

# THE current

RESEARCH AND HAPPENINGS FROM  
RHODE ISLAND NSF EPSCoR | FALL 2014

## STATUS FLOW

A new research project  
yields greater understanding  
of watershed health and  
resources in the Ocean State.

p 10



**Rhode Island NSF EPSCoR**

Experimental Program to Stimulate Competitive Research

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On the Cover:

Jacob Peterson, *right*, a Master of Environmental Science and Management student at the University of Rhode Island, and Matthew Wallace, a May 2014 graduate of the MESM program, measure stream flow in Middletown's Maidford River at a sensor location for the EPSCoR Track-2 project.

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# welcome



I hope that you all are having a productive and enjoyable fall semester. I am settling into my role as RI NSF EPSCoR Principal Investigator, and I have several EPSCoR updates to share.

We submitted the state's next five-year proposal in August 2014, and I wish to express my deepest thanks to the numerous individuals who contributed, as it was truly a collaborative project. We expect to hear of its outcome late spring/early summer 2015.

November 19-21, we will host NSF Program Officer Dr. Audrey Levine. She will meet EPSCoR Track I and Track II researchers, tour core facilities and field sites, and participate in our November 21 annual meeting at RI Commerce.

I plan to visit each of our nine partner institutions this fall to meet with EPSCoR partner liaisons, researchers, staff, and higher administration. And, work continues on several EPSCoR fronts, including our ER-Core (reporting) online module, diversity plan, and professional development programming.

As always, please feel free to contact me with any questions or concerns, or ideas for improvement.

Best wishes,

Carol Thornber

Our Mission is to provide a platform to promote collaboration and cooperation among Rhode Island's institutions of higher education (IHE) and to enable alignment of our efforts with the needs of the state to increase research competitiveness, especially in marine life science and affiliated sciences.

We believe this will improve the employment rate, provide more attractive employment opportunities, create new businesses, and preserve and strengthen our connection to Narragansett Bay, its watersheds, Rhode Island Sound, and the Atlantic Ocean.



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# The SURF difference

Rhode Island NSF EPSCoR gives undergraduate students a summer research experience that is as much learning about themselves as it is about the science.

By Amy Dunkle



Laura Anderson, a Marine Biology major at Roger Williams University, presents her work on the effects of ocean acidification on larval fish at the 7th Annual Rhode Island Summer Undergraduate Research Fellows Conference.

Forty undergraduates from the nine campuses of Rhode Island NSF Experimental Program to Stimulate Competitive Research (EPSCoR) spent their summer pushing the boundaries of science and gaining unparalleled hands-on research experience.

Under the guidance of 36 mentors, the students engaged in the 10-week program of intensive research offered by the Summer Undergraduate Research Fellowship (SURF) positions.

“It was the first time I had the opportunity to solely focus on lab work and research related to my lab work, instead of trying to find time between classes like during the school year,” said Megan Sylvia, a Salve

Regina University junior Biology major.

Sylvia worked on a project of Dr. J.D. Swanson, SRU, and Dr. Carol Thornber, University of Rhode Island, seeking answers to “How does gene expression change in *Ulva* bloom?”

In its eight summers, RI NSF EPSCoR’s SURF program has supported 215 fellows, who earn fellowships through a competitive selection process. The unique opportunity provides independent research in the lab of a faculty mentor and development of professional skills through topical seminars and workshops.

The program culminates with the presentation of research project findings at a major conference with Rhode Island IDeA Network for Excellence in Biomedical Research (INBRE) at the University of Rhode Island.

This summer’s event, the largest to date, featured more than 130 posters and drew more than 400 faculty, students, and administrators from URI, Brown University, Bryant University, Community College of Rhode Island, Providence College, Rhode Island College, Rhode Island School of Design, Roger Williams University, and Salve Regina University.

Reflecting on the experience, Sylvia said the summer reinforced her ambitions to go to graduate school and get her Master’s degree, although she remains undecided at this time about her specific area of interest.

“I do know that I love research,” she said. “It was nice to be able to ask questions and attempt to answer them myself through experiments that I came up with. It is a much different experience than going to class and participating in a lab experiment that has been completed over and over again and has definitive results.”

## A sample of summer 2014 projects

- How is protein expression of marine invertebrates affected by projected ocean temperature and pH changes?
- What is the potential for evolutionary adaptation of marine organisms to climate change?
- Impacts of climate change on harmful macroalgal blooms
- How can cutting edge genetic methods best be used in conservation biology?
- Causes of long-term declines of coral reef communities
- How will sea level rise affect abundance and distribution of near shore invertebrate and fish populations?
- Sea star wasting disease
- Can novel representations of living marine plankton foster public interest in and understanding of marine ecosystems?



Marine Biology major David Gleeson, University of Rhode Island, collects data for his SURF project, Coral Reef and Lionfish Study, in the British Virgin Islands. Photo by Kristian Dzilenski.

# What's killing the sea stars?

EPSCoR researchers investigate die-off on multiple fronts

By Amy Dunkle

**Balancing act:** Sea stars in many marine ecosystems represent the largest biomass of all benthic animals. They have a big influence on the ecosystem, with a diverse diet that ranges from microalgae and sponges to snails and bivalves like mussels, clams and oysters. There has been a profound die-off of sea stars on both the northeast and west coasts, causing considerable alarm among marine biologists.



A handful of sea stars rescued about five years ago after being stranded by the outgoing tide still live today at the Marine Science Research Facility on URI's Narragansett Bay Campus.

Although sea star die-offs occur periodically, the extent and severity of this die-off appears to be unprecedented. It is unclear how the ecosystem will respond without its biggest benthic operator. But, to better anticipate and appreciate, we can look to past experiences such as the 1983 rapid, widespread die-off of sea urchins. The sea urchins eat the algae that deposits on corals, which need to be clean to grow and reproduce.

When the urchins died, algae smothered the coral and the reefs died. Consequently, what begins as a seemingly innocuous die-off ultimately sets off a chain reaction that disrupts the relationships between organisms and the delicate balance of our oceans, which, in turn, can hurt our marine-based economy and quality of life.

Ed Baker first noticed something out of the ordinary with sea stars about five years ago, when thousands to tens of thousands were washing ashore alive, seemingly fit, at high tide and getting stranded by the outgoing tide.

Baker, manager of the Marine Science Research Facility at the University of Rhode Island's Graduate School of Oceanography, said he observed the mass stranding on the beaches either side of the Bay Campus pier; a fairly small area of coastline.

"It's very strange to see sea stars washing ashore and in such great numbers; this type of behavior reminds me of lemmings running off a cliff," said Baker. "So, I took some and put them in tanks. It was just a matter of curiosity, a science question — do these things survive if they're not left on the shore?"

Of Baker's initial group, all survived in the lab for years. Four remain alive today.

That the sea stars did not die in the tank led him to wonder: What were they doing coming into shallow water? What was

causing this seemingly voluntary behavior where they survived when not stranded at high tide?

A year later, sea stars brought in from the wild and kept in a separate tank, began to deteriorate. They developed lesions and died in a bizarre manner, their arms melting away as if they were subjects in a Salvador Dali painting.

Caitlin Del Sesto, then a URI Marine Biology senior, had intended to use some of them for an invertebrate zoology class project: "I collected sea stars and put them in a tank. They looked limp and slimy, with white lesions. Then, their bodies would just disintegrate. Before I could even start my project, they all started dying off."

That was about the time when Dr. Gary Wessel ran into trouble trying to find sea stars for his research at Brown University.

A biology professor, Dr. Wessel conducts research with sea stars in his study of how animals reproduce. The Woods Hole Marine Biological Laboratory's (MBL) Resource Center, the



From left to right: Ed Baker, Dr. Marta Gomez-Chiarri, Dr. Gary Wessel, Dr. Roxanne Smolowitz

main source of his supply, could not find live specimens, so he checked with Baker, who talked about the enormous numbers of live sea stars washing ashore.

Meanwhile, Dr. Marta Gomez-Chiarri, URI College of the Environment and Life Sciences, came across sea stars washed ashore and dead while walking her dog along a Jamestown beach. She, too, was intrigued by the incident.

Professor and Department Chairman, Department of Fisheries, Animal and Veterinary Sciences, Dr. Gomez-Chiarri studies oysters and oyster aquaculture, researching methods to manage disease. A great abundance of sea stars prior to the current die-off caused significant problems for aquaculture farms because of their predation.

“Something major was going on — the population exploded and then completely crashed,” Dr. Gomez-Chiarri said.

At Roger Williams University, Dr. Roxanna Smolowitz, whose expertise lies in aquatic veterinary science, fielded a call from the MBL about sea stars going limp, dropping legs, getting sick, and dying.

She said a major mass mortality of sea stars occurred in 1985, but researchers were unable to culture anything and couldn't find an infectious agent. The episode passed, as have other die-offs. None, however, have been on the dramatic scale of what is taking place today.

“We'd have one group dying in one location,” she said. “We didn't know what caused it, but then it would end. Now we have multiple groups of starfish that have developed very similar epidemiological circumstances.”

The general consensus is, the outbreak should have ended by now, but instead it is ongoing and generalized, with a range of impact from mild to severe.

### Collaboration on all fronts

As alarming as the trend is, the timing of it was fortuitous, coinciding with the seventh round of Collaborative Research Grants from the Rhode Island Science & Technology Advisory Council (STAC). The 2013 grant cycle called for proposals that addressed the three research questions related to Rhode Island NSF Experimental Program to Stimulate Competitive Research (EPSCoR): What are the impacts of climate change on marine life?

Dr. Wessel reached out to colleagues in the RI NSF EPSCoR community to capitalize on their varied expertise — Baker, at the Marine Science Research Facility; Dr. Gomez-Chiarri, prevention and management of infectious diseases in cultured and wild shellfish and finfish; and Dr. Smolowitz, marine animal clinical medicine and pathology.

Del Sesto, at the time applying for admission into the graduate program in Biological and Environmental Sciences at URI, jumped on board too, in Dr. Gomez-Chiarri's lab.

Dr. Wessel said, “We've approached the problem from a wide variety of disciplines. The collaborative grant got us together and talking, which was extremely productive. We all have very different backgrounds, different perspectives from each of the areas. It's made for a real synergy.”

The researchers find the mortality compelling on multiple fronts, starting with sea stars being a keystone species.

The ocean's benthic, or deep, areas are highly fragile and do not have a lot of resources to compensate for abrupt changes, said Dr. Wessel: “Everything is accounted for in the way the ecosystem is stabilized. Everything is in balance. It's like a house of cards — yanking out one card has a huge impact on adjacent cards.”

From the veterinarian's perspective, Dr. Smolowitz said diversity was critical in both direct and indirect ways: “It's like if we only had cows and no other kind of animal. What would that mean for the world?”



A system of tanks, left, holds sea stars from an oyster farm near Woods Hole, Mass. Jillon McGreal, right, a URI undergraduate student working on the sea star research, shows the white lesions and melted arms of a dead sea star. Photos by Andrea Cacase.

Certainly, populations do shift and change, but typically at a more natural pace, whether year to year or decade to decade.

The rapid and dramatic removal of a species, such as the case with the sea stars in Narragansett Bay, does not allow the ecosystem time to adapt. And, the fact that the die-offs can be seen on both North American coastlines poses an especially troubling scenario.

“When you're looking for epidemiological factors and you see that it's contagious, your ears perk up,” said Dr. Smolowitz. (continued on p 6)

## WHAT'S KILLING THE SEA STARS?

(continued from p 5)

"It's not just the common starfish. On the West Coast, several species are having massive die-offs. It's possible the same infectious organism may be causing mortality."

### In search of answers

One of six teams awarded STAC Council Collaborative Research Grants in 2013, the sea star group pools ecological, veterinary, molecular, microbial, and aquaculture expertise from three RI NSF EPSCoR institutions.

At the Marine Science Research Facility, Baker helped with the experimental design and set up of a tank system with filtered and sterilized water to monitor healthy, sick and dying sea stars.

Dr. Gomez-Chiarri's lab studies the characterization of the disease and mode of transmission, working to replicate the disease in a controlled situation, studying the cause and influential factors, trying to pinpoint the agent.

Del Sesto spends much of her time conducting experiments, making observations, taking skin swabs to determine what bacteria are present, comparing the healthy and sick animals, trying to isolate where any differences may lie. While answers remain elusive at this point, one thing is clear — once the sea stars get sick, life ends quickly.

"In seven to 10 days, they're dead," Del Sesto said.

Dr. Smolowitz examines what is taking place histologically, or within the tissue, hoping to identify any pathogen that might be causing death. Along with other veterinary pathologists, who are examining west coast species, she is looking at the microscopic appearance of lesions in the sea stars.

Dr. Wessel arrives from a molecular approach and sequences bacteria in healthy and sick sea stars to determine what commonalities might exist. One of his post-doctoral students, Vanessa Zazueta, works on identifying microbe candidates that might be involved in the disease, isolating and sequencing DNA, and establishing a list of candidates.

The team sends samples to a collaborator in Florida for identification of virus sequences in exposed sea stars. A neurologist at Cornell is looking at potential infectious agents.

Everyone involved basically agrees on what they are seeing. They just don't know what, yet. The researchers hope that by joining forces and putting together all of the pieces, a big picture will emerge.

### A sign of what's to come?

So far, the disease has proven to be infectious and not confined to a singular sea star species. It kills quickly and is transmitted through water, and does not require direct contact. And, while it causes damage on the skin, there do not seem to be huge changes in the tissue.

And, according to Baker, to this day it remains unclear if the mass beach strandings and wasting syndrome deaths are related or two separate events.

Certain environmental conditions appear to trigger the onset, although the specifics remain elusive, indicating that stress



Vanessa Zazueta, a post-doctoral student of Dr. Gary Wessel's at Brown University, works to identify microbe candidates that might be involved in the sea star wasting disease. Photo by Andrea Cacase.

plays a role. Researchers say the culprit is not a parasite. They see bacteria on the lesions, but bacteria are normally present. Is, then, the source viral?

Dr. Wessel said his sense at this time is that the disease could be a combination of multiple factors, possibly virus, bacteria, and environmental stress. Although the process is driven by the search for answers, he said, there is immeasurable value in the scientific journey.

"Any time there is a disease like this, it is instructive," Dr. Wessel said. "It could be a lesson on how to deal with future episodes, what to anticipate, how to go about solving it."

The research and the collaboration yield a greater understanding and push the boundaries of science. The mentoring and training of students prepares the next generation of explorers as they contribute to the overall body of knowledge.

Zazueta said the project was challenging both in scope and meaning, and it has given her the opportunity to learn new techniques and master new skills.

Likewise, Del Sesto, who wants to pursue marine pathogen research, said she was learning from the science as well as the scientists, who have gone out of their way and taken the time to walk her through the procedures.

"It's huge to get this kind of experience, to really develop an experiment, figure out what we're trying to learn and monitor the results," she said. "It's been an incredible experience. I've learned so much more than I ever imagined."

Veteran scientists also find tremendous worth and potential in the process. Dr. Gomez-Chiarri reflected, "To me, all of the diseases are interesting. It's part of nature, part of how populations are controlled."

The mystery of the sea star deaths raises compelling questions that transcend the die-off of a species and lends a sense of urgency to finding answers. Easily stressed and sensitive to environmental fluctuations, sea stars could be the harbinger of what the future holds.

Dr. Gomez-Chiarri said: "What are we doing to our oceans that may be making this worse? Is this a sign of more problems to come? If we wipe out sea stars or sea urchins, what could be the cascading effect? Our oceans are changing — are we changing the conditions too much? Can we expect changes in other populations?"

# Students serving students

Peer support programs help keep undergrads on track

By Amy Dunkle

Drawing students from diverse backgrounds into the science, technology, engineering and math (STEM) fields fosters individual growth and opportunity, while helping expand the knowledge base and contributing to discovery.

Ultimately, keeping these students in school and on track through graduation signals the true measure of success, from touching lives to broadening the STEM pipeline and bringing about systemic change, which plays a key role in the mission of Rhode Island NSF EPSCoR and its partner institutions.

At Rhode Island College, the two-year-old initiative, Learning 4 Life (L4L), takes an innovative tack with peer-to-peer guidance and institution-wide support, aiming to increase the number of underrepresented, first generation college students to graduate.

Similarly, working within the College of the Environment and Life Sciences (CELS) at the University of Rhode Island, Seeds of Success (SOS) focuses on student-run initiatives to provide the academic, social and professional guidance that often determine an undergraduate's success.



The College of Environment and Life Sciences Seeds of Success program offers guidance, resources, and opportunities to help students establish a firm footing. Photo by Chandu Dondeti, URI CELS.

bring together and make available the many resources that can mean the difference between dropping out and graduating. The intention is to connect students with academic, social, life-skill, financial, and career-related support.

“First generation college students — and I was one of them — are not accustomed to knowing that there are offices and services that can help them when they bump up against a struggle,” Lambert explained.

Often times, economic hardship will be what leads a student to the L4L program and Navigators. Housing, transportation, child care, book and computer needs — all pose serious obstacles.

Lambert said three quarters of underrepresented students work a job while they attend school at RIC; 86% are commuters. Although students can qualify for financial aid to cover tuition, they often run up against the challenge of how to go to college and live: “They don’t have someone funding them or maybe they contribute to the household income, or they’re parenting students with their own children to take care of.”

Michelle Fontes-Barros, CELS Coordinator of Student Diversity Initiatives, said the SOS program grew from what she saw as a gap in students of color achieving success in the college. Charged with engaging more students of color and making sure the resources were available for them to succeed, Fontes-Barros created a community of students within CELS and put them at the helm.

She said she managed and supervised students, but she asks them to step forward and determine what they need and want. Heading into its third academic year, the program pulls together a CELS SOS leadership retreat each summer to plan and set goals.

“What really ends up happening at the retreat is we identify  
*(continued on p 23)*



The Rhode Island College Learning 4 Life program pairs students with a network of trained peers to provide support and ensure successful completion of an undergraduate degree. Photo courtesy of RIC Learning 4 Life.

“Doors are opening, new opportunities are coming out into the light,” said Chris Lambert, director for RIC’s L4L program, an initiative heading into its third academic year this fall.

Funded by the federal College Access Challenge Grant, with the money administered by the state Office of the Postsecondary Commissioner, L4L pairs students with Navigators, a network of trained peers, either senior undergraduates or first-year Master’s students, who provide support as the newly matriculated students pursue their academic goals.

L4L also collaborates with College Crusade of Rhode Island, Goodwill Industries of Rhode Island, and College Visions, to

# Summer research in Antarctica

## Seeking clues in krill for climate change impact

By Abigail Bockus



Rhode Island NSF EPSCoR graduate fellow Abigail Bockus works at the Palmer research station during the austral summer on the Western Antarctic Peninsula. Photo by Matt Galaska.

Sometimes, the answers to society's biggest questions can be found only by travelling to the most remote places on earth.

Last December, a group of scientists from the University of Rhode Island and Rutgers University spent four months of the austral summer on the Western Antarctic Peninsula. There, isolated at Palmer research station with only 40 other people, these scientists set out to answer what impact climate change will have on the keystone species of the Southern Ocean.

Antarctic krill can be found in the stomachs of most whales, seals, penguins and birds around the Antarctic continent and serve as the link between these large predators and the primary producing phytoplankton — microscopic plants — that form the base of the marine food web.

Krill are not only an essential component of the ecosystem in this area, they also support a large commercial fishery that

variables on krill metabolism, growth and reproduction.

Choosing conditions that are expected to occur by the year 2100, we assessed the effect of both more acidic and warmer seawater on the krill alone, as well as in combination. Often, the influence of one stressor (in this case, lower pH) can be exacerbated greatly by the presence of a second stressor (increased temperature), as the two work together to elicit a stronger negative response.

Therefore, it is possible that while krill might do well when faced with only one of these challenges, they will be unable to handle the stress of both simultaneously. By looking at krill physiology under these conditions, scientists are beginning to understand their ability to acclimate to our changing oceans and how these animals, their populations, and the populations that depend on them will be affected.



Antarctica scenery, including, far right, the view from Palmer Station with Anvers Island in the background. Photos by Matt Galaska/Abigail Bockus.

The region surrounding the Western Antarctic Peninsula is experiencing some of the most rapid climate change with an increase in temperature five times the global average. With cold temperatures that last year-round, animals in this area already face an increased risk as they experience little natural variability and are ill equipped to handle a new, changing environment.

My colleagues and I are shedding light on what we can expect for the overall fate of Antarctic krill and the delicate ecosystem they support.

has operated for more than 35 years and whose marketability is growing. As the most abundant species on earth, the substantial ecological and economic contribution these animals provide is in danger as the population faces an uncertain future under the growing environmental challenges presented by climate change.

Last season, as a Rhode Island NSF EPSCoR fellow, I worked with a research group at Palmer station, experimenting on live krill to help predict the long-term health and status of the population. By manipulating seawater pH and temperature, the two major environmental factors being influenced by climate change, we were able to examine the effect of these changing

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*Abigail Bockus is a fourth year graduate student at URI, under the mentorship of Dr. Brad Seibel, earning her Ph.D. in Biological and Environmental Sciences with a specialization in Integrative and Evolutionary Biology. She next hopes to secure a postdoctoral position that combines her background in physiology with research focused on localized biogeochemical processes and cycling. Her career goal is to continue her research focus on marine responses to climate change under the umbrella of academia, industry or government.*



# Central Falls students join EPSCoR journey

By Amy Dunkle

When Rhode Island NSF EPSCoR grad fellow Abigail Bockus headed to the South Pole to study krill, she brought along eighth graders from The Learning Community in Central Falls.

The students weren't there in person, but they made the journey through a series of weekly videos that Bockus posted from the Palmer research station.

Prior to her departure in December 2013, Bockus worked with educators from the K-8 public charter school and Tim Pelletier, Rhode Island NSF EPSCoR education, outreach and diversity coordinator, to design a video feed that aligned content with the state's Grade Span Expectations (GSEs) and linked to the school curriculum.

She dubbed the initiative The South POLE: Polar Ocean and high Latitude Exploration and posted a video each week, typically against the backdrop of stunning Antarctic views.

In the classroom, Learning Community teachers played the video for their students, with Bockus' lessons sparking conversations about creating hypotheses, formulating predictions and anticipating results. The students kept expedition journals, broke into groups to discuss the lessons, and posed questions for Bockus to answer in the following week's video.

The interactive technology gave the school's eighth graders an inside look at what life is like at a remote field station. They learned about the scientific method, the ecology of the Southern Ocean, and why scientists travel 7,000 miles to conduct research there.

Bockus said she started the program to give students a chance to experience the questions and life of a scientist in a personalized way.



A class of 8th graders at The Learning Community in Central Falls engage in The South POLE project.

"My hope was that by meeting the students and letting them ask questions, they would be more engaged in the research, making it easier for them to learn the lessons," she said. "I wanted the kids to walk



**"I wanted the kids to walk away not only having learned something about field work and science, but feeling like they had been a part of it."**

away not only having learned something about field work and science, but feeling like they had been a part of it."

As the project came to life, Bockus said she was thrilled to receive positive, reinforcing feedback from the teachers. The students were excited to learn about life and science in Antarctica, and be called out by name in the video when their questions were addressed.

Bockus said planning the lessons with the teachers and administrators was, in itself, an amazing experience. And, it was rewarding to hear that the group's goal of engaging the students was working.

"As the scientist with the initiative, it was my first time working with people who knew how to take my ideas and mold them into concepts that were interesting and understandable for the kids," said Bockus. "I learned a lot about catering science to a younger demographic and the time and effort it takes to put outreach into action."

Bockus is looking forward to a return trip to Antarctica later this year to further her research. She also hopes her South POLE project and public Tumblr platform — <http://abigail-bockus.tumblr.com/> — will inspire others to bring interactive science to more classrooms.



# PRESERVE AND PROTECT

3-state project pioneers  
watershed health study

By Amy Dunkle



Colin Massa, *left*, URI Environmental Science major, and Mason Garfield, URI Civil Engineering major, calibrate and reinstall a water sensor at Middletown's Maidford River.

**T**he North East Water Resources Network (NEWNet) study is a multi-faceted, many

layered project that pulls together people, resources and disciplines in three different states in pursuit of one common goal — water quality.

Yet, the implied simplicity of those two words belies the great challenge of the three-year, \$6 million project (\$2 million to each state), which is as ambitious as it is pioneering.

Funded by the National Science Foundation (NSF) Experimental Program to Stimulate Competitive Research (EPSCoR) program, the Research Infrastructure Improvement (RII) Track-2 project features the best and brightest minds of Rhode Island, Delaware and Vermont, in the fields of hydrology, biology, chemistry, economics, and marine robotics.

Pooling the latest technology with cutting edge science, the Track-2 project is providing researchers with new, incredibly detailed information to better assess, protect and preserve water resources. Although tailored to each of the three states, the project's framework will set the stage for the next frontier of watershed management.

"This study gives us for the first time, real-time data from streams that drain into our drinking water and coastal waters," explained Dr. Art Gold, the project's Principal Investigator for Rhode Island.

Dr. Gold, Professor, Department of Natural Resources Science, University of Rhode Island, said information gathered by the study provides high-resolution information that can capture the movement of pollutants during extreme storm events.

"We have never had this kind of capacity before," Dr. Gold said. "Historically, we'd go out and monitor once a week. Now, with sensors, we can remotely sense all intense floods and monitor the pulses of contaminants every 15 minutes or half hour."

Researchers immediately noticed the value of the sensors during the July 4 arrival of the 2014 hurricane season's first storm, Arthur. A two- to three-hour period saw large amounts of sediment swept into the stream and downstream waters. These sediments were associated with a number of other contaminants and suggest the need for better sediment



Dr. Art Gold, *left*, URI, Principal Investigator for Rhode Island NSF EPSCoR Track-2, and Dr. Breck Bowden, University of Vermont, Senior Personnel, Sensor Project Watershed Expert, visit Aquidneck Island watershed sites.

controls. Under the old methods, the event likely would have been missed.

Given the real time data, communities can make better decisions on behalf of their water resources. To gauge the importance of this capability, we don't have to look any further than this summer's crisis in Toledo, Ohio, where a toxic algal bloom made the city's water unsafe for consumption and use.

"We are facing a very critical water quality challenge," Dr. Gold said. "In order for us to be efficient in the way we are protecting and restoring our water resources, we must understand how and when pollutants move.

"When we talk about water resources, we are very interested in how do we protect and restore drinking water reservoirs, lakes, streams, beaches, and estuaries. These are our receiving waters, the waters we recreate in and drink;

the waters that are important for our fisheries."

Essentially, the quality of these water resources mirrors what takes place on the land draining into water. They reflect the human activity and the decisions made about how the land is used.

During rainfall, whatever is on the pavement washes off and flows into the watershed. Subsurface, leaking sewer pipes drain into the watershed as well. On agricultural land, farming practices typically include applications of fertilizer, manure or pesticides, potentially contributing to further pollution.

Extreme weather events, with increased and prolonged downfalls, compound the problem and impact the flow of pollutants. What may stay put in lighter rain flushes into the water under the greater force of an intense storm.

"This project has a number of different components," Dr. Gold said. "How do we deal with the challenges to water resources posed by the intense land use that characterizes Rhode Island? How do our watersheds react to extreme climactic events? How do we sustain high water quality in dry and wet weather conditions?"

The key is that as we begin to understand the consequences of our land use – from how we farm to where and how much we build, and what we pave – we can better appreciate the risks, grasp the scope of the problems we create, target problem areas, and quantify the costs of resolution.

*(continued on p 19)*



# Watershed study treads new ground

## Latest sensor technology tracks data, gives in-depth look

By Amy Dunkle

**P**laced in Rhode Island watersheds early this summer, three state-of-the-art sensors are taking the pulse of freshwater resources in the Ocean State.

Researchers deployed the sensors in three streams, one in Scituate and two in Middletown. Each stream drains watersheds surrounded by differing land use — forested, agricultural and urban — yet, are similar in terms of size, soils and geology.

“Traditionally, the method for studying river water quality consists of collecting water samples periodically, like once per month or season,” said Kelly Addy, a University of Rhode Island hydrologist. “This approach can miss many trends that occur in short timeframes as well as the impact of extreme weather events.”

The sensors measure such parameters as water depth, temperature, dissolved oxygen and organic matter, nutrients, and cloudiness. They record the information every 15 minutes and transmit the data via cellular network with almost instantaneous Internet accessibility.

In addition, automatic water sampling equipment at each site is triggered to collect water samples every 30 minutes throughout the course of a storm or during some other period of interest thereby allowing the analysis of additional contaminants.

Addy said, “The ultimate goal of the project is to provide immediate and valuable information so that the state and local communities can make timely decisions and enact policies to best preserve and protect our water quality.”

As part of the North East Water Resources Network (NEWNet) partnership, Delaware and Vermont researchers are placing the same equipment in similar types of streams to provide a comprehensive regional picture of how climate variations may play a role in water quality and quantity during extreme weather events.

With three states of varying local climates, precipitation, and population density collecting data, the information compiled will present a unique and valuable perspective.

Geographically, researchers can view the project in terms of the north-south corridor of Vermont-Rhode Island-Delaware. From north to south, there is a progression from colder to warmer climate as well as from lower to higher populations.

Addy said the commonality in the equipment design and these varying features would allow researchers to tease out data



URI hydrologist Kelly Addy and Salve Regina University ecologist Dr. Jameson Chace test a water sensor (inset photo) in advance of setting up the system for the Track-2 research project.



trends to fill in unknowns and provide a more complete picture of what is taking place locally, statewide and throughout the northeastern corridor. Project results will give local and state officials the insight and tools they need to make better land use decisions.

### What the sensors tell us

Monitoring the Rhode Island watersheds involves two different types of sensors, one of which will track general parameters, such as temperature and pH. The second sensor records nitrate-nitrogen measurements. Nitrogen is particularly important to coastal waters.

Classic sources of nitrogen include fertilizers, whether agricultural or home use, and septic systems. Excess nitrate flowing into coastal waters can trigger algal blooms, a decline in dissolved oxygen, fish kills, and the decline of beneficial aquatic eelgrasses that can support shellfish communities.

*(continued on p 19)*



# Will better information lead to better choices?

## Researchers study influences on decisions that impact water quality

By Amy Dunkle

**T**he hydrological and geological data being collected by high tech sensors in three Rhode Island watersheds will do a lot more than track what flows through our water.

The information also will be plugged into economic models that can test how the better monitoring influences people's actions; whether people will make better choices if given better information.

"The social science role is to try to understand how better information about water quality affects people's decisions," explained Dr. Emi Uchida, Associate Professor, Environmental and Natural Resource Economics, who is leading the University of Rhode Island's economics team for the Rhode Island NSF EPSCoR watershed project.

Here in the Ocean State, Dr. Uchida is working with URI faculty Dr. Todd Guilfoos, Assistant Professor, Environmental and Natural Resource Economics; and Dr. Simona Trandafir, Visiting Assistant Professor, Environmental and Transportation Economics; and RI NSF EPSCoR graduate fellow Haoran Miao.

The group members also collaborate with their peers in Vermont and Delaware as part of the three-state North East Water Resources Network (NEWRnet), conducting experiments to gauge whether and how the information sways behavior.

### What incentives work?

For example, this spring, the economists experimented how better monitoring of water quality affected business owners' decisions about how much to produce when more production meant more contaminants and a higher penalty.

Non-point source pollution — when contaminants from many sources move with the soil through the watershed, untraced — complicates the situation. If the regulator cannot trace whether your business is responsible for the pollution, what incentives might encourage you to employ environmentally friendly, possibly more expensive, practices?

This base level of studying individual behavior, how specific information causes a person to act in a certain way, is being tested using methods in experimental economics. Student subjects involved in the study played for real money; the amount they took home depended on how well they performed, providing critical insight into how different frequency and intensity of water quality monitoring dictate behavior.

One of the challenges, however, stems from the fact that there are yet few applications of such experiments in the realm



Study subjects consider information and make decisions as part of a research experiment at the University of Rhode Island.

of water quality, so researchers faced the task of designing the experiment and integrating economic decisions with an appropriate hydrological model that can simulate their impact on water quality, explained Dr. Uchida: "How people react to better information about the environment is new territory."

That they are treading on some unfamiliar ground is not lost on the researchers. Dr. Uchida said the experiments could apply to other settings, such as climate change, where gauging the impact of information on behavior could yield valuable data.

### The decision-making process

The study gives subjects a role and specific information to act on — each operates a parcel of land alongside a river, and they get to make decisions about how much they will produce.

They also receive information about the impact of their production levels and details about water quality monitoring. Water quality monitoring is done at one or more points along the river at different frequencies. Will they opt to produce less if they know that the water quality is being monitored at a higher frequency or at more locations? What if they can get a subsidy to offset revenue loss?

"We start under a setting where there is no monitoring and no tax or subsidy," Dr. Uchida said. "Then, we change how the water quality is monitored and also introduce a tax or subsidy depending on the level of pollution. For example, in one setting water quality may be monitored at one point in the river, once a period. Then in another setting, the water quality is monitored four times per period. That's going to change the incentives — they will have a higher chance of getting detected. How will this better monitoring affect their business decisions?"

Researchers also can add more factors into the equation such  
*(continued on p 19)*



## Conversation: Cutting edge chemical analysis



Photo courtesy of URI.

Dr. Jason R. Dwyer, Assistant Professor, Department of Chemistry, University of Rhode Island, is a senior investigator on the Track-2 grant. Tapping into his area of expertise in Nanoscience, Dr. Dwyer is working on the development of cutting-edge, laboratory-based chemical sensing

platforms for use in aquatic environments. He talks to *The Current* about his role in the project and the direction of his research.

**The Current:** What are you working on and what do you hope to achieve?

**Dr. Jason Dwyer:** My lab is investigating two main chemical sensing technologies for this grant: (1) creating low-cost chips for surface-enhanced Raman spectroscopy (SERS) — a spectroscopic technique to identify a host of analytes, from molecules to bacteria, from their spectral signatures or spectral “fingerprints;” and (2) nanopore single-molecule devices, which use a conceptually simple, all-electronic method for sensing and identifying the molecular constituents of a sample. We are exploring microfluidic approaches to ease sample handling for the use of both technologies in aquatic settings.

**TC:** Why is this work important? What should people know, why should they care, and what does it mean?

**JD:** “What is in the water?” The importance of this question can be understood on a visceral level as one contemplates a glass of drinking water, and on a more abstract level as one contemplates land usage policy. It is a question of importance to human health, climate change and, underneath it all, fundamental discovery. How does this planet work, with its people and creatures, and cities, farms and wilderness, and all parts interacting together? The question of what one can do with such chemical — and biochemical — information is a complicated one that other elements of this grant address. Information-driven processes require information and we seek to provide it.

**TC:** How will the results or findings of your work fit with what the other areas of the project are aiming to do?

**JD:** We are trying to take the tools of an advanced chemical analysis laboratory and put them directly in the aquatic environment so that sophisticated chemical analysis can be

done on-site and in real-time. This requires a substantial amount of laboratory-based testing and development in order to understand how to cope with challenges of the aquatic environment. This work needs to be clearly placed in the context of the grant: We are performing next-generation sensor development work, and the sensor group as a whole is using state-of-the-art instrumentation to provide much-needed (classical) chemical data today, in a way that is linked to grand issues important to human well-being and to discovery.

**TC:** Where are you at in the process?

**JD:** We have already published one paper that includes a report on some initial SERS work, and that work continues. To test our sensors, we are ramping up the “messiness” of the samples in the laboratory that we are analyzing. We follow the classical laboratory chemistry approach of creating samples with ultrapure water and known quantities of different molecules, to investigate how the presence of one component may affect our ability to detect another. To be ready for sensing in a natural aquatic environment, we also have to prepare for the “messiness” of fouling — the growth, for example, of biological films on the sensor that can lead to incorrect results or shortened useful lifetime. Classical sensors, including the ones used by colleagues on this grant, are equipped with wiper blades to try to overcome this problem.

**TC:** On a grander scale, any thoughts on how this work might push science forward or find new ground? Or, is it limited to this specific project?

**JD:** Chemical analysis — finding out what molecules are present, and in what number, in a given sample — is incredibly challenging, even in the laboratory, for nearly any sample. We are researching how to analyze a water sample with a complicated mixture of inorganic, organic and biological material on-site, and in real-time, using laboratory equipment normally operated in a pristine laboratory setting.

The principles that will emerge from this discovery process will help us to overcome similar challenges in biomedicine, such as routinely analyzing the composition of blood (itself a fluid with a lot of chemical components, with each component providing information on health) in even remote, resource-limited settings. We are in the business of detecting and identifying molecules in whatever setting they may be found. So, many design principles are transferable to other diagnostic/sensing challenges.

**TC:** What do you think about Track-2 and the platform it provides for collaboration across disciplines and states?

**JD:** Simply, to quote the introduction to a childhood science show called *Wonderstruck*, “Good science is good questions.” We are all studying systems (human, landscape or molecular) where all components are interacting — it is vital that we ask questions that explore those interactions, as this grant proposed to do.

Compiled by Amy Dunkle

“While it’s great for them to learn about the rain forests, I want them to be as passionate about what’s in their backyard.”



Dr. Jameson Chace / Photo courtesy of Salve Regina University



## A chance to bring about change

Salve professor engages campus, communities, citizens in environmental issues

By Amy Dunkle

**W**hen Dr. Jameson Chace heard about the Rhode Island NSF EPSCoR Track-2 proposal, the watershed research project struck him as the perfect opportunity.

Dr. Chace, Associate Professor in the Department of Biology and Biomedical Sciences and the Environmental Studies program, spent the last decade teaching, researching and mentoring students at Salve Regina University in Newport, where he also is a Pell Center Faculty Fellow.

But, when it comes to Aquidneck Island, his roots run deeper than his lifetime, which together with his life’s work has forged an inseparable bond to the local environment.

Dr. Chace grew up in Portsmouth, Bristol and Tiverton. His father spent his entire law career in Portsmouth and his mother worked for many years at Pearson Yachts. His grandfather built what is now called East Passage Yachting Center.

“I’ve had ties to the island far longer than I have lived there,” observed Dr. Chace.

In terms of the watershed project, though, Dr. Chace adds much more than the happenstance of his family connection. An interdisciplinary research project such as NEWRnet requires the cooperation among many fields.

“I’m not an expert in developing sensors or robotics, that is Dr. Jason Dwyer,” Dr. Chace said, “I am not an economist — that is the work of Drs. Guilfoos, Trandafir and Uchida. And, Dr. Art Gold is the global hydrology expert.

“I’m really a bird guy, an avian ecologist, but what I bring to the project is getting people — students, citizens, municipalities, and scientists — focused and cooperating on local environment issues.”

He also works tirelessly to provide hands-on experiences for his students so they learn that they can tackle local problems and make a difference in a community.

“It’s good for students, it’s good for the university,” Dr. Chace said. “While it’s great for them to learn about the rain forests, I want them to be as passionate about what’s in their backyard. And that’s what comes out of this.”

From his perspective, Dr. Chace said, he sees enormous collaborative potential. Students gain valuable knowledge, develop skills and help push science forward. Universities contribute information, tools and expertise. Municipalities provide a training ground with opportunities to develop best practices.

And the outcome — the restoration and remediation of watersheds — means reduced dependence on chemicals to clean the water that people drink.

“What I hope comes out of Track-2 will be better cooperation between different municipalities,” Dr. Chace said. “I also hope that there will be better cooperation between municipalities and universities, and I think we’re already seeing all of those things.

“Ultimately, I hope we see more watershed protection and better management, and perhaps other funding opportunities. The sensor data we’re generating now enables us to do a whole lot more, with better information.”



# Marine robotics provide new platform for gathering data on watershed conditions

By Amy Dunkle

If you happen to see an unmanned kayak this fall, trolling a marsh in a monotonous pattern, don't get alarmed. There is no eerie explanation — just the latest in marine robotics at work, tracking the content and quality of the Ocean State's water.

"These are new platforms in our quiver of sampling tools," said Dr. Chris Roman, Assistant Professor of Oceanography at the URI Graduate School of Oceanography. "We need more monitoring of such places to understand the ecosystem, but monitoring is expensive."

In an effort to collect data less expensively, Dr. Roman is working on robotic systems known as autonomous surface vehicles, or ASVs, to gather critical information to help scientists better understand what is taking place and how natural resources cope with the affects of climate change.

He brings his marine robotics expertise to the three-state watershed study funded by the National Science Foundation (NSF) EPSCoR Research Infrastructure Improvement Track-2 program.

Dr. Roman said his unmanned kayak and an aerial drone (planned for the project's third year) would augment the data being gathered by URI hydrologists Dr. Art Gold and Kelly Addy with the sensors placed in Middletown and Scituate watersheds.

The watershed sensors paint a comprehensive, long-term picture along with what occurs during certain events — such as a storm — that initiate runoff. Researchers also want to know what happens as such events filter through the salt marshes and run into Narragansett Bay. That's where the ASVs play a vital role.

"The ASV goes out and samples the water," Dr. Roman explained. "It's good at doing repeated surveys. We give GPS positions and tell it to drive around in organized patterns, basically a mission with a bunch of waypoints. The ASV can do it for a long time and not get bored."

An electric trolling motor propels the unmanned, 14-foot kayak using on board software that tells it where to go. The boat drags sensors through the water to measure various

parameters such as temperature, salinity, pH, and turbidity. These can be used to map out the exit flow response to an extreme weather event. The idea is to look for the dynamic or changing aspects taking place within the water.

In the project's third and final year, Dr. Roman said he planned to invest in an unmanned helicopter, similar to a drone, to carry out aerial photography of the watersheds to assess conditions such as water levels and water clarity.

The tools will allow scientists to track how much water filters through the watershed along with how potential pollutants get sequestered or flow through the salt marshes, which act as a buffer.

Together, the kayak and helicopter drone can provide an unparalleled view of exactly what is taking place in the watershed and Narragansett Bay. Dr. Roman said:

"The kayak is very good at making precision measurements. It can drive around in places that are otherwise hard to get to by boat, in a very repeated fashion better than a person can. The helicopter drone can get you fast access and aerial views of marsh that we otherwise can't get to easily — marshes are hard to travel by foot, but very easy to fly over. There are also few obstructions and no people to bother, and we can quickly access at a relatively low cost."



Dr. David C. Smith, Associate Dean for Academic Affairs and Professor of Oceanography, URI Graduate School of Oceanography, talks with visitors at the Feb. 2014 Providence Boat Show about a kayak being used in the Rhode Island NSF EPSCoR Track-2 project to help collect data from watersheds. Photo by Michael Salerno.

The joint project with Vermont and Delaware encompasses multiple disciplines of study, pairing Dr. Roman's ocean engineering with hydrology, economics and chemistry.

The first year has focused on selecting and placing high tech sensors in watersheds and building economic models that will gauge how better monitoring information can impact decisions on water quality.





# Students gain vital experience, hone new skills with Track-2 project

By Amy Dunkle

Rhode Island NSF EPSCoR's Track-2 project holds great promise not only for its cutting edge research, but also in the training ground it provides for the next generation of scientists.

A key component of the North East Water Resources Network (NEWNet) collaborative study centers on an exceptional opportunity for undergraduate and graduate students to gain unique, hands-on experience alongside faculty mentors as they develop research protocol in several emerging fields.

"I'm finding out what it would be like to actually have a career in my field," said summer intern Zoe Moskwa, a senior at Salve Regina University with a major in Environmental Studies and a minor in Biology. "I've never worked in watersheds before. It's opened up a whole new field for me."

Fellow intern and Salve junior Meaghan Senack, also an Environmental Studies major and Biology minor, echoed

her thoughts, adding, "I never thought of this field before. I've always had the idea of grad school in mind, so learning how to do field research is definitely a foot in the door."

Both young women spent the summer under the guidance of Salve's Dr. Jameson Chace, the institution's Track-2 partner liaison, and Jacob Peterson, who is pursuing his Masters of Environmental Science and Management (MESM) degree at the University of Rhode Island.

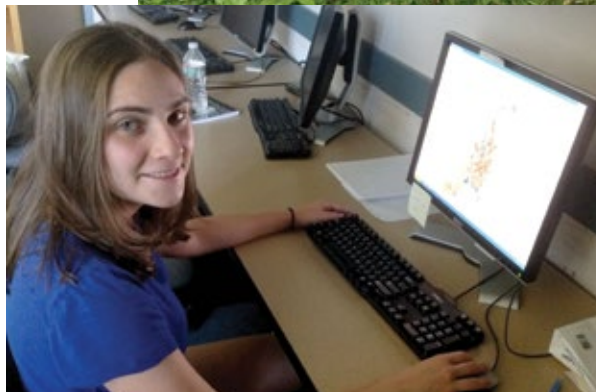
The student trio visited the project's stream sites on a daily basis, testing water and gathering data with handheld sensors and sampling macroinvertebrates, or bugs, in the water to track water quality.

They attended meetings with stakeholders, including Newport water system managers, state Department of Environmental Management representatives and members of Aquidneck Island communities.

The wide range of exposure and mix of undergraduate and graduate students, and faculty researchers, made for a remarkable summer of learning, according to Peterson: "It's a really fast process. The undergrads came in with zero hydrology knowledge. We collaborate, get them up to speed



Top: Rhode Island Track-2 interns Zoe Moskwa, middle, and Meaghan Senack, right, both Salve Regina University, work under the guidance of Jacob Peterson, URI, as they conduct macroinvertebrate sampling at the Maidford River site in Middletown.



Left: Kellie Brown, URI, spent her summer internship working with the URI economics team, researching the Clean Water Act, investigating non-point source pollution, and building watershed site profiles.

as fast as possible, all the while giving them relevant job experience."

Senack credited Dr. Chace with providing the chance to learn and encouraging the students to jump in, literally, with waders on in the streams.

"He's constantly bombarding us with emails about opportunities," she said. "This was definitely something new, and definitely better than typical lab research."

Nearing the end of the summer's research, Moskwa reflected, "I feel a lot more confident about doing research. It was a daunting task to go in with this question, having no idea if we were going to get any data. But, I learned, it's OK, we can go in with questions and we can learn from Jake and Dr. Chace, and get information from all sides."

## 'All under one roof'

In addition to the interaction between educational levels and expertise, the students also reaped the benefits of collaboration between disciplines, institutions and states.

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Mason Garfield, URI, analyzes data in the lab. He also worked with the installation and maintenance of the project's high tech water sensors.

## STUDENTS GAIN VITAL EXPERIENCE

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Delaware hosted the undergraduate interns twice during the summer, first at the beginning and then at the end.

"It was a great experience," Moskwa said. "My interest is in the broad spectrum of the environmental field, but it was really neat to see all the different areas coming together under one roof — chemistry, economics, physics, engineering, watersheds, environmental impact."

Kellie Brown, a URI Environmental Economics major, minoring in Political Science, and Tung Dang, an Economics major at Green Mountain College, Vermont, spent their summer with the economics team on URI's Kingston campus. They, too, spoke of the value of hands-on experience, learning new skills and narrowing down the course of their educational and professional journeys.

Brown, advised by Dr. Simona Trandafir, began her internship with researching the Clean Water Act, investigating non-point source pollution, taking field trips to the watersheds, and building site profiles. With Dr. Todd Guilfoos as his advisor, Dang designed economic experiments to help gauge how stakeholders respond to better information about water quality.

Both benefitted from the perspective of working with others in and outside of their disciplines. Brown, in particular, said her experience also revealed to her the gap between science and public understanding.

"I discovered how hard it was for me to find information," she said. "I had to do some digging. People who don't have that interest aren't going to do that."

And, for someone who had never left New England, the Delaware trips and interaction with others opened her eyes to the many available possibilities that exist: "I walked in completely unsure of what I wanted to do. Now, I'm thinking I want to do something with water quality. And, I definitely want to go to grad school."

Dang, from Vietnam, said the summer research experience confirmed what he thought he wanted to do — pursue a Ph.D. in economics — and substantially added to his skill set.

## Education, experience pay off

For Mason Garfield, a URI Civil Engineering student,

a hydrology class with Dr. Art Gold, Track-2 Principal Investigator for Rhode Island, led to his summer working with Dr. Gold and hydrologist Kelly Addy.

Much of the experience involved the project's state-of-the-art water sensors, installing and maintaining them, taking samples and analyzing data in the lab.

"It solidified what I want to do," Garfield said. "I really like the whole technical aspect."

Having completed requirements for his Master's this spring, Haoran Miao is pursuing a Ph.D. at URI in Environmental and Natural Resource Economics while working as a research assistant under the guidance of Dr. Emi Uchida with the NEWRnet social science team.

He investigates related literature, participates in economic experiment design, conducts and collects data from experiments, analyzes the data and draws policy implications. In the next year, he will help develop computational models used to simulate the actions and interactions of autonomous agents and policy effects.

Miao said the study provided him with experience well beyond his field of study: "I have learned a lot from the different disciplines. The professors inspire me to find my own research questions, solve questions with different skills and do philosophical thinking beyond the results."

Additionally, Miao said, the project helps students understand why water as a common resource should be under proper management and governance, and the importance of protection.

"Working with experienced hydrologists and economists, I can easily apply economic principles into the real world and gain more understanding about social dilemmas," he said.

## Real life application

Matt Wallace joined the project in the fall of 2013 as he headed into his last year of the URI MESM program and moved onto an environmental consulting job with Roux Associates, Woburn, Mass., less than two months after earning his degree.

"I did a little bit of everything," Wallace said of his Track-2 experience. "In the early stages, I was involved with identifying which stream we were going to put the sensors in, doing GIS work, making maps of land use."

Wallace worked on the front lines of the project as researchers selected the water sensor equipment, set up and calibrated the systems, and initiated the monitoring that is in place today. He learned freshwater sampling techniques, record keeping and data analysis methods.

Wallace said the extensive lab and fieldwork paid off: "It's important to have experience — it was a big selling point to get interviews and get my job."

And now that he's on the job, Wallace said, the experience continues to prove its value: "The fieldwork has translated very nicely. I've already been exposed to the same equipment we're using. It's almost the exact same set up, the same sensors, how to monitor streams. I'm doing the same baseline data collection."

## PRESERVE AND PROTECT *(continued from p 11)*

Through the work of the social scientists, the project moves from identifying levels and sources of contamination to designing effective rewards and subsidies for more environmentally conscious land use and decisions.

“The problem that we have in the Northeast is that we have very high expectations for our receiving waters, yet we have no backup,” Dr. Gold said. “We need to be pulling water on a daily basis, whether it’s for our drinking water or our tourist industry.”

With the Rhode Island sensors placed in three distinct locations — pristine forested, highly urbanized and agricultural — the Track-2 project offers a comprehensive look of the interactions between weather events and land use practices. Additionally, working back through the tributaries farther inland, researchers can extrapolate a more detailed picture of what contaminants are moving where and how.

Looking to the future, Dr. Gold said the scientists expect to see the cost of the sensor technology decrease and, subsequently, the use increase. What is being done now, he said, could not have been done 10 years ago.

The Track-2 study is laying the groundwork for other Rhode Island communities and other states to tap into the expertise and knowledge gained through the NEWRnet project, from static sensors placed in streams to the mobile systems being developed to roam the watersheds and economic models capturing human behavior.

Between the three NEWRnet states, Dr. Gold said, the project incorporates about a dozen sites in the study: “We don’t have a parallel situation. The way we are setting it up and the level of data we’re obtaining is unrivaled. EPSCoR is pioneering the use of real-time sensors for water management in the Northeast.”

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## WATERSHED STUDY TRENDS NEW GROUND

*(continued from p 12)*

Some algal blooms release toxins that can be harmful to humans and wildlife.

The obvious question is, if there is concern about nitrate in coastal waters, why place the sensors upstream in watersheds?

“It can seem like a little bit of a disconnection,” Addy said. “But, it is the practices within a watershed that can generate excess nitrate. Wetlands and streams can serve as filters for nitrate, but if these systems are overloaded, the nitrate will continue through the stream network and ultimately end up in coastal waters – for us, that is Narragansett Bay and coastal ponds along the south shore of Rhode Island.”

The sensor selected for the project detects and records information as a small beam of light passes through the water within a pathway on the sensor, giving researchers a full spectrum of data to consider. The continuous recording of data also will determine any daily pulses in water quality

## WILL BETTER INFORMATION LEAD TO BETTER CHOICES

*(continued from p 13)*

as employing a second sensor that will monitor businesses further upstream and penalize the entire group if the total concentration level increases.

### Observing strategic behavior

In the coming year, the study transitions to what is known as agent based modeling (ABM), where researchers can simulate how the reactions of different stakeholders to water quality affect each other’s behavior.

Dr. Uchida said one of the novelties of the project is that the social science team includes specialists in both experimental economics and ABM. In contrast to experimental economics that uses human subjects to observe real strategic behavior, ABMs are large scale simulations with different types of agents that are programmed with specific strategies, learning, or decision algorithms. This will allow the team to scale up the insights from the laboratory experiments, scaling up what they find in the experimental model in the ABM.

“We might be able to say, if we change the extent of water quality monitoring, not only how would a landowner respond, but also how that response affects other landowners,” Dr. Uchida said. “What happens if we allow business owners to communicate with each other? What happens if downstream businesses see that upstream businesses have cut their production? Will they come to a better decision that might result in less pollution?”

The team hopes to take the economic models beyond the test subjects to real stakeholders who make the decisions that impact water quality — landowners, farmers, business owners, municipal officials — and learn how to improve watershed management, which will lead to better water quality.

parameters as well as provide an in-depth look at extreme events, such as large storms or low flows that are extremely difficult to assess without such equipment.

Addy noted that the Scituate and Middletown streams of study also contribute water to public drinking water systems. These real-time sensors can be extremely helpful in detecting changes in parameters that may increase human health risks.

For example, high levels of organic matter being released into streams as a result of a major storm event could react with the chlorine used in water treatment facilities to generate trihalomethanes, which have been found to be harmful to humans. If the sensors detect organic matter levels above a certain threshold, the water managers could make adjustments necessary to prevent this hazard.

# Forum showcases economic development opportunities for RI NSF EPSCoR researchers

By Amy Dunkle

Rhode Island NSF EPSCoR provides the infrastructure where groundbreaking research takes place as scientists in the Ocean State seek to better understand the impact of climate variability on marine life and ecosystems.

The state's Science & Technology Advisory Council (STAC) and the University of Rhode Island are working to capitalize on these efforts with ambitious economic development initiatives that will reap dividends for the scientists, their home institutions and the state of Rhode Island.



Christine Smith

"We come in early on and help with seed funding," explained Christine Smith, STAC executive director. "STAC is a catalyst for projects that are multi-discipline efforts, working together to achieve what they can't do alone."

The driving force behind the RI NSF EPSCoR grant, the 13-member STAC was created in 2005. The following year, Rhode Island received its first NSF EPSCoR award — \$6.75 million for three years — with URI as the lead institution.

The Council serves in an ongoing role of advising state leadership on strategic investments that drive economic development and job creation by maximizing the economic impact of science and technology.

The state's second NSF EPSCoR award — \$20 million for five years — arrived in 2010 and is now in its fifth and final year. Lead Principal Investigator Dr. Carol Thornber, Associate Professor, URI Department of Biological Sciences, is spearheading the effort to gain the next five-year, \$20 million grant.

## Funding yields returns

Each year, STAC awards a round of Collaborative Research Grants to support projects well positioned to attract substantial follow-on investment and possess significant potential for development or commercialization.

The NSF mandates an annual state match of \$800,000 in collaboration with the RI NSF EPSCoR grant, with the funding dedicated to projects that focus on the RI NSF EPSCoR research themes. The 2014 grants announced in April represented the eighth round.

STAC has invested \$9.3 million to date in collaborative

research projects that have yielded a return of \$36 million back to the state in the form of grants for continued research, new federal programs, infrastructure improvements, commercialization of new products, and venture funding for new companies.

Smith, also Director of Innovation Programs at the RI Commerce Corporation, said the collaborative research projects, which can receive a maximum of \$200,000, also aim to produce the necessary data that helps launch the projects, push them to the next level, and make them competitive for additional funding.

As part of this effort, RI NSF EPSCoR hosted a group of STAC awardees and other EPSCoR researchers earlier this spring for a presentation and discussion about what opportunities exist to help them pursue product development.

"Projects that receive the STAC grants are in that very early stage," Smith said. "If you're going to receive these funds, it's important to understand where you can go. You may never get there, but you need to know where the resources are; you need to know where the path leads."

## Building new relationships



Katharine Hazard Flynn

In addition to Smith, Katharine Hazard Flynn, Executive Director of the URI Business Engagement Center (BEC), and Dr. Jim Petell, URI Associate Vice President for Intellectual Property and Economic Development, spoke about the resources their offices provide throughout the research and development process.

Flynn said the BEC interacts regularly with Smith and STAC on economic development opportunities, and with Dr. Petell and his office on making technological advancements accessible and available for development.

"When the BEC first opened, the idea was to create a front door, through which industry could interact with the university," explained Flynn. "But, even though we call it a front door, it's also a revolving door for opportunity."

Billed as the "business gateway to URI," the BEC offers connections to resources in five key areas — workforce talent, workforce development, sponsored research, moving ideas

**“STAC is a catalyst for projects that are multi-discipline efforts, working together to achieve what they can’t do alone.”**

**– Christine Smith,  
 RI STAC Executive Director**

Dr. Breea Govanar, *left*, Rhode Island College, and Scheri Fultineer, Rhode Island School of Design, accept a 2014 STAC award from RI Gov. Lincoln Chafee, far right, and STAC Co-Chair Dr. David Savitz, Vice President for Research, Brown University.



to market, and intellectual property — and interacts with students, faculty and businesses.

With the BEC as the central hub for activity, everyone benefits. Flynn said: “Industry wants to make one phone call. And, we can connect faculty and students to industry. STAC encourages collaborative research, which has been very successful for economic development. It goes to show, there is a return on the state’s investment.”

### Sustaining growth, development



Dr. Jim Petell

With the arrival of Dr. Petell three years ago, URI steadily began ramping up efforts to protect and advance faculty research. To reflect the changes in emphasis, his office was renamed.

“The intention of the URI Research Foundation is to create a vehicle to commercialize intellectual property, or inventions, by faculty,” Dr. Petell said. “It goes hand in hand with the STAC awards and other initiatives

such as state investment in SBIR grants.”

Dr. Petell said his work at URI started with structuring a new intellectual property, or IP, policy that now gives a faculty member as much as 90 percent equity in a company and URI and the Foundation about 10 percent.

The Research Foundation, together with his office, provides seamless guidance throughout the process, from providing feedback on ideas and the viability for commercialization to working with companies, drafting confidentiality and license agreements, and filing for patents.

In his time on campus, Dr. Petell said URI has seen about a tenfold increase in licensing along with a 25 percent increase in royalties, a growing number of patents filed and double the amount of patents issued.

Higher education also can offer companies intellectual capital, particularly for the small business that has limited resources. They can tap into the capabilities of students and faculty for innovative development that will help grow their business.

Another targeted initiative involves the Rhode Island Small Business Development Center funded by the SBA, which recently relocated to URI, where Dr. Petell is serving as interim director, to work with ventures of less than 500 people. The SBDC provides expertise for development, from offering guidance on business plans to launching a company or international marketing.

“The beauty is that now we can put all of these pieces together and fundamentally change the way we develop business in Rhode Island,” Dr. Petell said. “If you start with small companies, build them, there is a very high likelihood they will stay in the state. They build roots; they have family and connections. They’ll stay here and they won’t want to move.”



Students in the Educational Talent Search program wade through the rocky intertidal zone off Jamestown, in search of what lives beneath the water's surface, during a Hands-on Science Experience with Rhode Island NSF EPSCoR.

## Broadening the STEM pipeline

Trips introduce students to wonders of science, opportunities in education

By Amy Dunkle

In theory, Rhode Island NSF EPSCoR's education and outreach programming is simple — engage students in hands-on, meaningful learning opportunities that teach, excite and open the mind to possibilities.

The reality, however, is all that and so much more.

Called Hands-on Science Experiences, these trips bring youngsters from underrepresented racial and ethnic groups, typically first generation college track, to RI NSF EPSCoR research facilities and partner campuses.

"Part of our mission is to showcase what Rhode Island has to offer in terms of research infrastructure and higher education opportunities," said Tim Pelletier, RI NSF EPSCoR education, outreach and diversity coordinator. "These experiences provide students with the chance to learn about STEM fields and see that they can go anywhere they want with effort and direction."

Aligned with the classroom curriculum and state guidelines, the Hands-on Science Experiences model the kind of active, authentic and project-based learning that research finds most effective. The daylong trips package science experiments in the lab or out in the field with lunch in a bustling college cafeteria, dorm room and classroom tours, and admission information.

Equally critical to the success of the RI NSF EPSCoR program are the relationships and collaborative momentum Pelletier has built as the jurisdiction heads into the fifth of its five-year grant, and submits a proposal for another five-year round of funding.

### Pooling resources for best outcomes

One of RI NSF EPSCoR's early partners, since 2009, the Rhode Island Educational Talent Search (ETS) serves more than 1,000 low-income middle and high school students who are committed to their education and want to attend college.

Students must demonstrate the desire and ability to stay on top of their school work by achieving C's or better and, in exchange, gain guidance and support in pursuit of their college dreams.

ETS counselors meet regularly with students at their schools and make available an array of services, from study and test taking skills to standardized test prep, college information and tours, application assistance, career and financial aid information, and help filling out financial aid forms.

Bill Talbot, ETS Associate Director, said federal funding for the program remains contingent on its success in getting students to graduate high school and enroll in and graduate from college.

The ETS program retention rate from year to year runs more than 98 percent; 87.6 percent of graduating ETS seniors enroll in post-secondary education.

Talbot said opening doors and expanding potential played a crucial part in those success rates: "The Hands-on Science Experiences with EPSCoR have been huge for us in different ways. One is that for 10 years, funding from the federal government has been almost flat, so as costs go up, trips go down."



A day with RI EPSCoR includes exploring the creatures and ecosystem of the salt marsh at Jamestown's Fort Getty (left and middle photos) and learning about marine life at the URI Marine Science Research Facility.

Additionally, the STEM focus and the exposure to college campuses give students genuine insight into what might be possible.

“Not only to see a college, but to be at the Narragansett Bay marine facility or in a college lab, the experiences definitely help open their eyes and give them exposure to what they've never had,” Talbot said. “Tim and the EPSCoR program make college approachable.”

### Programs establish strong foundation

Manuel Pineda was born in the Dominican Republic, and came to the United States with his family when he was 11 years old. He graduated from Central High School this spring and is enrolled at Brandeis University.

Pineda said he joined ETS as a sophomore, after a friend told him about how Talbot helped him prepare for college. In turn, Pineda said, ETS helped him immeasurably with the entire college application process.

In his junior year, Pineda participated in a Hands-on Science Experience, dissecting sheep hearts in a lab at Roger Williams University.

“It was honestly one of the best experiences of my life,” said Pineda, who is the first in his family to attend college. “I learned so much from the dissection of the heart. I loved the part where we had to pour water in the heart and squish it, and it came out from a different vessel.”

Although Pineda is not on the STEM track at this time (he plans to study political science), he said the EPSCoR education and outreach program benefited students interested in all disciplines.

“If a student is interested in the sciences, he or she can see how they might want to have that as a career,” he said. “For other students, they get a chance to see what they might want to do when they go to college.”

And that, said Pelletier, is exactly the point — to make higher education accessible and attainable.

Pelletier said: “Hands-on Science is not only to give insight into the skills and education needed, and the research going on, but also to experience a day as a college student, to feel what it's like to be on a college campus and gain an understanding of college life.”

### DIVERSITY IN FOCUS *(continued from p 7)*

some of the barriers, such as some students are not buying books because they can't afford them,” Fontes-Barros explained. “So, we created a book exchange program where students can borrow books. Or lab coats — these simple things, you assume students can afford. One of the professors donated about 25.”

Students also are encouraged to donate books for their peers to borrow. The program often is about being resourceful and providing opportunities such as research internships. Or, it may be as basic as having upperclassmen share their journeys in higher education.

Said Fontes-Barros: “That exposure, that conversation among peers — that's a richness that no one else can provide.”

Whether guidance, resources, opportunities, or an open door, where students can walk in and find someone willing to listen and help out, SOS fills the gaps and helps students establish a firm footing.

Fontes-Barros said she knew it would take time to measure fundamental change, but she had no question that change would come and the numbers would increase in such areas as students applying for fellowships and the honors program.

But more than that, she said, she hopes to empower students coming through the pipeline to reach back and show those following in their footsteps what is possible to achieve.

“If I leave a legacy, it will be that we created a community of students of color who are mentors for incoming freshmen, building a network for each other,” Fontes-Barros said. “What gives me hope is this community of students coming together, whether it's just to talk or engage or share a lot of the same challenges.”

At RIC, Lambert, too, viewed the peer system as essential: “What's happening is that students are serving students — that piece is probably the most important. Their voices are bringing about institutional learning and change.”



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## RI Science and Technology Advisory Council

Launched in 2005 and sustained by legislative statute in 2006 to make innovation central to the state's leadership agenda, the Rhode Island Science and Technology Advisory Council (STAC) is the official oversight body of Rhode Island NSF EPSCoR.

In 2007, STAC created the RI Research Alliance to establish a statewide platform for collaboration across the state's research organizations, increase competitiveness for federal funding, and support efforts such as the EPSCoR, Centers of Biomedical Research Excellence (COBRE) and IDeA Networks of Biomedical Research Excellence (INBRE) networks.

STAC Council members represent the academic, business and policy leadership of Rhode Island. They meet on a regular basis to review progress and develop new recommendations for enhancing research and development, supporting entre-

preneurial activity, and increasing innovation in Rhode Island.

Christine Smith is Director of Innovation Programs at the RI Commerce Corporation and serves as STAC executive director.

### Council members are:

**David A. Savitz**  
Vice President for Research,  
Brown University (Co-Chair)

**Gerald Sonnenfeld**  
Vice President for Research and  
Economic Development, University  
of Rhode Island (Co-Chair)

**Janet Coit**  
Director, Rhode Island Department  
of Environmental Management

**Pierre Corriveau**  
Chief Technology Officer,  
Naval Undersea War Center

**David Hibbitt**  
Founder and Former Chairman,  
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