THE
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DIVISION OF RESEARCH
AND ECONOMIC
DEVELOPMENT

THINK BIG WE DO℠

Momentum:

Research & Innovation

Cover Story

THE SCIENCE OF
DETECTING SOLUTIONS
PAGE 4

Featured Inside

WRITING A NEW CULTURE
ON CAMPUS PAGE 16

CURRENTS OF
THE WORLD PAGE 44

Spring 2017

Momentum:

Research & Innovation

Welcome to the latest issue of *Momentum: Research and Innovation*, the research and scholarly activity magazine of the University of Rhode Island. We are proud to share with you the unique accomplishments of the faculty, students and staff in developing scholarship that will help to change the world. The responsibilities of a research university such as the University of Rhode Island include teaching and the discovery of new information. Sharing that new information with others allows it to be applied, leading to improvement in our daily lives. *Momentum: Research and Innovation* is one of the ways we can share our new information and new scholarly activities with the world. We hope you will enjoy the adventures.

Sincerely,

Gerald Sonnenfeld, Ph.D.
Vice President for Research
and Economic Development

spring 2017

What's inside

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The Science of

Detecting Solutions

written by **ALLISON FARRELLY '16**

Mindy Levine
associate professor
chemistry

URI student Sauradip Chaudhuri examining color changes to detect toxic compounds in the environment.

Oil spills, cardiovascular disease, and beverage safety don't sound like related fields of study, but they all fall under the research spectrum of University of Rhode Island (URI) chemist Mindy Levine.

As safety concerns around commercial products continue to grow, lengthy testing processes are currently the only way to know if what we put into our bodies is safe. Levine, an associate professor in the Department of Chemistry, is researching fast, efficient and on-site testing methods for our food and beverages.

"I don't want to spend my whole life in my lab playing with chemicals. I want to do something that is relevant and will help people," says Levine.

The chemist and her students are studying several critical research questions, through the lens of supramolecular organic chemistry. Her research examines how to apply the fundamental science of fluorescence spectroscopy to enable high-impact detection applications.

Levine investigates how fluorescence, which gives off a unique, highly specific and highly sensitive signal, can be used to detect specific chemicals in complex environments. The fundamental nature of her research allows her to apply the detection technology to find answers to many questions.

One issue that intrigues Levine is how we know if our food and beverages are safe for consumption. Despite the wealth of technology chemists have access to, she says they have yet to develop a method to crudely assess on-site whether harmful chemicals have leached into food or water.

Levine says when she microwaves her leftovers to eat for lunch in a plastic container, or finds a plastic water bottle in her sweltering car after a long day at the beach, she wants to know if the food or water is safe to consume without having to take it to her lab for testing.

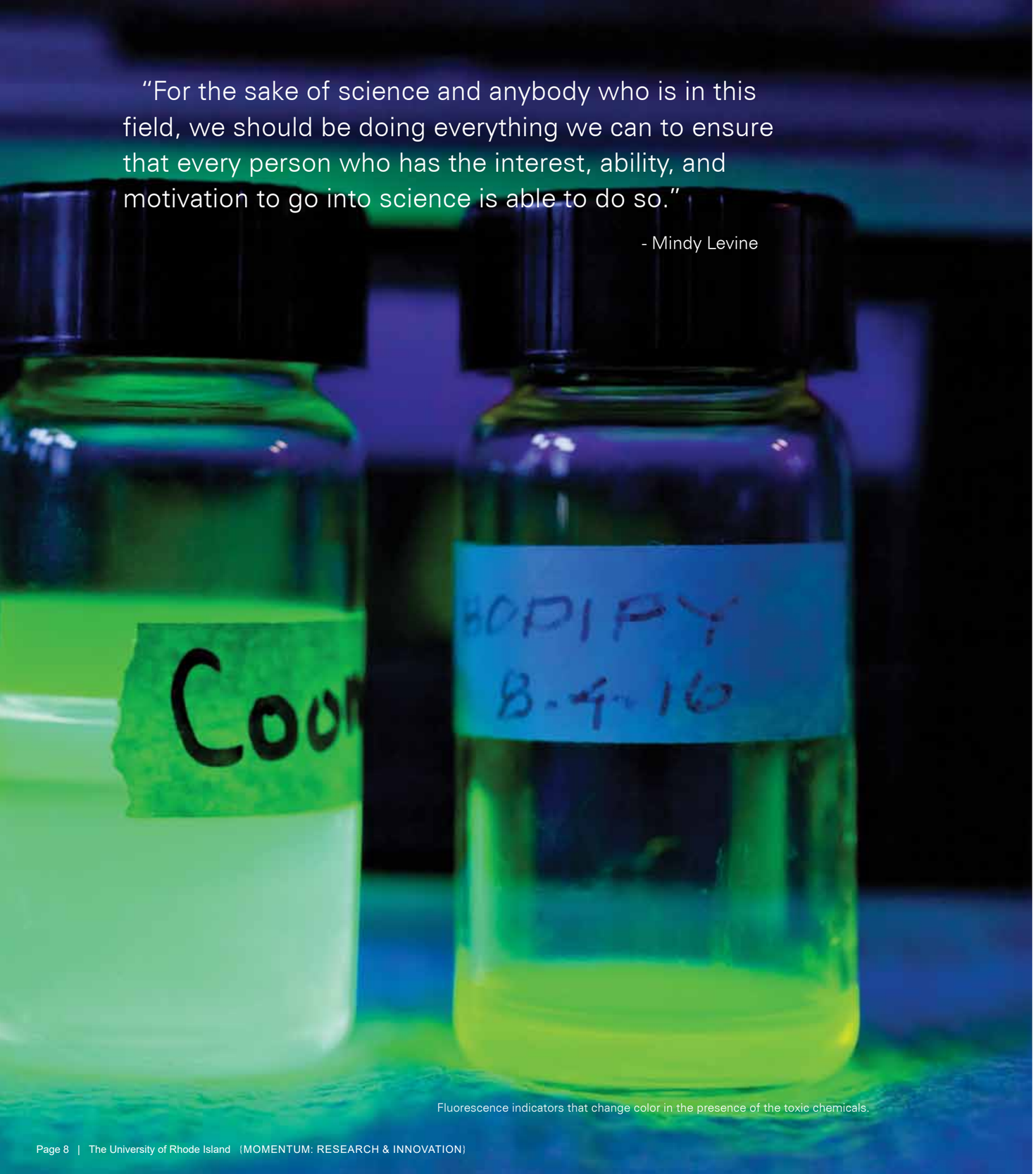
These questions led Levine to apply her research for the study of rapid Bisphenol A (BPA) detection

URI student Dana DiScenza measuring liquids from commercial containers to determine if packaging chemicals were found in the fluids.

technology. There is significant concern among scientists that long-term BPA exposure may cause harmful health effects. Now in the second year of a five-year $650,000 National Science Foundation grant, she is exploring the fundamental science that underlies sensor applications that could detect dangerous chemicals, like BPA, in food and water. One of her goals is to develop a smart phone app that could detect harmful chemicals by reading a test strip people would dip into their food or beverages.

This technology is merely one application of her research. The most accurate way to think of her research, according to Levine, is as developing

LEVINE SAYS WHEN SHE MICROWAVES HER LEFTOVERS TO EAT FOR LUNCH IN A PLASTIC CONTAINER, OR FINDS A PLASTIC WATER BOTTLE IN HER SWELTERING CAR AFTER A LONG DAY AT THE BEACH, SHE WANTS TO KNOW IF THE FOOD OR WATER IS SAFE TO CONSUME WITHOUT HAVING TO TAKE IT TO HER LAB FOR TESTING.



Fluorescence indicators that change color in the presence of the toxic chemicals.

URI student Benjamin Cromwell conducting a flame-retardant experiment.

One of her goals is to develop a smart phone app that could detect harmful chemicals by reading a test strip people would dip into their food or beverages.

fundamental science and a key detection technique for the detection of many different types of chemicals in many different environments.

"We are really tool makers," she says.

Currently, Levine is applying for grants to support the application of her research for the breath detection of cardiovascular disease and for the detection of marijuana in saliva. She also is developing, through a grant from the National Cancer Institute, carcinogen detection technology, and she just finished a grant from the Rhode Island Research Alliance that enabled her to research the detection of pesticides in Rhode Island waterways.

Levine received $213,816 in funding from the Gulf of Mexico Research Initiative in 2012 to detect traces of oil left in surrounding waters from the 2010 Deepwater Horizon Oil Spill. With the grant money, her team developed safe and effective ways to catalyze organic chemistry reactions to change toxic oil molecules into nontoxic molecules.

In the fall of 2016, Levine received the Stanley Israel Award for Increasing Diversity in the Chemical Sciences, an award granted by the American Chemical Society.

"It is our job, and a moral imperative, that when we are successful in science, we turn around and help other people be successful as well," Levine says. "Science is a really hard field and so, for the sake of science and anybody who is in this field, we should be doing everything we can to ensure that every

person who has the interest, ability, and motivation to go into science is able to do so."

Levine is particularly passionate about championing the effort to attract more women to science. She runs several programs, including a science camp every April school vacation for middle school girls, and a Sugar Science Day where high school girls conduct experiments with sugar.

Levine came to URI in 2010 from Massachusetts Institute of Technology, where she was a National Institutes of Health funded postdoctoral fellow for two years. She received her undergraduate and graduate degrees from Columbia University. Though her work holds many applications outside academia, mentoring research students is part of her calling.

"I could never get talked out of the fact that I could come up with any crazy idea in my head and tomorrow there could be a student in the lab running an experiment I designed to test that idea," Levine says. "That intellectual freedom is amazing."

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Levine developed safe and effective ways to catalyze organic chemistry reactions to change toxic oil molecules into nontoxic molecules.

flame-retardant experiment

THE WAVELENGTH DETECTIVE

written by **TODD MCLEISH**

Yi Zheng, University of Rhode Island (URI) assistant professor of mechanical, industrial, and systems engineering, may soon improve the detection of lung cancer, make solar cells more efficient, and monitor harmful algal blooms in the ocean.

All chemicals and bio-molecules emit and absorb electromagnetic radiation over a wide spectrum of different wavelengths, depending on the material and its temperature. Zheng is creating biosensors to detect the specific wavelengths emitted or absorbed by particular objects.

Zheng, who earned master's and doctoral degrees from Columbia University and joined the URI faculty in 2014, has already completed the design for a 3D-printed, hand-held device the size of an iPhone to detect three species of marine algae that produce toxins harmful to humans. With funding from the National Science Foundation (NSF) Experimental Program to Stimulate Competitive Research (RI NSF EPSCoR) and matching funds from the Rhode Island Science and Technology Advisory Council (STAC) in 2016, he and colleagues from URI and Roger Williams University set up an "opto-electronic system" that uses an LED light source and a photodetector integrated with a nanostructured wavelength-selective thermal transmitter to target the unique wavelengths of the three algae species. This system can monitor water-borne contaminants such as toxic algae and others in coastal waters.

"You just insert a seawater sample and the LED light source generates the particular wavelength for each species," Zheng explains. "If the sensor doesn't detect the wavelength, that means it's been absorbed by the algae. A measurement of zero, for instance, means that there is a large quantity of that species in the sample."

Zheng is taking a similar approach to improving the energy conversion efficiency of solar cells. Conventional solar cells convert sunlight to energy at an efficiency rate of just 25 to 30 percent, in part because the cells are only sensitive to the particular wavelengths emitted by visible and near-infrared light. Zheng's research suggests that the energy conversion efficiency could reach 84 percent with an improved technology that is sensitive to other wavelengths, such as those from ultraviolet or infrared light.

With this in mind, he has designed a thin film containing a three-dimensional nanostructure that could be applied to the top of solar cells. The black film absorbs more energy over a wider spectrum of light from the sun, and the underlying nanostructure, made of silicon carbide and tungsten nanoparticles, modifies the emission spectrum to match the absorption characteristics of the solar cell.

Zheng applied for a grant from the NSF to continue work on the project, and is contacting solar companies in the region to conduct additional tests of his thin film.

Zheng's latest funded project involves the design of a nanoscale biosensor for the early detection of lung cancer, which he believes will be crucial to lung cancer therapy and increase a patient's chance for a full recovery. He recently received three grants, from the Rhode Island Foundation Medical Research Fund, the Rhode Island IDeA Network for Excellence in Biomedical Research (RI-INBRE) Pilot Research Development Award, and the RI-INBRE Early Career Development Award.

Zheng's latest funded project involves the design of a nanoscale biosensor for the early detection of lung cancer, which he believes will be crucial to lung cancer therapy and increase a patient's chance for a full recovery.

Yi Zheng

associate professor
mechanical, industrial,
and systems engineering

holding a nanofabricated wavelength selective thermal emitter for solar cells.

Conventional solar cells convert sunlight to energy at an efficiency rate of just 25 to 30 percent. Zheng's research suggests that the energy conversion efficiency could reach 84 percent with an improved technology.

"Detecting lung cancer is far from a mechanical engineering project, but I think I can apply my knowledge of small-scale heat transfer to design a thermal infrared biosensor to take advantage of the microscale and nanoscale thermal effects in cancer biomarkers," he says.

Zheng and his research team are building a highly-sensitive and selective biosensor that can be tuned to the desired wavelengths of early lung cancer biomarkers to indicate whether the patient is at high risk and should be screened further.

"The first thing we need to do is exactly locate the particular wavelengths we want," Zheng says. "No one has done this before. Then we have to narrow the emission spectrum down further to design a wavelength-selective biosensor that filters out the wavelengths we don't want. The narrower the spectrum, the more accurate and effective it will be."

While these three projects show the most promise, Zheng takes pride in a recent accomplishment for which he has not yet identified an appropriate application. He created what may be one of the smallest nanofibers ever made, constructing a thread of polystyrene embedded with silver nanoparticles that is just 100 nanometers in diameter or about 400 times thinner than a human hair.

"My goal is to increase its thermal conductivity so it's comparable to that of metals," he says. "The advantages include reduced cost, light in weight, easy fabrication, tunable high thermal conductivity, and unique mechanical and electrical properties."

While nanotechnology is currently a popular buzzword among scientists and engineers, many of whom think it can address most of the world's challenges, Zheng says it's important that the macroscale – humans – aren't left out of the equation.

"I want my research to go full circle," he says, "from the human macroscale to the microscale to the nanoscale and back to the macroscale to benefit humans."

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3D-printed handheld device for monitoring the harmful algal blooms.

Zheng takes pride in a recent accomplishment for which he has not yet identified an appropriate application. He created what may be one of the smallest nanofibers ever made, constructing a thread of polystyrene embedded with silver nanoparticles that is just 100 nanometers in diameter or about 400 times thinner than a human hair.

Writing a New Culture on Campus

written by **ALEX KHAN**

SciWrite@URI offers a model for developing graduate science writers that starts from the premise that scientists engage a variety of audiences for a range of purposes.

SciWrite@URI workshop.

As a University of Rhode Island (URI) Writing and Rhetoric Professor and Director of Writing Across URI, Nedra Reynolds envisions a campus community that acknowledges the challenges of writing effectively while also supporting each and every writer.

"I tell people that writing is the most intellectually and cognitively challenging activity that humans engage in," says Reynolds. "Most humans learn to speak the languages they grow up hearing fluently and expertly, but writing doesn't come so naturally. People have to learn to write the alphabet, then words, then sentences. Learning to write, unlike learning to talk, requires sustained practice and coaching."

Reynolds discovered her chosen field in her master's program when she was assigned to tutor in a university writing center. Her Ph.D. training gave her a foundation in rhetorical theory and linguistics and knowledge of composition research since the 1970s. Although her degree is in English, her field is rhetoric and composition studies, which borrows research methods and scholarly traditions from psychology, education, philosophy, anthropology, and cultural studies.

When Reynolds was hired by URI in 1991, she found a number of graduate students in English who were interested in studying rhetoric and composition as a primary or secondary area. She continues to work with a number of doctoral students in the English Ph.D. program, but increasingly she creates programs or leads initiatives focused on writing.

In 2008 Reynolds and her colleagues established an undergraduate major in writing and rhetoric, one of the first in the country for an independent writing program.

"Founding this major was a badge of honor for our department and for URI," says Reynolds.

It cemented her as an innovative force on campus and in her field.

When the URI College of Pharmacy wanted to improve the writing skills of their students, particularly with its SOAP* notes necessary for their certification,

"Growth in writing comes from tackling critical thinking problems for genuine audiences and purposes. When writers can anticipate a reader's needs, they begin to develop a fundamental awareness of what makes writing powerful."

- Nedra Reynolds

* Subjective Objective Assessment Plan: A common way of organizing patient care.

Nedra Reynolds
professor
writing and rhetoric

Celia MacDonnell, professor clinical, URI College of Pharmacy, with Nedra Reynolds.

they came to Reynolds for help, and she recommended an online application that facilitates anonymous peer review of drafts. Peer review, an essential element in scholarly publication, is a fundamental element in improving anyone's writing. With instructor guidance built into this platform, writers rate the drafts of their peers and give each other concrete feedback to guide their revisions.

Peer review also captures data that researchers can use to study; for example, what language patterns indicate a helpful review or what criteria reviewers rely on to inform the ratings they give. Along with her colleague URI Assistant Professor Ryan Omizo, Reynolds wants to show others that online reviews offer a huge potential for research and are not simply tools for teaching. Her interest in formative peer review connected to her next big initiative with URI Associate Professor Ingrid Lofgren and three other co-PIs.

"Ingrid came to the writing faculty asking for help in making her Nutrition and Food Science graduate students better writers because they needed to publish to complete their degrees," Reynolds says.

Reynolds joined a team that co-wrote a successful proposal to the National Science Foundation. With a three-year, $500,000 grant, SciWrite@URI offers a model for developing graduate science writers that starts from the premise that scientists engage a variety of audiences for a range of purposes.

Through training informed by science communication and the study of rhetoric, SciWrite fellows participate in workshops, writing boot camps, and internships – gaining experience in writing for different audiences, including the public and non-specialists.

"Too many student writers have written only school assignments for the teacher," says Reynolds. "But growth in writing comes from tackling critical thinking problems for genuine audiences and purposes. When writers can anticipate a reader's needs, they begin to develop a fundamental awareness of what makes writing powerful."

As the director of a new initiative called Writing Across URI, Reynolds hopes to encourage more faculty to embed writing opportunities into their courses and

to ask more of students as writers. She is currently working with nine faculty from six different colleges on creating a new emphasis on writing for their courses. Writing Across URI is also sponsoring a faculty writing retreat that will give faculty writers a chance to jumpstart their summer writing project by working in a supportive environment, surrounded by other writers and with the option of meeting with a writing consultant, reference librarian, or statistician.

"I think that we need to acknowledge more and more that writing is hard work for all of us," says Reynolds. "We need to lessen the burden, promote the writer, and ultimately broaden the writing culture on campus."

"Founding the writing and rhetoric major was a badge of honor for our department and for URI."

- Nedra Reynolds

A Cross-Disciplinary Diet

Feeds Future Success

written by **ALEX KHAN**

Pictured: a visual aid of an artery with atherosclerotic plaque [left] and a healthy artery [right].

URI student Dara LoBuono and Ingrid Lofgren.

Positioned around three pillars — writing across genres, habitual writing, and regular peer review — SciWrite@URI encourages graduate science students and faculty to embrace writing beyond the academic audience of teaching and publishing.

Ingrid Lofgren concentrates on examining how diet impacts blood lipids like cholesterol and triglycerides levels.

Lofgren, a registered dietitian, associate professor, and graduate coordinator in the University of Rhode Island's (URI) Department of Nutrition and Food Sciences, deeply appreciates food.

Having spent six months in Italy learning to cook, and having worked as a dietitian prior to receiving her doctorate, Lofgren's career of studying the impact of diet at a systematic level — how do various foods impact the body's ability to stay healthy — takes precedence in her current work.

She collaborates with the URI Department of Kinesiology to better assess the nuances of nutrition and exercise on health outcomes, and the URI Department of Communicative Disorders. She also seeks to ensure that the public understands the results of her research.

Lofgren believes this cross collaboration is not only a means to improve her work but broadens the impact of the research.

This cross-disciplinary exploration led her to identify a problem among her peers and herself — how to effectively communicate science.

"I want my students to advance their communication skills, be it communicating in a scientific journal, giving a talk at a conference, or explaining their research to their friends," says Lofgren.

She found particular interest in the concepts of writing and rhetoric. She says she felt that by working with another department outside of the sciences she could find a resolution.

With a team of faculty and staff from the life sciences, the URI Assessment Office, and URI Department of Writing and Rhetoric Professor Nedra

The SciWrite@URI program has been consciously constructed to empower graduate science students to communicate with audiences beyond their immediate peers and researchers.

Reynolds, they put together a comprehensive initiative called SciWrite@URI to improve the communication skills for graduate science students and faculty.

With support from the University, the SciWrite@URI team received a $500,000 grant from the National Science Foundation in 2015. The program's first cohort enlisted six graduate student fellows, seven faculty fellows and two faculty mentors.

Positioned around three pillars — writing across genres, habitual writing, and regular peer review — SciWrite@URI encourages graduate science students and faculty to embrace writing beyond the academic audience of teaching and publishing.

Lofgren emphasizes that innovation in writing requires a firm writing foundation.

"It's kind of like a diet," she says of writing, pulling a metaphor from her research. "I want you to eat healthy here in this class, but if no one ever talks about it again after that class, who is going to remember that?"

One fundamental question Lofgren says she identified when creating SciWrite@URI was, "How do students feel about their own writing confidence?"

In some cases, confidence is low and apprehension is high.

"Some of the fundamental writing skills faculty expect a student to have are not developed yet," says Lofgren.

Students develop better skills through the SciWrite@URI workshops and courses. It teaches them to carve out time on a regular basis to write and reflect on their own work and that of their peers through a peer review process. Students also write for various audiences, which expands their communication skills. Students and faculty from across the University participate in SciWrite@URI Writing Boot Camps, which are scheduled time for writing with accountability. One to three weekly boot camps were held during the past academic year, including winter break. These events help set a cognitive framework for students and faculty to appreciate the concept of habitual writing.

"I never used the term habitual writing before this grant, but now I talk about it all of the time," says Lofgren. "I now apply it to myself and my students outside the SciWrite@URI program."

The program has been consciously constructed to empower graduate science students to communicate with audiences beyond their immediate peers and researchers.

"Students are going to be able to communicate research with any population," she says of SciWrite's writing across genre theme, noting that limitations in spreading knowledge often exist in the scientific community. SciWrite@URI works through a series of workshops that deliberately seeks to gain a sense of "who is the audience" other than the scientific community.

Lofgren implanted both faculty fellow and mentors into the program. While both elements challenge instructors to think differently about writing, SciWrite@URI goes a step further, asking faculty fellows to reconfigure an entire class to better convey the ideas of communication.

This tenacity touches upon a favorite Lofgren quote: "Luck favors the prepared mind."

Financial Literacy:

Exploring the Relationship between Knowledge and Confidence

written by **LIANNA BLAKEMAN ’19**

Stephen Atlas, assistant professor of marketing at the University of Rhode Island (URI) and his behavioral economics team, the Mental Accounting and Pricing Lab, are conducting a long-term study to understand the financial literacy of young adults.

“In the broadest context,” explains Atlas, “this basic research is about understanding consumers’ financial behaviors and what drives those behaviors.”

Rather than assuming people will always follow a specific path toward greater well-being, behavioral economics takes into consideration psychological insights that may affect economic decision-making.

“With mainstream economics,” Atlas explains, “you have theory built on assumptions of economically rational behavior. Behavioral economics considers that to make decisions, people have to think about alternatives and decide between them, and that process often doesn’t match the theory.”

Atlas decided to study behavioral economics to explore what he can learn about how people behave without strict assumptions regarding their economic behavior.

The National Endowment for Financial Education awarded his research project, Financial Literacy Decay, a $176,522 grant. The funding will help Atlas, along with URI Human Development and Family Studies Professors Nilton Porto and Jing Xiao, as they study the financial behavior of young adults. Together, the team is surveying a sample of 300 graduating seniors, of which only 200 will be exposed to a free, online financial literacy course.

“Our mission is to train advanced undergraduate students and graduate students to apply sophisticated experimental, survey, and statistical techniques to help consumers make better choices,” Atlas says.

Mental Accounting and Pricing Lab Research Team
Back row, from left: Carrie Gill, Stephen Atlas, Cynthia Guan; middle row: Nilton Porto, Alison Plunkett, Mike Weir, James Blair; Front row: Jiyoon An.

For the financial literacy project, the researchers will study the financial behaviors of a group of students over a year, through six surveys — one before a financial education course, one after, and four more at a later time.

“My research involves a combination of online experiments where I’ll ask a question in different ways or I’ll change something about a scenario and see how people would behave or decide differently based on the different sets of information,” says Atlas. “We want to see what happens to their financial knowledge, their confidence in that knowledge and their intentions to engage in certain financial behaviors over time.”

Atlas wants to understand when confidence and knowledge shift out of alignment and become overconfidence, how well knowledge and confidence predict financial behaviors, and what knowledge is forgotten over a period of time.

With the information Atlas obtains from this research he wants to create programs to better influence a person’s financial decisions and to encourage people to

Stephen Atlas

assistant professor
marketing

"This basic research is about understanding consumers' financial behaviors and what drives those behaviors."

- Stephen Atlas

become educated in financial literacy.

He wants to learn more about timely education interventions such as when to sequence them, when to time them, and how to encourage people to pay attention to information when it is most relevant to their financial futures.

"Many students," says Atlas, "are going to encounter complicated financial realities for the first time in or soon after college. So, this research provides interesting information to shape the curriculum."

According to his proposal to the National Endowment for Financial Education for this research, young adults are making financial decisions that impact their entire live. For example, 23 percent spend more than their income, 68 percent have no rainy-day fund, and 22 percent have a mortgage. They have the highest exposure to financial education but the lowest usage.

His team concurrently pursues a number of projects producing insights about consumer financial decisions. He recently completed a paper relating confidence, knowledge and consumer decisions, coauthored with Porto and Jialing Lu, URI master's student. Another project tests elective payment strategies like pay-what-you-want pricing, which included a field study at a local restaurant. He also is examining impatience and mortgage choices for a paper to be published in the *Journal of Marketing Research*.

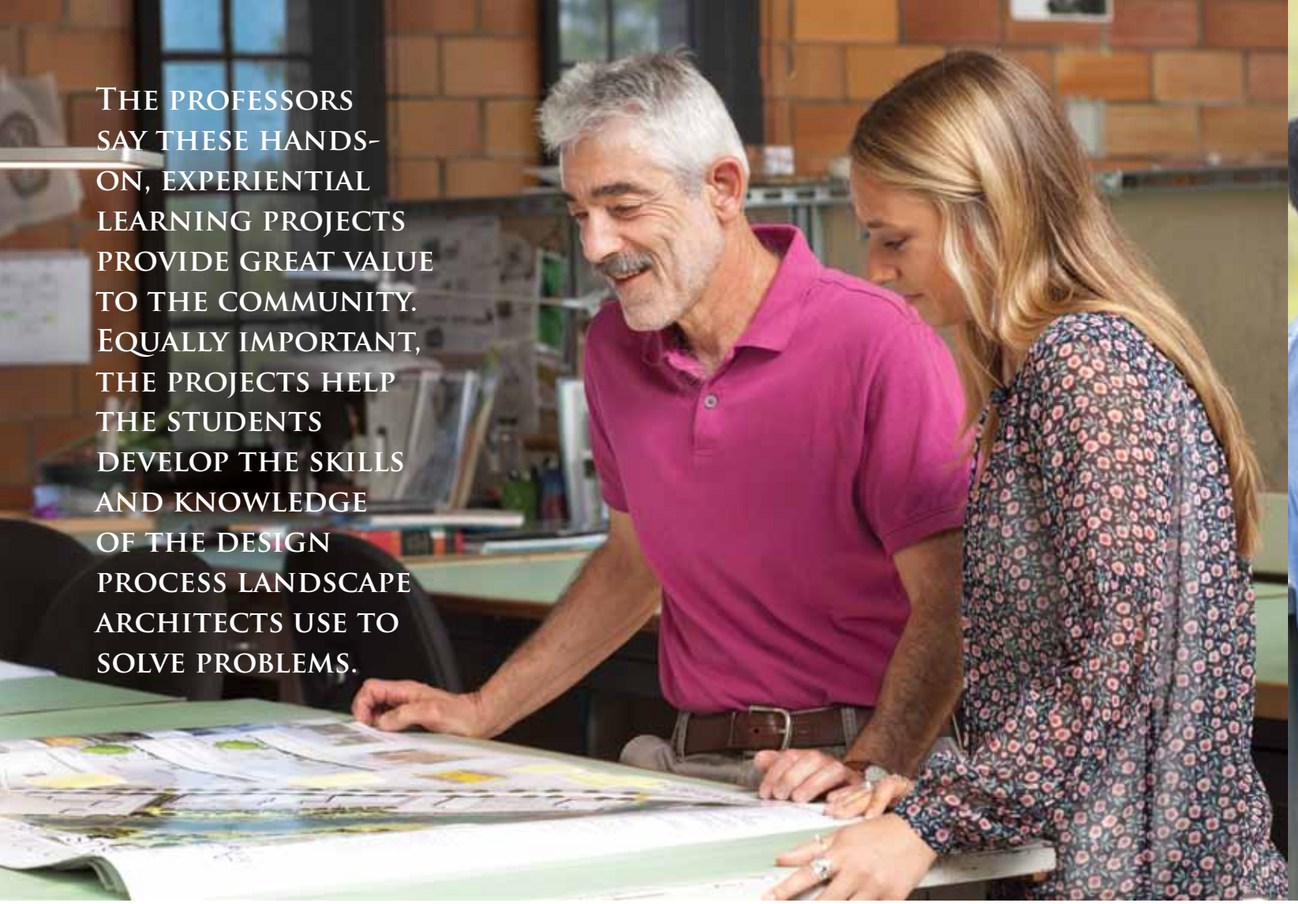
In the future, Atlas hopes to build on this research to explore new questions related to consumer decisions that cross traditional disciplinary lines, such as between health, environmental decisions and business decisions.

Mental Accounting and Pricing Lab Research Team workshop.

Young adults are making financial decisions which impact their entire live. For example, 23 percent spend more than their income, 68 percent have no rainy-day fund, and 22 percent have a mortgage.

Designing
OPPORTUNITIES

written by **TODD MCLEISH**



The professors say these hands-on, experiential learning projects provide great value to the community. Equally important, the projects help the students develop the skills and knowledge of the design process landscape architects use to solve problems.

William Green and Richard Sheridan

professors landscape architecture with URI students Emma Winkler and Kelvin Huang.

University of Rhode Island (URI) landscape architecture Professors William Green and Richard Sheridan field dozens of phone calls and emails each year from municipalities, government agencies and non-profit groups looking for help. More specifically, the inquiries seek the help of Green's and Sheridan's landscape architecture students, who participate in studio courses during their junior and senior years that require them to develop design alternatives for community projects.

The URI professors' students have created design plans for a 9/11 memorial to police and firefighters in Massachusetts, a community recreation area in Richmond, R.I., a major intersection in Wakefield, R.I., the Port of Providence, URI's East Farm and Peckham Farm, and parking lots in Wickford Village, among many others.

The professors say these hands-on, experiential learning projects provide great value to the community or agency through a detailed process that involves public workshops and presentations with community members, professionals and stakeholders. Equally important, the projects help the students develop the skills and knowledge of the design process landscape architects use to solve problems.

"By working on such a public project, we had to effectively communicate with town planners, the economic development committee, business owners, and residents living and working in Wakefield."

- Emma Winkler

"Since ours is a professional program, the focus is to get students jobs, to give them the skills to be professional," explains Green, who joined the URI faculty in 1992. "The more opportunities the students have to problem solve, to apply their skills and techniques, the more likely they'll find themselves moving into a job or internship that will allow them to be a professional."

Sheridan adds, "The products our students generate, which are great instruments of discussion for the towns, are also the products that will open doors for them as professionals. As they go through this program they produce portfolios, which they use to showcase their skills."

Green and Sheridan wade through the community requests each year and identify those most conducive to educating their students. Then they spend long hours working out the details, developing contractual relationships, and responding to client questions as the students work their way through each assignment.

Last fall, students in Green's senior design studio were tasked with creating a vision for the Saugatucket River corridor in Wakefield and the adjacent Main Street commercial district.

"The most valuable skill that I took away from this project was the ability to work so closely with such a diverse group of people," says student Emma Winkler. "By working on such a public project, we had

to effectively communicate with town planners, the economic development committee, business owners, and residents living and working in Wakefield."

"I see the lessons learned from this project as muscle memory of the mind," adds classmate Zachary Driver. "It showed us how to act and what steps to take when faced with a dynamic town planning problem such as this."

One project that was especially memorable to Sheridan involved the design of a park that was to serve as both a place of healing and education about spousal abuse.

"It was a very heavy duty project," says Sheridan, who owned his own design firm in New Hampshire for 25 years before joining the URI faculty in 2005. "We laid the groundwork for the students to understand the ability they would have to communicate and work to heal on different social issues."

After meeting with the victim's family and visiting the site where the park was envisioned, the students developed a variety of design ideas, some of which included educational exhibits, places for serenity and contemplation, areas for children to play, and places that encouraged people to interact. The project won an award from the Rhode Island chapter of the American Planning Association, though the park was never constructed.

In 2016, Green's students won an award to create a vision for the future of the Port of Galilee in the face of rising sea levels and increasingly severe coastal storms. They spent the semester analyzing the existing conditions and uses, assessing the implications of climate change, and designing how to keep the port accessible and operational during uncertain times while enhancing connections between businesses, and local destinations.

After the class broke into groups and started working on design ideas, Green brought in local engineers, environmental officials, professional landscape architects, and town officials to provide feedback.

"I bring professional landscape architects to campus every year as part of a lecture series I've organized for 24 years and bringing professionals to comment on student work is a way of pushing my students, keeping them fresh and on task," says Green.

One student proposed a hurricane barrier, another suggested including a museum to the commercial fishing industry, and a third recommended installing a "living breakwater" similar to one being constructed in New York City that links the physical, ecological and social elements of the area.

Emerging from almost all of these service learning projects are lessons that turn into applied research papers for professional journals or presentations at meetings of the American Society of Landscape Architects, the Council of Educators in Landscape Architecture, the European Council of Landscape Architects, and other groups. They have given presentations about the value of service learning, demonstrating how these projects empower students to make a difference in their communities and how student work translates into professional design proposals. They write and present about the studio process, the integration of student work, and how these time-intensive projects affect and enrich the faculty who lead them.

Green says he is particularly interested in sustainability and sustainable design. He worked for 12 years with several groups to create the Rhode Island Holocaust Memorial, which was completed in 2015. Sheridan came to URI because of his interest in coastal design and coastal environments, and he, along with his students and Rhode Island landscape architect Elena Pascarella, won an award last year from the National Park Service for their historical documentation of Wilcox Park in Westerly, R.I.

As expected, the student designs typically do not end up being selected by the client and implemented as presented. However, that's not the purpose of the assignments. Instead, the communities use the ideas the students generate as a starting point for community discussions and in writing grants that will fund a project's next steps.

"Students can get away with certain things," says Sheridan. "They are particularly advantageous with a project that impacts multiple organizations and constituencies because they explore fresh and innovative solutions without being vested in a particular outcome."

For example, students sometimes recommend that communities retreat from eroding coastlines or move infrastructure like sewage systems away from the water, both of which can be sensitive and politically charged ideas. The students are also less constrained by real-world budget limitations.

"Those recommendations and the community response give us more material for conference presentations," concludes Sheridan.

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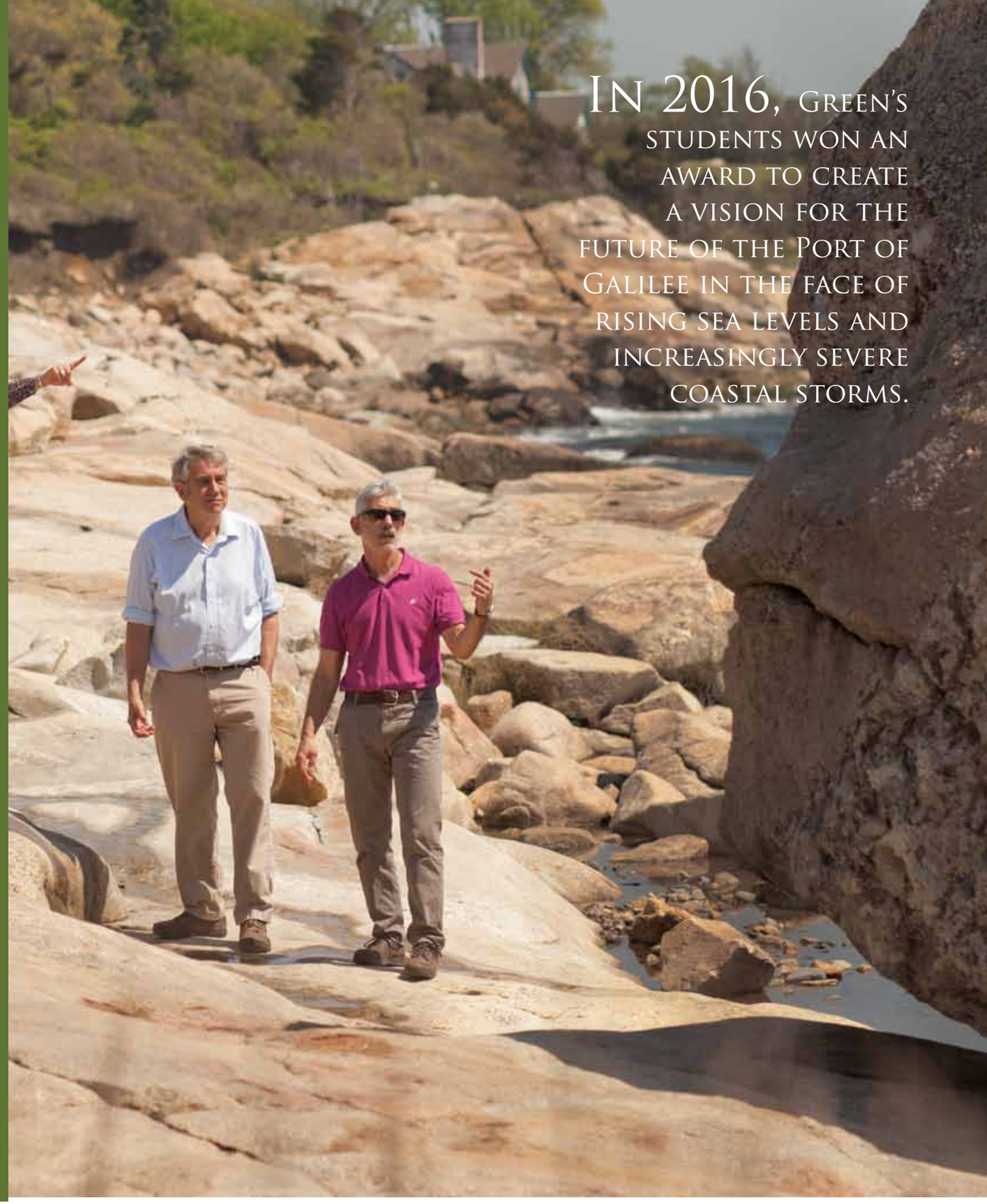


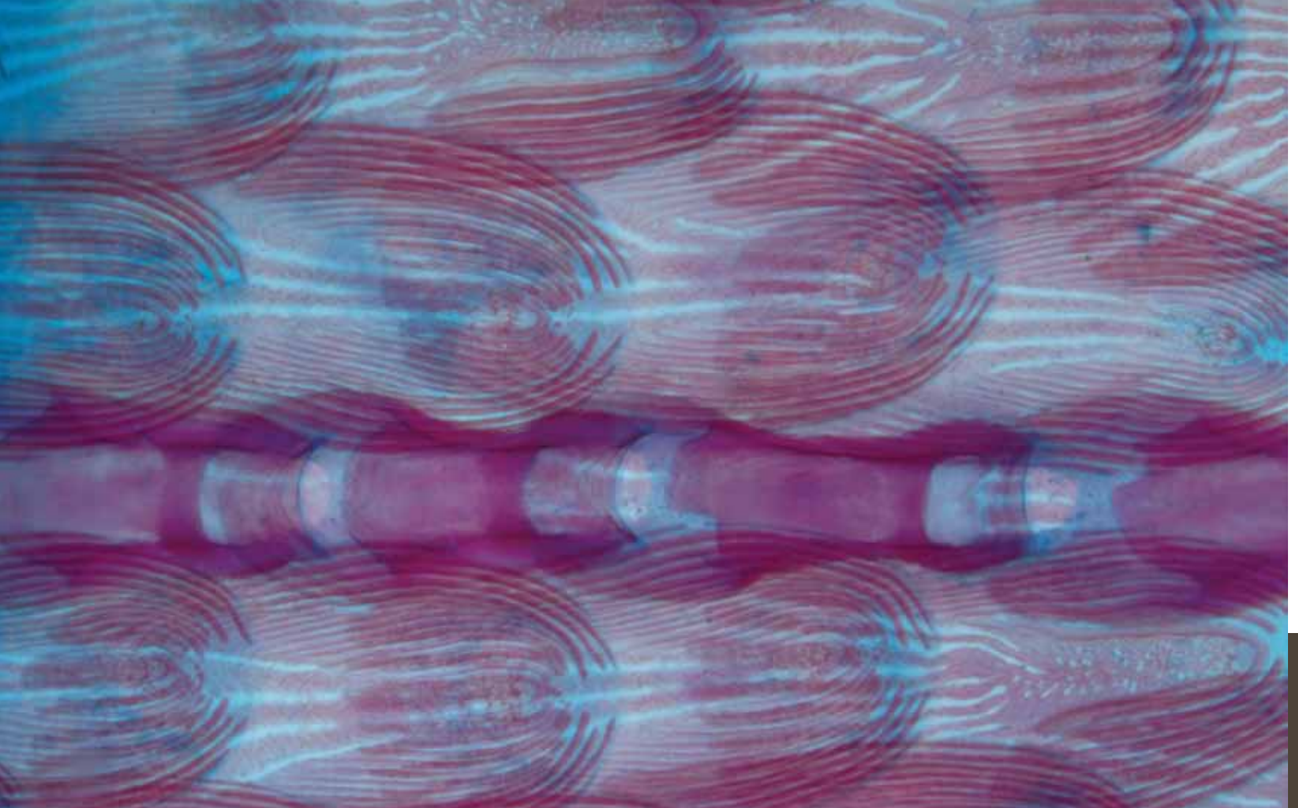
Investigating

THE SENSORY WORLD OF FISHES

written by **ALLISON FARRELLY '16**

"We need to know how fishes navigate their world to understand the ecological roles that they play."

- Jacqueline Webb



Pacific Northwest greenling

The course of Jacqueline Webb's career studying the sensory biology of fishes was set by a challenge presented by her Ph.D. advisor — to produce a book chapter on the diversity and evolution of an intriguing sensory system found in all fishes, the mechanoscensory lateral line system. Webb rose to the challenge, and the results of that work have been providing research questions for her research lab to this day.

"There are over 30,000 species of fishes in the world's lakes, rivers and streams and at all depths of the world's oceans, and we still have a lot to learn about these fascinating organisms."

- Jacqueline Webb

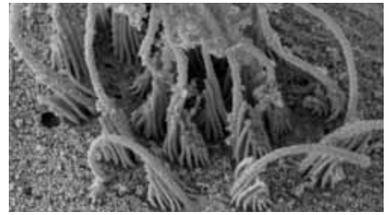
As a post-doctoral fellow, Webb's studies focused on coral reef fishes, the result of what she calls "a great example of serendipity in science."

"What's this?" a colleague asked her when she was a researcher at Cornell University, pointing to a small hole in the skull of a coral reef butterflyfish. The simple question prompted an investigation that would span the next decade.

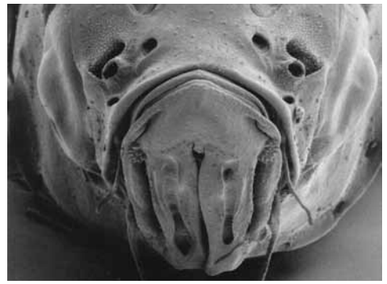
Webb, a University of Rhode Island (URI) professor of biological sciences and the George and Barbara Young Chair in Biology, has studied the structural diversity, function, and development of the lateral line system in a wide range of species, from butterflyfishes and gobies on coral reefs to dragonfishes in the deep-sea.

Neon Gobies

Neuromast receptor organ



Bundles of cilia of a neuromast receptor organ.



Zebrafish

"The ability of fishes to detect prey using senses other than vision is so important, especially given the effects of human activities and global environmental change. With increased nutrient enrichment in aquatic habitats, as the direct or indirect result of human activities, water clarity can decrease significantly. This could give non-visual fishes, those that can detect prey using the lateral line system, for instance, a distinct ecological advantage, which can ultimately alter the composition of fish communities."

- Jacqueline Webb

As the first vertebrates, fishes evolved the sensory organs that humans have: eyes, nose, ears and taste buds. However, fishes also evolved two sensory systems that allow them to exploit the physical properties of water, the electrosensory system and the more ubiquitous lateral line system.

The lateral line system comprises a string of sensory organs found on the head body and tail. Called neuromasts, they detect the slightest water flows in the fish's vicinity - when small hair-like cilia on the surface of the organ's cells are bent even less than a micron, that information is sent to the fish's brain. The neuromasts are found on the skin, but also in canals in the skull bones, and in the scales on the body.

"A fish is really a swimming sensory array," Webb says.

Fish use the nervous impulses from their lateral line system to generate behaviors critical for detection of prey, avoidance of predators, and to communicate with potential mates.

To answer that question posed by her colleague at Cornell in 1989, Webb began to study butterflyfishes. Due to the natural noisiness of the coral reefs where they live — breaking waves, parrotfish chomping on coral, snapping shrimp, dolphins' chirping — scientists had not thought that butterflyfishes would communicate acoustically.

However, when Webb and her students investigated that esoteric hole in the skull, she found that the fish's gas bladder, which is known to regulate buoyancy and amplify sounds, had air-filled tubular extensions in the head that pressed directly against the mysterious hole in the bone, an opening into a canal of the lateral line system. Webb's research suggested that this anatomical specialization was an indication that butterflyfish might convert sounds amplified by the swim bladder into vibrations that are detected by the lateral line system in addition to the ears. This suggested that these fishes might indeed communicate by producing sounds and that they use both their ears and lateral line system to

Jacqueline Webb
professor, biological sciences
George and Barbara Young Chair in Biology

receive and interpret those sounds.

"Connections between the swim bladder and the ear are well-known adaptations for enhancing hearing, but, this was the first instance of a swim bladder-lateral line connection," says Webb.

She says her discovery of this unusual, and seemingly minor piece of anatomy prompted a series of investigations of butterflyfish behavior on coral reefs and the impact of sound on their social behavior by colleagues in Hawaii.

"It goes to show you that anatomy needs to be studied, because you never know what you will learn or where it will take you," Webb says.

When Webb arrived at URI in 2006, she looked for a pair of fishes that have distinctly different lateral line systems to study the role that the lateral line plays in prey detection. She turned to the cichlids, the largest family of freshwater fishes, which includes a few thousand different species found primarily in the Great Rift Lakes in Africa. Webb says this is a commonly studied family of fishes, especially with reference to feeding, because of the rapid evolution of their teeth and jaws. Their visual system had been studied intensively, but their ability to find prey using their other senses, including their lateral line system, was unknown.

She chose to compare two cichlids from Lake Malawi in Africa, a species with widened lateral line canals in the skull (a peacock cichlid, in the genus *Aulonocara*) and a narrow canal species in the genus *Tramichomis*. Both fish eat invertebrates that live in the sandy bottom of the lake, but were known to have different strategies for catching prey.

By studying their feeding behavior in the lab, Webb and Margot Schwalbe, her Ph.D. student at the time, determined experimentally that the narrow canal species depend on vision for the detection of live prey. The widened canal fish, however, used their lateral line system to detect prey, and were able to detect live prey in the dark — a behavior of cichlids previously unknown to scientists.

"This was a really big discovery," says Webb, noting that the behavior of cichlid fishes during the day has been well studied, but little is known about the behavior of the cichlid fishes in Lake Malawi, or of most fishes for that matter, at night.

"The ability of fishes to detect prey using senses other than vision is so important, especially given the effects of human activities and global environmental change," says Webb. "With increased nutrient enrichment in aquatic habitats, as the direct or indirect result of human activities, water clarity can decrease significantly. This could give non-visual fishes, those that can detect prey using the lateral line system, for instance, a distinct ecological advantage, which can ultimately alter the composition of fish communities."

The lateral line system has been known as a sensory system of fishes since the 19th century. However, while writing a comprehensive review chapter for a book on the lateral line system a few years ago, Webb noticed significant gaps - the lateral line system of some prominent groups of fishes had never been studied.

"No one knew that much about the sensory biology of deep-sea fishes," she explains.

That is when Ashley Marranzino, a master"s student and National Science Foundation graduate research fellow in the Webb lab started studying deep-sea hatchetfishes and their relatives.

"These are wonderfully bizarre fishes that live in all of the world's oceans," Webb says. Through intense study of preserved specimens collected on cruises and borrowed from museum collections, Ashley found that the prehistoric-looking fish's body is covered in hundreds of small neuromast organs that appeared as white dots, and she found the same thing in more than two dozen closely related deep-sea fishes.

"This is the first time anyone has done a detailed study of the lateral line system in these fascinating deep-sea fishes," Webb says. "Ashley's discovery has opened up a whole new world of possibilities for understanding the sensory biology of fishes in the deep ocean."

Webb trained at Cornell University and Boston University, and did post-doctoral fellowships at the Scripps Institution of Oceanography, CA, and the Friday Harbor Laboratories at the University of Washington. She has published more than 40 works on the lateral line system over the past 30 years. Her research has been supported by National Institutes of Health Fellowships, a Grass Foundation Fellowship, a Summer Research Fellowship at the Marine Biological Laboratory in Woods Hole, MA, and several major National Science Foundation research grants. She is also a research

Butterflyfishes

associate in Ichthyology at the Museum of Comparative Zoology at Harvard, and a Guest Investigator at the Woods Hole Oceanographic Institution.

In July 2016, Webb was named the first George and Barbara G. Young Chair in Biology, which also is the first-ever endowed chair in the URI College of the Environment and Life Sciences. The honor is reserved for individuals with an exceptional teaching and research record, and is one of the highest honors bestowed on a professor at the University. As a woman in a field that was predominantly male when she entered it, and still is, this honor carries special meaning for Webb.

"Any recognition of a woman at this level is very important, especially in the eyes of students and younger colleagues," says Webb.

Today, two out of three students in the thriving URI Marine Biology Program, which she directs, are women. In contrast, she remembers when there were just one or two women in the biology department when she was a student.

"Now there is now a growing 'old girls' network in addition to the 'old boys' network," she adds.

With respect to her work, Webb says, "We need to know how fishes navigate their world to understand the ecological roles that they play, how to exploit them sustainably, and how to conserve fish biodiversity. There are over 30,000 species of fishes in the world's lakes, rivers and streams and at all depths of the world's oceans, and we still have a lot to learn about these fascinating organisms."

As she tells the students in her courses on marine biology and evolution and diversity of fishes, if nothing else, one of the most important reasons for studying fish is simply that, "fish are cool."

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Currents of the World

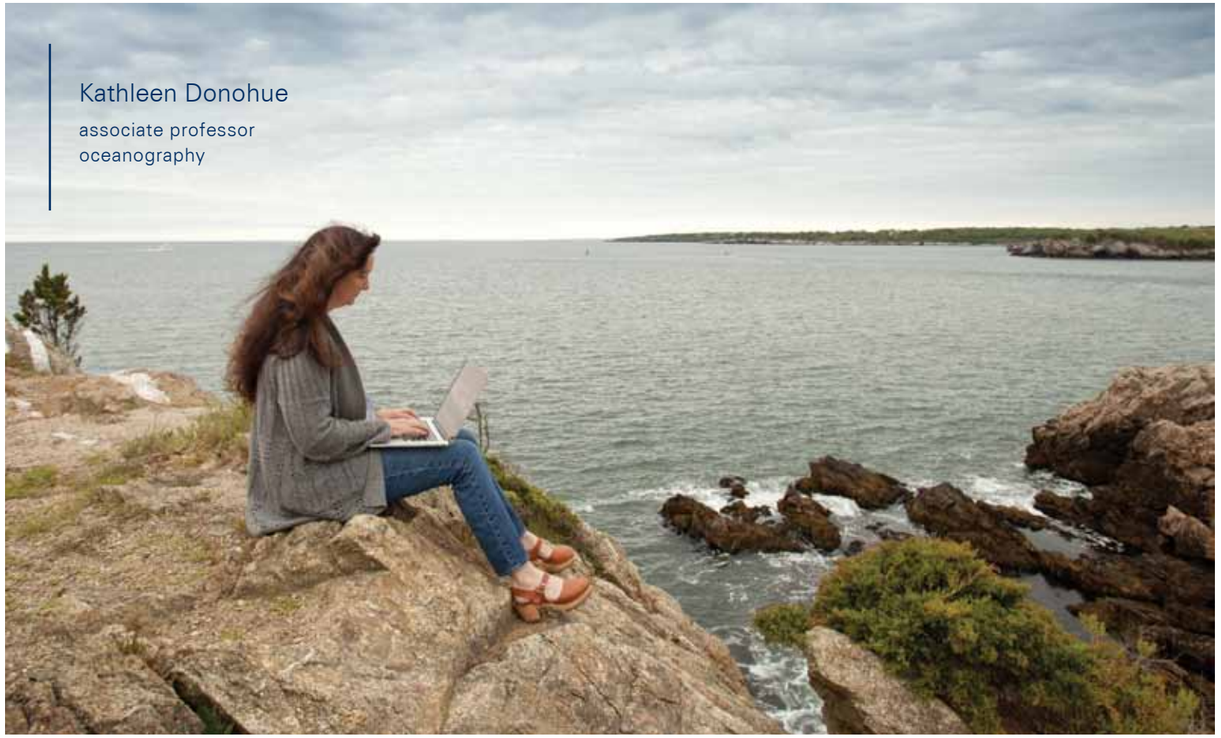
written by **COLIN HOWARTH '16**

Kathleen Donohue, associate professor of oceanography at the University of Rhode Island (URI), has a research career that spans the entire globe with experiments ranging from Antarctica to the North Atlantic and from the waters near Japan to those offshore of the United States.

At its core, her work focuses on improving our understanding of ocean currents and how they evolve as our climate changes. Recent projects examine fundamental physics of the currents between Antarctica and the southern tip of Chile in windy Drake Passage, the behavior of the complex Loop Current system in the Gulf of Mexico, and the multi-decadal evolution of the Gulf Stream as it travels northward just offshore of the U.S. East Coast.

Circling Antarctica, the Antarctic Circumpolar Current is the world's strongest current. Scientists have long understood that the region's powerful easterly winds drive the current, but the detailed physics that ultimately control its strength, position and variability remain an active research topic. Donohue and her colleagues, URI Research Professor of Oceanography Randolf Watts and Research Oceanographer Teri Chereskin of the Scripps Institution of Oceanography, CA, suspected that ocean eddies, the atmospheric storms, were an essential but poorly understood piece of the Antarctic Circumpolar Current puzzle. Their National Science Foundation funded research program, known as cDrake, showed how ocean eddies funnel energy from the powerful surface current into the deep ocean and thereby control its strength.

The cDrake experiment also provided the first modern measurement of how much water the Antarctic Circumpolar current carries through Drake Passage, the 500 mile strait between Cape Horn and the South Shetland Islands of Antarctica. This number is an often used benchmark for global circulation and climate models that serves to help climate scientists understand if their models are functioning properly. Importantly, cDrake research shows that the Antarctic Circumpolar Current transports 30 percent more water than previously thought.



Kathleen Donohue

associate professor
oceanography

"It is only through the expertise and exceptional efforts of the engineering and technical team that our experiments have been successful."

- Kathleen Donohue

"Rather than a response to climate change, the increase likely reflects improved tools to measure ocean circulation," says Donohue. "It's hard to believe, but the last time transport through Drake Passage was measured was in the late 1970s. In cDrake, we had unprecedented horizontal and temporal resolution that enabled an accurate assessment of the current."

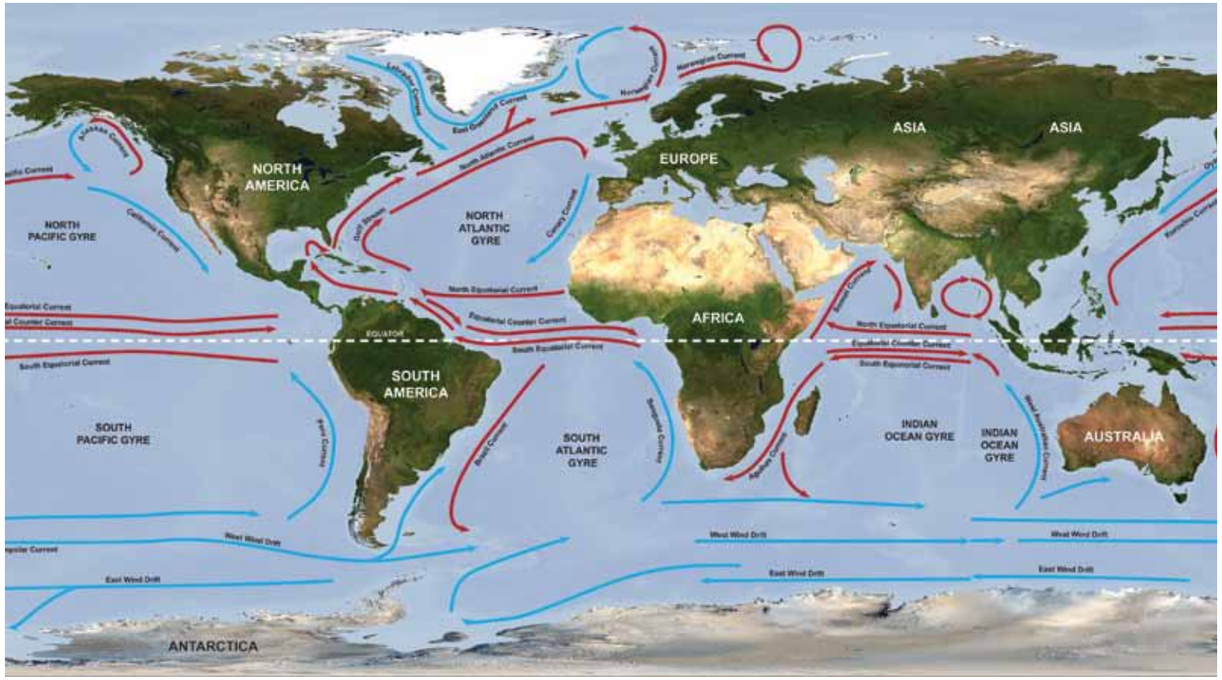
For more than a decade, Donohue and Watts have deployed moored instruments in the Gulf of Mexico. Funded by the Bureau of Ocean Energy Management, four mooring arrays were positioned in the western, central, and eastern Gulf of Mexico. The goal was to understand the relationship between the Loop Current, a strong current that enters the Gulf of Mexico through the Yucatan Channel between Cuba and Mexico from the south and exits to the east through Florida Strait. Like many ocean currents, the Loop Current periodically ejects a large eddy or ring, and it is during the generation of these Loop Current Eddies that momentum and energy are transmitted to the deep Gulf.

"Besides being fascinating from a scientific point of view, understanding Gulf of Mexico circulation supports the societal need for accurate ocean forecasting to aid in hurricane prediction, guide oil-drilling operations, and assess oil-spill impacts," says Donohue.

The ocean, especially the deep ocean, presents a harsh environment. The moored instrumentation, the inverted echo sound, deployed in cDrake and the Gulf of Mexico were created and developed by URI Oceanography Professor Thomas Rossby and Watts, are essential for conducting Donohue's research.

"I've been extremely fortunate in my scientific collaborations during my career at URI," says Donohue. "It is only through the expertise and exceptional efforts of the engineering and technical team that our experiments have been successful."

Donohue also participates in the ongoing Oleander Project, a partnership between the Merchant Marine and oceanography that provides long-term observations of key elements of North Atlantic



"Besides being fascinating from a scientific point of view, understanding Gulf of Mexico circulation supports the societal need for accurate ocean forecasting to aid in hurricane prediction, guide oil-drilling operations, and assess oil-spill impacts."

- Kathleen Donohue

circulation. Beginning in late 1992, Rossby and Research Professor of Oceanography Charles Flagg from Stony Brook University, NY, placed an acoustic Doppler Current Profile into the hull of a container ship named the Oleander. This supply ship has been measuring upper ocean currents on its weekly trips between New Jersey and Bermuda for more than 25 years, creating one of the longest series of directly measured upper ocean currents in the world.

Results show that the Gulf Stream has been steady over the past 20 years — a critical piece of information as scientists keep an eye on the ocean response to global change.

In addition to Donohue's research, she teaches and trains graduate and undergraduate students in oceanography.

"I'm especially proud to have been involved in the Summer Undergraduate Research Experience in Oceanography, (SURFO) program — as a graduate student liaison during my doctoral studies at URI, as a faculty mentor, and as SURFO program co-director and director," says Donohue.

For more than 30 years, undergraduates from Rhode Island and around the country have spent 10 weeks during the summer at the Graduate School of Oceanography actively engaged in research.

"SURFO provides students with both the thrill of success and frustration of authentic, cutting-edge research." Donohue explains, "Often, SURFO research outcomes provide critical initial results that lead to subsequent research proposals. In fact, SURFO launches the next generation of scientists."

Designing a Space Odyssey

written by **EMMA GAUTHIER '18**

When it comes to space travel, science fiction and pop culture give us two models for interstellar outerwear: the chunky, white head-to-toe space suits with an opaque face shield, or sleek, multi-colored tracksuits.

But Karl Aspelund, assistant professor at the department of textiles, fashion merchandising and design at the University of Rhode Island (URI), approaches apparel for space travel in a different way when considering on-board clothing for long duration space flight. As we draw nearer to travel beyond our solar system, Aspelund says a monochromatic, polyester future is indicated for mankind.

Aspelund is a member of the 100 Year Starship organization, a group of scientists, anthropologists, engineers, designers and researchers committed to making human interstellar travel capabilities a reality within the next 100 years. He is focusing his research in two main directions, the technical aspect of what a person wears while traveling and living away from Earth, and the anthropological and philosophical side: analyzing behavioral factors related to clothing that are heightened under the strenuous conditions in outer space.

"You can't just stick people in a craft and send them off," Aspelund says. "They have to eat, they have to keep themselves clean, they have to dress, and they have to stay sane."

For long missions, Aspelund explains, personal comfort in such close quarters is a crucial factor. "I told the students on my team that we're not designing clothes for space, we're rethinking the concept of clothing, as if humans had never worn clothes before."

Currently, Aspelund is determining which textiles are best for different challenges travelers may face, especially for missions further than the International Space Station, to Mars and beyond.

"That's what why we have to think about hygiene, durability, and radiation protection, before we begin to consider what the clothes look like," Aspelund says. Depending on funding, he says,

Karl Aspelund
associate professor
textiles, fashion
merchandising and design

> “I told the students on my team that we’re not designing clothes for space, we’re rethinking the concept of clothing, as if humans had never worn clothes before.”
>
> - Karl Aspelund

he would like to have garments ready to test their capabilities within the next two years, ideally, in a Mars simulator.

This is where gray scale polyester comes in. One potential method of creating lightweight fabric that also protects from cosmic rays would result in all fabrics being on a gray-to-black spectrum. The outfits may not be radically different than what people wear on Earth, he says, but could look similar except with more options for functionality. There are also gravitational factors to consider in space, therefore something similar to athletic gear makes the most sense, but admittedly limits options. This also leads Aspelund to another issue: individuality.

“The establishment of an individual identity is an inherent desire in humans,” Aspelund explains. “We’re constantly trying to walk the line between belonging to a larger whole, and identifying as a specific person. If everyone around you is dressing the same, you may develop anxiety caused by loss of individuality.”

Aspelund knows just how important the interplay of individuality and group identity is; he did his dissertation research on the history and nature of women’s national dress in Iceland, where he looked into the development of identity with clothing at the individual, the small-group culture, and at the national level. He found that the influence and motivations of personal interaction, politics, technology and historical tradition, both actual and invented came into play, which resulted in a research project, with Professor Terry Gunnell of the University of Iceland, on nationalist culture creation in Iceland in the late 19th century. This project will be completed with the publication of a book of essays this year.

Aspelund worked as a designer on approximately 40 productions in both film and theater in Iceland for 10 years before coming to the U.S. in 1996, and he says those experiences have fed into his current research, by providing insight into the nuanced relationship of clothing and character.

While many of us may not get to travel to the further reaches of our solar system, Aspelund emphasizes that investing in space research truly benefits society. For instance, by figuring out ways to recycle garments in space, Aspelund says, those procedures could help combat pollution on Earth.

“We should eventually be able to scale the starship’s problems and solutions toward people on Earth,” Aspelund says. “The importance may indeed be more impactful on the home planet. The starship can be seen to be a testbed for Earth-bound solutions.”

He is focusing his research in two main directions: the technical aspect of what a person wears while traveling and living away from Earth, and the anthropological and philosophical side: analyzing behavioral factors related to clothing that are heightened under the strenuous conditions in outer space.

Using Biostatistics to Conquer

HIV AND THE OPIOID EPIDEMIC

written by **BRUCE MASON**

The University of Rhode Island's (URI) first biostatistics faculty member is a quantitative enthusiast with an interest in improving the health of populations facing substance use disorders and at risk for or living with HIV/AIDS.

"I was drawn to the fields of biostatistics and epidemiology because public health appealed to me," explains Pharmacy Practice Assistant Professor, Ashley Buchanan. "Preventing diseases alleviates more suffering than waiting to only treat clinical disease at the individual level. I wanted to do something meaningful with my quantitative skills that has the potential for broadly improving the health of often marginalized populations."

Biostatistics is the development of statistical theory and methods for the purpose of application to medical research to promote the advancement of public health and medical science. Epidemiology studies how disease spreads in a population and specifically focuses on ways to prevent and treat disease in a variety of populations.

Buchanan's research lies at the intersection of HIV infection and opioid-use disorder research. Individuals often face both of these issues simultaneously and research efforts that recognize this connection offer the possibility of more holistic solutions. She says this research holds critical value in the effort to address a public health problem that has grown to such overwhelming proportions — both in Rhode Island and on a national level — that it is now considered an epidemic.

URI students Hilary Aroke (left) and Andrew Descoteaux (right) pictured with Ashley Buchanan (center).

BUCHANAN WANTS TO ACTIVELY EMPLOY PUBLIC HEALTH RESEARCH IN ORDER TO CONTRIBUTE MORE BROADLY TO OUR UNDERSTANDING OF SUBSTANCE MISUSE AND DISORDER MECHANISMS.

The Rhode Island Department of Health reported in February 2017 there were more than 326 drug overdose deaths in 2016 compared to the 290 in 2015. Drug-related deaths in Rhode Island rose 30 percent since 2011. Nationally, the CDC reported in December 2016 that drug overdoses claimed more than 50,000 lives in 2015.

Buchanan has been working with Natallia Katenka, URI assistant professor of computer science and statistics, to develop new statistical methods at the intersection of causal inference and network science with applications to improve the lives and health of people living with HIV/AIDS and facing opioid-use disorders. Because these populations often encounter overlapping issues such as biological or social influences that lead to increased risk, Buchanan is researching how the benefits of intervention might work at a community level. She says behavioral change, such as using condoms, treatment, and needle exchange, help prevent the spread of HIV, yet social influences, such as peer pressure and social norms, also can play a role.

A former Harvard research fellow, Buchanan has nearly a decade of experience collaborating on HIV/AIDS research. Her interest in HIV/AIDS research began in 2007 at the Center for Biostatistics in AIDS Research at the Harvard T.H. Chan School of Public Health. She engaged in collaborative work that involved design, monitoring, analysis, and manuscript writing for the Pediatric HIV/AIDS Cohort Study and the International Maternal Pediatric Adolescent AIDS Clinical Trials Network.

A majority of her fellowship research has taken place in Sub-Saharan Africa, where she has been developing methods to estimate the spillover effects of a multifaceted, randomized package of interventions in HIV treatment and prevention studies. In 2015, Buchanan lead statistical trainings at the African Academy for Public Health located in Dar es Salaam, Tanzania.

She also collaborated with colleagues on the President's Emergency Plan for AIDS Relief (PEPFAR), which funds support more than 120 HIV treatment and care clinics in Dar es Salaam. In 2016, PEPFAR — of which the Centers for Disease Control (CDC) is a key partner — announced ambitious new HIV prevention and treatment targets. The announcement came as part of the 2015 United Nations meetings on Sustainable Development Goals, an outcome of which was the goal to end the AIDS epidemic by 2030.

Currently, Buchanan is collaborating on a methods development project motivated by an observational network-based study among injection users with Samuel Friedman, associate director at the Center for Drug Use and HIV Research in New York City. Given her extensive experience in HIV research and strong background in casual inference methods, Buchanan continues to gain expertise in research among people who inject drugs, advanced casual inference methods for network-based studies, and mathematical modeling approaches.

"While there are many statisticians developing methods for HIV/AIDS research, there seems to be fewer focused on specifically on statistical methods development for substance disorder research applications," Buchanan says.

Working to become a leader in biostatistics methods development for studies of people facing substance misuse issues and living with or at risk for HIV/AIDS, Buchanan wants to actively employ public health research in order to contribute more broadly to our understanding of substance misuse and disorder mechanisms. She says she hopes such understanding will generate greater support for those groups of people — on both the local and national levels — most vulnerable to HIV/AIDS and substance use disorders.

Many people assume novel drugs will conquer disease epidemics. Buchanan says until researchers find that magic bullet for HIV or substance use disorder, biostatistics can continue to provide new insights to improve the lives of those often marginalized in our society.

"Preventing diseases alleviates more suffering than waiting to only treat clinical disease at the individual level."

- Ashley Buchanan

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