extreme events, such as

floods, droughts and heat waves. This requires the creation of future scenarios that provide a sense of how locally controllable factors, such as land use, river corridor management and governance, can influence our resilience. To solicit local expertise,

THE BREE TEAM RECENTLY CONDUCTED AN EXPLORATORY SCENARIO DEVELOPMENT EXERCISE WITH MEMBERS OF ITS POLICY AND TECHNICAL ADVISORY COMMITTEE (PTAC), A STEERING COMMITTEE COMPRISED OF REPRESENTATIVES OF DIVERSE LOCAL, STATE, FEDERAL AND BI-NATIONAL INSTITUTIONS.

Post-doctoral associates Patrick Bitterman, Elizabeth Doran and Scott Hamshaw led interactive activities that elicited participant responses regarding future

changes in governance, land use, and river corridor management in the basin. Participants evaluated a wide range of changes, ranging from measures to increase the connectivity between river channels and floodplains to tax and incentive policies to encourage best management practices. Concurrent societal changes in population growth and transportation were considered, as were other ones that participants suggested. This initial exercise helped postdoctoral associates leverage the expertise of the PTAC for their current research. For instance, Hamshaw,

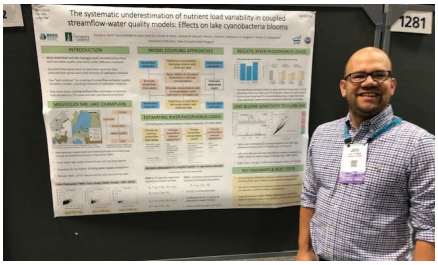
who is collaborating with state agencies to prioritize river corridors for sediment management, is leveraging the responses from the activity to weight different floodplain management objectives, ranging from restoring the geomorphic stability of river channels to providing recreational opportunities.

HOWEVER, THIS SCENARIO ELICITATION EXERCISE WAS JUST A FIRST STEP IN A MULTI-YEAR SCENARIO DEVELOPMENT PROCESS.

BREE will continue working with the PTAC and other local stakeholders to develop scenarios depicting future basin change storylines that feature coherent changes in land use, governance and river corridor management. They will also consider different best management practices to reduce the amount of phosphorus that enters Lake Champlain. The Integrated Assessment Model (IAM) that BREE is developing provides a tool with which the climate-change resilience implications of different changes in land use, river corridor management and other aspects of governance can be jointly considered.

"THE KEY TO THIS WORK IS NOT MERELY UNDERSTANDING WHAT MIGHT HAPPEN TO THE LAKE'S WATER QUALITY MERELY AS A RESULT OF OUR DECISIONS," SAYS JORY HECHT,

a postdoctoral associate working on BREE's Integrated Assessment Model. "What we are really



trying to do in the long-term is understand how we respond to the shocks that extreme events bring to the system and how our responses to them – policies even changes in governance structures - may affect our resilience to future extreme events, which many climate models project to become more frequent and severe over the course of the 21st century." This approach will help the BREE team better understand the dynamic evolution of resilience to climate change in the basin and will provide a template for conducting similar analyses elsewhere.

CLELIA MARTI JOINS VERMONT EPSCoR TEAM

Clelia Marti, PhD has joined Vermont EPSCoR and the University of Vermont as a Research Assistant Professor with the College of Engineering and Mathematical Sciences. She is currently contributing to the development of a fully 3D coupled physical and biogeochemical model of Lake Champlain as part of the Vermont EPSCoR Basin Resilience to Extreme Events (BREE) project. Dr. Marti has a wide range of experience with both environmental and water resources engineering applications. She obtained her PhD in Environmental Engineering that the University of Western Australia and held previous academic appointments in Argentina, Australia, and the United States. Her research is focused on improving the understanding of transport and mixing processes in surface water systems. Dr. Marti will serve as part of the BREE Ecological Systems team, where she will analyze the processes and the biogeochemistry of the environment using high level field data analysis, numerical modelling, and mathematical scaling.

For more information please visit https://www.uvm.edu/cems/cee/profiles/clelia-luisa-marti

LARGE CONTINGENT OF BREE SCIENTISTS ATTEND THE AMERICAN GEOPHYSICAL UNION (AGU) 2018 FALL MEETING

by Dr. Jory Hecht, Postdoctoral Associate, VT EPSCoR

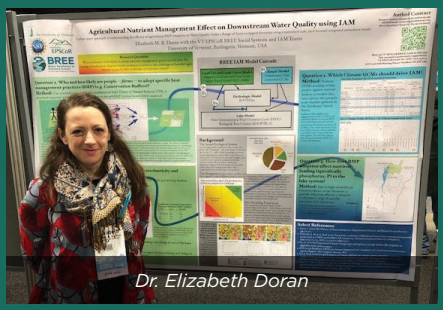
A large contingent of BREE scientists attended the American Geophysical Union (AGU) 2018 Fall Meeting, which ran from December 10th to December 14th in Washington, DC. More than a dozen BREE faculty members, post docs, graduate students, and undergraduate interns made oral and poster presentations. Topics of these presentations included evaluating climate model parameter specifications, estimating sediment and phosphorous transport during floods, modeling impacts of watershed management on lake cyanobacteria blooms, and more.

In addition to convening thousands of scientific presentations, the conference also had forums for linking scientific research to policy development. Ecological Team member Dr. Breck Bowden presented on the BREE project in this area, highlighting the nature of the project as a co-evolution of science, monitoring, and management in the Lake Champlain Basin. Dr. Bowden emphasized the fact that Vermont research and data collection was able to inform a renewed Total Maximum Daily Load (TMDL) and water quality act, which is quite unusual and special.

In addition to sharing current research, BREE scientists returned to Burlington with many new ideas after having indulged in the vast intellectual offerings that the large annual conference offers.

Representing Vermont EPSCoR, Breck Bowden, Julia Perdrial, Erin Seybold, Kristen Underwood, and Matt Vaughan all made oral presentations. Members who made poster presentations included Alan Betts, Elizabeth Doran, Scott Hamshaw, Janel Hanrahan, Jory Hecht, Huanping Huang, Brittany Lancellotti, Maxwell Landsman-Geroj, and undergraduates Jessica Langlois and Eric Romero.

Dr. Breck Bowden


Dr. Elizabeth Doran

More information about the AGU Fall Meeting can be found here: fallmeeting.agu.org/2018

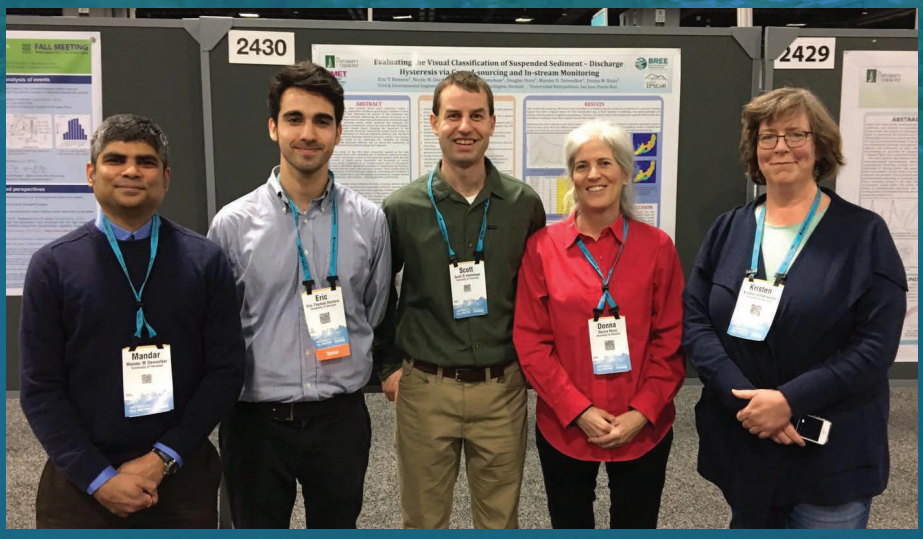
Dr. Bowden's presentation can be viewed here: alturl.com/hspn2

HIGH SCHOOL STUDENT SPOTLIGHT:
by Julyanice Cruz

The Vermont High School Streams Projects was one of the reasons I decided to come from Puerto Rico to Saint Michael's College. I was already familiar with the campus, I knew a few people, I had great scholarship opportunities, it was a totally different place from home, and I have all the support I need to do what I propose. Saint Mike's has definitely been a whole new and different experience for me thanks to the High School Streams Project.

After researching and investigating benthic macroinvertebrates, I am prepared to do independent research, in December 2018, investigating macroinvertebrates in coffee plantations in Puerto Rico.

EPSCoR summer 2016: Julyanice Cruz, an SMC biology freshman, during one of her summers as a VT EPSCoR Streams Project high school researcher. In the photo, Julyanice is pictured with her teacher and teammate from Academia Maria Reina in Puerto Rico.



AGU3: From left to right: Dr. Mandar Dewoolkar, Eric Romero, Dr. Scott Hamshaw, Dr. Donna Rizzo and Dr. Kristen Underwood during Eric's poster presentation at AGU 2018.

UNDERGRADUATE INTERN SPOTLIGHT:
Eric Romero

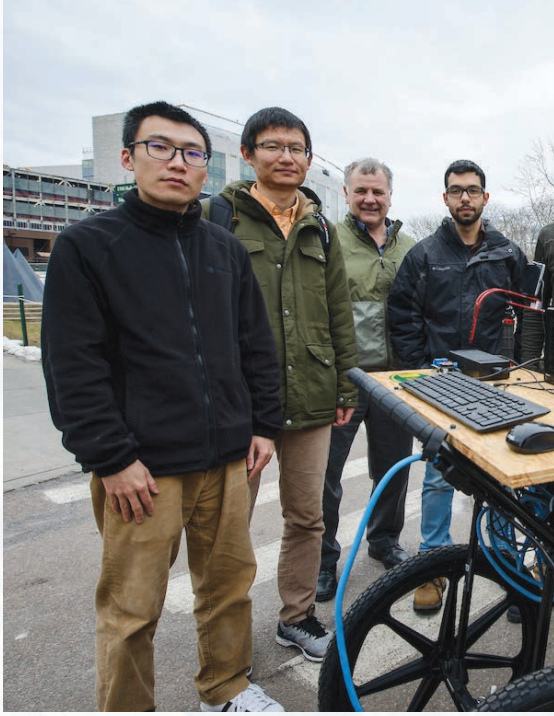
Eric Romero, is currently a senior studying Environmental Engineering with a minor in Geospatial Technologies at the University of Vermont.

Eric was a BREE undergraduate intern in the summer of 2018, working with Drs. Donna Rizzo, Mandar Dewoolkar and Scott Hamshaw. His research was on categorizing storm events based on the hysteresis in the suspended sediment-discharge relationship.

A total of 17 BREE-related research presentations took place during the December 2018 American Geophysical Union Conference (AGU) in Washington, DC – including one from Eric Romero.

NSF PROGRAM HELPS UVM ENTREPRENEURS ADD MISSING INGREDIENT — CUSTOMERS

by Jeff Wakefield, University of Vermont Communications



Over the years, mechanical engineering professor Dryver Huston and his team have become adept at understanding the needs of what they've always thought of as their main customers -- federal agencies like the National Science Foundation, the National Institutes of Health, the Department of Defense and NASA that fund their research.

"Faculty have incredible expertise in a specific area," he said. "But they frequently don't have expertise in projecting whether or not people outside of their area would be interested in buying a product based on their research. Without that information, it's like setting off without a compass."

The team of Dryver Huston, Tian Xia, and Dylan Burns received a Vermont EPSCoR Pilot Award for Faculty / Small Business Partnerships in 2017 to advance their work in using ground penetrating radar to access the health of municipal water infrastructure. After receiving this award, outreach from Vermont EPSCoR informed the team of the I-Corps training that was coming to UVM and encouraged them to apply.

Vermont EPSCoR sponsored breakfast at the final half-day I-Corps training session and State Director Arne Bomblies spoke to the attendees about the range of funding opportunities and private sector resources offered by Vermont EPSCoR.

"It's a bit of a mystery, but we think hard and we can often figure out what the U.S. government wants," Huston said.

But what about the needs of those other customers, the ones who might actually buy the products and services that grow out of Huston's research, which nearly always has a tech transfer bent?

"We don't think about them so much," he admitted.

Among faculty seeking to translate their research findings into commercial ventures, Huston's orientation isn't uncommon, said UVM's vice president for research, Richard Galbraith.

Thanks to a National Science Foundation I-Corps training that was held on the UVM campus last month, the first ever, eight entrepreneurially-minded faculty and student teams -- including Huston's -- have gotten to know quite a bit about the needs of their customers.

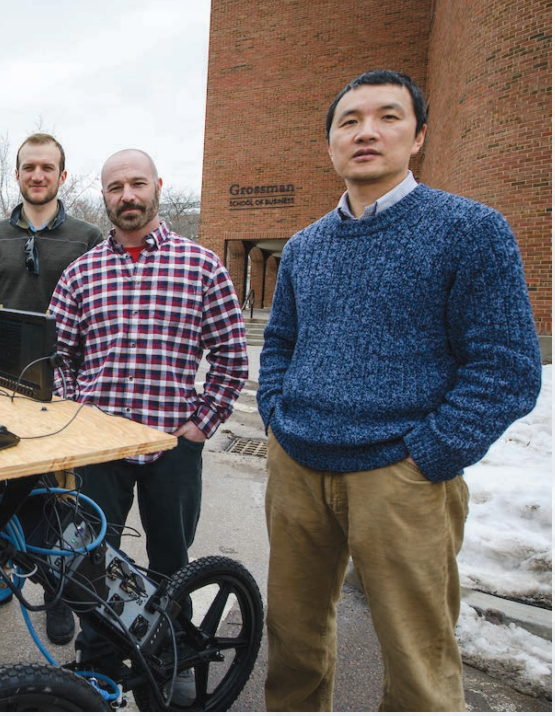
The group received a full day of instruction from trainers from an I-Corp regional hub in upstate New York -- called the Upstate New York (UNY) I-Corps Node -- on why customer discovery is central to business success, how to identify key customers and what to talk with them about.

Then, over a two-week period, each team set out to interview 30 potential customers, reporting on the results during two remote check-in sessions with the trainers and finally in a half-day session that capped the training. "It was a really good experience," said Huston, whose research group is commercializing an intelligent ground-penetrating radar system that municipalities can use to map underground infrastructure. Other members of Huston's team who took the training included electrical engineering professor Tian Xia and post-doctoral student Dylan Burns, who conducted the interviews and gave the team's presentations.

The university plans to repeat the I-Corps training in the spring and offer it twice a year in the future, working in coordination with the UNY I-Corps node and developing I-Corps trainers from the State of Vermont and the Vermont Center of Emerging Technologies who will help with future trainings.

LONG TIME COMING

UVM has long wanted to give faculty access to I-Corps, a division of NSF whose mission is to use the customer discovery process to help entrepreneur-



Members of the ground penetrating radar research team. Three members participated in an NSF I-Corps training: faculty leaders Dryver Huston (third from left) and Tian Xia (far right) and postdoctoral student Dylan Burns, second from right. (Photo: Brian Jenkins)

ial faculty explore the commercialization potential of their research for the benefit of society.

But the university wasn't certain it could field a sufficient number of teams year after year to make the program sustainable over the long term.

Enter UNY I-Corps, led by group of entrepreneurs and educators from Cornell, RIT and the University of Rochester, one of nine regional I-Corps hubs spread around the county.

"Our program director at NSF encouraged us to bring I-Corps to Vermont," said Shannon Sullivan, regional director of the node. "They wanted to make sure Vermont entrepreneurs were getting the training and opportunity to participate in the national I-Corps program."

"When they reached out to UVM, our response was immediate – let's do this," said Corine Farewell, director of UVM Innovations, who knew members of the UNY I-Corps from her days working in the tech transfer offices of the University of Rochester and Cornell.

The way around the university's sustainability concerns? "We opened the program to a wide variety of groups in or near Vermont," Farewell said. "Any Vermont startup or potential startup, whether at UVM, Middlebury, Champlain, Vermont Tech or Norwich, or even outside higher education, is eligible to apply," Farewell said.

Dartmouth was also welcome, and the institution sent a team to the October training.

GOING NATIONAL: $50,000, SEVEN WEEKS AND 100 INTERVIEWS

UNY I-Corps calls the two-week training held at UVM its short course "because it's like a mini-version of what the national I-Corps Teams program offers," Sullivan said.

Teams in the short course who excel in the customer discovery process and who have a deep STEM technology innovation are eligible to apply to the national program, a seven-week training that comes with a $50,000 grant so participants can travel anywhere in the United States to conduct at least 100 customer discovery interviews.

Teams who complete the national I-Corps Teams program have a much higher rate of success when applying for an SBIR or STTR grant, which is frequently their next step, Sullivan said.

"I think this higher success rate among I-Corps grads is related to the fact that they have developed and tested a data-based business model," said Sullivan.

The national I-Corp Teams program requires participation in the form of a three-person team: an entrepreneurial lead, usually a graduate student or postdoc, who leads the team and the customer interview process; a technical lead, who is usually the faculty member; and an industry mentor, who has real world startup experience.

Academic researchers who already have NSF funding, as Huston does, are automatically eligible to apply for the national I-Corps Teams program, and his team is strongly considering participating. Post-doc Burns would be the entrepreneurial lead. Having also done the short course strengthens their application.

Huston has gotten religion about the value of the I-Corps approach.

"They asked us some tough questions about our product and our customer base," he said. "You don't always think about the tough questions; you often ignore the tough questions. Just because your product is cool doesn't mean it's a viable thing."

Faculty and student entrepreneurs interested in participating in the spring I-Corps training should contact UVM Innovations at innovate@uvm.edu or 656-8780.

RII TRACK-2 FEC:
FROM GENOME TO PHENOME IN A STRESSFUL WORLD:

Epigenetic Regulatory Mechanisms Mediating Thermal Plasticity in Drosophila
Vermont Lead Institution with Rhode Island and Kentucky
Sara Cahan, University of Vermont, (Principal Investigator)
Seth Frietze, University of Vermont (Co-Principal Investigator)

by Sara Cahan, Ph.D.

A fruit fly resting on a leaf.

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.

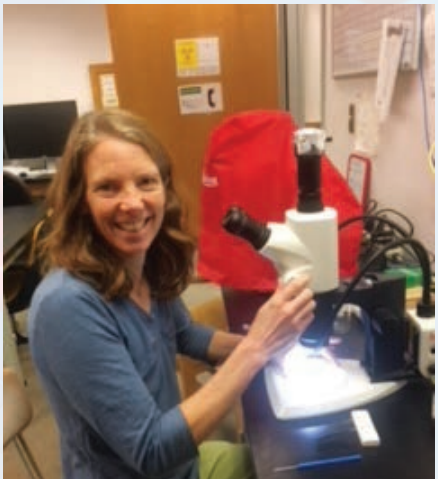
As part of the project's mission, the team will also be developing outreach activities to broaden STEM participation to underserved communities in Vermont and beyond. These include an intensive summer research program for undergraduates, and weeklong summer workshops to introduce the exciting field of Genetics to high school students.

Associate Professor Sara Helms Cahan with high school students during a summer workshop.

Assistant Professor Seth Frietze in the laboratory with a student.

RII TRACK-4:
EPSCoR RESEARCH FELLOW: LAURIE GRIGG, NORWICH UNIVERSITY

by Laurie Grigg, Ph.D.



Grigg searching for organic material for radiocarbon dating.

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

Research assistant, Irene Magdon, preparing split cores for imaging and description.

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

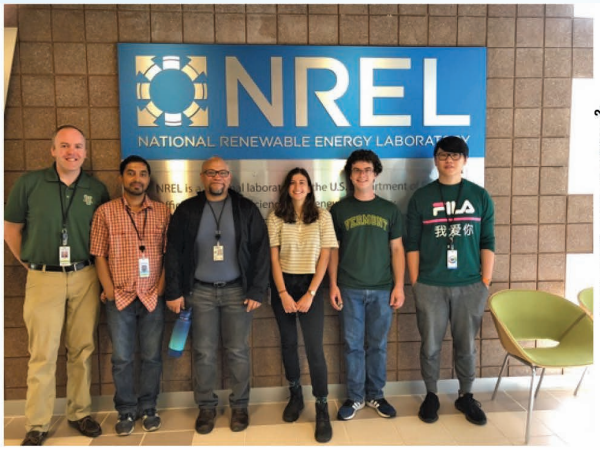
Sediment cores from Twin Ponds. The bark brown cores at the top are more recent and then get progressively older towards the bottom of the photo. The total age of the cores is ca. 14,000 years.

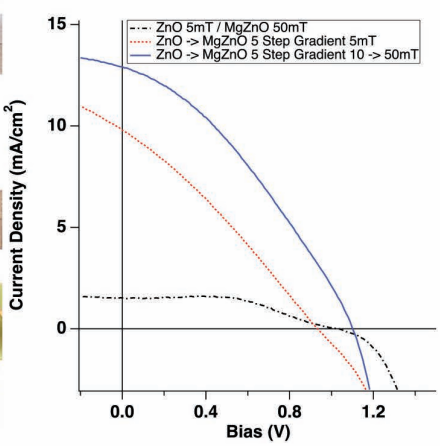
and his graduate students to discuss issues in Holocene paleoclimate and is working with Shuman and another co-author on a manuscript from previous work. Grigg and Magdon will use the remaining time in Wyoming to finish pollen analysis, isotope preparation, learn new methods to analyze the data, and will submit an abstract to northeast Geological Survey of America meeting in March, 2019.

RII TRACK-4:
EPSCoR RESEARCH FELLOW: MATTHEW WHITE, UNIVERSITY OF VERMONT

by Matthew White, Ph.D.

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.





1. Larsen, A., Dahal, E., Paluba, J., Cianciulli, K., Isenhart, B., Arnold, M., Du, B., Jiang, Y., and White, M. S. "Nonlinear Impedance Spectroscopy of Organic MIS Capacitors and Planar Heterojunction Diodes" Organic Electronics 62, (2018): 660–666. doi:10.1016/j.orgel.2018.07.003

ACCOLADES

DR. ASIM ZIA LEADS PANEL AT UNFCCC

BREE Integrated Assessment Co-Leader Dr. Asim Zia led a panel on December 8, 2018 titled "Implementing Food-Energy-Water Security Early Warning Systems for Adaptation to Climate Change" at the United Nations Framework Convention on Climate Change in Katowice, Poland.

Speakers on the panel included Dr. Zia, Dr. Ghulman Rasul (Pakistan Met Department), Dr. Maria del Pilar Cornejo (National Secretary of Risk Management in Ecuador), and Dr. Michael H. Glantz (Director, Consortium for Capacity Building). The research presented included NSF EPSCoR funded work on Lake Champlain. To view a video of the panel, click here: www.bit.ly/2SaMjBi

More information about the Katowice Climate Change Conference can be found here: https://unfccc.int/katowice

KEVIN ANDREW WINS TRAVEL GRANT TO ATTEND SUPERCOMPUTING CENTER SUMMER WORKSHOP

Vermont EPSCoR GRA Kevin Andrew attended the San Diego Supercomputing Center at the University of California San Diego (UCSD) from August 6-10, 2018 for their Summer Institute Workshop. Kevin was able to attend because of a student travel grant he received through the program, which covered the majority of costs, including room and board on UCSD's campus for the week of the workshop.

The workshop introduced researchers in both academic and industry fields to the usage, programming, and optimization of software for supercomputers, high performance computers (HPCs) and devices enabled for use with a graphics processing unit (GPU).

As a research student in computing science, one of the largest parts of Kevin's research is developing machine learning models that run on Vermont EPSCoR's Pascal HPC. This workshop was thus useful in accelerating Kevin's work with the BREE project.

For more information about SDSC please visit: **www.sdsc.edu**.

SAVING OUR WATERS WINS 2018 EMMY AWARD

Saving Our Waters, a three-part documentary, produced by VT PBS with major funding by VT EPSCoR was recognized with a Boston/Regional Emmy Award in the Environmental category, on June 2, 2018. The series focuses on the health and resiliency of Lake Champlain Basin especially with the increase of extreme weather events. VT EPSCoR Science Leaders from the University of Vermont and who are from multiple disciplines ranging from engineering, social, natural and computational sciences, were instrumental in the content development and provided guidance on the science and complex issues surrounding the Lake Basin. Together they work with

broader teams of researchers from across the state on the National Science Foundation (NSF) VT EPSCoR RII-Track-1 Award, Lake Champlain Basin Resilience to Extreme Events (BREE).

The series was complemented by multiple town hall meetings in some of the communities most affected by watershed issues. Vermont PBS also aired a panel discussion on the Lake Champlain basin that was pre-recorded in Montreal, Canada – one of many sources of water flowing into Lake Champlain and the pollutants associated with it. Corresponding curriculum guides for each of the episodes were developed and are available to all middle and high schools throughout Vermont.

To view the series, town-hall meetings and curriculum guides, please visit: www.vermontpbs.org/water/

Where are they Now?

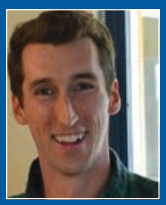
IN BRIEF FROM RECENT VT EPSCoR GRADUATE STUDENTS AND POSTDOCTORAL ASSOCIATES

Steve Scheinert, PhD completed a post- doctoral program with the University of Vermont in 2016, where his research focused on agent-based modeling of complex networks that make and implement public policy. He then served as a fellow with Democracy Works before becoming a Assistant Professor of Industrial Engineering and Management Systems at the University of Central Florida's College of Engineering and Computer Science.

Linyuan Shang, PhD presented his PhD dissertation, "Climate Change And Land Use/ Cover Change Impacts On Watershed Hydrology, Carbon, Nutrient Dynamics: A Case Study In Missisquoi River Watershed" on October 29, 2018. He currently works as a Data Scientist at the digital marketing company Conversant, where he designs and develops machine learning algorithms on big data platforms.

Yushiou Tsai, PhD completed her tenure as a post-doctoral research associate with the University of Vermont and published more than a dozen research articles between 2014 and 2017. Her most recent research includes "*The Multivariate Climactic and Anthropogenic Elasticity of Streamflow in the Eastern United States,*" which appeared in the Journal of Hydrology: Regional Studies.

Kristen Underwood, PhD presented her PhD dissertation, "Smart Classification and Bayesian Inference for Evaluating River Sensitivity to Natural and Human Disturbances: A Data Science Approach" in May 2018. She now serves as a Research Assistant Professor in the University of Vermont's College of Engineering and Mathematical Sciences. Her teaching responsibilities within the college include courses in applied river engineering and environmental site characterization.



Matthew Vaughan, PhD presented his PhD dissertation, "Shining Light on the Storm: Using High-Frequency Optical Water Quality Sensors to Characterize and Interpret Storm Nutrient and Carbon Dynamics Among Contrasting Land Uses," on October 19, 2018. He currently serves as a Technical Coordinator with the Lake Champlain Basin Program (LCBP) and serves on the BREE Policy and Technical Advisory Committee (PTAC).

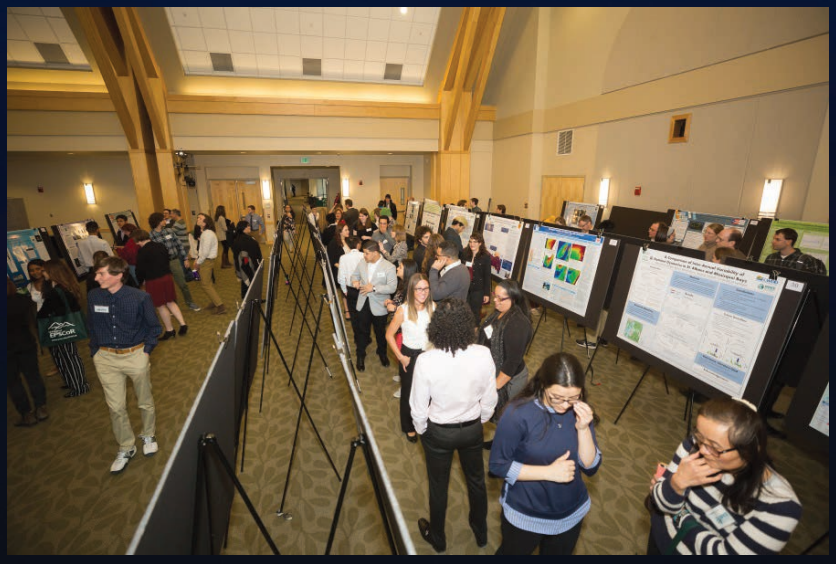
CWDD ANNUAL STUDENT SYMPOSIUM

The Vermont EPSCoR CWDD held its Annual Student Research Symposium on March 20, 2018 at the University of Vermont's Davis Center. The symposium provided an opportunity for high school teams and undergraduate students to present BREE-funded research to a wide audience.

The symposium featured a total of 60 high school teachers and students as well as 28 undergraduate interns who presented BREE research performed in 2017 and 2018.

The night examined not only environmental resilience but also personal resilience, as the attendees acknowledged the damage done by Hurricane Maria in Puerto Rico and the aftermath caused by that natural disaster.

The 2019 Symposium will be held on April 2, 2019. For more information please visit: www.uvm.edu/EPSCoR



UVM PROFESSOR A KEY CONTRIBUTOR TO LATEST FEDERAL CLIMATE ASSESSMENT

by Kevin Coburn, UVM Communications

A new federal report finds that climate change is affecting the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare across the U.S. and its territories. UVM Professor of Geography Lesley-Ann Dupigny-Giroux, who also serves as the Vermont State Climatologist, was the lead author of the Northeast chapter of Volume II of the Fourth National Climate Assessment, issued by the United States Global Change Research Program.

Dr. Lesley-Ann Dupigny-Giroux is a faculty researcher with the VT EPSCoR Basin Resilience to Extreme Events in the Lake Champlain Basin (BREE) climate team.

In Volume II of the climate report, greater emphasis has been placed on assessing the risks posed by a changing climate to the peoples, resources, and livelihoods throughout the 10 regions of the U.S. and its territories than in previous assessments. Volume I (Climate Science Special Report) analyzes the impacts of global change.

The National Climate Assessment is the U.S. Government's premier resource for articulating the risks and impacts posed to the nation by climate change. It is an interagency effort, bringing together experts from not only the 13 federal agencies of the U.S. Global Change Research Program, but the broader federal government, and hundreds of experts in the academic, non-profit, and private sectors.

Without substantial and sustained global efforts to reduce greenhouse gas emissions and regional initiatives to prepare for anticipated changes, the report anticipates climate change is expected to have implications for human health and wellbeing, cause growing losses to American infrastructure and property, and impede the rate of economic growth over this century.

Dupigny-Giroux was selected from nearly 200 experts across the United States nominated by her peers to serve as Chapter Lead on the NCA4. Her work concentrated on assessing the impacts of climate change on multiple sectors and communities across the northeast from Maine to West Virginia and Washington, D.C.

As the State Climatologist for Vermont, Dr. Dupigny-Giroux's work takes her across Vermont to assist colleagues in state agencies and community organizations to help plan for and adapt to climate change. She is an expert on floods, droughts and geospatial technologies and the ways in which climate affects Vermont's landscape and people.

"One of the key takeaways are the observed and anticipated risks posed to our 'forests, wildlife, snowpack, and streamflow' in our rural environments as our climate changes," Dupigny-Giroux said. "Another is that the ongoing impacts to human health are also of great concern to our region. Climate change is also affecting the interconnectedness of the urban centers of the northeast. Finally, northeastern states, including Vermont, continue to be very proactive in planning for and 'implementing actions to reduce risks posed by climate change."

As part of its Congressional mandate, the National Climate Assessment is required to analyze the effects of climate change on a number of topics, including agriculture, ecosystems, and human health. To better prepare the Nation to respond to these changes, there is a need to understand how a variety of climate change impacts are being experienced in different parts of the country, as well as how regional stakeholders are beginning to respond to the risks posed to society by those impacts.

2018 VT EPSCoR Native American and First Generation Scholarship Recipients

At the Vermont State House

Shown from left to right: Veronica Sosa-Gonzalez (CWDD Coordinator), Mike Schirling (Secretary of the Agency of Commerce and Community Development) Jared Paul Lehouillier, Shay Pouliot, Lajla Badnjevic, Sydney Whipple, Gideon Toussaint and Arne Bomblies (VT State EPSCoR Director)

Applications now being accepted. Deadline April 1, 2019

For more information please visit:

https://epscor.w3.uvm.edu/2/node/134 *or contact*

VT EPSCoR Center for Workforce Development and Diversity
Saint Michael's College • One Winooski Park Box 137 • Colchester, VT 05439
802.654.3270 • cwdd@smcvt.edu

Vermont EPSCoR
University of Vermont
Marsh Life Science Building
Carrigan Drive
Burlington, VT 05405