College of Letters & Science
UNIVERSITY OF WISCONSIN–MADISON

BioScience Now

News for Alumni and Friends of the Department of Integrative Biology

FALL 2018

LAKES AND STREAMS IN JEOPARDY?

Read more on page 4.

Midnight sunset from the Myvatn Field Station, Iceland.
Image by Tony Ives

Department of Integrative Biology
UNIVERSITY OF WISCONSIN–MADISON

BioScience Now
is the alumni newsletter of the
Department of Integrative Biology
at the University of Wisconsin–Madison.

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From the Chair

Welcome to the latest edition of *BioScience Now* showcasing some of the exciting happenings in the Department of Integrative Biology. From national news pieces, like Emily Stanley's work on the effects of climate change in streams and lakes featured in the *New York Times*, to the work of field biologists in far-flung places like Iceland, Israel, and Antarctica, to digitizing irreplaceable museum collections, to unlocking the cellular secrets of the brain and the embryo, our department really spans the amazing world of biology.

We have much to celebrate. Our faculty and staff continue to garner important awards while our students are making important research discoveries. We are grateful for the remarkable careers of two of our faculty: Tony Stretton and Warren Porter. Tony and Warren exemplify the excellence, commitment, and passion of our faculty and are an inspiration to all of us. As they transition to the next phase of their careers, Hilary Dugan has joined us as a new faculty member in the Center for Limnology. We are looking forward to searches this year that will bring other new faculty faces to the department.

This edition of *BioScience Now* marks a milestone for me personally. It hardly seems possible, but this summer I completed ten years as department chair. The wonderful people in our department have made serving in this role a real privilege.

None of this would be possible without *you*; your generous support is essential as we continue to carry out our mission to our students, the campus, the state, and the world. As always, you can keep up to date on the department at our website: **ibio.wisc.edu**. And please share news on what you're up to by emailing our Department Manager, Julie Lindsey, at **jzlindsey@wisc.edu**.

Best wishes,

Jeff Hardin
Raymond E. Keller Professor and Chair

Message from Dean Scholz

Every year, I wait eagerly for the results of the Chancellor's Distinguished Teaching Awards. The honor has been given out since 1953 to recognize the university's finest educators. The vast majority—at least nine out of twelve every year—go to L&S faculty.

I'm always humbled and a bit surprised. After all, we have only 39% of the faculty at UW–Madison. But in L&S we care about great teaching because we teach 64% of undergrad credit hours (and 57% of all credit hours taught on the UW–Madison campus). Moreover, knowledge creation and outstanding teaching often go hand in hand.

It is a myth that great research comes at the expense of great experiences in the classroom. Many of our internationally known scholars can be found working with undergraduates in labs and in archives, organizing first-year interest groups, and developing innovative teaching methods. We call these "high-impact practices," and they happen across the college, in large lecture classes (where one professor implemented small but important changes in the way he called on students, ensuring that all had a voice), and smaller courses (like the Shakespeare course that visited the Chazen Museum to view relics from the bard's era).

If you could see, as I do, the notes from our graduating L&S seniors recalling their favorite professors, you would understand that not only do our faculty create knowledge, but they also change lives. I couldn't be more proud of what they do.

Your support of our teaching and learning efforts is greatly appreciated. Visit **ls.wisc.edu/about/our-faculty** to find out more about teaching and learning in L&S, and **allwaysforward.org/ls** to support our work.

On, Wisconsin!

Milestone Retirements

For 50 years, **Warren Porter** served as professor in the department. As a leader in the fields of ecophysiology and biophysical ecology, Warren is recognized internationally for his important contributions to the understanding of physiological limits and climate effects on animal range limits and distributions. He served as department chair from 1993 to 1998, bringing a spirit of cooperation to the department that continues to this day. Through his teaching, service, and research endeavors, Warren has greatly impacted the department and university community. "I will always remember and be grateful for the wonderful, collegial, supportive people, the faculty and superb staff in our department, and across campus, who have made my career here a dream job where I can't wait to get out of bed in the morning and get started again," says Warren. In retirement, Warren plans to continue his research on 3-D animal energetics and behavioral constraints.

"Being a scientist and a professor at the University of Wisconsin–Madison has been the best job I could ever imagine. I have been so lucky to have been here, in a job I have loved, for 47 years," says **Tony Stretton**, who retired in May 2018. Tony trained in his native England during the advent of molecular biology and later shifted his career to neurobiology. Throughout his career, Tony impacted the lives of almost 20,000 undergraduate and dozens of graduate and PhD students through his teaching and training in his laboratory. His instrumental work with neuropeptides on synaptic signaling in the nematode *Ascaris suum* became an excellent model of neuropeptide regulation of the nervous system. Tony was instrumental in establishing the UW–Madison Neuroscience Training Program. He has been an exemplary member of the department, engaging in innovative research, teaching, and service. Tony looks forward to continuing his research in the neuromuscular system of the nematode and feeding his curiosity in the natural world in his retirement.

New Faculty Focus

Hilary Dugan joined the department in January 2018 as an assistant professor of Integrative Biology. She received her PhD from the University of Illinois at Chicago and previously served as a postdoctoral fellow in the Center for Limnology at UW–Madison.

As a limnologist, Dugan studies how terrestrial and atmospheric changes, such as warming air temperatures or land use patterns, alter biogeochemical fluxes and aquatic processes in lakes. Her research sites span from Wisconsin to Antarctica. She is particularly interested in hydrological processes at the poles, where the hydrological cycle is poised to change dramatically over the coming decades. Retreating glaciers and ice sheets, melting permafrost, and increasing precipitation have the potential to boost nutrient delivery to surface waters and stimulate groundwater flow. She is interested in answering how groundwater interacts with surface waters in permafrost environments, how heightened primary productivity in lakes act as a carbon sink on a regional scale, and to what extent will resources extraction alter or degrade freshwater ecosystems.

Originally from Canada (Woodstock, Ontario), Dugan says she was always fascinated by earth sciences, and how ecosystems worked. During her undergrad, she worked as a research assistant in the Canadian Arctic and fell in love with fieldwork and studying global change. At some point, her interests narrowed to water, and eventually lakes. "Having grown up around lakes, this was probably a natural progression, but it took me a while to get there," says Dugan.

Study Suggests Climate Change is Altering Lakes and Streams

By Carl Zimmer, *New York Times*

Members of Emily Stanley's research team collecting samples from an urban stream.

To scientists who study lakes and rivers, it seems humans have embarked on a huge unplanned experiment.

By burning fossil fuels, we have already raised the concentration of carbon dioxide in the atmosphere by 40 percent, and we're on track to increase it by much more. Some of that gas may mix into the world's inland waters, and recent studies hint that this may have profound effects on the species that live in them.

"We're monkeying with the very chemical foundation of these ecosystems," said Emily H. Stanley, a limnologist (freshwater ecologist) at the University of Wisconsin–Madison. "But right now we don't know enough yet to know where we're going. To me, scientifically that's really interesting, and as a human a little bit frightening."

Scientists began taking continuous measurements of carbon dioxide in the atmosphere in the 1950s, and today they have more than six decades of consistent readings. In the 1980s, oceanographers followed suit, developing carbon dioxide sensors and deploying them across the planet.

Over the past three decades, they've chronicled a steady rise of carbon dioxide in seawater. The increasing concentration can harm marine life in many ways.

It lowers the pH of seawater, for one thing, making it more acidic and interfering with the chemistry that coral, for instance, use to build their calcium skeletons. Ocean acidification also thins the shells of oysters and other animals.

Many marine organisms rely on chemical changes in water to find food and avoid danger. "Many fish are not able to detect their predators anymore," said Linda C. Weiss, an aquatic ecologist at Ruhr University Bochum in Germany. "They can even get more bold."

Dr. Weiss first came to appreciate the impact of ocean acidification in 2010, when she spent time at a marine research station in Australia. The experience left her wondering if lakes and rivers might face a similar threat.

Her first step was to look for historical data about carbon dioxide levels in fresh water. But a literature search brought her to a surprising conclusion. "I discovered there was no information," she said.

Traditionally, scientists who have studied inland waters have focused on different questions. They've been more concerned, for example, with sulfuric acid and other pollutants in acid rain, along with the impacts of runoff from farms and yards.

Now that researchers have grown concerned about carbon dioxide levels, they've been developing ways to reconstruct their history.

The level of carbon dioxide in a lake depends on such variables as its temperature and how much organic carbon it contains. If those factors have been tracked in the past, scientists can use them to get an estimate of a lake's carbon dioxide level, too.

Dr. Weiss and her colleagues used this method to figure out the carbon dioxide levels in four reservoirs in Germany from 1981 to 2015. They reported Thursday in the journal *Current Biology* that the amounts tripled in that time.

"We didn't really know what to expect," said Dr. Weiss. "But the speed

of acidification we find is quite fast."

The researchers wondered what effects this fast rise in carbon dioxide might have on freshwater life in decades to come. So they ran experiments on the humble water flea.

These tiny, shrimplike creatures filter algae and microbes from water. They are devoured in turn by small fish, which are eaten by bigger fish. If rising carbon dioxide were to affect water fleas, Dr. Weiss reasoned, it could influence the entire lake ecosystem.

Water fleas use a bizarre but sophisticated defense to escape predators. They can sense chemicals given off by fish in their vicinity, and in response they make themselves harder to eat.

Some species grow a massive crest on their head, while others sprout spikes. Dr. Weiss and her colleagues found that high levels of carbon dioxide caused water fleas to make smaller crests and shorter spikes.

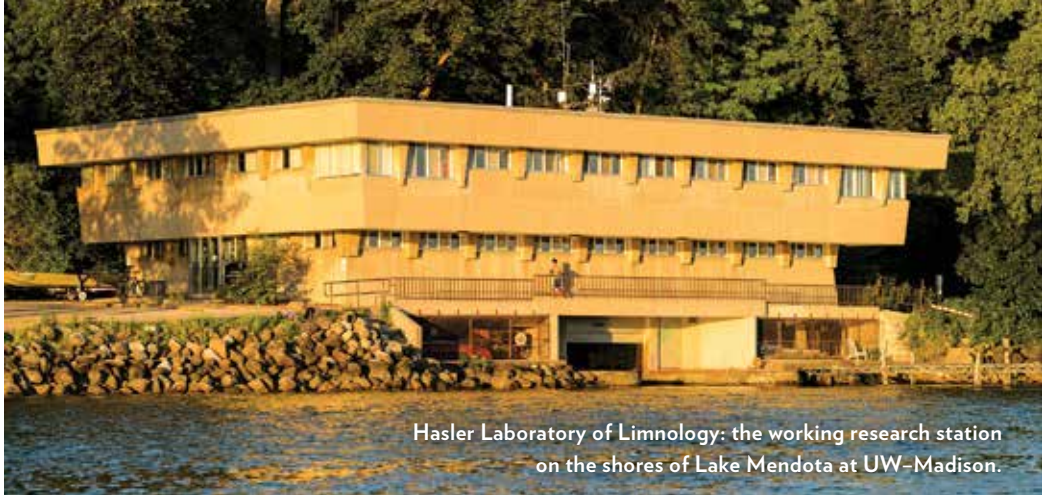
Rather than the acidity of the water, carbon dioxide itself seems to be affecting the water fleas. When the researchers lowered the pH with hydrochloric acid, the water fleas responded normally to predators.

Dr. Weiss hypothesized that carbon dioxide interferes with the nervous system of the water fleas, blunting their ability to look out for predators.

Caleb T. Hasler, a biologist at the University of Winnipeg, said that the new research addressed an unanswered question: the amounts of carbon dioxide that might harm freshwater life.

"This paper is really important because it starts to show where those levels might be," he said.

Dr. Hasler's own recent research hints that water fleas may not be the only freshwater animals to be altered by carbon dioxide. He and his colleagues studied minnows swimming in water rich with carbon dioxide and found that the fish don't respond as quickly to alarm signals released by other minnows.



Hasler Laboratory of Limnology: the working research station on the shores of Lake Mendota at UW–Madison.

In another study, the team studied two species of mussels. One species relaxed its muscles in water high in carbon dioxide, so that its shell gaped open. The other species clamped its shell shut, so that it could no longer filter food.

These sorts of changes may send ripples out across entire freshwater ecosystems. Mussels are vital for filtering food and keeping water clear, for example. If water fleas do a worse job of escaping predators, their population may decline, leaving less food in the long run for fish.

But it's not certain that inland waters around the world are building up carbon dioxide at the rate that Dr. Weiss and her colleagues observed in the German reservoirs.

In November, Dr. Stanley and her colleagues published a study of carbon dioxide levels in lakes in Wisconsin. Between 1986 and 2011, they detected no significant change at all.

The mismatch points to the complex chemistry varying from one lake to the next. While lakes and rivers all absorb carbon dioxide from the atmosphere, some also draw in the gas from surrounding soils.

The chemistry of some inland waters causes a lot of carbon dioxide to be converted into other compounds. Some lakes and streams may support a lot of underwater plants that take up the gas, for instance, while others may have microbes can release more of it.

Making matters even more complicated, the carbon dioxide levels in any particular body of freshwater can change drastically over time with swings in temperature and other conditions.

"You can have lakes where the carbon dioxide increases tenfold at night," said Dr. Hasler.

In decades to come, as carbon dioxide levels continue to climb in the atmosphere, Dr. Stanley speculated, the picture will only get more nuanced.

"I honestly don't know where we're going," said Dr. Stanley. "I'll probably put my money on increased variability from lake to lake. They're just going to be more extreme."

Dr. Weiss agreed that it wasn't possible to draw big lessons from the preliminary data. "I think this study we're publishing is like a door-opener," she said. "I hope there will be other scientists who will follow."

Faculty & Staff Updates

2018 G. Evelyn Hutchinson Award

Professor Emily Stanley is the 2018 recipient of the G. Evelyn Hutchinson Award from the Association for the Sciences of Limnology and Oceanography. This award honors a limnologist or oceanographer who has made considerable contributions to knowledge, and whose future work promises a continued legacy of scientific excellence. Emily is recognized for her outstanding contributions to the understanding of the roles hydrology and the biogeochemistry of nitrogen and carbon play in lake and stream ecology.

Peralta Awarded 2018 Forward in Access Award

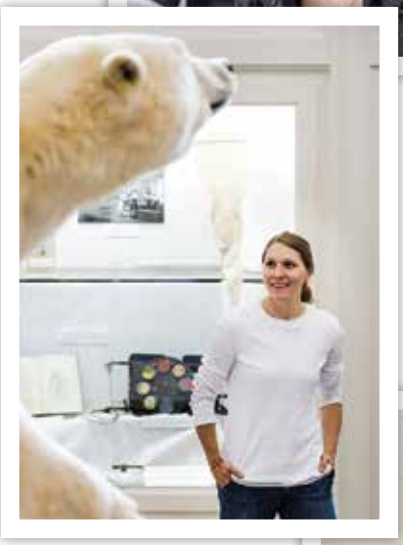
Associate Faculty Associate Carlos Peralta received a Forward in Access Award from the McBurney Disability Resource Center. This award recognizes individuals who support inclusion and access within the UW–Madison community. Carlos has shown exemplary efforts supporting access for students with disabilities in Introductory Biology 151/153-152 courses.

Damschen Receives Chancellor's Inclusive Excellence Award

Associate Professor Ellen Damschen is one of the UW–Madison recipients of the Distinguished Teaching Award, an honor given out since 1953 to recognize the university's finest educators. Ellen is known for empowering students to develop critical thinking skills that allow them to succeed in their careers and in life. Ellen stands out in her ability to use teaching approaches that are grounded in the literature, especially regarding gender differences in students' learning, to empower her students.

Mid-Career Achievement Award

Senior Academic Curator Laura Monahan received a Mid-Career Achievement Award from the College of Letters & Science at UW–Madison. Recipients have 8+ years of service and demonstrate outstanding performance in their position, leadership and service beyond their position, and substantial professional competency and the promise of continuing contributions. Laura has made significant contributions to the UW Zoological Museum and the university in general through teaching, public outreach, acquiring funding, and leadership.



Judith S. Craig Distinguished Service Award

Jean Heitz, Distinguished Faculty Associate, is a recipient of the Judith S. Craig Distinguished Service Award from the College of Letters & Science at UW–Madison. The award recognizes staff with 15 or more years of service who have demonstrated outstanding service to the college and university throughout their career. Through her campus and nationwide leadership in STEM education, her leadership within Introductory Biology 151/153-152, and development of the Peer Learning Association, Jean has greatly improved the lives and learning experiences of students during her 40-year career.

Student Stories

Zoë Sippl

Neurobiology sophomore Zoë Sippl was awarded a 2018 Summer Research Award funded by the Lowell E. and Ruth Chase Noland Memorial Fund. In Marc Wolman's laboratory, Zoë performs behavioral genetic experiments in zebrafish to better understand how neural circuits control a fundamental learning behavior, called habituation. Habituation allows all animals (including humans!) to ignore irrelevant information. This function is often disrupted in neuropsychiatric disorders. To study habituation, Zoë uses a zebrafish mutant, named *dory*, which doesn't habituate to repeatedly experienced, irrelevant sensory stimuli. In fall 2017, Zoë discovered that *dory* mutants have a mutation in gene that codes for a calcium channel subunit, which mediates synaptic function. Together with PhD student Nick Santistevan, her summer work aims to establish genetically modified zebrafish, which will allow her to ask when and where in the nervous system is the calcium channel subunit required for habituation. "I am very thankful for the opportunity the Summer Research Award gave me to work full-time in the lab. I look forward to continuing my work in the Wolman lab and using the transgenic fish I'm making now to get *dory* mutants to learn!"

Lucas Nell

If we were to go back in time and slightly alter environmental conditions, would life have evolved as we know it today? Understanding the repeatability of evolution informs solutions to issues such as disease and pest control, vaccine management, and biodiversity conservation. By combining a series of experiments with computer simulations, Zoology PhD student Lucas Nell in Tony Ives' laboratory measures the repeatability of evolution in pea aphids, which are able to clone themselves during the plant growing season. Capitalizing on the aphid's cloning ability, Lucas measures different parameters for each clone line, such as rates of reproduction and dispersal. Computer simulations based on these measures provide predictions for the dynamics of multiple-clone populations (e.g., which clone is most abundant, which goes extinct). Longer-term experiments test these predictions. Doing this multiple times allows Lucas to see if there is only one set of winners, or whether chance events produce multiple outcomes of evolution. Lucas' research was possible thanks to generous contributions from the Dr. and Mrs. Carl Bunde Fund as well as the Anna & Edward Birge Scholarship.

Grandparents University

This summer Neurobiology hosted a Grandparents University (GPU) with the Wisconsin Alumni Association (WAA). During GPU, grandparents and their grandchildren take part in the Badger experience, staying in a residence hall, participating in engaging and hands-on activities in a major, and earning a GPU "degree!" Cathy Auger, our Neurobiology Major Coordinator, provided action-packed instruction to grandparents and their 11–14-year-old grandchildren. Participants learned about neuronal physiology by making bead neurons, and simulating the action potential with swim noodles and Ping-Pong balls. Attendees also examined brains from a variety of animals, as well as a human brain. On day two of the program, participants delved into questions of how the brain perceives different stimuli, with activities like prism goggles and mirror-drawing boxes. On this day, grandchildren were able to measure their grandparents' directed attention skills using a Stroop Test. Grandparents University began on the UW–Madison campus during the summer of 2001. Grandparents do not need to be UW–Madison alumni to attend; however, one member of the family—a grandparent/older adult relative or a parent of a grandchild—must be a WAA member to attend.

SUPPORT INTEGRATIVE BIOLOGY

The generosity of our donors allows the Department of Integrative Biology to help our students, faculty, and staff reach their full potential. Please consider making a gift to the Integrative Biology Department Fund (#132860093) through the UW Foundation.

allwaysforward.org/giveto/integrativebiology

Check donations can be made out to the University of Wisconsin Foundation. Please include the fund number on the check.

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SPECIMEN JARS AT UW ZOOLOGICAL MUSEUM

The UW Zoological Museum, along with the university's four other natural history museums, will centralize their database collections as part of a new UW2020 initiative. The merged records will allow researchers to study the full scope of natural artifacts in one central location. This digital cabinet of natural history will link the museums' combined 9 million-plus specimens that span all seven continents, the moon, and Mars.