ARTS + LIFE » CLIMATE CRISIS

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Vermonters Face Stormwater Threat With Fungi, Rain Gardens and More

By ELIZABETH M. SEYLER

New weather patterns are affecting Vermont, according to **the state's climate change website**. Some locals might welcome rising average temperatures and shorter winters, but more intense storms? Not so much.

Shelburne Farms drainage ditch overflow into field after heavy rains | COURTESY OF JESS RUBIN

Increasing precipitation means more flooding in basements and backyards. Cities and towns must work harder to manage and clean stormwater before it reaches our waterways. And farmers face pressure to keep phosphorus and other agricultural chemicals from leaching into Lake Champlain, where they cause blue-green algae blooms and other hazards.

While many Vermonters are working to reduce the state's carbon footprint, others are focused on adapting to the changing climate. Two in particular are working to clean and reduce the volume of stormwater runoff: Jess Rubin and Juliana Dixon.

Rubin is the founder and creative director of **MycoEvolve**, which conducts research, provides education, and offers landscape analysis and enhancement to homeowners, businesses, farmers and municipalities. The Burlington resident, who holds a master's degree in environmental studies, has been working in the field for more than 20 years.

Through MycoEvolve, a business extension of Rubin's earth- and faith-based education company **Roots and Trails**, she aims to help ecosystems recover and thrive through mycoremediation and phytoremediation. In the former, fungi break down toxins; in the latter, plants provide "reparative infrastructure," Rubin said.

"The key to fungi's alchemical potential lies in their collaboration with microbes and plants," she explained. "Fungi are bridges." Applying both forms of bioremediation can improve soil health, filter water, store carbon, improve plant health and enhance pollinator habitat.

To mitigate the destructive effects of increased precipitation, Rubin promotes "green stormwater infrastructure." The term was coined in the mid-1990s, and the practice has gained traction over the past decade.

Traditional gray stormwater infrastructure is composed of curbs, gutters, drains and other structures that move water away from the built environment and into waterways. In contrast, green stormwater infrastructure — made of living organisms often arranged in

FIRED UP
Vermonters respond to the climate crisis

"Fired Up" is a semi-regular series exploring Vermont's climate-related challenges and what residents are trying at a local level to mitigate the planet's heating trend — noting what's catching on and what isn't. We'll also look at ways to become more resilient in the

aesthetically pleasing ilandscapes — captures rain where it falls, cleans it and slows its flow, "allowing time for it to percolate, infiltrate and evaporate," Rubin said.

The goal of these efforts is to keep water where it can nourish the landscape rather than degrade it.

face of changes that may be inevitable.

Got a suggestion for the series? Send it to coordinator **Elizabeth M. Seyler**.

Going BLUE

Dixon is the owner of **Salix Solutions**, a licensed BLUE rainwater mitigation consulting company. Run by the Tethys Corporation, BLUE educates property owners on pollution sources, evaluates their property's capacity to handle stormwater, recommends infrastructure improvements and confers various certifications.

Rachelle Gould's rain garden | COURTESY OF RACHELLE GOULD

In 2018, the City of Burlington ran a pilot project called BLUE BTV in collaboration with Lake Champlain International and the Lake Champlain Sea Grant.

Working with Dixon, BLUE BTV helped residents register for free BLUE services, provided online videos for do-it-yourselfers and offered rebates for infrastructure improvements. These included rain barrels, tree plantings and the creation of pervious driveways, which allow water to seep into the soil below.

Rachelle Gould participated in this pilot project at her triplex on Front Street. The building sits a few meters from a street drain, and water had consistently pooled along one side of her house on its way there. Dixon recommended a rain garden, a pervious driveway and a rain barrel near the street.

A rain garden is a depression in the ground that's filled with drainage materials such as crushed stone and covered with native shrubs, perennials and flowers. It's carefully designed to hold stormwater until it gradually soaks into the ground.

Gould, who already had two rain barrels, chose to install the rain garden and a third barrel and put up gutters over her porch. Dixon recommended that Rubin do the rain garden installation because of her experience in watershed-friendly landscaping. The installation cost about $1,000, Gould said, but city funds helped defray all but a few hundred.

"I watch it with great excitement when it rains," Gould enthused about the rain garden. "You can't tell what's going on underground. It just looks like gravel with some plants." But when it rains, she said, the water "goes into the gravel and disappears. I've never seen it pool." Her rain garden even absorbed a downpour last Halloween, when 3.3 inches of rain fell on Burlington in six hours.

Gould is an assistant professor in the environmental studies program and the Rubenstein School of Environment and Natural Resources at the University of Vermont. She studies the relationships between ecosystems and well-being. Though she's pleased that the rain garden is doing its job, she also likes "that it's a symbol of putting a little bit of time and energy into this project that is benefiting the lake." Her single garden "is not making a giant difference," Gould acknowledges, "but if everyone had one by their house, it *would* make a difference."

Sixty properties were evaluated during the BLUE BTV project, and 15 owners installed some form of green stormwater infrastructure, according to Dixon. Based on that reduction of impervious surface area, she estimated that the new infrastructure keeps 322,000 gallons of stormwater from running into the lake each year, assuming an average annual rainfall of 36 inches. Had all 60 homeowners taken action, installations could have diverted nearly 2 million gallons annually.

This year, the towns of Williston and Colchester have hired Dixon's Salix Solutions to run BLUE programs much like Burlington's. State stormwater-discharge permits require that towns reduce phosphorous, *E. coli* and other contaminants in their waterways and help residents understand and mitigate such contaminants, according to Christine Dougherty, Williston's stormwater coordinator.

Williston "is committing $10,000 to help offset the costs" to residents who participate in its pilot program this summer, she said. "We're running this pilot to see what kind of interest Williston residents have."

Meantime, Colchester is offering the program again after a successful 2019 pilot. "Our goal was to get 10 homeowners," said Karen Adams, the town's technical services manager, "but about 25 signed up, and more are on a waiting list for this year." The town offers rebates to help defray installation costs through a grant from the state's Clean Water Initiative Program.

Cleaning Up

Jess Rubin (third from right) with volunteers in Colchester COURTESY OF JESS RUBIN

In addition to helping residents understand and improve stormwater management on their properties, Colchester has contracted with Rubin's MycoEvolve for a pilot mycoremediation project. The aim is to reduce *E. coli* and phosphorus concentrations in Smith Creek, which runs through municipal property and is one of 18 impaired waterways in the Malletts Bay watershed, Rubin said.

According to Adams, the creek flows along a series of well-established neighborhoods where no recent development can account for steadily increasing levels of the two contaminants.

Rubin's team believes that the levels of *E. coli* — which tests show is generated by wildlife activity, not by humans — are probably increasing due to degradation of underground networks in forests, she said. These networks transport nutrients and offer natural filtering services.

One culprit could be the Japanese snake worms that a colleague and adviser of Rubin's, professor Josef Görres of UVM's Department of Plant and Soil Science, found in the area. This invasive species eats through organic matter and soil layers at an alarming rate. It has been threatening perennial ecosystems throughout the Northeast and Midwest over the past decade, Rubin said, and could be contributing to the creek's increased pollutant levels.

While Görres researches how to control the snake worm, Rubin is testing mycoremediation and phytoremediation as tools for uptaking phosphorus and degrading *E. coli* in the creek and adjacent woodland.

"There are no silver bullets, and the ultimate solution is to stop the sources of pollution through changed land practices."

JESS RUBIN

Last August, she and her team strategically placed logs and large filtration socks in the creek after inoculating some of them with saprophytic fungi (shiitake and turkey tail), which live on dead or decaying matter. They also planted mycorrhizally dipped native plants along the eroded banks. By measuring pollutant levels before and after water flows through each filtration system, Rubin's team will determine which treatment is most effective.

"There are no silver bullets, and the ultimate solution is to stop the sources of pollution through changed land practices," Rubin said. But "we'll also keep trying strategies to remediate damaged areas.

"We're going to get more data in the spring" at Smith Creek, she continued, "but the most exciting data so far is that the combination of mycorrhizal and saprophytic fungi seems to be decreasing both *E. coli* and phosphorus concentrations."

If additional data bear out those positive results, Adams plans to do follow-up studies to help Colchester develop new ways to manage these pollutants. "It can be very expensive to remove phosphorus and *E. coli* from the environment," she said. "So this might be an opportunity for a lower-cost application: You're using native materials. You're returning what is essentially the forest filter to the forest. That's a heck of a lot cheaper than constructing gravel wetlands and man-made features that are supposed to mimic what the natural environment does."

Shiitake mycelium (white vegetative fungi structure) for mycoremediation in Colchester | COURTESY OF JESS RUBIN

In addition to leading MycoEvolve, Rubin is pursuing a second master's degree, at UVM, focused on ecological design. Her thesis project is a case study in using mycoremediation strategies to reduce phosphorus in agricultural runoff at Shelburne Farms while also increasing pollinator habitat.

"Agriculture contributes 41 percent of base phosphorus loading on the Vermont side of the Lake Champlain, according to a report put out by the EPA in 2016," Rubin said.

The focus of her research is a drainage ditch alongside an agricultural field at Shelburne Farms now used as sheep pasture and compost staging. The ditch is overgrown with glossy buckthorn, a nonnative species that crowds out native plants, decreases soil's filtering capacity and increases erosion. Rubin aims "to reestablish ecological structure, function and succession" by encouraging biodiversity.

"Mycoremediation is a young field," Görres said. Rubin's research has the potential not only to clean up toxins but also to demonstrate how mycorrhizae can improve crop performance. "If you already have a lot of phosphorus in your soil, why add more?" he asked rhetorically. "Try making the plants more efficient at uptaking it through mycorrhizal associations."

On March 11 and 15, Rubin will offer free workshops at the Fletcher Free Library in Burlington. At the first, participants can learn how mycoremediation breaks down toxins in soil and water. At the second, Rubin offers strategies for enhancing bird, pollinator and wildlife habitat.

Rubin believes that everyone can use such practices — farmers, municipalities, homeowners — and that they should be taught in schools.

"I call today's youth the remediation generation," she said. While she applauds youths' activism, she encourages them "to better understand earth systems and hone skills to create a remediation workforce. It's astounding how old microbes, fungi and plants are; how much potential they have in earth repair; how many toxins are in our environment ... As we de-

grow to save the planet from our species, we can create jobs that, instead of extracting and producing, actually clean, nurture and support earth health."

The original print version of this article was headlined "Holding Back the Tide | Vermonters face stormwater threat with fungi, rain gardens and more"
