In Their Element

Water. Fire. Air. When it comes to today's biggest environmental challenges, these are the elements at the heart of the issues. Meet three L&S experts who are at the top of their field in finding sustainable solutions.

BY ALLI WATTERS

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Emily Stanley studies lakes all across Wisconsin, from Lake Mendota in Madison to Trout Lake in Vilas County. PHOTO: CARLIN SOOD

Water

When Emily Stanley says she's knee-deep in her research, she means it literally. The professor of aquatic biology and ecology spends many of her days taking samples in Wisconsin's rivers, streams and lakes around Madison and at the Center for Limnology's Trout Lake Station in Vilas County. And when she's not in the water, she's diving into the data and analyzing what is going on in some of our most precious freshwater resources.

"I love Wisconsin, because everyone here seems to have a connection to and an appreciation for water – because some part of their life is linked to all of these lakes and rivers that we have," Stanley says. "My hope for a brighter future is that people recognize the value in that and really prioritize making sure that things don't get worse and, perhaps, even get better."

The things that Stanley is looking for as a scientist when evaluating the health of a water resource aren't all that different from what passersby look for when they're deciding if they should take a dip. She's looking at water quality and whether there are algal blooms, zebra mussels or dead fish. But she and her research team in the Stanley Lab aren't just passing by. In some cases – such as the North Temperate Lakes Long-Term Ecological Research (NTL-LTER) program – they've been studying these lakes for 44 years. This effort is part of the larger LTER Network funded by the U.S. National Science Foundation (NSF) since 1981.

"LTER allows us to be in the right place all the time," Stanley says. "We have this remarkable long-term data set that is unique in the world."

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For example, there's been a lot of attention on winter salting in cold states like Wisconsin. The salt used to prevent slipping on sidewalks and roads ends up in our lakes, and this study has allowed researchers to understand the consequences of that salt buildup. What they found is that not only has salt content in lakes increased over the past 40 years but that the salt is interrupting the stratification of lakes in the spring, which is what's responsible for the temperature layers in lakes like the cold bottom and warm top.

In true Wisconsin Idea fashion, scientists on campus have worked with city leaders in Madison to help reduce excess salting in the city to support beloved water resources such as Lake Mendota. But for Stanley, efforts like this are just the beginning. As she researches more climate struggles such as how human activity is increasing the amount of greenhouse gases coming out of surface waters or adding more phosphorus to lakes that fuel algal blooms, she wants to remind people that problems develop over a long time and take a long time to solve.

"We know from our science that if you could magically wave a wand and stop all the phosphorus from going into Lake Mendota today, it would be many years before we would see the phosphorus concentrations going down in the lake," Stanley says. "We humans are impatient, and the lesson is to not give up just because it didn't happen really fast."

Monica Turner returns to burn sites decades after wildfires to research new plant growth. PHOTO: ALTHEA DOTZOUR

Fire

For Monica Turner, being in the right place at the right time meant being at Yellowstone in the summer of 1988 when lightning sparked 18 massive fires that scarred 800,000 acres (or about 36%) of the national park.

"We never did the project we thought we were there to do," says Turner, the Eugene P. Odum Professor of Ecology and Vilas Research Professor in the Department of Integrative Biology. "But we were able to start studying the effects of those fires in what I call a natural experiment."

Pointing at photos of the aftermath of the flames, Turner describes a "mosaic" etched across the landscape. There are blackened areas where the trees were all killed, but also brown edges where the pine needles and cones hadn't fully combusted, as well as green space where the forest still lived. In the 37 years following those fires, she's carefully studied that mosaic as it changes and recovers to answer one critical question: What happens when a forest burns?

Her pursuit of understanding has led to massive studies on everything from plant communities to elk populations to aspen trees. Early on, the findings were surprisingly optimistic. She learned that forest systems were incredibly resilient. Wildlife, native species of plants and trees all came back. This was by design, since these forests had burned once every one to three centuries for the past 10,000 years. But this positivity was challenged by climate warnings that predicted that the hot, dry conditions that caused the fires of 1988 would eventually become the new normal.

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"That completely challenged my understanding of the system and what the future might be," says Turner, who wrote the textbook on landscape ecology. "From that point I shifted a lot of our effort to understanding what would happen and whether forests could persist if fire became more frequent."

Turner's passion for the Greater Yellowstone Ecosystem is unwavering, and she's trained a generation of new fire ecologists who match her enthusiasm for this beloved ecosystem through the Turner Lab Group. Together they study how and why the forests will change and preview what tomorrow's Yellowstone will look like. In 2016, the opportunity to test theories about frequent-interval fires came in the form of another wildfire across much of the same landscape as 1988. As she predicted, the forest wasn't ready to respond so quickly, and very few trees came back. What once was a lush young forest is now an airy meadow.

"My research journey has been a long and winding road, which is very characteristic of the way science works," Turner says. "But it's important to understand how natural ecosystems are adapting and responding to a change in climate. Without that, we'll be pretty clueless about how these ecosystems will respond."

Tracey Holloway has worked on air quality solutions through government service and academic research. PHOTO: HILLARY SCHAVE

Air

Analyzing the last 50 years of American air quality, Tracey Holloway sees a success story.

"The work we've done on clean air in the United States has been amazing," says Holloway, the Jeff Rudd and Jeanne Bissell Professor of Energy Analysis and Policy jointly appointed in the Department of Atmospheric and Oceanic Sciences and the Nelson Institute for Environmental Studies. "We're driving more, using more energy, and our population and economy have grown, but our air — aside from wildfires — has gotten cleaner and cleaner."

In the 1970s, air quality was suffering due to industrial pollution, but thanks to intentional policymaking and industry investments in cleaner cars and greener electricity sources, Americans have benefited from cleaner air year over year. Holloway's been a part of this effort firsthand. She served twice as the leader of the NASA Health and Air Quality Applied Sciences Team (HAQAST), where she used NASA data to work with stakeholders and create beneficial policies.

Today, she continues to make a difference by training the next generation of air quality scientists and conducting critical research through her lab, the Holloway Group. Together, scientists, graduate students and undergraduates work to advance air quality research that informs science and policy. They regularly partner with organizations on the local and national levels to make sure their work serves real-world needs. Having worked in air quality for more than 20 years, Holloway's amazed at how far the field has come and the progress that has been made.

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"What we're doing with satellite data now by tracking what people are breathing on the ground and using that to make policy decisions — 10 or 15 years ago, that would've seemed like science fiction," she says.

When tackling air quality challenges, scientists are looking at particulate matter and nitrogen oxide levels. Both these chemicals are reactive, which is why applying pollution control devices at power plants and on automobiles has been so effective. However, carbon dioxide isn't reactive, which makes addressing the climate carbon challenge more difficult. Still, Holloway is hopeful that there are ways to take the research done on air quality and apply it to lowering carbon dioxide rates. But she knows it will take collaboration between researchers, policymakers and industry to make that dream a reality.

"I really believe that science is a team sport," Holloway says. "And I think there are a lot of win–win opportunities to take what we've learned about air pollution control and apply it to carbon control so that we can get cleaner, healthier air and tackle climate change and carbon emissions."

TAGS Atmospheric and Oceanic Sciences Center for Limnology Faculty Integrative Biology Research