SUBURBAN WARFARE

Q MAGAZINE

THE HOMEFRONT COSTS OF OUR BATTLE WITH NATURE KEEP RISING . . .

VOLUME 4 / ISSUES 1 & 2

A PUBLICATION OF THE UNDERGRADUATE CERTIFICATE IN ENVIRONMENTAL WRITING
AT THE UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

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Our Gracious Donor ...

A very special thanks to Janelle Joseph, who has continued her support of the Institute for Sustainability, Energy, and Environment (iSEE) with several generous donations to help *Q Magazine* student writers go on location and research their stories.

Her gifts have also funded the Janelle Joseph Environmental Writing Contest, which debuted in 2020 and offered U of I undergraduates the opportunity to submit articles for cash awards and publication in *Q!* Several prize-winning articles are featured in Volume 4.

"Through my dear friend Joel Friedman, I became aware of iSEE's dedicated programs," said Joseph, pictured here with her dog Moonbeam. "The planet and the environment are where all things future begin. All needs and other great causes depend on where we live and are safe.

"After hearing about iSEE and *Q Magazine*, I felt HOPE, for the first time in many years, that brilliant young people are working on improvements and solutions."

With Joseph's funding, student writers are inspired to explore environmental issues up close and in person.

We are grateful!

About Q Magazine

Welcome to *Q Magazine*, a showcase for inspired environmental writing at the University of Illinois.

Q Magazine features outstanding articles by U of I students, most of them enrolled in the Undergraduate Certificate in Environmental Writing (CEW), a joint venture of the Institute for Sustainability, Energy, and Environment (iSEE), the School for Earth, Society, and Environment (SESE), and the English Department.

When enrolled in the CEW capstone course (ESE 498), students have the opportunity to submit their writing for publication in Q, working closely with instructors and production staff to develop their work to a professional, publishable standard.

The motto of the CEW is "turning data into narrative" — to absorb the latest environmental research and communicate that research effectively to the public. Certificate courses allow students to engage with the latest on-campus research in sustainability science and identify environmental issues they are passionate about. Whether dropping in to take one of our courses or completing the full three-course sequence, students work with dedicated professors, meet enthusiastic students from disciplines all across campus, and build marketable skills in environmental communication.

Enjoy these student voices, broadcasters for change and a livable planet.

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Kratika Tandon

Kayla Vittore

The Writers

Editor's Note:

In *Q Magazine*'s fourth annual print edition, climate change comes to our backyards. You don't need to travel to the deforested Amazon or melting polar caps to witness its manifestations. Read on to discover how writers from the U of I's Certificate in Environmental Writing and other undergraduate authors are tackling environmental and social justice at home and beyond.

In our headlining piece, the Great American Lawn has devolved into an ecological nightmare. Nicolas Ramkumar explores the environmental costs of pristine green grass, and the possibilities for suburban sanctuaries that are both beautiful and sustainable.

The fight for the environment is waged on many fronts, from lawns to blockchains. In the grand prize-winning piece of the 2021 Janelle Joseph Environmental Writing Contest, Tyler Swanson exposes the digital world's effects on our very real, natural world — though perhaps it should come as no surprise that the capitalistic craze of crypto has detrimental effects on the environment.

The profit motive likewise drives the ongoing tragedy of American fossil fuel infrastructure. In "Black Snake," I offer my first-hand account from the frontlines of oil pipeline protests in Minnesota, where the construction of Line 3 re-enacts the genocidal dispossession of local tribes, cutting a swath through traditional lands they have stewarded with care.

We hope this volume encourages you to ponder sustainability in your own backyard and beyond. Whether your interests lie in energy, agriculture, Earth's natural marvels, or all of it together, what matters most is that we continue to carry those passions with us in our everyday actions and conversations.

Maria Maring
Student Editor
and the *Q* Editorial Team

ABOUT THE COVER: Illustration by Haley Ahlers using photo from Shutterstock.com.

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IN THIS ISSUE:

By Maria Maring

BLACK SNAKE

EDITOR'S NOTE: Although Line 3 is far north of Urbana-Champaign, it is important that we acknowledge that the University of Illinois exists upon the traditional lands of the Peoria, Kaskaskia, Piankashaw, Wea, Miami, Mascoutin, Odawa, Sauk, Mesquaki, Kickapoo, Potawatomi, Ojibwe, and Chickasaw Nations.

Before I begin this oil pipeline story, a few disclaimers ...

First, the political battle surrounding the Line 3 pipeline is a fast-moving target. Between the time that I visited the frontlines in July 2021 and the writing of this piece in November 2021, Line 3 was completed. Will oil still be flowing when you read this article? I pray not.

Second, I am cognizant of my whiteness as I write about this Indigenous-led movement. I aim not to be a white savior nor to replace Indigenous voices with my own. Being an ally is a constant learning process; therefore, I recognize and apologize for my naivety in navigating this delicate space. Merely, I witnessed this movement, and I want to share that story.

Third, this memoir only scratches the surface of Line 3. There are so many facets to this illegal pipeline, it is impossible to pay them all adequate attention in a single essay. I encourage you, reader, to continue your research and activism beyond this narrative.

Rusty pipeline. *Credit: Shutterstock*

I struggled to write after returning from Minnesota. The cliché "words could never describe" was never more applicable, as much as that frustrated me. Yet, every time I tried to recount my memories and synthesize my emotions, my mind became almost as thick and hazy as the wildfire-ridden Minnesota air.

So, let's start with the most basic facts. Enbridge is a Canadian multinational pipeline company worth more than $163 billion as of 2019, and it boasts more than 3,000 miles of pipeline throughout the North American continent. It is to blame for more than 800 spills in the last 15 years alone. In 1991, Enbridge caused the largest inland oil spill to date when the old Line 3 released 1.7 million gallons of oil into Minnesota ecosystems. Nineteen years later, it caused the second-largest inland oil spill in U.S. history.

The current Line 3 project aims to expand the corroded and leaking 1960s-era Line 3. This pipeline carries tar sands oil — from which the resulting gasoline produces 15% more carbon dioxide emissions than conventional oil — from Alberta, Canada, to Superior, Wis. The Line 3 Replacement Program has established 337 miles of new pipeline through Minnesota and abandoned 282 miles of old pipeline. Line 3 also includes 13 miles through North Dakota and 14 miles through Wisconsin. The revamped pipeline crosses 200 bodies of water, including the headwaters of the Mississippi, and it carries more than 760,000 barrels of tar sands oil every day.

On the human rights side, there is a direct link between pipeline construction projects and sexual violence, against both Indigenous and non-Indigenous women and girls. The Virginia Sexual and Domestic Violence Action Alliance explains that temporary settlements of pipeline construction workers become places of "isolation, drug and alcohol abuse, violence, misogyny, hyper-masculinity, and racism." In February 2021, two Line 3 workers were arrested for sex trafficking; two more were arrested in July. As of June 2021, more than 40 reports were made to a Minnesota crisis center about Line 3 workers harassing local women and girls. Already, one in three Indigenous women will experience sexual violence in her lifetime, and they are murdered at a rate 10 times higher than the national average — bleak statistics disproportionately higher than any other demographic. The Missing and Murdered Indigenous Women, Girls and Two-Spirit People (MMIWG2S) and No More Stolen Sisters movements have been striving to bring these discussions into the spotlight.

Though the new Line 3 avoids Leech Lake Reservation, it still invades Fond du Lac Reservation, as seen in Enbridge's Line 3 map. Completely missing from the Enbridge map, however, are the lands ceded to the Anishinaabe people by the Treaty of 1855. Line 3 is explicitly illegal by encroaching on and endangering areas for hunting, fishing, *manoomin* (wild rice), and cultural resources of the Anishinaabeg, rights guaranteed in 1855. Not only is Line 3 illegal, but it perpetuates the colonization and genocide of Indigenous peoples.

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I began my journey last summer at the Water Protector Welcome Center in Palisade, Aitkin County. I chose Palisade over the countless other camps because it's where most Water Protectors get their start, going through a vetting process to ensure they're not spies. Also, I knew a few people at the camp, so I wasn't totally alone. I made the 13-hour drive on pure adrenaline, not knowing what to expect. Previous to this experience, I had a very superficial idea of climate and social activism. I had romanticized the frontlines, imagining activists with flags slung around their shoulders, swinging off bulldozers like

acrobats, fists pumped in the air — a Eugène Delacroix-esque scene. Alas, the frontlines were much more subdued than a battlefield.

The Welcome Center was founded on an activist's private property-turned-base camp, situated on the headwaters of the Mississippi River and Highway 10. The landowners' sheds served as storage for food, protest signs, and medical supplies. The front yard was littered with collapsible camping chairs, whiteboards with scrawled lists of supplies and protest ideas, and tons of artwork with slogans like "Love water, not oil," "Water is life," and my favorite, "This is not ecotourism."

The property continued to the banks of the river, where months of activists' marching feet had stamped down the grass. Primitive campsites dotted the path. The constant white noise of the moving water was peaceful, the droning mosquitos less so.

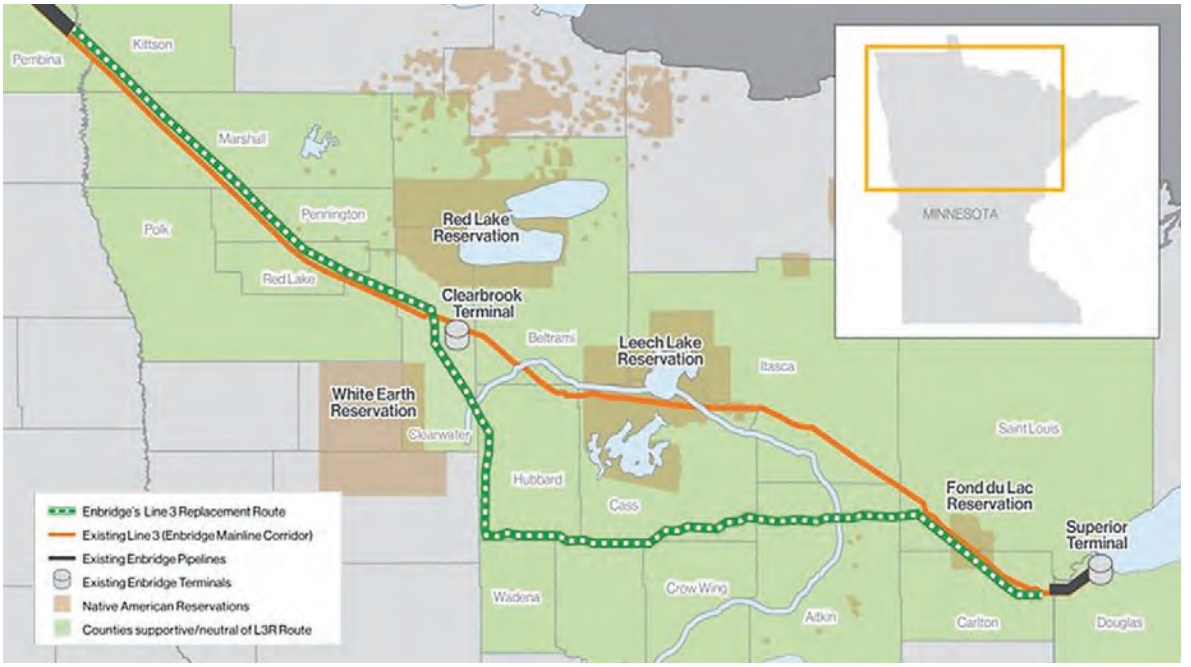
When I arrived, acquainting myself with the sleepy grounds, the veteran camp members' walkie-talkies started blowing up: "There's cops on boats, I repeat, there's cops on boats." We proceeded to the easement — the strip of land that the government acquired for Enbridge to build underneath. Intruding on the otherwise contiguous tree line were huge bulldozers and broken land. On the banks of the river, Enbridge workers decorated in neon vests were roping off the area, lowering a small pump into the drought-ridden Mississippi and using their hardhats as hammers to plow stakes into the ground. We Water Protectors chuckled: *Where's OSHA when you need 'em?* The water was extra murky and 10 feet lower than its typical level. Minnesota Department of Natural Resources (MDNR) personnel in riot-proof wear were aboard speedboats, protecting the pump. Why was the MDNR protecting the water thieves instead of the natural resource — water?

Enbridge had legally obtained permits from the MDNR to use 500 million gallons of water for construction purposes. Then, on June 4, 2021 (a couple of weeks before my arrival), the MDNR inexplicably amended the permit for 5 billion gallons of water amid a historic drought. It doesn't take an expert conservationist to conclude that the amendment made no sense; there is good reason to suspect that the MDNR is taking orders from Enbridge.

As of April 2021, Enbridge had paid law enforcement upwards of $750,000. The rationale is to make Enbridge

Water Protectors load into canoes on July 15, 2021, before paddling up the Shell River to take part in a direct action against Enbridge Line 3 pipeline construction in Menahga, northern Minnesota. During a time of increasing climate crises, the fossil fuel project has been widely opposed by Indigenous communities and environmentalists alike. *Credit:Tim Evans*

The new Line 3 invades the Fond du Lac Reservation and the 1855 treaty area surrounding the Leech Lake Reservation. *Credit: Enbridge*



pay for the extra law enforcement costs associated with pipeline construction so that Minnesota taxpayers don't have to pay extra — which isn't a bad idea, at least for taxpayers. However, the police and MDNR are now inadvertently biased: The more hours they work, the more arrests they make, the more handsome their paychecks are. Subsequently, peaceful Water Protectors have been shot with rubber bullets, tear-gassed, surveilled, and cited with copious charges including felonies, leading to unparalleled stress on Minnesota's legal systems. In the words of the Sierra Club: "Local police have been defending a pipeline company's right to make a profit as the world burns, instead of defending our right to clean air, clean water, and a stable climate." Enbridge has both the MDNR and law enforcement in its pockets.

In Minnesota, I witnessed that power dynamic firsthand. The Department of Natural Resources, the government entity that is supposed to safeguard our land, water, and air, instead protects the company violating Earth with corporate-funded weapons. In my naivety, I thought the Department of Natural Resources truly prioritized Earth's well-being. When I instead witnessed the epitome of corruption, I felt so empty. Each night, lulled to sleep by the incessant beeping and drilling of the machinery just outside my tent, I cried.

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My subsequent experience at so-called Shell City, Minn. was very unlike that at Palisade.

For months, Winona LaDuke, an Indigenous environmental activist, founder of Honor the Earth, and hero of mine, had been occupying a campground on the banks of the Shell River, named for its absurdly dense population of freshwater mussels. Now, thanks to unpredictable weather patterns, water pollution, and acidification, the mollusk namesakes of Shell River are dying in swaths nationwide. Line 3 will only further jeopardize these organisms, which are essential for water purification and other ecosystem services.

I drove two hours from Palisade to Shell City for an event called Women for the Rivers. Though not as large as the Treaty People Gathering the month previous, a charter bus from Minneapolis brought about 200 people, in addition to the couple hundred out-of-staters like myself who came independently. We milled about the Shell City Campground, located mere meters from the Shell River. In the middle of the area was a huge tipi with

The entryway of the Water Protector Welcome Center in Palisade, Minn. *Credit: Maria Maring*

beautiful artwork on all sides: deer and bears and fish and other creatures, each antler, claw, and scale given careful artistic attention. Near the wooden staircase leading down to the river were a few dozen canoes and kayaks all colorfully decorated with phrases like "Honor the treaties." Honor the Earth was selling merch and manoomin in the corner of the campground. A hundred or so folding metal chairs faced the river in a semicircle, a microphone stand and amp at the ready. Cameras sat atop tripods as both local and national reporters waited.

There are three different tiers of direct action, organized according to arrest-ability: red, yellow, and green. Green means you do not want to risk arrest or fines whatsoever. This may look like peacefully walking in a march. On the other end of the spectrum, red means that you intend to stir up some trouble, perhaps by chaining yourself to machinery. Yellow is the in-between: If the moment arises, you are willing to incur a citation or two; if not, just as well. I declared myself yellow, so I reported to the registration desk to provide emergency contact information. We also were instructed to ink the bail fund phone number in Sharpie somewhere on our bodies, so that even stripped of all our possessions, we could still call for help from jail.

As noon approached, we took our seats. The presentation began with the distribution of sacred tobacco to offer to the river. We passed around burning sage nestled into a mussel shell, beckoning the smoke into our auras, preparing us for the direct action that would follow.

The speakers ranged from LaDuke to Sierra Club Executive Director Michael Brune to a youth from White Earth Reservation, and they all had a similar message: We must hold President Joe Biden, Secretary of the Interior Deb Haaland, and the state of Minnesota accountable, and together we can stop this environmental degradation and blatant racism against the Anishinaabeg.

Winona LaDuke. *Credit: Stop Line 3*

After the speakers, we traveled 1 or 2 miles from the campground to the easement. Some folks boarded the charter bus and drove there. Some mounted horses and maneuvered along a trail. Others, myself included, paddled kayaks and canoes down the Shell. We all brought bouquets of flowers as symbols of peace, love, and hope in the oppressive face of Enbridge.

At the intersection of the pipeline and river, the tree line broke to make way for a sprawling, ugly boardwalk running perpendicular to the river. We dismounted from our boats and splashed into cold water, the insidious "black snake" of the pipeline sleeping just below our feet. We "yellow" and "red" folks hiked up the steep incline of the boardwalk to the construction site — which is technically trespassing on federal property. The "green" folks stayed in the river to pray and chant.

At the crest of the boardwalk, the construction site came into view. On what would otherwise be a wooded area, the ground was barren. Tall metal fences surrounded the bulldozers and spotlights and drills. Three police officers were waiting for us. I took note of the guns, tasers, and yellow plastic handcuffs on their hips. They were calm, even robotic. As some Water Protectors tried to engage with the police — spitting facts about MMIWG2S and the environmental degradation and economic pitfalls that come with a pipeline — the officers gazed past us as if we weren't even there. No arrests were made.

I sat down on the hard wood and closed my eyes. I listened to the drums and song in the distance. I thanked — not God, but some entity — for the opportunity to be here and do what is important. I thanked the universe for such a beautiful day, for such a beautiful ceremony, and for such beautiful company. The horses whinnied and the dogs barked with the songs as if they, too, knew the lyrics. At that moment, I knew that even if Line 3 became operational (which it did), good people fighting the good fight do exist. Suffering immensely every day from climate anxiety, I often feel alone and doomed, but not then. In that moment, I felt empowered and unafraid.

I had to depart the next day. It was morning, and most people were still snoring in their tents. Emotional, I retreated to the bank of the river to stand in her and say *goodbye* and *thank you.* LaDuke was also there. I tried to keep a distance from her, not wanting to disturb her meditations, and also not wanting her to see me cry. But she approached me and thanked me for coming to Minnesota and fighting Enbridge alongside her and everyone else.

Police guarding a Line 3 construction site near Shell City Campground in Shell City, Minn., on the day of the Women for the Rivers event. *Credit: Maria Maring*

She chuckled to me, "You know, redheads are my lucky charm."

I didn't feel so lucky when Line 3 became operational three months later in October 2021.

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According to the United Nations, the definition of genocide is: "Acts committed with intent to destroy, in whole or in part, a national, ethnical, racial or religious group, such as … deliberately inflicting on the group conditions of life calculated to bring about its physical destruction in whole or in part." I'd say Line 3 fits the bill. The United Nations Committee on the Elimination of Racial Discrimination (CERD) is currently investigating Enbridge for its offenses against the Anishinaabe. However, bureaucratic wheels turn slowly, and oil is now flowing.

Like the arrival of the pilgrims, like Manifest Destiny, like Termination, like every treaty that has been broken over the centuries, Line 3 is another instance of the U.S. government stealing Indigenous land, life, and liberty. Line 3 is the epitome of modern-day colonization and genocide. Days after Line 3 became operational, LaDuke published an opinion piece in the Star Tribune, and she concluded, "It's time to quit acting like Columbus."

Still, good things are happening. The Indigenous Environmental Network and Oil Change International reported that as of August 2021, Indigenous resistance has stopped or delayed the equivalent of one-quarter of U.S. and Canadian greenhouse gas emissions. President Biden proclaimed Indigenous Peoples' Day this year.

During the entire week of Indigenous Peoples' Day, momentous demonstrations occurred in Washington D.C., during which more than 650 people were arrested, all demanding that Biden declare a climate emergency.

Most pertinently, Line 3 was initially scheduled to be operational in 2017. Water Protectors successfully caused such a ruckus that it wasn't completed until 2021. Success is a convoluted and subjective thing. Though Line 3 is operational, we were successful. In the words of LaDuke:

In one narrative, the Canadian corporation (Enbridge) won. Columbus conquered anew, proof that might and money remain the rulers. Then, there's another. That's the Ballad of the Water Protectors — a movement born in the battles in northern Minnesota and North Dakota, a movement that will grow and transform the economy of the future.

Maria Maring is Q Magazine's Volume 4 Student Editor. A senior from Carbondale, Ill., she is double-majoring in Earth, Society, and Environmental Sustainability and Spanish, with a minor in National Resource Conservation. She is also an iSEE Communications Intern.

One gorgeous spring day in April 2021, I shed the constraints of the pandemic and visited the Atherton Island Natural Area, a stunning wild place about 20 miles north of Terre Haute, Indiana. The occasion was a wildflower hike organized by the Ouabache Land Conservancy (OLC). My research mentor, Assistant Professor Esther Ngumbi, and I were invited by her colleague in the Entomology Department at the University of Illinois. The hikers consisted of Indiana conservationists, some adorable dogs, and a few entomologists from the university, all of us united by our enthusiasm for enjoying wild areas.

In spring, riparian areas hold the promise of new life — bright marigold lichens and velvety moss on rocks, green buds and catkins on trees, little shoots poking up from the ground, dried grasses from last season tipped with bursting seed pods containing fuzzy little seeds inside — just waiting for an aggressive wind to shake them free and scatter them on the fertile soil.

BURSTING WITH LIFE

By Erinn Dady

Closeup of pawpaw flowers. *Credit: Erinn Dady*

Background: *Credit: Shutterstock*

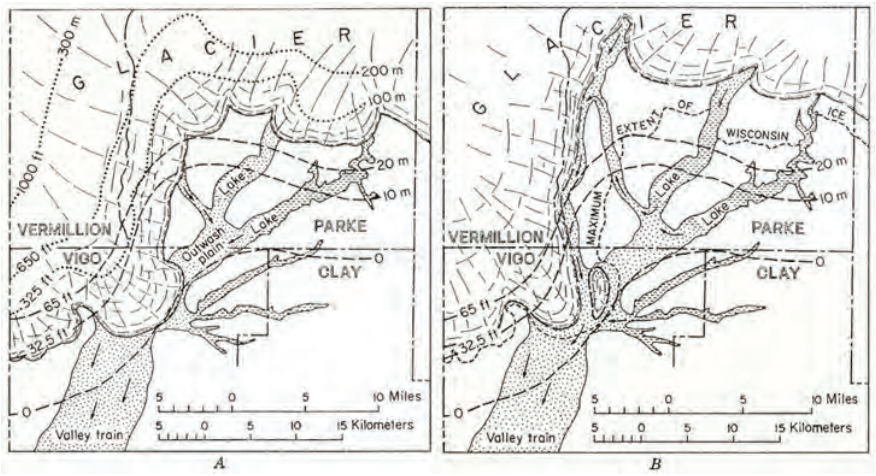
Jim Nardi showing flowers of pawpaw trees (*Asimina triloba*). *Credit: Erinn Dady*

Despite spending many hours of my life becoming familiar with ecosystems alongside the Illinois branches west of the Wabash River, I was surprised to find so many unfamiliar flowers along the banks of Indiana tributaries. Atherton Island, a preserved natural area, is part of the eastern watershed of the Wabash River. Within the preserve, there are several unnamed creeks which flow out of the natural area and into the channelized Lyford Dike and Levee Association Ditch. These unnamed creeks empty into the Wabash, circulating with water from many other tributaries, including the Boneyard Creek, which runs through the campus of the University of Illinois at Urbana-Champaign. The name Wabash is the English spelling of the name given by French traders, Ouabache. This is a corruption of the Miami-Illinois Native American name for the river, *waapaahšiiki*, which roughly translates to "white-shining" or "water over white stones," due to the distinctive limestone river bottoms.

The OLC and its members protect more than 800 acres of natural areas in west-central Indiana. I discovered the Atherton Island preserve through Jim Nardi, a Research Scientist in Entomology at the U of I, whose family used to own an 80-acre orchard there. Jim's grandfather purchased the land around 1915 and planted orchards of apples, peaches, plums, and grapes. By the time Jim was born, 28 acres of orchards grew along the ridges. His parents sold the orchard and all of the equipment in 1970, and the property passed through four different owners before Jim was able to buy it back in 1993. The once picturesque orchards had fallen into disarray, and the house had burned down. There was junk everywhere — cars, an old bus, fridges and stoves — and all manner of trash was dumped into the ravines. Jim was perplexed that people could so mistreat the land. Nonetheless, he got right to work. He hauled out the junk, cut back and pulled out the invasive species such as black locust trees, bush honeysuckle, and multiflora rose, and built a Quonset hut to replace the old barn.

In early 2018, Jim and his spouse Joy generously donated the family's land to the Atherton Island Natural Area, which was already part of OLC. And the Nardis have stayed busy; in 2021 they finally removed the last of all the old fence rows from the last hundred years. They have planted many native trees, starting with 800 planted by hand, including wild cherry, persimmons, tulip trees, and oaks — white, black red, pin, and chinkapin. In April, the month of my visit, they had just hired a forester to plant 16,000 more trees over 35 acres, using a tree bar planter to plant walnut trees, beechnuts, tulip trees, Kentucky coffee trees, and more oaks. They have also replanted 4.5 acres of native shortgrass prairie. As the Nardis told me, "This place is for the animals and wild things to live, and we humans are the visitors."

Atherton Island, part of the Ouabache Land Conservancy in west-central Indiana. *Credit: George Bakken*



A: Depositional environments in Raccoon Creek area at the time of the maximum extent of Wisconsin glacier. Dashed contours show extent of crustal depression and dotted contours show estimated thickness of glacial ice.
B: Raccoon Creek area at the time of the drainage of proglacial lake and reversal of drainage, before isostatic rebound. Contours show extent of crustal depression. *Credit: William J. Wayne, 1965, The Reversal of Raccoon Creek at Atherton Island, West-Central Indiana*

Being an entomologist, Jim told us of the tiny gall wasps that live on white oak trees; they were everywhere when he was a kid, but their populations have seen steep declines. However, in the last few years, he has seen their galls in the trees again. Gall wasps are tiny, solitary wasps that inject an egg into plant tissue, which provides the perfect food and shelter for the developing larvae. The grub secretes chemicals and hormones which cause the plant tissue to develop and swell into a sphere, or gall. This doesn't harm the tree, and the insects are an important source of food for birds. These wasps have two different generations each year; one of sexual young (both males and females) and one of asexual females (that may lay eggs without mating). These wasps were studied for 20 years by Alfred Kinsey, until he left the field of entomology to study human sexual behavior and develop his famous Kinsey Scale.

One of my fellow hikers, a geology enthusiast named Tom Zeller, told me Atherton Island was actually a land island, formed from sediment deposited by glacial meltwaters over several glaciations (Kansan, Illinoian, and Wisconsin) throughout the Pleistocene Epoch (between 2.58 million and 11,700 years ago). This land island was caused by an ice dam backing up the lake and then leaving a large amount of sediment behind. The resulting blockage caused the drainage of Raccoon Creek to reverse direction.

Jim stopped to discuss an Indiana native, the pawpaw tree, in bloom with deep burgundy flowers tipped in yellow. I've had the fruit before, known as the Indiana Banana. It is sweet and tangy, tasting like a cross between a banana and a mango. I've even planted pawpaw seeds, but had no luck growing the trees. Other well-informed hikers were happy to explain the trees' preferences: Seedlings initially require shade to survive, but as they mature, they need sun to produce fruit. On other hikes, when I recognized the trees but found no fruit, I simply assumed some lucky squirrels ate them all. Apparently, it is difficult to get the fruit to set, as they are pollinated only by carrion flies. One hiker, Hannsford Mann, helpfully informed us that he takes roadkill he finds and hangs it from trees in his pawpaw patch, drawing flies to pollinate the flowers. His trees produce a large crop of fruit, and presumably no one is brave enough to pilfer his crop!

We didn't see much wildlife, as there were about 30 of us talking and visiting along the hike, but the wildflowers were incredible! Thanks to a class I was taking on plant systematics, I was well prepared for identification of plant families. It was very enjoyable for me to recognize the flowering plant families I had learned in textbooks, while out in nature. One of the more remarkable flowers was the dwarf larkspur, an herbaceous perennial of the buttercup family, boasting a cluster of deep violet, spurred flowers. They made me think of a firework exploding with little purple stars. Another reason I noticed these flowers was their attractiveness to pollinators. Their nectar and pollen are especially attractive to long-tongued bees such as bumblebees *(Bombus spp.)*, digger bees *(Anthophora spp.),* and miner bees (*Osmia spp.*).

As our hike was winding to its very satisfying conclusion, Jim told us what a pleasure it was to work with volunteers who donate their time to such a worthy environmental cause. The feeling was mutual. The hike was an inspiring experience for me; I was so glad to meet folks working to conserve wild spaces. We are all residents on this planet together, and meeting people working to conserve it reminded me that all of us, whatever our path, have a chance at creating a better, biodiverse world.

Erinn Dady is a senior majoring in Earth, Society, and Environmental Sustainability. After graduating in May 2022, she will pursue a graduate program in Ecology and Entomology. Through her undergraduate research in Entomology Assistant Professor Esther Ngumbi's lab, Erinn is enthusiastic about improving food systems by helping farmers boost their crops' defenses against insect herbivory.

By Kayla Vittore

PLANTPOWER

The COVID-19 pandemic hasn't only affected human life; the global climate also felt the impact of this historic event. There was a 6 to 7 percent decline in atmospheric carbon dioxide emissions last year due to a drastic reduction in travel and commuting. As encouraging as that sounds, 2020 was still one of the top three warmest years on record. Actually, *all* top 10 recorded warmest years have occurred between 2005 and 2020, each new year breaking the previous record. It doesn't take a genius to see the trend:

We're in trouble.

Pennycress (*Thlaspi arvense*). *Credit: Shutterstock*

As an optimist, I try to focus on solutions rather than despair over problems. Across the dark sea of climate anxiety there is a lighthouse of hope that catches my eye: biofuels. Biofuels are liquid fuels made from plant material and a promising alternative to fossil fuel energy sources. Alternative fuels are in need of rapid development because as human populations grow and living standards improve, global fuel consumption and prices are increasing. Simultaneously, our current fuel sources are finite and quickly being depleted. Biofuels can help meet this growing demand for energy through renewable means, and in some cases with benefits to our carbon equilibrium.

Many people know corn ethanol as a plant-based renewable energy source, but other options are also being considered. Some fuels are made from the secondary parts of crops — inedible parts like corn stalks or wheat straw. Another strategy is to grow a specific biofuel crop that is bred to produce higher quality feedstock for producing fuel. For example, pennycress is a new winter cover crop being developed for jet fuel, and researchers are selecting for seeds with the best oil composition. As a cover crop, pennycress also prevents soil erosion and nitrogen loss, making it an attractive cultivation option.

Perhaps the most promising biofuel candidates are perennial grass species. These hardy plants such as miscanthus, switchgrass, and biomass sorghum are known for their high yields, low management requirements, and impressive root systems. These traits allow the grasses to thrive, even on poor-quality land, utilizing areas that are not optimal for conventional food crops. Additionally, perennial grasses can be buffer strips between cropland and natural waterways, where their extensive fibrous root systems protect waterway banks from erosion and filter fertilizers from field runoff water. Perennial grasses also support greater biodiversity and provide ecosystem services like nesting material for native birds. Where does the biofuel come in, you may ask? Well, the above-ground growth of perennial grasses can be harvested and processed into biofuel. The roots are left intact, so the next season the grasses can produce new above-ground growth — no annual planting required.

Even more biofuel technologies have been proposed, from farming algae to raising orchards of fast-growing trees. At this point it's tempting to say, "Sounds great, problem solved!" and move on to other issues. Yet there's good reason why most of us are still trapped in a gas-guzzling lifestyle instead of rolling to work via Mother Nature's homemade petrol. Besides the fact that current biofuel production rates are insufficient to meet present energy demands, the bitter reality is fossil fuels are more convenient. Because infrastructure for fossil fuel transportation, processing, and distribution has been well-established for generations while novel biofuel crops are still in the early stages of building supply chains, fossil fuels are currently easier and cheaper to produce than biofuels. Additionally,

The December 2021 CABBI *Miscanthus x giganteus* harvest at the Illinois Energy Farm. *Credit: Mark Herman, CABBI*

A field of Switchgrass 'Independence' strain researched by University of Illinois Crop Sciences Professor D.K. Lee. *Credit: Institute for Sustainability, Energy, and Environment*

fossil fuels consume less water during processing than biofuels, and the difference becomes even more dramatic for biofuel crops that require manual irrigation. On the surface, biofuels seem like an obvious answer to climate change, but closer investigation reveals there are issues to be solved first. As my bioenergy professor often reminds us, "There are no silver bullets!"

Those of us in STEM know this multiplication of problems happens frequently. It's frustrating to think you've discovered a solution, only to open Pandora's box and release a plague of new problems. Meanwhile, every year that passes without significant change in our societies' fuel consumption makes the climate situation more difficult to navigate for present and future generations.

What's the way forward? When perennial grasses get chopped down, they grow back anew, and that's how we need to approach our dire future. Even during discouraging times, we must continue researching biofuels and other solutions, too. There are no silver bullets for the wicked problems of climate change and finite resources. Still, with each new idea we explore, we learn about the tools at our disposal and how to optimize them. No single biofuel crop is perfect for all situations, but their diversity of traits means there are optimum species for each region of our diverse planet. Switching from fossil fuels to biofuels may mean inventing infrastructure from scratch, but that also means a fresh opportunity to build a brand-new system.

That new system is being steadily established thanks to the hard work of the U.S. Department of Energy's Bioenergy Research Centers. There are four centers of this kind, and one is right here on campus: the Center for Advanced Bioenergy and Bioproducts Innovation (CABBI). The University of Illinois Urbana-Champaign is playing an active role in growing the biofuel industry out of its infancy stages.

Biofuels are an exciting topic, but they are only one piece of the puzzle to addressing climate change. If you're passionate about these problems and projects, know that there is plenty of room for you at the workbench. You don't need to be in the bioenergy field to contribute — simply talking to others about these ideas can inspire new solutions and garner public support. Together we can keep moving bioenergy science and climate action forward.

Kayla Vittore is from Belvidere, Ill. She is a senior studying Plant Biotechnology and currently works at the Sarah Refi-Hind Lab investigating vegetable pathology. In Fall 2022 she will begin pursuing a Ph.D. in the Crop Sciences Department under Professor DoKyoung Lee, researching the use of perennial grasses as feedstock for industrial application.

Covering Up

By Zara Nyhus

Pulling up to Two Mile Creek Farm, I had to smile, because owner Steve Buxton looks just like I expected a lifelong Midwestern farmer to look. He is tall, broad, and thoroughly sun-kissed. He wears thick brown boots, a tattered red hoodie, and blue jean overalls that top off his timeless look. But Buxton's unique farming practices set him apart from that classic farmer prototype: Buxton is one of the few fully organic farmers in East Central Illinois. He uses no chemicals, pesticides, or herbicides in his fields. Instead, he boasts about his pride and joy, the reason for his farm's great success: cover crops. Cover crops are plants used to cover the soil rather than for the purpose of being harvested. They can be planted while the cash crop is still growing, as a companion plant with the cash crop, or after the cash crop is harvested — all for the benefit of the soil instead of crop yield. They ready the land for the cash crop by improving the health of the soil, in turn resulting in a larger, healthier yield for the growing season.

Water runoff from a farm. *Credit: North Carolina State University*

At Two Mile Creek Farm near Sullivan, Buxton has experimented with multiple forms of cover crops, ranging from eight species of legumes, clovers, alfalfa, rye, and other grasses. These diverse plants give his fields a lush, green look, as well as dense, dark soil that results in a biodiverse agroecosystem. His best-growing cover crop this year has been the medium red clover. Cover crops have a wide range of benefits with, as he puts it, "little to no drawbacks."

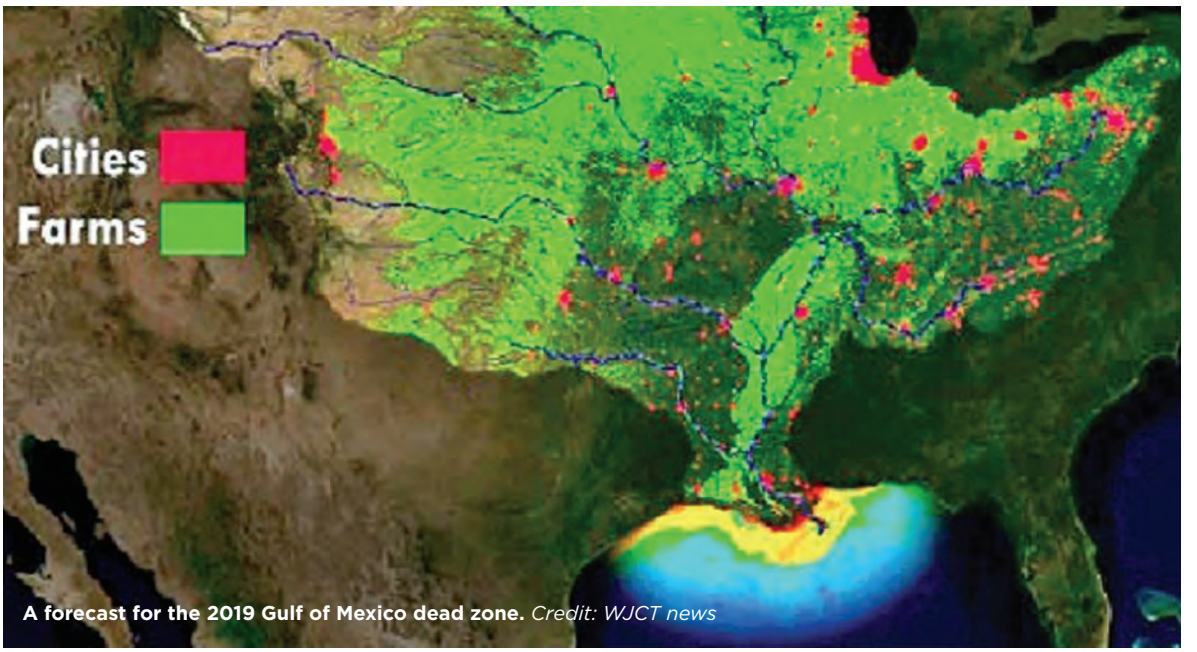
Inspired by Two Mile Creek Farm, I interviewed farmers in my Central Illinois community to learn more about cover crops. What I discovered applies far beyond the Land of Lincoln. According to Liz Rupel, Policy Organizer at the Illinois Stewardship Alliance (ISA), cover crops are "an amazing tool that farmers, gardeners, and anyone really can plant to keep a living root in the soil. Cover crops are great at holding the soil in place, preventing soil erosion, and thus improving our water quality."

Soil Erosion

Cover crops help counter a giant enemy of the agricultural world: soil erosion. Buxton calls it "one of his biggest fears in this community" — and soil erosion is a concern far beyond the local farming community. Niche agricultural methods do not regularly make the headlines of the daily paper, but climate change, water, and food crises often do. Soil erosion ties all these concepts together. Topsoil, the soil closest to the land's surface, holds soil intact and provides integral nutrients for crop production. According to NPR, "The most fertile topsoil is entirely gone from a third of all the land devoted to growing crops across the upper Midwest," including Indiana, Illinois, Minnesota, and Iowa. Every year, Illinois has the highest rates of soil erosion in the United States. In 2015, about "one-fifth of Illinois farmland lost more soil than it made." With the expectation of increased wind and rainfall, these numbers are projected to only grow with time. This vast land

According to NPR, "The most fertile topsoil is entirely gone from a third of all the land devoted to growing crops across the upper Midwest," including Indiana, Illinois, Minnesota, and Iowa. Every year, Illinois has the highest rates of soil erosion in the United States.

Medium red clover at Two Mile Creek Farm. *Credit: Zara Nyhus*



A forecast for the 2019 Gulf of Mexico dead zone. *Credit: WJCT news*

degradation results in loss of nutrients in consumer food, increased pollution and sedimentation in waterways, and carbon losses that exacerbate the effects of climate change.

Soil loss is detrimental not only to Midwestern farms, but the rest of the world. One study found that about $8 billion has been lost globally from soil erosion due to increased water usage, decreased crop yields, and reduced soil fertility. Soil is eroding faster than it is being formed, creating a world unequipped for agriculture. Without proper conservation practices and land management, soil will continue eroding up to *100 times* faster than it is forming.

Water Runoff

The mix of sediment and rainwater produced by soil erosion leaks into various waterways, polluting them and, in turn, our drinking water and various aquatic habitats. Suzanne Smith, local co-owner of the 250-acre Smith Family Farms, has implemented cover crops as a solution to soil erosion. Smith says cover crops make the soil "more like a sponge so the water can actually get into the soil." Each root of the cover crop creates pores in the ground. These pores allow water to sieve deeper into the ground, reducing runoff. Buxton described his experience of local soil erosion in simple terms by comparing his farm to his neighbor's farm when it rains. Due to his success with cover crops, the water pools up in his fields and "up to 95% is absorbed into the ground.

"Opposingly," he says, "as little as an inch of rainfall causes my neighbor's farms to turn into small rivers," consistently overflowing into his fields. This has forced him to create a "buffer of isolation" by building 30-foot barriers around some of his farms, creating tension between him and his more traditional farming neighbors.

Another consequence of this detrimental water runoff is in the Gulf of Mexico's "dead zone," which stretches from the coast of Louisiana to the shores of Texas. Due to runoff from various water sources along the Mississippi River, such as farms, sewage treatment plants, and lawns, nitrogen and phosphorus are being washed into the Gulf of Mexico. These nutrients result in an algae bloom that chokes off oxygen in the water and, in turn, makes surrounding marine life suffer.

The region is so depleted of oxygen that most species are forced to swim away from the area, making fishermen spend more time and money by traveling farther from land to catch fish. Other species, however, become trapped and die, leaving the estimated 7,000 square mile area barren. With 40 percent of the United States' seafood coming from the Gulf, that costs seafood and tourism industries up to $82 million a year. Managing and capturing nutrients more effectively in farming would reduce much of the runoff.

These risks of soil erosion do not stop in the United States. Flood erosion, the collapse or subsidence of land along the shore of a lake or other body of water, is rampant in places like the Philippines, India, Columbia, and many other countries. In early 2020, in Indonesia, upstream eroded sediments clogged Jakarta's rivers and canals, causing an overflow that produced deadly floods. These floods left dozens of people dead and more than 60,000 displaced.

Biodiversity

As Rupel explains, cover crops are planted not only to improve water quality and soil health; they also increase soil biodiversity, a web of subterranean biological activity that improves the storage and entry of water, plant nutrition, erosion resistance, and organic matter breakdown. Buxton and I tested this ourselves by getting our hands dirty and comparing one shovel full of his soil with one of his neighbor's. In his, we counted one-by-one and eventually found 15 plump, pink, individual worms. In his neighbor's, we found one. Buxton's soil is not only biodiverse but also rich, moist, and as he stated proudly, had perfect texture.

Cover crops help create biodiversity above soil as well as within it. Mike Ward, Professor of Natural Resources and Environmental Sciences at the University of Illinois, studies the impact of cover crops on migratory birds. Birds are on a massive decline in the United States. According to Thomas Benson, Senior Wildlife Ecologist of the Illinois Natural History Survey, Illinois has lost more than 80% of grassland-dependent bird species over the past 50 years. Cover crops provide migratory birds with a place to find insects, as well as an escape from wind and predators. According to Ward, the relationship between birds and farmers is symbiotic, as bringing a healthy number of birds back into the habitat helps control pests like beetles, moths, and rootworm that otherwise "potentially contribute to crop loss."

Rick Faut, a farmer from the Gibson City area, uses cover crops and found an increase in the number and diversity of birds in his farm. His advice to other farmers is that it takes time, but it is possible make the changes and still be profitable. "It takes time for the soil to heal itself, the insects to rebound, and the birds to come," he said. "It's baby steps, but as long as we keep moving forward the rewards are well worth the effort." Results of cover crops are, unfortunately, not immediate, making them less appealing to the average farmer. Yet with patience, they can transform a farm.

This effort to increase biodiversity stretches far beyond birds and insects to our entire atmosphere. The roots in Buxton's soil have small, white bulbs of nitrogen sprouting in every direction, something I did not realize was of great importance until we discussed the vast environmental impact that depleted soil can have. Instead of buying synthetic fertilizers, farmers using cover crops provide the opportunity for a natural source of carbon and nitrogen that will not run off into water tributaries. These two elements are leading contributors to climate change as well as essential ingredients in crop production. Fertile soils, however, can potentially insulate 5% of manmade greenhouse gas emissions. In terms of nitrogen alone, cover crops suck up and insulate nitrate, eventually releasing it into the intended crop. These "nitrogen fixing plants" pull nitrogen from the air and store it in their roots. Ward finds that cereal rye is potentially the best cover crop for sequestering nitrogen, a recommendation Buxton follows in planting cereal rye at Two Mile Creek. His farm alone creates up to 150-200 pounds of nitrogen every year. To put it into modern perspective, here is a statistic from the American Farmland Trust: "50,000 acres of cover crops would have the ability to remove the amount of nitrate and phosphorus put into the atmosphere from over 5,000 cars on the road." Illinois alone has 27 million acres under cultivation.

Cover Crop Incentives

Learning about the multi-faceted success of cover crops, I was itching to ask why everyone had not implemented them yet. Buxton chuckled and replied that he gets asked this a lot. "What side of the bed do you get out of? Tomorrow, I'm going to ask you to get out of the other side. And then, I want you to change your toothpaste. I want you to do what I think you should do. It's just the fear of change. It really is that simple."

Fear of change in the farming community can be alleviated by monetary incentive programs that are in place both at the federal and state level. According to the NRCS, "Most crop farmers across the United States are eligible for cover crop incentive payments" that help get them started using cover crops for the first three to five years. The payments vary by state, ranging from $30 to $70 per acre "for the 'basic' cover crop rate of a single species and increasing with the use of multi-species cover crop mixes or for special categories." Another option is the Conservation Stewardship Program, which includes a variety of practices such as improving grazing conditions, developing wildlife habitat, and increasing crop resiliency with cover crops. The payments per acre range from $30 to $80. These financial assistance programs provide

A statistic from the American Farmland Trust: "50,000 acres of cover crops would have the ability to remove the amount of nitrate and phosphorus put into the atmosphere from over 5,000 cars on the road." Illinois alone has 27 million acres under cultivation.

Sun setting over Two Mile Creek Farm. *Credit: Zara Nyhus*

"Soil health has the ability to improve environmental, human, and climate health. If we start with planting cover crops, we as humans can be benefited by more nutrient dense food, cleaner water, and a better atmosphere."

Liz Rupel, Policy Organizer at the Illinois Stewardship Alliance (ISA)

transitory support to cover cropping that makes the change not only possible, but profitable. Based on the typical rates in the Corn Belt, assuming $50 per acre, cover crops will pay for themselves in a single year.

From Rupel's experience with local farmers, fiscal yield is not their primary motivation behind the implementation of cover crops. When she speaks to farmers, "it's not always about the financial gain by any means. They are passionate about improving what was given to them. They want to leave the land in a better place than they found it," she said. For Buxton, it is a mix of both. He knows farmers who are saving $60,000 to $70,000 a year using cover crops. However, primarily he wants to "prevent the loss of the long term that was here" and be proud of what he farms.

Cover crops are a beautiful concept; they fix the world by planting more of it. Organic matter is, and always has been, the solution to reversing the damage that we, as humans, have created. We live in a symbiotic relationship with plants that, according to Rupel, "cannot be denied any longer." When asked what the future would look like if all farmers implemented cover crops, she wistfully sighed, let out a soft laugh, and began describing her dream world: "Soil health has the ability to improve environmental, human, and climate health. If we start with planting cover crops, we as humans can be benefited by more nutrient dense food, cleaner water, and a better atmosphere."

Unfortunately, this agricultural nirvana is not within our grasp — yet. But with cover crop advocates like Rupel, willing farmers like Smith and Buxton, and inspired readers (you!), we can solve the soil depletion crisis that affects us all.

Zara Nyhus is from Peoria, Ill. She graduated from the University of Illinois Urbana-Champaign in December 2021 with a B.A. in English Literature and the Certific te in Environmental Writing. She is currently applying for various environmental writing graduate programs in hopes of pursuing a career in journalism.

Mona Fang is the founder of Karma Trade in Urbana, a sustainable fashion swapping service. A University of Illinois aerospace engineering major with a strong sense of style, Mona is passionate about changing how we view the fashion industry and acquire clothing. *Q Magazine's* Jane Halloran talked with this eco-conscious entrepreneur to find out how Karma Trade got its start — and why it is crucial to revamp the fashion industry.

SUSTAINABILITY WITH STYLE

By Jane Halloran

Q. How did an aerospace engineering major wind up in the sustainable fashion business?

I have sold clothes since I was 15. I wasn't allowed to get a job in high school, and I wanted a secondary source of income, so I sold clothes online. About a year and a half later, my friend and I were at a coffee shop working on our entry for an academic competition. We had to come up with an international business plan for this competition. We had so many clothes that we don't wear, and we didn't want to donate them because we know that donated clothes are sometimes just thrown into landfills. So we thought, what if you could swap clothes? I am sure that you have clothes that I would love to wear and that I have clothes you would love to wear. One person's trash is another person's treasure. The fashion industry makes so many clothes every year and it's just repeated styles from the '90s, from the 2000s, etc. There are so many variations of fashion that can be recirculated.

Q. How did your business get started?

I started Karma Trade from the top down and thought in an international scale, considering the financial aspect and operations of the business. We realized this was very feasible and started Karma Trade my junior year in high school. I discovered quickly that it was much harder to create a business than I thought. It was especially difficult

Karma Trade founder Mona Fang.
Credit: Mona Fang

> **We wanted to make sure we were still zero waste while being profitable at the same time. We operate with a closed-loop supply chain.**

to create an app. I thought I could learn how to code easily, but I was so naïve. I created a business plan, and it gave us a lot of insight on where we wanted to go.

In January 2018, we officially launched Style 360, which was what Karma Trade was originally called. Customers would send Style 360 their unwanted clothes, and we would send back a new set of clothes with the same value based off what style the customer wanted. We realized this didn't work as well as we wanted it to and decided to change the business plan so customers could come to a store and swap the clothes themselves. We began to host clothing swap events as well. Our first event was at North Central College, which was really successful; we just had zero marketing because we only had one day to prepare. The people who came to the event were the students who happened to pass by due to moving out, so timing was on our side.

Karma Trade's first location was a storage unit for the clothes inventory from that event. Then we rented a space in the Co-Lab for a few hundred dollars a month, put a team together, started up the store, and created even more events. We had to shift our target audience to customers who sell their clothes on online marketplaces. So rather than going through the work of selling a clothing item for a few dollars, why not swap your clothes to get new styles and only pay $1? We held events throughout Champaign-Urbana and got a ton of traction — and created an even stronger team that I am proud of.

Q. Has the COVID-19 pandemic affected your business?

We got into our current store in July 2020 when COVID was still happening, but that didn't stop us. Since we opened, we have helped the local community recirculate more than 5,000 clothing items, allowing nearly 400 individuals to build their dream closets.

We wanted to make sure we were still zero waste while being profitable at the same time. We operate with a closed-loop supply chain. We do not donate our clothes because some charities will send the unsellable clothes to developing countries, mainly in Sub-Saharan Africa, to sell in their second-hand stores. This disrupts their local economies, and most of the donated clothes end up in a landfill. About 250 million tons of textile waste are

A fitting room at Karma Trade. *Credit: Mona Fang*

produced annually, so this is a problem. Instead, we have upcycling initiatives in which we work with high schools and universities to turn our "less than perfect" textiles into trendy new upcycled garments. Karma Trade closes this loop because you do not have to buy anything new, but rather swap existing clothes.

Q. There are so many facets of sustainability to focus on. What made you choose to tackle the fashion industry?

I wanted to make an environmentally positive impact on the world. Back in the day, I was really into shopping for clothes with my mom, and that's how we would bond. I realized that these habits were actually bringing me and the environment harm. I could either stop doing it or find a better way to shop. I looked into sustainable fashion online; however, there is no such thing as sustainable production in fashion because you're always disrupting the environment to produce something, especially something so resource-intensive like clothing.

I chose clothing because there is so much unknown about it. It is so tied in with our egos and how we feel, but we don't notice what goes on behind making clothes. Most people think that clothes are made by machines, but they are made by humans. We think clothes are made by robots because we treat humans like robots. Clothes are being sold at such low prices that it feels like the production process is automated, but it's not. I would consistently watch the documentary *The True Cost*, about what goes on behind the fashion world and how people are dying from cancer from clothing dyes and the like. I would watch it to motivate myself.

For every pair of jeans you create, you have to dye it 20-something times in water. That means you have to cycle out a lot of toxic chemicals. This leads to dye pollution, which is terrifying and not talked about enough. People who eat food near areas of dye pollution often get cancer and other health issues. Even the color of the rivers with dye pollution changes as the fashion seasons change. This type of pollution also includes bleach and other toxic chemicals.

Something that has really impacted me: A woman who I never met read my posts about these things. She messaged me and said, "Mona, thank you for shedding light on these issues. Our government doesn't care about these issues in Ukraine. The factories here are polluting our nat-

Jeans must be dyed repeatedly to get that deep blue color they're known for, but the resulting dye pollution causes serious health issues. *Credit: Mona Fang*

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ural rivers and they used to be so beautiful. Everything is dying and no one cares because the government is so corrupt. Thank you for sharing this. People are getting sick; we just need to know about it and spread awareness."

We talk about polar bears and how the ice caps are melting, but this is something we can change right now by making less clothing. There was a story about Bangladeshi women who worked in a clothing factory who got a trip to go to Walmart, and they saw the clothes they made on the floor, not cared about, which was crushing to them. That is what makes me so passionate about this industry because there is so much work to be done to improve it.

Q. According to the EPA, 11.2 million tons of textile waste ended up in landfills last year. How should the fashion industry become more sustainable?

Instead of creating new fabrics, you can upcycle old fabric and turn it into new clothing to sell. You can take a skirt from the '90s that is out of style now and redo it to make it new. The challenge is industrializing this process, so involving local artists and creating a movement is essential. Selling these items would mean you have to sell them at higher price points. The other option is to recirculate clothing, but I think people are gravitating more toward thrift stores now because of the markdowns. There is no ethical production when creating new clothing.

Q. What has been the best part about creating Karma Trade?

Ideating, and thinking about what can be possible. You can't create anything without first thinking about it. I like to look at objects in the world and remember that they started with an idea. In a company, for example, people want a service. But the question is, can we make it happen?

Q. What are the next steps for the company?

Looking into the future, our potential for e-commerce is great. We have a large following on social media and want to grow regardless of location. We want to do this sustainably, especially in regard to shipping. To keep carbon emissions low, we would like to build hyper-localized shipping routes with pickup and drop-off locations and mini-warehouses near our customers. One idea we have is that for every package sent, an extra $1 in shipping costs could go toward planting a tree. I want to have an environmentally positive company and avoid greenwashed marketing.

In the long term, I am still interested in running this company in conjunction with my career in aerospace engineering and plan to work in China and the United States. My father, who is also an entrepreneur, runs an exhaust engine testing company in China, and I would like to work for him. I treat both China and the United States as my home. I want Karma Trade to be run by a collective of people since it was created by a collective of people.

Jane Halloran is from South Elgin, Ill. She graduated from the University of Illinois in August 2021 with a B.S. in Agricultural and Biological Engineering. She previously worked as a Research Assistant studying clay mineralogy and imaging with Dr. Jorge Guzman. She is interested in working on a small farm or a non-profit in the future.

THE DARK SIDE OF THRIFTING

By Nikki Palella

Visiting home for the weekend called for a classic mother-daughter ritual. The two of us giddily loaded up our car with what my mother deemed "old junk" and drove down the winding road to our favorite secondhand store. We had been donating to Sparrow's Nest for decades. Its mission is one worth supporting, as all proceeds go to helping women transition out of domestic violence situations. Noticing the locked door and absence of employees upon our arrival, we approached a small sign on the wall to investigate. It read: "Not taking donations, we are at capacity." With that, my mom and I agreed to donate to Goodwill instead. To our surprise, we observed a completely different response from others. One by one, each person approached the sign, read it, and proceeded to empty out their car to sprawl their things against the brick building. When all was said and done, their old clothing, furniture, and toys were stacked like pancakes waiting for the gusty winds to blow them over. The sign clearly stated the store was at capacity. Anything more would have put additional stress on operations and the elderly women who run the shop. What we had witnessed was the construction of a miniature landfill right before our eyes.

Many donation centers closed due to the COVID-19 pandemic, but that hasn't stopped people from dropping off their unwanted items. *Credit: Ashlee Burns via Caller Times*

This exact behavior is startlingly similar to the conduct of the thrifting industry at the local and global scale, harming both the physical environment and people's livelihoods almost without notice. As Western society continues to heavily rely on the thrifting industry, we are undoubtedly hurting our neighbors across the world. Our unwanted clothing threads its way across cities and continents, creating an invisible web that most of us will never see.

Being told *no* when donating your belongings is an odd feeling. It's natural to think we are being good Samaritans, that we are certainly helping someone by letting go of things we don't need anymore. Perhaps we convince ourselves we are heroes for parting with the excess in our lives because without us, people in need would be hopeless. But this narrative just isn't true. The trouble lies in the lifestyle that supports this type of thinking, which is based on glorification of overconsumption, short-lived use, and eventual disposal. The lifestyle in question is synonymous with Western culture, as it pertains to a particular sense of Americanness.

The history of the thrifting industry in the United States can be traced all the way back to the Salvation Army. Originating in London under the name "Christian Mission," the organization was renamed and first appeared in Pennsylvania in 1880. It proved to be a charitable force during the years of the Great Depression, providing food for those in need. Protestant social activists summoned their philanthropy through the establishment of donation centers. Here, unwanted clothing heaped in from all walks of American life. Endorsed by the Salvation Army, thrifting was seen as a "civic-minded campaign" used to assimilate

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Babe Ruth says: "A Home Run for the Salvation Army Home Service Fund means at least a dollar from you and a dollar from me. Let's bat a thousand per cent in this shop right now." Salvation Army House Girls.
Credit: Library of Congress

Inhumane conditions and health risks are imposed on the garment industry while the environment is suffering from the effects of water contamination via microplastics and the release of harmful chemicals into the atmosphere. Given the fast fashion industry's status as the second-largest polluter in the world, it's high time we found a better source for the garments we wear.

the inflow of immigrants into "American cleanliness and habits of dress." In response to rampant anti-Semitism and xenophobia, buying secondhand clothes was a way for the "other" in society to blend in as they began their new lives after the war. In hiding their outward expressions of cultural and ethnic identity all while calling it *charity*, this ultimately reinforced and validated pervasive xenophobia. In her piece "From Goodwill to Grunge," Jennifer La Zotte sums up the goal of thrift stores, flea markets, and garage sales to be both "profitable and influential" during those times. With Salvation Army restoration efforts starting in 1897, Goodwill set up shop in 1902, and the rest is history.

As we chug along into the 21st century, it's clear that societal perceptions of thrifting have shifted. Gone are the days of looking down upon the avid thrift shopper. What was once judged as a "dirty" habit is now a matter of social prestige among our youth. Considered a new wave of fashion, teenagers compete online over who can find the best threaded gems. The overall trendiness and aestheticization of buying secondhand is increasingly alluring as people of *all* social classes wish to be viewed as eco-friendly and fashion forward.

Enthusiasm for sustainable clothing sources has blossomed during the past few years as the horrors of the fast fashion industry have been exposed. Cheap sites like Shein, Zara, and Romwe offer us an irresistibly easy way to have clothes delivered to our doorstep within days — a convenience that comes at a steep social and environmental cost. Household brands commonplace in many American wardrobes are often not a reliable alternative. Rip Curl, Urban Outfitters, GUESS, Victoria's Secret, and GAP all fall on the naughty list, aligning with destructive fast fashion practices. Social and environmental plight manifest themselves in horrendous forms of worker exploitation and pollution — the aftermath of fast clothing manufacturing. Inhumane conditions and health risks are imposed on the garment industry while the environment is suffering from the effects of water contamination via microplastics and the release of harmful chemicals into the atmosphere. Given the fast fashion industry's status as the second-largest polluter in the world, it's high time we found a better source for the garments we wear.

As we begin to shy away from the fast fashion industry, the obvious solution appears to be thrifting. At first glance, this mode of clothes shopping seems perfect to combat our issues with waste. Instead of starting from square one of the manufacturing process, we can reuse whatever domestic textiles already exist to cut down on an abundance of physical waste and pollution. However, like any other industry, thrifting has very problematic ways of functioning. In fact, our prolonged ignorance of the very systems that support our discarded clothing is responsible for perpetuating the suffering of innocent people across the globe. The damage inflicted has both social and economic dimensions that are worth examining.

Troubling economic implications of the thrifting industry are apparent on the global scale. Next time you're debating whether or not to donate one of your old favorite shirts, consider that less than 10 percent of clothing donations are actually sold in stores. The remaining 90 percent are vended off to recyclers, who make a living off this low-profile trade-off. If you had asked me, I had hoped to see my old winter jacket on the back of someone who truly needed it to stay warm. Instead, most of what we offer becomes a load of cash in the back of some stranger's pocket. Just last year, the secondhand apparel market generated $33.03 billion worldwide.

A majority of the donated clothing is either disposed of in a landfill or sent off to a textile recycling warehouse. At these warehouses, textile salvagers sort the clothes into two categories: industrial or vintage use. Those that fall into the vintage category serve as a bonus that makes vendors a little extra cash, as they're always in demand from the fashion-forward elites willing to pay the upcharge. Clothes sorted into industrial use are henceforth used as rags. After the vintage and industrial materials are sorted out and separated, the rest of the clothes are compressed into 100 to 1,000 pound bales. Stacked to the top of the warehouse ceiling, they are prepped for international travel, about to become someone else's problem. The single largest source of secondhand clothing is Western countries, particularly the United States and Britain. Their unwanted fabrics are almost always shipped out to countries in the Global South, particularly in Sub-Saharan Africa, Asia, and South America. This exchange is inherently

problematic because it perpetuates the power dynamic that positions Western countries at the top, passing their junk down to their "younger sibling" countries. It conjures up colonial sentiment where whiter, wealthier countries feel entitled to boss around their previous subjects, giving them only the scraps.

Let's hone in on Sub-Saharan Africa. There is no doubt that this region has suffered considerably at the hands of the thrifting industry. The West has freely dumped its unwanted garments here for years, slowly creating textile landfills in localized African towns. It may seem that shipping this stock over is both the eco-friendly and charitable thing to do — in a way, it looks like Western countries are attempting to recycle.

However, even the progressive, liberal, sustainable ethos behind thrifting can be wrongheaded without a better appreciation of the complexity of global economic forces. Upon closer examination, we find that this "charity" is hurting local textile industries in African countries and shifting a Western waste problem to places that might not have the financial or technological means to manage it. In fact, by 2019, Kenya, Tanzania, South Sudan, Burundi, Rwanda, and Uganda finalized a complete ban on textile imports on the basis that they were hindering local textile industries from thriving. Africans from these countries believe that receiving discarded clothing "undermines their dignity and the development of the nascent textile industries in their nations," as they were becoming dependent on Western countries despite major domestic cotton production. The result is the theft of jobs that could be filled by local community members. It's estimated that African exports could generate $3 billion annually, were it not for interference from the thrifting industry. If we explore the concept of circular fashion, we can deduce that cotton grown in the Global South is sent to the Global North to produce fabrics that are sent back to the South as secondhand garments. This perpetuation of colonial capitalism is not efficient in either the manufacturing process or in methods of disposal.

It is in the best interest of African countries to continue to ban imports not only for economic reasons, but for the protection of their environment. Consequences of anthropogenic climate change disproportionately affect the Global South. These stark inequalities compounded with the mismanagement of Western waste leads to additional complications. For example, the accumulation of "trash mountains" is causing numerous ecological and health hazards stemming from garments African people never wanted in the first place. These trash mountains are not so *out of sight, out of mind* for our neighbors in the Southern Hemisphere. As a matter of fact, trash mountains are so pervasive that many of them can be seen from residential areas in African countries. They are known to contribute to groundwater contamination through various processes of leaching. After rainfall, synthetics in the fibers that contain harmful chemicals percolate through the soil into the groundwater. This is dangerous because the aquifer is a freshwater source that people depend on for drinking water and household use. The trash mountains poison this shared source, posing a massive health risk to those who live within the drainage basin. This chemical slush can also sit on the surface and evaporate, transporting toxins into the atmosphere. Acid rain is the result, which damages natural ecosystems through the alteration of soil and water acidity. Once we acknowledge our global presence, it is impossible to ignore that Western fabrics are not only snuffing economic independence in Sub-Saharan Africa, but they continue to compromise the health of humans and wildlife species native to the landscape.

While this all may seem so distant from us, the thrifting industry has even sparked human rights outcries in our own backyards. The harmful reality is this: We are giving an absurd amount of unchecked power to the thrifting industry and its most staple businesses. It is no secret that for years, Goodwill companies have happily employed people with physical and mental disabilities, yet fail to pay them a living wage. The Labor Department discovered that "Goodwill (has been paying) workers in Pennsylvania as little as 22 cents an hour." Goodwill is a "charitable nonprofit organization" that seems to use its nonprofit affiliation to excuse clear human rights violations. Employees with disabilities put in as much time and effort as anyone else. They are doing the same

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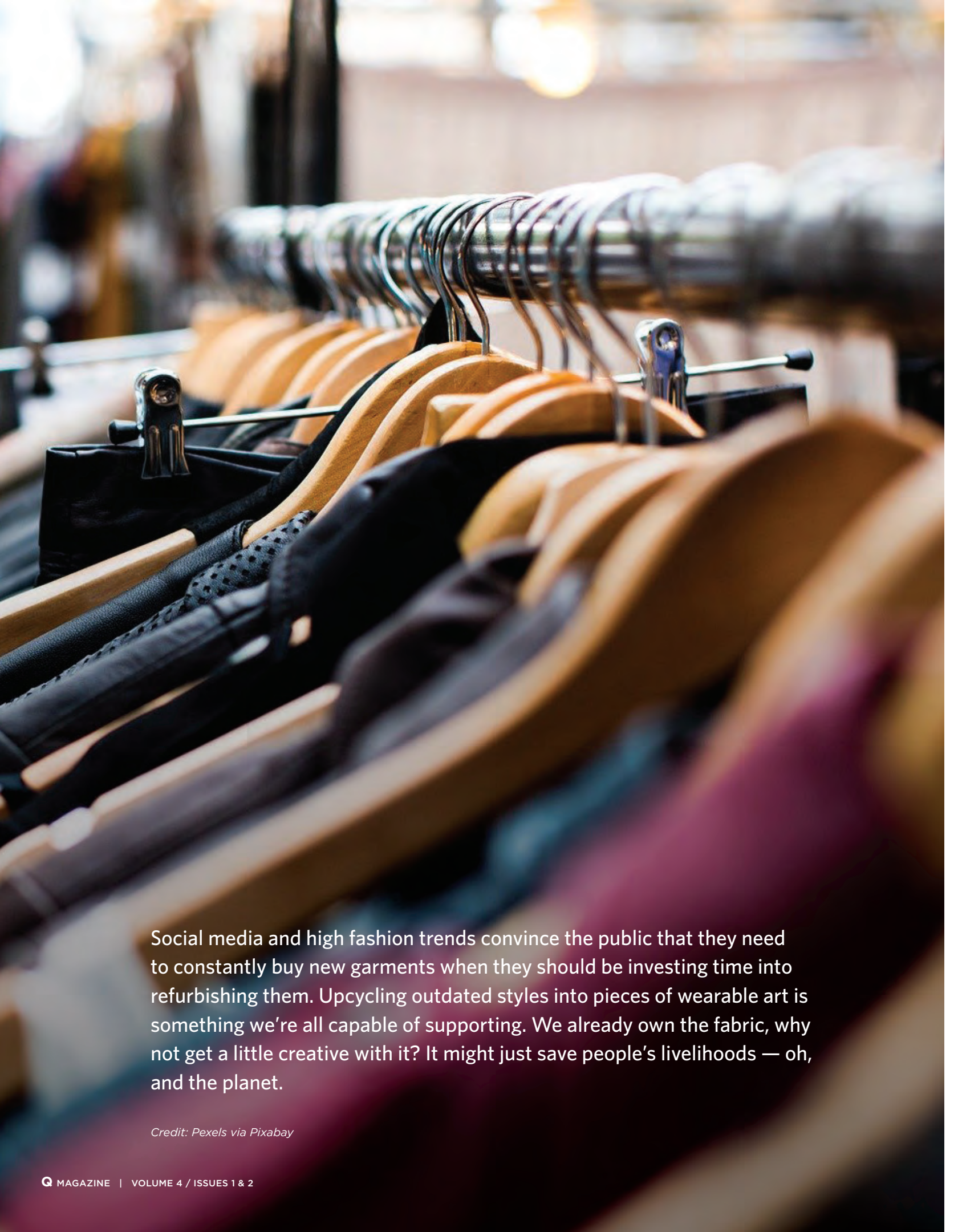

Social media and high fashion trends convince the public that they need to constantly buy new garments when they should be investing time into refurbishing them. Upcycling outdated styles into pieces of wearable art is something we're all capable of supporting. We already own the fabric, why not get a little creative with it? It might just save people's livelihoods — oh, and the planet.

Credit: Pexels via Pixabay

To make any headway in providing environmental and economic justice with respect to the thrifting industry, Western countries must face our habits of overconsumption head on.

tasks, and they do their job well. Nevertheless, Goodwill's Senior Director of Government Affairs Laura Walling didn't seem to appreciate their work. When asked about the Special Minimum Wage Certificate, which validates someone's disability under federal law and allows them to be paid a living wage, Walling stated that Goodwill's goal is to "transition people with disabilities employed under the Special Minimum Wage Certificate into competitive, integrated employment while ensuring individual choices are honored." It seems the actual people with disabilities weren't allowed to have any say in this choice that directly affects their lives. This is just a glimpse of social injustice within this industry, and from what we can see, it's not as heroic as we have been led to believe.

To make any headway in providing environmental and economic justice with respect to the thrifting industry, Western countries must face our habits of overconsumption head on. America became a consumer society in the 1920s, when cars and other household products became affordable for a larger portion of the population. It is now a century later, and we haven't slowed down. The average American throws away 68 pounds of clothing each year, constantly refilling our closets. Americans cannot continue to consume in the same manner we did when we were ignorant of the social and environmental costs of our antiquated modes of purchasing.

It's not all our fault, though. Some influences can feel colossal. By now we've caught on to the fact that most companies (from electronics to garment producers) have immersed many of us into a trap called "planned obsolescence." By producing lower-quality products that aren't built to last and encouraging a societal desire for the latest and greatest, companies ensure that consumers will keep coming back to buy more. "Fashion, more than any other industry in the world, embraces obsolescence as a primary goal."

As individuals, we have to personally assess if we are *OK* with this. Do we approve of a world where companies have the final say over the health of our shared planet? It's time for us to finally call out corporations for catering solely to their business models, while neglecting those they claim to serve. The consumer society is powerful; we hold the potential to put corporate giants out of business. But let's not forget about the social forces at play. Social media and high fashion trends convince the public that they need to constantly buy new garments when they should be investing time into refurbishing them. Upcycling outdated styles into pieces of wearable art is something we're all capable of supporting. We already own the fabric, why not get a little creative with it? It might just save people's livelihoods — oh, and the planet.

As far as what to do with clothing that we really can't stand to keep, I would advise all to continue to donate to small, locally owned thrift stores. If you think there aren't any in your area, you might just not have noticed them! A quick web search can uncover where these shops are and what their mission is. It's up to us to think critically and responsibly about where we allocate our goods. If you can see your donated shirt on the rack, chances are that business aligns itself with ethical use of their donations. It is comforting and rewarding to know that they avoid selling to vendors who care not for people or the environment.

Secondhand clothing and the thrifting industry, while well-intentioned and helpful to a small portion of society, cause real pain. The crimes of these businesses have economic and social consequences in both the United States and abroad. The Global South does not exist as a sitting landfill site for Westerners to fill, just like the back of *Sparrow's Nest* was no invitation for a giant junk pile. It is necessary that we attack the root of our environmental waste issues by coming face to face with our habits of overconsumption and holding companies accountable. If we don't, we may end up buried in our own trash — and it will have been a long time coming.

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GLOWING POSSIBILITIES

By Grace Finnell-Gudwien

It was a dimly moonlit night in January 2020 when University of Illinois freshman Lauren Bartels and her sister boarded a tandem kayak in Laguna Grande, Puerto Rico, for a tour. Paddling through a canal, they saw ahead something quite extraordinary — a light show in the water. Bioluminescent dinoflagellates — tiny, microscopic plankton that can produce their own light through a chemical reaction — were the performers. Bioluminescence, it turns out, is a ubiquitous natural phenomenon, both on land and sea, and has myriad potential applications in the laboratory for the sciences of human health and sustainability.

As Bartels glided across the bioluminescent bay, every stroke of her paddle disturbed the dinoflagellates, causing them to light up. Reaching her hand into the water had the same effect. The tour guides made them shine even brighter by throwing a tarp over the paddlers to create an area of complete darkness. Inside this void, kayakers could "splash around" and really experience bioluminescence; she described it as a "pulse" or a "firework that would stay around a second longer than usual."

Dinoflagellates called *Noctiluca scintillans* glow on the shores of Hong Kong. *Credit: Kim Cheung / AP*

Clear bottom kayaks allowed tourists to see the dinoflagellates right under their noses. As Bartels described it, this "really cool" boat allowed you to feel that you were among the dinoflagellates. While the dinoflagellates need to be disturbed to glow, she explained that paddling pushed just enough water under the kayak for them to sparkle. They looked like "little specks of dirt," she joked, "but not dirt because it was light."

Many, many years earlier, in 1832, Charles Darwin experienced a similar phenomenon aboard the *HMS Beagle*. Darwin described his observations in his journal, mentioning a "luminous" sea and the water "giving out sparks" when collected in a bottle near the Canary Islands.

Although both Bartels and Darwin were struck with wonder in the face of living light, bioluminescence is actually quite common in the ocean, especially in deep waters. The National Oceanic and Atmospheric Administration's (NOAA) Ocean Exploration and Research website states that 80 percent of the animals that live between 200 and 1,000 meters (or about one-eighth to three-quarters of a mile) deep in the ocean can produce light. Terrestrial organisms that can generate "living light" include fireflies and some species of fungi. While not all dinoflagellates bioluminesce, the Latz Laboratory at the University of California San Diego states that dinoflagellates are one of "the most common sources of bioluminescence at the surface of the ocean."

The "wonder" of bioluminescent organisms is chemically produced, though scientists continue to work on understanding how. At the most general level, the mechanism of bioluminescence is similar for all living things.

Glowing waters like those Bartels and Darwin witnessed are signs of populations that have overproduced, so that a massive amount of the microbes all live in the same water. Under these circumstances, according to the Latz Lab, they become a "red tide." Named for the rusty red shade that the organisms color the water during the day, these collections of "blooms" arise from extra nutrients in the ocean; according to Philip Weinstein of the University of South Australia, these spots of high nutrients can form naturally due to upwelling, the overturning of the ocean water that brings nutrients deeper in the water column up to the top. Paradoxically, some red tides sparkle a bright blue at night.

"Red tide" is a familiar danger to coastal dwellers, for the color often signifies harmful algae blooms that release toxins affecting both marine life and the humans who eat seafood. Although algae blooms can be naturally produced, they are also often an effect of agricultural runoff, especially fertilizers that leach into the ocean. Yet dinoflagellates are critical to supporting a healthy ocean. When dinoflagellates are harmed, "dark events" occur, where the microbes do not produce light. Protectores de Cuencas, an organization dedicated to protecting Puerto Rico's ecosystems, explains that coastal erosion and water pollution are hurting dinoflagellates at the well-known tourist destination Puerto Mosquito and other bioluminescent bays. Kelly Thompson of the *Vieques Insider* described a months-long dark event at Puerto Mosquito that started in January 2014. She explained that this lack of light occurred because the concentration of nutrients and materials in the water was harmful to the dinoflagellates. This imbalance in the water stems from coastal erosion depositing sediment and pollution from agricultural runoff, or pesticides used on farm fields. The water may be further polluted if humans swim during their visits and their sunscreen, insect repellent, and other cosmetics wash off in the bays. While Lauren's tour group did allow visitors to place their hands in the water, they were not allowed to swim in the bays.

The "wonder" of bioluminescent organisms is chemically produced, though scientists continue to work on understanding how. At the most general level, the mechanism of bioluminescence is similar for all living things. J. Woodland Hastings, in the Cell and Physiology Source Book, explains that bioluminescence is a specific form of chemiluminescence, which is when light is produced by a chemical reaction. Thus, fireflies, fungi, dinoflagellates, and even the anglerfish in *Finding Nemo* contain chemicals used to glow. For a bioluminescent reaction to occur, a substrate generically called luciferin must be present and react. This chemical substrate is specifically named by the type of organisms, such as "bacterial luciferin" or "firefly luciferin." A second chemical involved is the enzyme luciferase, which is also a generic name. Enzymes connect into substrates like jigsaw puzzle pieces and regulate the

speed of a chemical reaction, and luciferase is this puzzle piece in bioluminescent reactions.

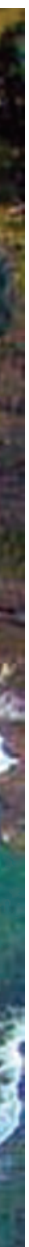
At the same time, though, the process has evolved independently in specific organisms through evolution; some organisms are understood better than others. Illinois Natural History Survey Principal Mycologist Andrew Miller explained, for example, that currently fireflies' chemicals are better understood than those in fungi. Scientists "(don't) really know for sure in fungi" how the chemical reaction works. Nor are they entirely sure why different organisms have evolved to glow.

Hastings posits that dinoflagellates sparkle to scare away predators, but fireflies shine to attract mates. *National Geographic* speculates that a form of bioluminescence, counterillumination, helps some organisms hide from sharks. Since sharks hunt from deeper in the ocean and look up toward the surface for prey, some bioluminescent fish, such as the hatchet fish, hide in plain sight. These fish will swim near the top of the surface where sharks are looking, but they have the ability to control how much light they emit from their undersides. By emitting the same amount of light that penetrates into the ocean from the sun, they fool the sharks, who cannot determine that a hatchet fish swims above them; they will just see a continuous sea of light overhead.

Beyond helping themselves, bioluminescent creatures offer humans many uses. Some of these applications of living light are simply utilitarian, such as putting fireflies in a jar for light; you may have even done this yourself as a child. In an article for *Health & Safety International*, Andrew Watson tells of how miners sometimes collected fireflies to light their mines before the invention of the oil lamp. More peculiarly, miners were also known to use dried fish skin to produce light.

This skin was "crawling with bioluminescent bacteria," explained Ferris Jabr in *Hakai Magazine*.

A red tide bloom of *Noctiluca scintillans* in New Zealand.
Credit: M. Godfrey



Jabr also describes how in 17th century Indonesia, Indigenous Peoples used glowing fungi as "flashlights in the forest" to light their paths. While some of these fungi can be seen in central Illinois, such as the Jack-O-Lantern and honey mushrooms, Miller explains that because fungi in the tropics glow much brighter, we should not expect to be guided by the light of fungi in Illinois. Often, he elaborates, fungi in the woods are fungal mycelium, or more colloquially "fungal roots," that live inside of rotting wood called "foxfire." Interestingly, Miller says that when these mushrooms are outside of the wood and producing spores, they do not bioluminesce. Since the hypothesized reason that fungi glow is to "attract insects to transport spores" for reproduction, it is uncertain why these foxfire fungi glow at all.

The light from bioluminescent dinoflagellates has also been used in naval warfare. In 1918, during World War I, the British found and sank a German U-boat by detecting the glow of the water churned up by the nearby submarine. Research about locating submarines and other underwater weapons and vessels became prevalent during World War II and the Cold War, and similar studies have been done until recently by the United States Navy.

Named for the rusty red shade that the organisms color the water during the day, these collections of "blooms" arise from extra nutrients in the ocean.

Fighter pilot and Apollo 13 astronaut-to-be James Lovell is thankful for bioluminescence. Jabr tells Lovell's story, explaining how one night in 1954 Lovell's fighter jet short-circuited during training, leaving the pilot without light or the ability to use the jet's technological maps to land. Lovell then noticed a mysterious green glow in the dark ocean below, and realizing that it was bioluminescence caused by the wake of the aircraft carrier he needed to find, he used the glow to safely land.

Other uses of bioluminescence are more scientific. Sara Lewis, author of *Silent Sparks: The Wonderous World of Fireflies,* explains that the firefly luciferase and luciferin can be used to detect when food is contaminated with bacteria. The chemicals cause ATP, an energy molecule found in every living cell, to glow. Since food poisoning-inducing bacteria like salmonella and E. coli are living organisms, their cells possess ATP. Thus, when luciferase and luciferin are added to food with "bad" bacteria, these chemicals can cause the bacteria to glow, literally bringing light to a potentially dangerous situation. This knowledge has been around since the 1960s, but more recently scientists have turned to synthetic luciferase and luciferin. These man-made chemicals work significantly faster than the ones from fireflies (minutes instead of days), but the idea to create chemicals to detect bacteria in dairy, meat, soda, and other consumables was certainly influenced from nature's own living light.

Perhaps the most unexpected use of bioluminescence is its ability to aid in tagging and tracking genes. In 1962, Osamu Shimomura discovered a green glowing protein in the bioluminescent jellyfish *Aequorea victoria;* the Green Fluorescent Protein (GFP) was used in study genetic processes in ways that garnered Shimomura, Martin Chalfie, and Roger Y. Tsien the 2008 Nobel Prize in Chemistry. In his study about GFP tagging, Peter J. Clyne describes some of the glowing protein's abilities in more detail; GFP is a fusion protein, a kind of macromolecule that can determine the specific location of a gene on a strand of DNA. It can even specify between different variants of the same gene.

Natalie Kofler, former visiting scholar at Illinois and now an advisor and curriculum lead at Harvard Medical School, has plenty of experience with the GFP. Trained in molecular biology, Kofler explained that GFP is "a really, really common tool" that she and her lab researchers used "in tons of different contexts." One of these contexts is at the cellular (or even subcellular) level. "You can use GFP on different sorts of proteins to be able to see different compartments of cells or just use it more generally just to watch the movement or functions of cells," Kofler said. This is done by linking the GFP into the DNA of another cell or organism, a process called transgenics. For example, to see the entire surface of a cell, scientists can link GFP to a protein on the cell membrane and literally make the cell's border glow. Other options include linking GFP to a protein in the nucleus, cytoplasm, or any other organelle in order to see those specific cell parts.

While she is not actively performing lab work, in the past Kofler has used GFP to observe cell migration. By forcing the cells to glow, she could "really clearly" see how they spread throughout a culture as well as "take interesting pictures" under a microscope. The fluorescence makes simply counting cells from under the microscope easier, too.

At a larger level, GFP can be used in mouse models to see

how neurons move throughout a mouse's brain. Kofler detailed how if a scientist creates mouse models where a specific gene is linked to GFP, then every time that gene creates a protein, that protein will also have that genetic connection to GFP. With this ability, scientists can observe neurons grow and move in a living mouse, or they can "sacrifice the mouse and remove a tissue and look at where the neurons are." To see the neuron in removed tissue, scientists shine a light on the tissue, which causes the fluorescence to show where the GFP-linked neurons are located as well as what other kinds of cells express the GFP-linked gene.

GFP, as well as similar fluorescent markers, are also used in immunohistochemistry. In this branch of science, GFP is linked to antibodies that target specific proteins. When a scientist stains a piece of tissue with these GFP-linked antibodies, the antibodies' stain will glow under a microscope. Since these antibodies migrate to certain proteins, wherever the antibodies' stain is visible is where the desired proteins to study can be found. Kofler cited the example of using GFP-linked antibodies to look at layers and different cell types in skin. Oftentimes, though, immunohistochemistry uses antibodies to find disease- or cancer-causing proteins and toxic substances in cells, called antigens. As Kofler so clearly stated: "The point is, we just use GFP all the time."

> Perhaps the most unexpected use of bioluminescence is its ability to aid in tagging and tracking genes.

Another side of transgenics and bioluminescence intrigues Kofler as well: bioluminescent trees. Currently, scientists are

Foxfire bioluminescence from *Panelluses stipticus* in Mount Vernon, Wis. (long exposure).
Credit: Wikipedia Commons

A firefly's light is used to attract prey and members of the opposite sex and to warn off predators. Scientists have also found research uses for the chemicals that cause firefly bioluminescence.
Credit: tomosang / Getty Images

working on genetically engineering trees to produce their own light with the end goal of using these trees to replace streetlights. Detailed in a *Smithsonian Magazine* interview with entrepreneur Antony Evans, who works with biologists Omri Amirav-Drory and Kyle Taylor, these trees would produce a dimmer, more spread-out, and "much more beautiful light." Plus, using natural light over electricity is significantly more sustainable.

Unfortunately, trees take a long time to grow, making the research move slowly. This example of biomimicry, though, or the idea of how we can copy nature to engineer better things, is fascinating. "How can we create urban environments that are still functional in the ways we need that feel more natural and more generative?" Kofler asks. "That's something that I've always been super interested about." This question is the direction science is headed, and new answers come every day. Many of them are coming from bioluminescence, but only time will tell.

Regardless of whether trees will someday glow or not, bioluminescence is something to keep in the limelight. As a tourist attraction, an ecological marker, a lifesaving source of light, or a biomedical tool, bioluminescence is certainly important. In the future, perhaps the phenomenon will become an everyday part of people's lives, but until then, humans can marvel at the uses, beauty, and mystery of bioluminescence.

For example, to see the entire surface of a cell, scientists can link Green Fluorescent Protein (GFP) to a protein on the cell membrane and literally make the cell's border glow.

Grace Finnell-Gudwien is a senior studying Earth, Society, and Environmental Sustainability with a minor in Ecology and Conservation Biology and certific tes in Geographic Information Sciences and Environmental Writing. She is currently applying to graduate school and plans to pursue a master's in Environmental Journalism.

Single-use plastics are both an environmental issue and a human rights issue. *Credit: Streetwise Cycle via Wikipedia Commons.*

By Andy Sima

WE HAVE MET THE ENEMY AND IT IS PLASTIC

Single-use plastic water bottles stink, right? They're the worst. If someone came up to me and told me this, I'd roll my eyes and say, "Of course. Any environmentalist worth their soil says so. They're gross and use fossil fuels and end up in the oceans and rivers. Turtles eat them and stuff. They're very bad." **But let's be honest; we're way past that by now.**

At this point, saying plastic water bottles stink is like saying we need to ban plastic straws or something. Yeah, sure, that's great and all, it'll help the oceans a little, but it's missing the point. It's easy to look at plastic water bottles or other single-use plastics and label them as the devil's tool (a stance I admittedly often take), and I will literally dehydrate myself before I buy a bottle of water from the gas station. But what's easy to blame isn't always the culprit; for example, that gas station selling the plastic water bottles, the one I have no problem using to fill up my car, uses tenfold more resources than any plastic water bottle I might or might not buy.

And for me, it's easy to not buy single-use bottles. Where I live in Illinois, the most basic necessity of life spits right out of a pipe in my house and I don't think twice about it. I can go to any department store and buy a reusable plastic water bottle — or better yet, a reusable metal one — and fill it up with clean, life-giving water any time I please. And I can get two of them, four of them, *500* of them, for all it costs to me, and fill them up and stick them in my basement and have water for months.

The plastic bottle business is perpetuated by people who stand to make a profit from plastic. But at the same time, there are people who, if they can't get their hands on a single-use plastic water bottle, will die.

This isn't some sort of hypothetical statement, or one of those generalized statements about some "third world" country. This is happening right now, all the time, in our own communities. All you need to do to find the most newsworthy example is look north to Flint, Mich., which is *still* in a water crisis, with residents unsure if their tap water is safe to drink.

People living near reservoirs poisoned by algal blooms must turn off the sinks. There are towns with tap water you can light on fire from all the fracking and gas production; it's so well-known that *The Simpsons* even had a bit on it. Sometimes water just straight up runs out. What are all these people to do if they can't use their own water? Buy water bottles.

What other choice do they have, really? On one hand, you have toxic tap water, and on the other hand, you've got a clean, plastic bottle that hides its environmental costs behind cheap prices and being "recyclable." And it is recyclable only in theory, as mountains of plastic recycling are never actually recycled, and are instead just buried in a landfill as garbage — or worse yet, left to rot out in the wilderness, picked up by wind or rain. The bottled water industry does a lot to hide its dirty secrets, like the fact that it's mostly just bottled tap water, no mountain springs involved. They're great at hiding the trash that they produce, too.

Plastic water bottle litter is at the back of most Americans' minds, but try telling Mexico, with its massive water bottle litter problem, that plastic bottles aren't an issue for scenery and cleanliness. You could make a great case for reducing single-use plastic bottles with Mexico as an example. Mexicans are the single largest consumers of bottled water in the world, and therefore one of the single largest receptacles of bottled water trash. Scenes of trash-strewn deserts, alleyways overflowing with tossed bottles, little children playing with plastic bottles, homes and walls built out of collected garbage — it all makes for a great media campaign about how stopping plastic bottles will save the world. But for all that buzz, there's a reason that Mexico imports so many plastic bottles of water: The citizens can't trust their tap water. If you take

But for all the plastic out there, and as convincing an argument as it is to cut out single-use plastics to save the turtles, it could just as easily be reframed as a human rights issue. Water is life; it makes up 70% of us, and if we don't get any for three or so days, we die.

away bottled water, and there isn't a safe drinking alternative, what are they supposed to do? Die?

If you ask me, the kicker is this. Somewhere, somehow, way up the chain of command, someone who doesn't have to worry about where their water is coming from is making money. And making a *lot* of it. A quick search suggests that James Quincey, CEO of Coca-Cola, the producer of Dasani water, has a net worth of about $45 million. Okay, that's chump change when you compare it to the likes of the mind-bogglingly rich, like Jeff Bezos, but that's still *45 million dollars*. Then again, deeper digging is a little more damning. It's estimated that James Quincey was awarded around $18 million in total compensation as CEO of Coca-Cola in 2019 alone. In just one year, he got enough money to buy 50 average-sized American homes. I can say with certainty within two standard deviations that anyone reading this will never, ever, in their entire life, have that much money at once. And that's *one guy*.

Sure, it's Coca-Cola, so the money isn't all coming from plastic bottles. But that doesn't change the fact that the bottled water industry is a billion-dollar industry, and most of those billions of dollars aren't going to fund new drinking water infrastructure. Those dollars are lining the pockets of very wealthy people who are making a great deal of money off the backs of people who may not have any other means of accessing clean drinking water. And these very wealthy people are almost always, with some notable exceptions, white, male, and English-speaking. That's odd — it's almost like you could use bottled water as a tool of neo-colonialism, fattening the rich white men while charging the poor, predominantly people of color for a resource that *should be a human right*.

Toxic tap water in Flint, Mich.
Credit: Joyce Zhu via Flintwaterstudy.org

This doesn't excuse, nor should it distract from, bottled water's awful health track record. Plastic bottles, and most other plastics of that similar composition, produce microplastic beads as they break down in UV light, and those microplastics and bisphenol A and whatever other chemicals leach out from the bottles into the water eventually end up inside somebody. Maybe it'll be a fish, and that plastic-stuffed fish will end up on someone's dinner plate. Or it's just in the bottled water itself, silently and stealthily contaminating a source of drinking water that's supposed to be as pure as possible. There's no escaping the grasp of plastic now; whether we like it or not, it's already everywhere, even in the deepest parts of the ocean.

And don't forget that making water bottles is a mess, too. Producing single-use plastics is incredibly cheap and energy efficient compared to multi-use anything, but more often than not, the dirty work of refining the oil, creating the plastics, melting and shaping the bottles, and breathing in all those toxic fumes is all outsourced to poor areas. Oil refining and plastic production use so many different acids, solvents, burners, oxidizers, and countless others that end up in the bodies of the people who work with them. And those that don't end up in the product or in the workers ends up in the nearby environment. Imagine someone out there right now who works in a plastic bottle factory, making bottled water, and is forced to buy and drink bottled water because the plastic bottle factory is dumping sludge into their river. It's a self-feeding cycle that can't grow forever.

But for all the plastic out there, and as convincing an argument as it is to cut out single-use plastics to save the turtles, it could just as easily be reframed as a human rights issue. Water is life; it makes up 70% of us, and if we

A plastic bottle littering a beach in Melbourne, Australia.
Credit: Greener State

don't get any for three or so days, we die. If someone lives in an area without access to any of the water that I personally take for granted, bottled water might be their best bet. Their only bet. But someone, too, is going to make a lot of money from charging these people for water. The industry grows because it's filling a need that, in some cases, it creates. And the circle remains unbroken, and we get giant floating trash vortexes in the Pacific Ocean.

What's there to be done, then? You can swear off plastic bottles and other single-use plastics, as I attempt to, but that won't do nearly enough — even though it's a great start. Influencing local and national politics is a better option. Petition your town to put a ban on watering yards in summer. Send letters to your senators to push for national subsidized water infrastructure. Join the UN's Water Action Decade, which strives to promise sustainable drinking water to the entire planet. They know what has to be done, and there's a *lot* to do. But we can all help.

If you want to solve the issues of plastic pollution, you can't just tax the industry or boycott your grocery store. The money will just move elsewhere, and boy howdy, is there a lot of it. So there needs to be a push for something else, a more sustainable, human-friendly and earth-friendly solution. Something like better infrastructure. Something like water as a right. Something like equal resource access.

Single-use plastic water bottles stink. They're the worst. But they are less of a cause as they are a symptom of a much larger problem. You can clean up the plastic and save the whales, but if you really want to fix it at the root, you have to save the people, too.

Andy Sima is a recent graduate of the University of Illinois, with a bachelor's in Environmental Sustainability and Creative Writing. He currently lives in Minneapolis, and is working on an endangered species book for children. He runs a blog at www.owlmanandy.com, and is also looking for an agent to represent him.

By Kratika Tandon

The Birth of Environmental Law

A courtroom sketch of Lazarus's Supreme Court appearance in *Murr v. Wisconsin*.
Credit: Dana Verkouteren

Richard Lazarus grew up in Urbana, Ill., and enrolled at the University of Illinois Urbana-Champaign a couple of weeks after his 17th birthday. Known today as a pioneer in the field of environmental law, he created a path from the beginning by fashioning his own major at the U of I — before environmental law was even an accepted discipline. Since then, Lazarus's lengthy career has been highlighted by arguing environmental cases before the U.S. Supreme Court and serving on the U.S. Department of Justice transition teams for Presidents Bill Clinton and Joe Biden nearly three decades apart. As a Professor of Environmental Law at Harvard University and one of the preeminent experts in the field, he is passing his knowledge on to the next generation. He returned to his hometown during Earth Week in April 2022 to share his experiences and his hopes for the future with the University of Illinois community. Ahead of his visit, *Q Magazine's* Kratika Tandon sat down with him for a Q&A.

> The EPA had just been created, the Clean Air Act just passed, the Clean Water Act had not yet passed, so it was fairly early on. With the benefit of five decades of hindsight, I now appreciate that I was a bit disturbingly focused and very strategic for a 17-year-old punk. But that's how I began on the pathway I have been on ever since.

Q. Tell me about your background and how you got involved with environmental law.

It's fairly interesting. I went to University Laboratory High School (Uni High) in Urbana and graduated at age 16. I looked about 8 years old. When I first went to college in Illinois, I was way too young to be there. The U of I Police used to constantly try to kick me off campus. I had to show my ID and claim that I wasn't a high school kid, and I actually should be on campus. Anyway, I didn't have any idea of what I wanted to do. After my first semester there, I left school and I spent the semester traveling mostly around Europe. And when you're 17 years old, you think you're pretty old — and I thought I was pretty old. It's during that period that I decided on environmental law for my career. I was looking for a combination of things, and I was trying to identify something I could care about and something I would be good at. I wanted both. I picked environmental law because I was interested in politics and public policy.

I remember in June sitting down with my UI course catalog trying to decide what classes I should take if I wanted to be an environmental lawyer. I flipped through the catalog, trying to decide what I should major in. Because I knew what I wanted to be; I just didn't know how I wanted to get there. I flipped through the catalog, and I naturally arrived at the courses beginning with the letter "C" right away. And I saw there was a course in environmental chemistry, so I thought, "OK, I should get a bachelor of science degree in chemistry." And then I kept flipping and I got to "E" and I saw a course in environmental economics, so I said, "OK, I should also get a separate bachelor of arts degree in economics." And that's just how I did it. There was no environmental studies program back then. So, I had to create it myself. And people would ask me, "Why are you getting two separate bachelor's degrees in chemistry and economics?" And I would say, "Pre-environmental law," and people would most often say, "What's that?" Because it didn't then exist. The EPA had just been created, the Clean Air Act just passed, the Clean Water Act had not yet passed, so it was fairly early on. With the benefit of five decades of hindsight, I now appreciate that I was a bit disturbingly focused and very strategic for a 17-year-old punk. But that's how I began on the pathway I have been on ever since.

Q. Can you tell me a little bit about your journey starting off law school and after graduating from Harvard as well?

I came to law school absolutely wanting to do environmental law. There weren't that many programs back then, at any school, including Harvard. There weren't a lot of classes to take here. Environmental law was only beginning to be taught. But I did everything I could do in law school to learn what I needed to learn. I took the few classes, I joined the Environmental Law Society, I worked for the *Harvard Environmental Law Review*, which was created during my first year of law school. It's now been around for 40+ years. My peers and I mostly learned on our own outside of the classroom. We learned from each other, we learned from student organizations, we learned from working on projects together. And a lot of those people, from my first year of law school, are some of my closest friends now, and they're environmental lawyers in all kinds of rewarding careers. The greatest gift that Harvard Law School gave me was the opportunity to immerse myself with a terrific group of students who were motivated the way I was then motivated.

So, my law school experience was less directed to classroom learning than to experiential learning with other students — with one important caveat. There is one important lesson I discovered in law school that changed the way I thought about environmental law: The best environmental lawyers are not the best environmentalists; they are the best lawyers. If I'm trying to take care of a park or an endangered species or trying to address climate change or water pollution, I want to go in and think, "What are the legal issues?" The stakes are environmental, but the legal issue that resolves it may not be uniquely environmental. The summer after my first year of law school, I learned this while working for the Environmental Defense Fund. After my second year of school, I worked for the President's Council on Environmental Quality,

> Environmental law also exists on many levels of government. It exists on the local level, the state level, the national level, and the international level. And ultimately pollution control laws and natural resources management laws are just two different sides of the same coin of environmental law.

which does all the National Environmental Policy Act (NEPA) work. After law school, I went to the Department of Justice and joined the Land and Natural Resources Division, which is now the Environment and Natural Resources Division. My work was all environmental nonstop, but with a broader lens. My career objectives never changed, but I had come to appreciate that it was more important to become the best possible lawyer rather than just the best possible expert only in environmental law.

Q. What exactly is environmental law? What all does it comprise, and how grand is its scope?

There are a couple of dimensions to it. There's the pollution control side and then there's the natural resources management side. The first set of laws deals with pollution. And that can be water pollution, air pollution, hazardous waste pollution. A no less important side of environmental law is natural resources law. That's the management of natural resources, national parks, national forests, wilderness protection, endangered species protection, and water rights law. Obviously the two frequently overlap. Environmental law also exists on many levels of government. It exists on the local level (there are local environmental laws here in Urbana), the state level, the national level, and the international level. And ultimately pollution control laws and natural resources management laws are just two different sides of the same coin of environmental law.

Q. What does an environmental lawyer do? What might a day-to-day schedule look like?

If you're working as a lawyer in the EPA, on a day-to-day basis you're taking the statutes that Congress passed, the Clean Air Act and the Clean Water Act, and you're filling in the details. So, the job of a lawyer at the agency will be to work with the language Congress wrote and then to collaborate with the scientists, engineers, and economists from the agency to write the detailed rules that impose pollution control requirements on industrial activities. The EPA attorneys who write those rules are not themselves scientists, but they speak to the experts. They translate their expertise into actual rules with the force of law.
If you're working at the Department of Justice, where I spent my first years after law school, then you enforce the law. You bring lawsuits enforcing those requirements, both civil and criminal, or you defend the validity of those pollution control requirements when others file lawsuits challenging their lawfulness. Another prominent place many environmental lawyers work is with public interest groups: Environmental Defense Fund, Natural Resources Defense Council, Earthjustice, Sierra Club. Their job is to be zealous advocates for stringent environmental protection requirements. They accordingly support the federal, state, and local governments when they think government is being sufficiently aggressive — and they sue the government when they think they're not doing enough. Finally, many environmental lawyers work for law firms. Those

Richard Lazarus. *Credit: Harvard University*

lawyers frequently work on both sides depending on the interests of their clients. They mostly represent industries challenging environmental laws for imposing environmental protection requirements that their clients believe to be too tough. But there are also a lot of companies who do not want to fight the laws; they instead say, "I just want to know what to do," so there's a lot of counseling that happens. Because of tough environmental protection laws, there is also now a multi-billion-dollar pollution control industry in the United States — for instance, companies that provide equipment and services needed for pollution control — and lawyers who represent those industries support stringent pollution control laws.

Q. I understand that you've represented governments on the local, state, and federal levels and various environmental groups before the U.S. Supreme Court in approximately 40 cases. Which of these have been significant to you on a personal level or simply just struck you as groundbreaking or impactful on a large scale?

I've done 40 cases; I've argued 14 of them. I'll just pick some environmental ones since all 40 weren't environmental — I've done criminal cases, all kinds of cases. One is a case in which I represented the Environmental Defense Fund in the Supreme Court against the city of Chicago. The city was collecting enormous volumes of household waste and rather than simply dumping it all on land was instead burning it in an incinerator. There was a lot about what Chicago was doing that was very positive. The city used the heat produced by burning the waste to heat homes, while reducing by about 90 percent the volume of waste that then had to be disposed of on land. The problem was with the ash residue that remained after the incineration process, and whether that ash residue was hazardous or not. If it was hazardous, it had to be disposed of in a licensed hazardous waste land disposal facility, which is very strictly regulated. If instead the ash was merely solid and not hazardous waste, it goes into a different kind of landfill, which doesn't have the same high level of protection. Not surprisingly, it's far more expensive to put it in a licensed hazardous waste landfill than in a solid waste landfill.

The city of Chicago was disposing of the ash in a solid waste landfill. The Environmental Defense Fund said, "No, this stuff is hazardous and therefore you should put it over here," in a strictly regulated hazardous waste landfill. The irony of this case is that there was really no dispute. In matters of the chemical constituency of the ash, it was clearly hazardous. The problem was that the relevant statutory language could be read to include an exemption for household waste. The legal issue before the Justices was strictly a question of statutory construction and whether the statutory language creating the household waste exemption applied to the ash. Representing EDF, I was taking the position that it didn't apply to the ash and therefore because there was no statutory exemption, the ash residue had to go into the hazardous waste landfill. The city was against me, as were most of the states in the rest of the nation, as was the EPA.

So, it was a fun, interesting case. No one expected us to win; I like those kinds of cases. And we actually won. We won the case 6-3, and Justice Antonin Scalia wrote the opinion for us. Scalia was a very conservative justice. He wasn't a justice who people think of as "pro-environmental." But we persuaded him that we were right about the meaning of the language of the statute. That regardless of what people thought as a matter of policy, that was what the statute said. It was a tough legal argument, but it was very gratifying to win and to get some conservative justices on our side, too. That's why you want to be a good lawyer, not just a good environmental lawyer. My argument for the court wasn't, "This is good policy" (though I also think it was). It was, "No, this is the law." And that's how we won.

The other Supreme Court ruling I want to talk about is an unusual case for me. I mostly represent governments and public interest groups. I rarely represent individual clients. *Norfolk & Western Railway v. Ayers* is a case where my clients were individuals: six retired railway workers in their 70s and older. When they were all working for railroads, the way the railroads prevented fire hazards was to coat their engines with asbestos fibers. This was before it was necessarily well known how dangerous asbestos was. And these six retired workers had all consequently become seriously ill with asbestosis, which is a significant lung disease from breathing in asbestos fibers. They had brought a lawsuit against the railroads, and the issue in the U.S. Supreme Court was whether the former railway workers were entitled to receive compensation for their reasonable fear of cancer in addition to their physical illness.

This was another case where people thought we would lose. We won the case 5-4. With nine Justices on the Court, that is of course as close as you can get. Justice Ruth Bader Ginsburg wrote the majority opinion for the court and the five Justices joining the opinion were RBG, David Souter, John Paul Stevens, joined by Scalia and Clarence Thomas. The first three were the most liberal members of the court, and the next two were the most conservative members of the court. So, we won 5-4 and lost the entire middle of the court — all the people in between. You don't typically win by getting none of the

> People need to remember and believe that there's hope, and we can still effectively address the climate issue. The work is too important not to be done.

swing justices. It's like in bowling when you've got the two pins on the outside — a 7-10 split— and hit them both. It was rewarding to find a way to argue this case to get that kind of majority. It was also both very gratifying professionally to win a case people thought wasn't winnable and to secure significant compensation for six very deserving elderly clients. Arguing before the Justices is ridiculously demanding. It is also great fun. The Justices, all of them, are very smart and in 30 minutes they pummel you with about 60-70 questions. It's pretty intense, to say the least, and the stakes in law are as high as they get. But it's a blast, too.

Q. Aside from teaching, you've also authored *The Making of Environmental Law, Environmental Law Stories,* and *The Rule of Five — Making Climate History at the Supreme Court*. Can you tell me a bit about these?

The first one, *The Making of Environmental Law*, is a history of the emergence and evolution of modern environmental law in the United States, and in many ways, it's my life. No, I don't mean it's about me, it's not at all. But the book is about how environmental law emerged and why it emerged when it did in the United States, and how it since evolved over time. And that's been fun for me, because it emerged in about 1970, just when I was getting into this. I have had this extraordinary opportunity to witness and be part of environmental law's remarkable evolution over the past 50 years. The book fully engages in this sweep of history. The beginning of the book involves a fair amount of science and discusses why, because of the sheer complexity of environmental science, it's very hard to make environmental law. The book also discusses environmental economics, why environmental economics likewise makes environmental lawmaking hard. And then the first edition of the book discusses how we see those challenges reflected in the way environmental law evolved in the 1970s, '80s, and '90s. That first edition was published in 2004 and covered modern environmental law's first 30 years. This summer I'm coming out with a second edition, which will take us through the next 20: through the Bush, Obama, and Trump years. So, the second edition's coverage will expand to modern environmental law's first 50 years in the United States.

The Rule of Five, which is what I'll be talking about when I come to Illinois, is a book about the most important environmental law case ever decided by the Supreme Court. This is a case called *Massachusetts v. EPA*, which environmentalists often refer to as their own *Brown v. Board of Education* because of its significance. *Massachusetts* was the Supreme Court's first climate change case and it led to a truly historic ruling. By a 5-4 vote, the court agreed that a party injured by climate change could sue in federal court to redress that injury and that greenhouse gases are air pollutants covered by the federal Clean Air Act. The latter ruling meant that the U.S. Environmental Protection Agency has the authority to restrict greenhouse gas emissions as needed to address the threat of climate change. Almost every single thing the EPA has done since the *Massachusetts* ruling to reduce greenhouse gas emissions is based on that court decision. My book, The Rule of Five, tells the story of the case. The case was decided in 2007, but it began in the late 1980s. I tell the full story of the young public interest and government lawyers who initiated the litigation that led to this history-making Supreme Court decision: who they were, the enormous hurdles they faced in bringing the case, the efforts of the federal government and industry to stop them, and the battles and conflicts the lawyers faced on all sides of the litigation in crafting their opposing arguments. The story extends to what happened at the Supreme Court itself behind the scenes, in the chambers of the Justices as they discussed, debated, and finally wrote their opinions. So, it's a very engaging, often suspenseful, and ultimately uplifting story about one case.

Q. Why is introducing people to environmental law more important now than ever?

There are many important environmental issues today, but obviously one of the most important is climate change. Climate change is a massively hard problem to address, and we're struggling. And it's not going to go away soon. My own generation of environmental lawyers, scientists, economists, and policymakers have been working on it for decades, with limited success. We need new generations of talented and committed people to

come in, reinforce, and bolster those longstanding efforts. We need people with new ideas about how to address these issues. It's very important to get a new generation of people to come in and take over, including some outstanding environmental lawyers. And that's why I teach. I do a lot of stuff. I do a lot of litigation, I do a lot of writing, I love it. But probably the single best thing I do is launch students: teach them, promote them, help to get them jobs, and then send them on their way. I probably have had 40 of my students go on from law school to work as environmental lawyers at the Department of Justice, where I began my own career after law school. And I have many former students working at EPA, the Department of the Interior, with state and local government, with environmental groups, with law firms, and some now with industry committed to developing solutions to the climate crisis. That's probably the single most important thing you do as a teacher: Launch terrific, hard-working, and committed people into their careers.

Q. You are a professor at one of the top law schools in the nation. Tell me about your students. What does the future hold for the field of environmental law?

My students are highly motivated and hard-working. They often come to law school with a commitment to environmental protection that can be traced back to their childhoods, and that is reflected in classes they took in both high school and college. They come so well prepared, whether it's from a policy or science or government perspective. Many of our students have been out of college for a year or two before coming to law school, so they've worked at different jobs. The students here at Harvard are not surprisingly very smart. But being very, very, very smart is not enough. You need to be hard-working and resilient. If you do this work, it's hard work. You're not always going to succeed and will lose a lot. So, we're looking for people who are smart, that's fine. But we're looking for people who are resilient, hard-working, high-achieving, persistent, and kind. Law — especially environmental law — is very collaborative. No one person is going to do this on their own. They need to work well with others. I'm looking for that as well. And I've got a lot of them who are enormously talented, hard-working, and kind-hearted. Many of them not surprisingly are UI alums! I have one in my class right now. They're literally chomping at the bit to go out there and do good things. I think the future is in good hands. It's a great time to be an environmental lawyer. It's a hard thing to master, which means that if you've mastered it, you can make a big difference.

Q. What would your message be to students at the University of Illinois who wish to be the next generation of environmental leaders, and how can we stay hopeful?

The first thing to do is to work hard. I spent more time in the UI library than at the Red Lion or Murphy's. You can have a good time in college, but it's important to take your studies seriously. You want to develop the skills to show that you can learn how to problem-solve, and I received a fabulous education at the UI from so many outstanding professors and classmates. There is nonetheless one transformative skill that I learned from my time as an undergrad at Illinois — more important than anything else — that has served me well: I learned how to face a tough problem, not be unduly intimidated by it, and take the time needed to figure it out. It is important to be passionate about one's work, but it takes more than passion to problem-solve. It requires hard work, discipline, rigor, and unbending focus. There are no substitutes.

How to remain hopeful? Well, that's harder. Our nation, let alone the world, is not doing so well on the climate issue. The climate news each month always seems increasingly dire. But I always strive to be optimistic and hopeful. If you want to be a pessimist, you should probably wrap it up, because it's very easy to be a pessimist, but then you're not going to want to keep at it. People need to remember and believe that there's hope, and we can still effectively address the climate issue. The work is too important not to be done.

Kratika Tandon is a sophomore from Peoria, Ill., and is a Communications Intern with the Institute for Sustainability, Energy, and Environment (iSEE). She is studying Natural Resources & Environmental Sciences (NRES) with a concentration in Human Dimensions of the Environment. She is also pursuing a minor in Political Science and plans to attend law school after graduation.

CRYPTO'S DARK SECRET

By Tyler Swanson

Illuminated mining rigs operate inside racks at the CryptoUniverse cryptocurrency mining farm in Nadvoitsy, Russia.
Credit: Andrey Rudakov via Getty Images

Bitcoin has been called "The People's Currency" and "The Currency of the Future," but whatever the name, its rise to prominence in recent years is astonishing. While Bitcoin was initially intended to act as a decentralized currency that anyone could generate and trade for secure transactions, it has become a tool for investors on the stock market to try and get rich quick with occasional disastrous consequences. Worth over $40,000 per coin at the time of writing, Bitcoin has captured the fascination of tech enthusiasts, financiers, and the public alike. For some, the widespread rush to invest in Bitcoin may seem reminiscent of the gold rush of 1849, and that notion isn't too far off. Many people have used their savings, and some have even mortgaged their homes, to invest in the cryptocurrency. This high level of risk sometimes pays off, but sometimes doesn't, and families are left destitute as the value of Bitcoin rises and falls almost at a whim. But the relative successes or failures of investors distracts from a much darker shadow: the environmental impact of Bitcoin.

The technology of "mining," as the process is called, is so energy intensive that global mining operations consume as much energy as some nations; unfortunately, the majority of this energy is generated from fossil fuels. As demand for Bitcoin grows, more companies emerge to mine for this digital gold, resulting in the resurrection of long-dormant power plants, creating revenants from the fossil-fueled past America is trying to leave behind for a clean energy future. Nowhere is this more evident than in Dresden, N.Y., where Bitcoin has revived a once-dead power plant, with destructive impacts on local ecosystems in addition to a new spike in carbon emissions.

The village of Dresden is on the banks of Seneca Lake in Yates County, N.Y., and is home to just over 300 people. Situated in the heart of the Finger Lakes region, Dresden and the surrounding community are home to a burgeoning tourism industry centered on wineries. With the beautiful lake, lush vineyards, and rural atmosphere, the region was developing into a getaway destination for foodies and nature lovers alike until a private equity firm called Atlas Holdings bought an abandoned power station.

The Greenidge Generation Plant, located right on the banks of Seneca Lake, operated as a coal-burning power plant until high operating costs put it out of business in 2011. Closing the plant might be held up as a victory in the transition from fossil fuels, with coal proved economically unviable. However, in 2014, Atlas Holdings purchased the plant to supply electricity to the grid after converting the fuel source to natural gas. Thanks to a significant economic development grant resulting from the firm's lobbying efforts, the fuel transition was complete, with only one slight problem: low demand for energy.

In an interview with Peter Mantius, a journalist who has been covering Greenidge's crypto story as it unfolds, he explained that the energy grid had adapted after the initial plant closing, and once it reopened, the grid only occasionally needed the plant's power during peak hours. In 2019, the Greenidge Plant was only operating at 6% capacity. After such a large investment in purchasing the plant, lobbying efforts, and overhead costs, Atlas seemed to be on the verge of losing its money. With this significant investment on the line, the plant's operators turned to a new financial stream: Commercial Bitcoin mining.

To appreciate the value of this new direction taken by Greenidge Generation Holdings, the subsidiary of Atlas Holdings that runs the plant, requires an understanding of the process of Bitcoin "mining." As a digital currency, there is no physical manufacturing or minting of Bitcoins; instead, mining takes place through a computer solving a complex cryptographic puzzle. Once decoded, the latest "block" of Bitcoin transactions is revealed and published to a public network known as the blockchain. As a reward for the decoding efforts, miners receive a set amount of Bitcoin — 6.25 as of April 2021. While this process may seem easy, there is a catch. As more miners join in and

use their computers to earn Bitcoin, the cryptograms become more complex and require more processing power and energy to solve efficiently.

For the owners of the Greenidge plant, Bitcoin mining was a no-brainer. More than 90% of the plant's capacity was unused, and all they had to do was construct a room full of computers to mine the Bitcoin with that excess energy; every time the computers at Greenidge successfully solved a cryptogram, the owners would earn over $60,000. After Bitcoin's value skyrocketed to more than $50,000 in April 2021, the plant owners would be making more than $300,000 for every cryptogram solved.

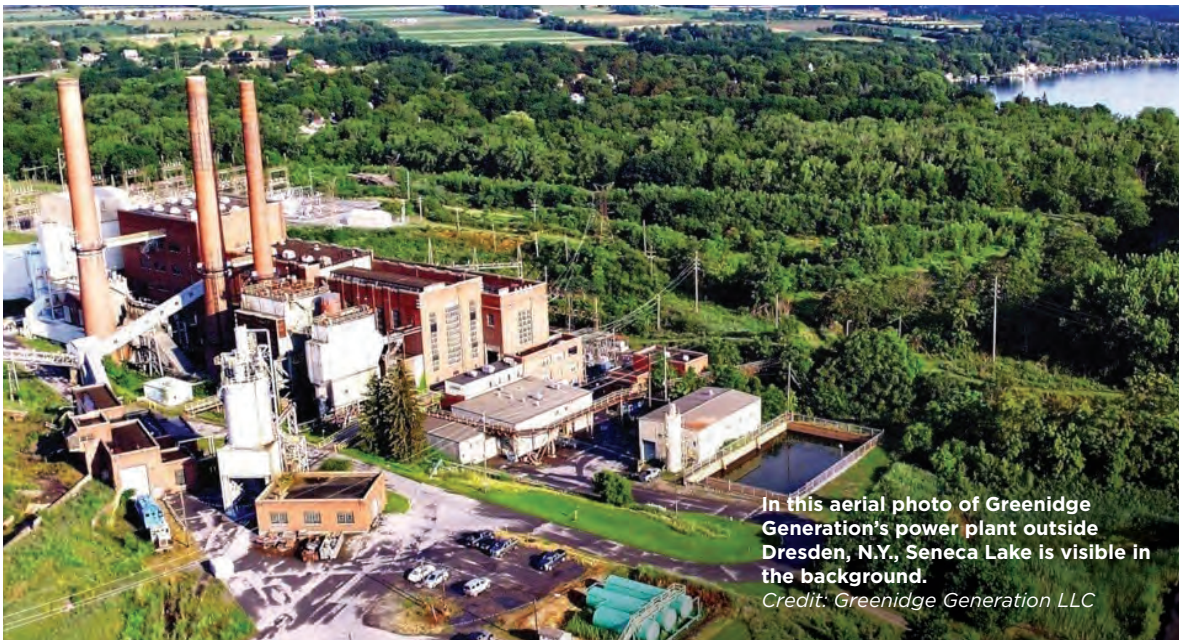
While an attorney for the company claimed that the plant would use a maximum of 66 of the plant's 106 MW capacity for Bitcoin mining in April 2021, Greenidge Generation Holdings announced its intent to increase mining capacity to 85 MW by the end of 2022 and to 500 MW by 2025. These announcements elicited outrage from environmental activists, which resulted in a march on the plant by a group of protestors in April organized by the Seneca Lake Guardian. This environmental group focuses on organizing around the Finger Lakes.

Yvonne Taylor, one of the group founders, cited several concerns with the Greenidge Generation Plant — concerns that reflect the real consequences of the plant's operation, particularly those related to water. As an old power plant, it does not have the same closed-loop standards as newer plants, which require water drawn in for cooling to be recycled through the plant system. Instead, a large pipe protrudes from the plant into the lake to take in water, drawing in up to 139 million gallons per day, cycling it through to cool the machinery in the plant and draining the water into the nearby Keuka Lake outlet, a designated fishery populated with trout. The plant's water withdrawal system has significant impacts on wildlife. The former owners of the Greenidge plant conducted a report estimating that water withdrawals caused the death of nearly 10,000 fish or crayfish annually, while also entrapping 592,000 eggs, larvae, and juvenile fish. Meanwhile, the draining of heated water into the Keuka Lake outlet contributes to a decreasing trout population in the lake and an increase in Harmful Algal Blooms (HABs) when the heated water mixes with the rest of the lake. In our interview, Taylor explained that the HABs are a particular concern for community residents, as removing the harmful algae from drinking water is a costly and technologically intensive process.

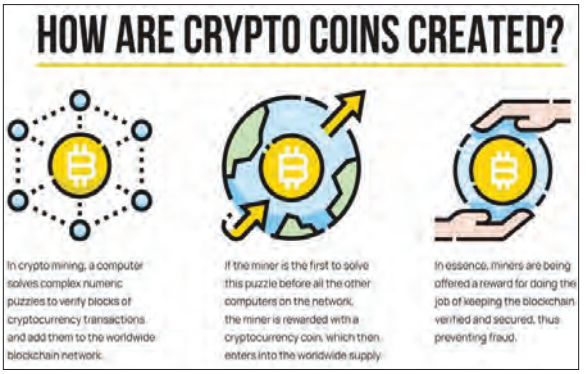
These ecological impacts have led to fears about the effect of the plant on the community's growing tourism industry. Michael Warren Thomas, a local radio personality who produces shows relating to gardening, wine, and food in the Finger Lakes region, detailed those fears in an interview:

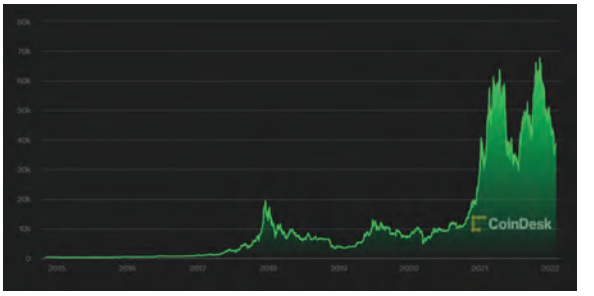
"The Finger Lakes wine industry has built its reputation over generations. They've been making wine at the Finger Lakes since the early 1800s, but we've only really become a world-class wine region in the last 20 years... do [international wine companies] come here and build a $10 million winery when there's a power plant across the lake from you? ... Frankly, I wouldn't do it."

To counter these ecological and economic concerns, Greenidge Generation Holdings has tried to build up its environmentally friendly reputation with the community. In May, the company announced that its operations at the



In this aerial photo of Greenidge Generation's power plant outside Dresden, N.Y., Seneca Lake is visible in the background.
Credit: Greenidge Generation LLC





Above: Price of Bitcoin from 2015 to '22. *Credit: CoinDesk*

Left: *Credit: Investor's Business Daily*

plant would go entirely carbon neutral by June 1. However, this carbon neutrality would not be achieved by transitioning the plant to renewable energy, but by purchasing carbon offsets to account for the hundreds of thousands of tons the plant is emitting into the atmosphere. While this may green the plant's operations to an extent, it does little in the eyes of the state, which prohibits the electric generations sector from using carbon offsets to account for emissions under the state climate action plan. Essentially, while Greenidge can purchase all of the carbon offsets it wishes, it will not help New York achieve the state's ambitious goal of 100% zero-carbon electricity by 2040.

State legislators noticed the environmental impact caused by Greenidge and other Bitcoin mining operations and sprang into action. New York State Assemblywoman Anna Kelly introduced a bill in June that would implement a three-year state moratorium on the practice of energy-intensive cryptocurrency mining. However, union opposition to the bill — driven by fear of job losses — derailed its passage. Another legislator, State Sen. Kevin Parker, sponsored a bill that would require state officials to study the viability of renewable energy to power crypto mining, but it is unclear what impact the bill could ultimately have. As of this writing, no legislation restricts Bitcoin mining in New York or nationally.

Meanwhile, the opportunity for immense financial gain combined with lax government regulation has empowered Greenidge and other firms to expand and construct new operations. In July, the firm announced its plans to build a second Bitcoin mining operation at a recently closed printing plant in South Carolina. This new plant can draw 80 MW of power, two-thirds of which is produced from nuclear energy or other zero-carbon sources. Digihost International, another cryptocurrency firm, is looking to purchase a natural gas power station in Buffalo for Bitcoin mining. Additionally, a crackdown on crypto mining in China, where a significant portion of the world's Bitcoin mining occurs, is likely to send many more firms to the United States to continue their operations.

While the situation around the Greenidge Plant and the larger Bitcoin industry seems bleak, not all hope is lost. In September, Greenidge's air permits with the State of New York expired. Further, New York Department of Environmental Conservation Commissioner Basil Seggos tweeted, "Greenidge has not shown compliance with NYS climate law." While not a certainty, it is possible that the company will face new regulations or some other form of enforcement from the state that could compel the plant to either alter its operations or become more environmentally friendly. Nationally, the Biden administration is weighing crackdowns on crypto mining after the hackers behind a ransomware attack on the integral Colonial Pipeline demanded payment in Bitcoin. Regarding the overall Bitcoin mining process, other techniques for blockchain verification do not require such energy-intensive methods. This less energy-intensive model is called Ethereum, the second-highest valued cryptocurrency (just over $2,800 at the time of writing), which is in the process of transitioning to Proof-of-Stake.

Bitcoin has without a doubt secured the interest of the world of finance through its potential to generate high-value returns, and new firms in the United States are emerging that seek to produce cryptocurrency at a large scale. Unfortunately, these operations have revitalized once unviable fossil-fuel power plants into virtual gold mines that generate millions for the owners, but also pollute the air and water and threaten the growth of more environmentally friendly industries. If the U.S. is to achieve a carbon-neutral future and avoid the harshest perils of climate change, governments must take action to return these fossil-fueled revenants to the historical dustbin from whence they came.

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The GRASS isn't Always Greener

By Nicolas Ramkumar

As a child growing up in East Central Illinois, I loved to play in my family's lawn. I spent hours running around the lush green grass, playing games like tag and capture the flag. When my family had barbecues, we set chairs and tables up on the lawn to enjoy our meals on warm summer evenings. I have myriad fond memories of times spent in our yard. On summer mornings, when it was cool out, my parents would ask my brother and I to go outside to pull out weeds and we grudgingly obliged. We removed dandelions, crab grass, clover, and anything else that was not the turf grass that we reseeded every spring. In the evenings, my mother set sprinklers out and let them soak the soil so that the grass could grow healthy and tall. But once it grew healthy and tall, my father took our lawn mower and cut the grass back down. All our work resulted in a pristine lawn, weedless, green, and evenly cut. Throughout this process, there was one important question that none of us asked: **Why does our lawn need to look like this?**

A perfectly manicured lawn — dream or nightmare?

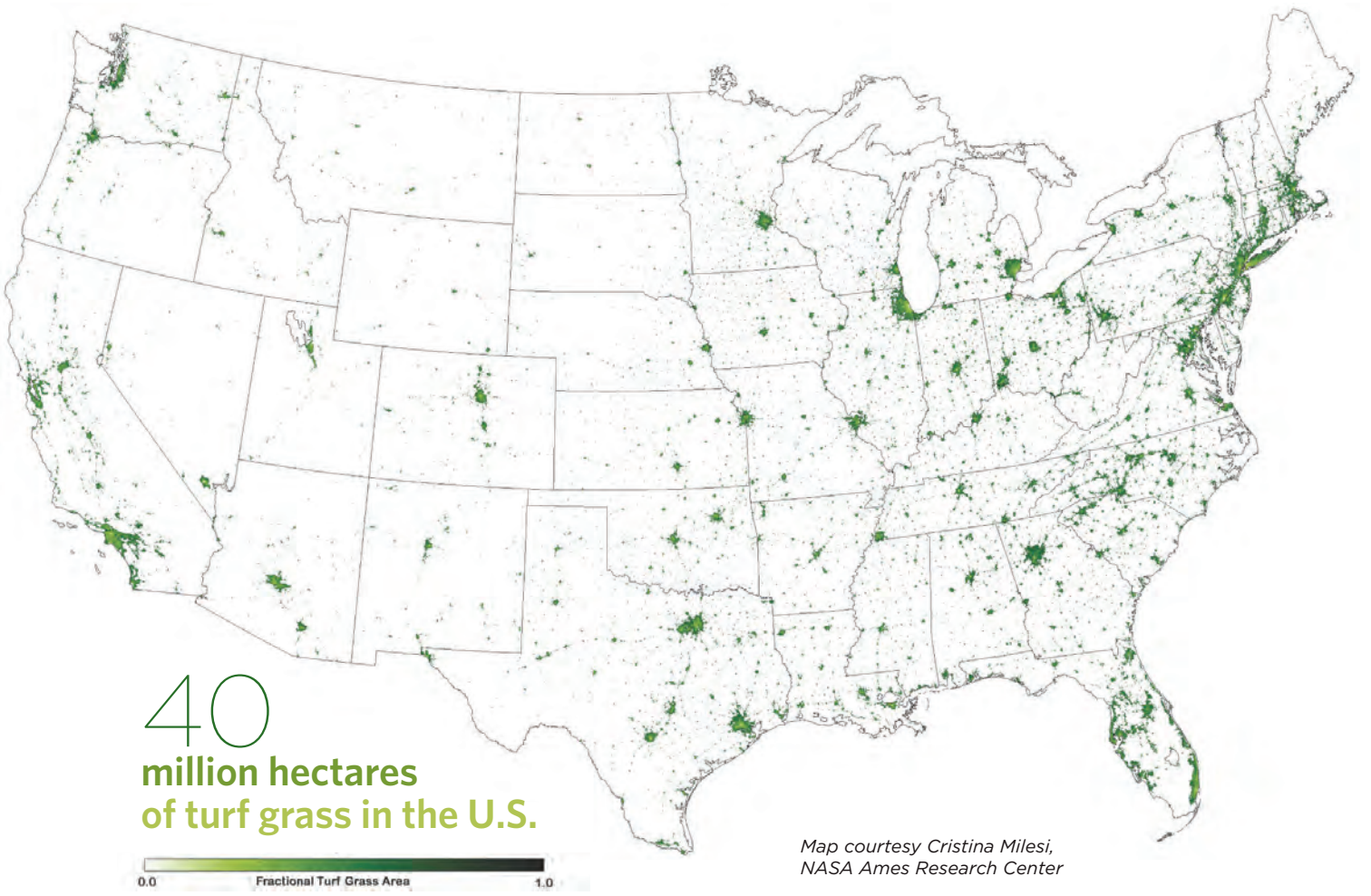
Credit: Skitterphoto via Pixabay

America's largest irrigated crop is not corn, soy, or anything else you might find in the commodity marketplace. It's turf grass: the crop that American homeowners grow in pursuit of the dream of a lush, green, manicured lawn. According to NASA, the United States has around 40 million acres of turf grass, which is an area roughly equivalent to that of the state of Wisconsin. This makes turf grass our largest irrigated crop and one that has replaced scores of diverse habitats for wildlife. Turf grass helps lawn-owners achieve a long-cherished suburban fantasy, but it does not produce food or anything else useful for the environment. In fact, the dream of a pristine lawn comes at a high cost, requiring excessive inputs like water, gas, and chemicals. What might it take to reimagine the American lawn?

Grass and Status

To understand how the modern American lawn came to be, it is helpful to look at the origins of lawns. The first lawns were created by 12th-century British and French nobility as status symbols. They were the only people with the resources to maintain large swaths of land not cultivated for food. These lawns were often made of a mix of turf grass and low growing herbs such as chamomile. The rise in the popularity of manicured turf grass lawns did not take off until the Victorian Era, over 700 years later. It was during this time that the standards of what makes an ideal lawn were set.

In the United States, lawns were first introduced by the wealthy landowners such as George Washington and Thomas Jefferson, who wanted to imitate the landscape architecture of the European elite. They were able to have pristine lawns because they owned slaves who would do the necessary labor to maintain them. However, for most Americans during this period, the most common landscaping practice was to leave the ground naturalized. The Industrial Revolution and the subsequent creation of the suburbs facilitated the transition of lawns into the mainstream, and the ideal aesthetic of manicured, green, weedless turf was baked into the American psyche. By the end of the 19th century, pristine lawns would become a symbol of status and prestige in American culture, much as they were in aristocratic Europe. In leaving the pollution of the city, suburbanites hoped that the green lawns they surrounded their homes with would create pockets of clean, healthy air for them to breathe. Ironically, those uniform green lawns have had the opposite effect.



Map courtesy Cristina Milesi, NASA Ames Research Center

Grass is Not Green

Much more than care goes into the average American lawn. Because many regions of the United States are not suitable for growing grass, lawns must be artificially engineered to sustain the green grass that conforms with social expectations. Lawn owners add a vast amount of natural and unnatural substances to maintain that uniform, green aesthetic: gasoline required to power lawn mowers, excess water to keep thirsty grass green, fertilizer to maintain that grass's texture, and herbicides and pesticides to kill weeds and insects.

Every year, Americans use enough water on their lawns to fill the Chesapeake Bay. According to the United States Environmental Protection Agency (EPA), about one-third of water used for residential purposes in America is for landscape irrigation, which totals about 3.2 trillion gallons per year. As much as half of this water is wasted due to inefficient watering systems, evaporation, and runoff. Lawns were designed to grow in the cool, temperate climate of Northwestern Europe. To grow lawns in arid desert conditions in places like California and Arizona, thousands of gallons of extra water need to be added. In the American Southwest, up to 60% of all residential water is used to keep lawns healthy and green. Considering that much of the Southwest is in the midst of a two-decade-long megadrought, using so much water purely for the sake of aesthetics is particularly wasteful.

To maintain a lawn with a lush, green, velvety surface, Americans douse 2.4 million metric tons of fertilizer on their grass. All this fertilizer requires a lot of energy to manufacture, and that manufacturing process produces nitrous oxide, a greenhouse gas 300 times more potent than carbon dioxide. For similar reasons, 70 million pounds of pesticides are applied to lawns annually, according to the EPA. For perspective, in the state of Massachusetts, a typical lawn service company uses 5 to 7 pounds of pesticides per acre of lawn annually, which is twice the amount used on an acre of agricultural crops.

These chemicals frequently run off lawns and pollute our groundwater, rivers, streams, lakes, and oceans. This chemical runoff can even contaminate our drinking water. Fertilizer runoff can lead to harmful algal blooms, which can be toxic to humans and wildlife in addition to creating dead zones. Much of the fertilizer runoff in the eastern United States ends up flowing down the Mississippi River and into the Gulf of Mexico, where it contributes to a hypoxic dead zone the size of Massachusetts. Pesticides in waterways can poison aquatic animals and harm humans who recreate in them or eat contaminated seafood. These pesticides can kill valuable invertebrates like earthworms and soil microorganisms, disrupting subterranean ecosystems. They also impact terrestrial life and have had a devastating effect on insects and birds which eat food that has absorbed pesticides from the ground. Pesticide pollution is contributing to an "insect apocalypse" and precipitous declines in bird population. There is a growing body of knowledge about the harmful impact of pesticides on humans, including neurological, reproductive, and carcinogenic effects, with children often being the most vulnerable to these health risks.

Sprinkler systems are horribly inefficient and support a crop grown for strictly aesthetic purposes. Perhaps not the best use of our water.

Credit: Wikipedia Commons

Once a thick, verdant lawn has been established, lawn owners then ironically go to huge expense and environmental cost to remove grass through the regular lawn maintenance practice known as mowing. The United States uses upwards of 600 million gallons of gasoline per year mowing lawns. A typical lawn mower running for an hour produces about as much smog-forming hydrocarbons as an average car does driving between 100 and 200 miles, thus contributing to air pollution. Decreased air quality has a major impact on human health, causing increased respiratory illnesses, heart disease, and premature deaths. Additionally, these lawn care practices release greenhouse gasses, worsening climate change.

Lawn owners who pursue a pristine, weedless turf also contribute to a lack of biodiversity. Weeds, as it turns out,

> **There is no biological definition of a weed. It's a flower that you don't want where it is.** There have been a number of studies that show the two most frequently encountered weeds, dandelions and clover, are fabulous resources for pollinators. A weedy lawn is a better resource for pollinators than a sterile lawn with no flowers to provide nectar.
>
> **May Berenbaum, Professor and Head of Entomology at the University of Illinois Urbana-Champaign**

get a bad rap. According to May Berenbaum, Professor and Head of Entomology at the University of Illinois Urbana-Champaign, "There is no biological definition of a weed. It's a flower that you don't want where it is. There have been a number of studies that show the two most frequently encountered weeds, dandelions and clover, are fabulous resources for pollinators. A weedy lawn is a better resource for pollinators than a sterile lawn with no flowers to provide nectar." Turf grass lawns are monocultures, meaning they are the only crop grown in a given area. While they might look appealing, they are biodiversity deserts. Lawns provide little or no habitat for other plants, pollinators, and animals. Berenbaum likened an insect trying to survive solely on turf grass to a human trying to survive by eating only Brussels sprouts. Neither would get all the nutrients necessary for life from only eating one food and would therefore struggle to survive.

After Grass

Given all the environmental costs of maintaining a lawn, it's easy to demonize grass and lawn culture. But grassy lawns are deeply entrenched in American culture, and it is worth understanding what we might give up as we move to a more sustainable option. Lawns are part of our built environment, our cultural landscape, and even our memories, but it is time to rethink what the American lawn should look like. Given the urgency of climate change, the harmful health impacts of turf grass, and biodiversity loss, the time is right. We need to shift the paradigm of a manicured monoculture with resource-intensive maintenance to a landscape with polyculture that sustainably supports thriving ecosystems, human health, and well-being.

The idea of completely relandscaping one's lawn might seem intimidating, but there are several fairly easy ways to reduce the harmful environmental impacts of grass lawns. Leaving a lawn alone for longer periods of time is one of the easiest approaches. By mowing less, watering less, and refraining from using synthetic chemicals, much of the most harmful effects of heavy resource consumption can be lessened. Opting for electric or human powered tools, rather than gas powered ones, will greatly reduce the amount of greenhouse gases that lawn maintenance produces. Mowing less frequently, about once every two weeks instead of weekly, and mowing higher, no more than one third of the blade length at a time, promotes stronger and healthier grass. Longer grass blades, at least three inches above the ground, have greater photosynthetic surface, allowing for development of thicker, deeper-rooted turf that makes it more drought-, pest- and disease-tolerant. Watering slowly, deeply, and infrequently (ideally one inch each week) also trains the root system to grow deeper. This and letting the lawn dry out thoroughly in between makes the grass stronger and more resilient to drought. To further lower the lawn's water footprint, use watering systems that mimic a slow, soaking rain and take steps to reduce evaporation, such as watering at dusk and dawn.

Turf grass, like all plants, requires nutrients to grow and thrive. Decreasing or eliminating the use of synthetic fertilizers is an important step in sustainable lawn care practice. One of the simplest ways to fertilize grass in a safer way is to leave the grass clippings on the lawn after mowing; those clippings are rich in nutrients. Adding a thin layer, 1/4 to 1/2 inch, of organic matter like compost will also add nutrients and improve soil quality. Use of organic fertilizers made from plant or animal byproducts should supplant synthetic fertilizers. If synthetic fertilizers are used, this should be done sparingly based on soil sample analysis and only supplement what nutrients are lacking.

More ambitious lawn owners might consider joining the growing movement toward diverse, polyculture lawns. A

more diverse lawn contains a greater variety of insects and other organisms, many of which are beneficial and maintain ecological balance. This can be considered an example of integrated pest management, which involves the use of biologic and cultural practices and chemicals. Chemicals, preferably natural products, when used should be kept to an absolute minimum and in a targeted manner to control "weeds." Many plants that are commonly considered weeds such as dandelions, violets, and clover are tremendously beneficial for soil health and pollinators. The aesthetic of having these plants coexist in lawns should be the new norm. Additionally, we should consider groundcover such as creeping perennials, moss, and low-growing herbs as alternatives to turf. For instance, creeping thyme and chamomile are becoming increasingly popular as substitutes for turf in low foot-traffic areas. The lawn care industry is starting to wake up to these changes, and more companies are offering eco-friendly, organic lawn care services to meet the increased demand.

Another step in the paradigm shift of lawn aesthetics is the No-Mow movement. According to the Natural Resources Defense Council, no-mow yards fall into four categories. The first is turf that has been left unmowed and allowed to grow wild. The second is lawns with grasses that grow low and need little maintenance. The third incorporates native plants that are suited for the lawn's environment. Finally, in the fourth category, parts of turf grass are replaced with edible fruits and vegetables. This movement has huge potential for restoring native habitat and building resilience against climate change. There are states and local governments that offer incentives to convert traditional lawns to diverse, sustainable ones. For example, California incentivizes property owners to convert turf lawns to xeriscapes, lawns that use drought-resistant native plants as ground cover. Another example is Minnesota, which has a Lawns to Legume program to help homeowners install pollinator-friendly native plantings in residential lawns. My hometown of Champaign, Ill., has a Pollinator Pocket program to encourage landowners to plant pollinator-friendly gardens.

Given the dire situation of habitat loss, fragmentation and ecosystem collapse, these strategies mentioned above play an important role in reversing damage. It's time to reimagine our built environment. In our cities and suburbs, we need more no-mow, low-mow, chemical-free areas in public spaces. Public spaces such as school yards could be home to community vegetable gardens that serve as a living teaching laboratory for students and grow produce for the community. Public parks and lawns should reflect the native flora and a more naturalized, polyculture aesthetic to lead by example in shifting the public's perception of what constitutes an attractive lawn. Ordinances, rules, and regulations that govern lawns need to be revised to facilitate more eco-friendly, biodiverse, and sustainable landscapes.

Over the years, my family's lawn has changed substantially. Instead of a monoculture of green turf with every blade cut the exact same length that it once was, it is now a variety of different plants, all with different colors, heights, and textures. When I look out the window, I can see the white heads of clover flowers peeking above the grass, insects buzzing around the dandelions, and wild strawberry ground cover that we no longer spend time and energy removing. The violets and purslane that now grow throughout the yard present no problem for my two dogs as they run around and play. We mow less frequently and allow the grass to go dormant in the hottest parts of the summer, knowing that the brown patches will spring back to green in the cooler fall months. We are still able to enjoy the lawn while coexisting with nature. Those backyard barbecues that I enjoyed as a child are still just as fun with this polyculture, input-free lawn.

Picture a generation of children playing in lawns that don't harm their health or destroy biodiversity, but instead support thriving ecosystems and capture carbon and water. Picture public lands that are naturalized with native plants, shrubs, and trees to create pollinator habitats, biodiversity corridors, and food forests. Picture these nature-based solutions as part of the strategy to combat climate change and build resilience in sustainable communities. This is the reimagined American lawn.

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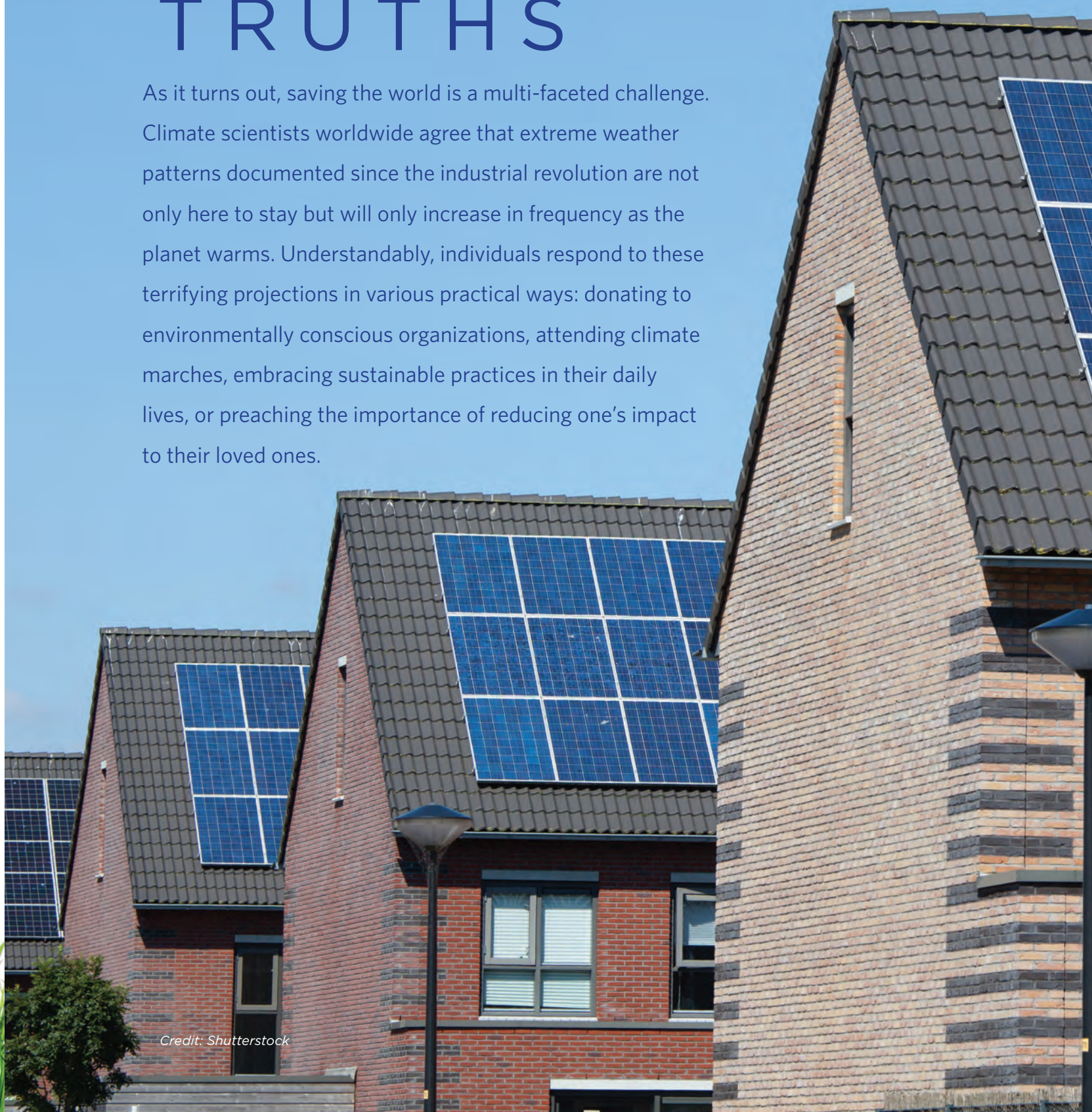
By Kalyn Nowlan

HOME TRUTHS

As it turns out, saving the world is a multi-faceted challenge. Climate scientists worldwide agree that extreme weather patterns documented since the industrial revolution are not only here to stay but will only increase in frequency as the planet warms. Understandably, individuals respond to these terrifying projections in various practical ways: donating to environmentally conscious organizations, attending climate marches, embracing sustainable practices in their daily lives, or preaching the importance of reducing one's impact to their loved ones.



Credit: Shutterstock

They might even vote for politicians, like U.S. Sen. Bernie Sanders of Vermont and U.S. Rep. Alexandria Ocasio-Cortez of New York, who use the term Green New Deal in their rhetoric. As supporters of the Green New Deal have emphasized, the environmental crisis of climate change is closely related to the social and economic crises of poverty and racism — and one way these intersecting crises might be addressed all at once is through the development of green housing.

Those who study sustainable housing are conscious of how a Green New Deal could not only control and manage the climate crisis, but help mitigate America's socioeconomic crisis as well. According to his most recent publication "A Green New Deal for Public Housing to Deliver Racial, Economic, and Climate Justice," Daniel Aldana Cohen, an Assistant Professor of Sociology at the University of California at Berkeley, asserts that a Green New Deal would "deliver massive health and economic benefits to disadvantaged communities." With plans to "invest $119 billion to $172 billion in green retrofits that include all needed capital repairs," this plan for green housing would not only dramatically reduce carbon emissions but also improve "health, safety and comfort." The plan would reduce annual carbon emissions by roughly 5.6 metric tons, which is "the equivalent of taking over 1.2 million cars off the road," while also reducing public water bills by up to 30% and energy bills by 70%. Not only is the plan cheaper annually and radically more environmentally friendly; it also has the potential to "create up to 240,723 jobs nationally across multiple sectors" due to the redirection of government funds toward a modern, retrofit economy. These jobs would benefit low-income areas, which struggle with both high unemployment rates and the impacts of environmental racism.

According to this project, green housing, an idea that has been mentioned but not successfully implemented by the political left, is not only an important step toward addressing climate change, but an essential one for the planet — particularly those who are currently living in low-income housing.

In addition to his research, Cohen collaborates with the Climate + Community Project, an organization that explores the impacts of environmental racism and aims to release briefs that will "make recommendations ... that center the needs of [low-income communities], expand democracy at all scales of governance, and facilitate flexible implementation." According to this project, green housing, an idea that has been mentioned but not successfully implemented by the political left, is not only an important step toward addressing climate change, but an essential one for the planet — particularly those who are currently living in low-income housing. "We know how to do this," Cohen argues, but getting the public to really understand the importance of housing as a part of a broader agenda of climate justice remains a challenge for its advocates.

One approach to this challenge is simply to provide examples of what successful green housing might actually

The Equinox House on a summer day in Urbana, Ill.

Credit: Build Equinox

look like. While Cohen's focus is on sustainable housing in urban settings, the kinds of retrofits he describes will be required everywhere, including the most rural parts of America. As the home of one of the world's leading universities, Champaign-Urbana is not just a major hub of climate research; it is also a testing ground for climate solutions, including housing.

Having lived my whole life in the Champaign-Urbana community, I was privileged in my proximity to top scholars in the area, some of whom made home renovations that would limit or eradicate their house's carbon footprints. A few of these Chambana homeowners strove to make their homes "net zero," or the ability to "generate sufficient energy on-site over the course of a year to supply all expected on-site energy services for the building users." This feat isn't always achievable, and while there are homes that come close, truly net-zero homes are currently few and far between.

But in Spring 2021, I learned about Equinox House — a completely solar-powered and net-zero home in Northeast Urbana. Equinox House is a miraculous feat of engineering, but it's also a home, situated in an ordinary-looking neighborhood. From the highway, the solar panels are visible, but as you drive toward the family home, you are shocked by how ordinary it really looks. There's a two-car garage, manicured vegetation, a back patio, a flower garden off to the side. It appears no more than a nice house in an up-and-coming development. Unless, however, you are lucky enough to speak with the owner: University of Illinois Engineering Professor Emeritus Ty Newell.

Newell argues that the technology needed to lower the carbon footprint of an everyday Midwestern home is already possible for ordinary Americans — they just don't know it yet. Occupied since 2010, Equinox House was designed by Newell's son, Ben, following the 40-year Newell family dream. The house regularly hosts more than 100 guests and is toured annually by thousands. But the most innovative part about Equinox house is not just that it is sustainable but that it is a sustainable home.

"It's a healthy, comfortable environment," Newell said in a 2013 interview with the Grainger College of Engineering. "It took me a few years to research … but it's like the stars have aligned now: the cost, the efficiency, the technologies, they are all here right now just waiting for people to figure out how to put the pieces together to this puzzle in an economically efficient manner."

Hoping to learn more about housing, I looked deeper into how Equinox House differed from the "normal" American family home to potentially answer further questions of cost, efficiency, and comfort. According to a study by a team of scholars at Colorado State, 21% of the average American homeowner's housing expenses are utilities. This is more than 8% higher than the average yearly food and transportation costs in the year 2009. In "Valuing Green Home Designs: A Study of Energy Star Homes," Bryan Bloom and his co-authors contend that "by choosing to place more value on unseen amenities such as added insulation, infiltration reduction, duct sealing, or high efficiency furnaces" rather than aesthetic additions, "homeowners can realize significant reductions in utility requirements." These reductions in cost, however, are not the only benefits of making green changes to a home. "It is evident that energy-efficient homes can play a significant role in reducing U.S. energy consumption, greenhouse gas emissions, and home ownership expenses," the article argues.

21% of the average American homeowner's housing expenses are utilities.

These figures are seen in action with Equinox House. In a 2011 column on Equinox House's efficiency, factors such as lighting, cooking, dishwashing, and clothes washing and drying were analyzed to compare the footprint of the house to the average Midwestern home, and the findings were generally consistent. Equinox House is more efficient because of features such as subpanel circuits, a fresh air ventilation system, electric water heaters, and other energy-saving technologies. There is no denying that the home is state-of-the-art, but when we spoke, Newell emphasized that Equinox House's construction costs are affordable and feasible for the general public today. Constructing a net-zero home, Newell said, "is doable now. This is not future technology."

According to Newell, the cost of integrating sustainable technology into homes has substantially decreased in the last few decades. Equinox House has about 125 LED lights, and each bulb cost $25 in 2010, he said. "Now, you get like a 4-pack for 4 bucks," Newell asserted during our interview in early March 2021. Solar panels were twice

The solar photovoltaic array on University of Illinois Physics Professor Scott Willenbrock's Colonial Solar House seriously cuts down on the house's electrical costs. Credit: Scott Willenbrock.

as expensive when he installed solar in his home and business. Today the cost is about $3 per watt installed, he said. "We really are getting to a place where we don't need tax credits, we don't need renewable energy credits to drive the market."

If integrating LED lights or solar panels into a home was once only possible for the wealthiest and most innovative, argues Newell, it is becoming increasingly accessible. As he explains, many individuals without an engineering background have been able to build very efficient houses. "A Leal Elementary school teacher who all our kids had as a soccer coach... he retired; he built a very nice, all-electric solar powered home outside of St. Joe ... so there's another solar-powered house. Another fellow who's a truck driver" did the same thing, Newell told me, citing examples of locals who worked to make their homes "net zero" without tremendous expertise or exorbitant cost.

"It's like a contagion. When somebody in a neighborhood that doesn't have solar collectors, when they start building a house that's going to be zero energy, they start infecting others in the neighborhood, and you start seeing clusters build up as people think, 'Oh, I can do that!' "

After speaking to Newell, I was interested in learning more about the possibility of others, in Champaign-Urbana and beyond, embracing net-zero or near net-zero housing. Newell noted an important trend: In the past 15 years, the price of necessary features for net-zero housing have decreased to where the masses can already access them. According to a 2015 study by Stephen Berry and Kathryn Davidson, in the past "lower energy use homes [were] associated with higher construction and lower energy use costs." But the years since have brought a decline in construction costs, which Berry and Davidson say "respond to regulatory changes." When performance-based standards for net-zero homes are improved (whether on local, national, or universal levels), costs tend to decrease, they argue, because they require improvements in crucial sectors such as industry knowledge, supply-chain development, and production. While optimistic for those who are already invested in the environment, these findings focus on the individual level; the Green New Deal would involve investing national funds in larger-scale projects. They do, however, home in on a very important truth: If the average American family can currently access the resources that are needed for green housing, the American government certainly can. What we need to do for the future of the planet, and the quality of the communities that dwell here, we can do.

While Newell makes it very clear that sustainable housing is the way of the future, and that it is only becoming more and more economically viable, not every American family is willing or able to start from scratch when it comes to sustainable home improvement. Built in 1929, Colonial Solar House began as a scantily insulated family home in Champaign. For decades, the home was powered with

natural gas, which kept residents comfortable during many frigid Midwestern winters but also released carbon dioxide into the atmosphere and contributed to ongoing climate change. That is, until University of Illinois Physics Professor Scott Willenbrock was inspired by Newell's Equinox house and sought to find out more about how to make his 90-year-old home more sustainable.

Almost on a whim in 2013, Willenbrock installed a solar PV system in Colonial House, which consists of a solar panel and a separate inverter, which "inverts" solar energy that is generated from the solar panel to a format where it can be used throughout the house. Willenbrock followed in the footsteps of a colleague, Phil Krein, a Professor in Electrical and Computer Engineering, who with the help of photovoltaic panels made the switch to solar energy in 2012. Willenbrock felt that Krein's process seemed safer and better fit for a beginner. He makes the point that "the microinverters don't produce any voltage until the system is connected to the grid, which makes them inherently safe to work with." Though he describes himself as "well below average in handiness," he has made it very clear that he believes others are as capable as he is in home renovation.

So, if the technology needed to transition to lower-impact housing is not only available but more affordable for ordinary homeowners, it seems like it would be feasible, on multiple levels, to transform American public housing into an integral part of a Green New Deal. What do we need to do to get there? Newell and Willenbrock are encouragingly transparent about the resources that made their renovations possible, and about the net good that even small changes can make to a homeowner's carbon footprint. But in a country that in 2019 recorded 34 million people living under the poverty line, it is inevitable that these changes are not yet possible for every family — which underscores, as Cohen has shown, the need for more sweeping policies for green housing across the board. But if these changes can be made by ambitious individuals in Champaign-Urbana, and if those who have the means are willing to make similar changes to their homes, the supply-in-demand will go up, paving the way for families who may be waiting for cheaper materials.

Newell argues that many people who may have otherwise been able to afford sustainable changes to their homes often don't know that they are already capable of doing so. In 2006, a study found that the initial building investment of a net zero house would be between $8,432 and $15,166. But those costs have dropped significantly, as Berry and Davidson's study shows. So, if you are currently able and interested in making environmentally conscious changes to your home, you play an essential role in driving governments and the people who vote for them toward a greener future.

Local programs such as Geothermal Urbana-Champaign are wonderful places to start. The program is focused on educating the local public on geothermal as a more sustainable energy source, hosting free "Geothermal Power Hours" that outline how going geothermal can save families money through making the switch. They assert that "whether you adopt geothermal this year or in five years from now, we truly hope you gain a better understanding of this technology and the energy options available to you through this program." But it's clear from innovation that has happened right here in our little college town that net-zero is the way of the future.

"We are there right now, technologically and economically," Newell promises, "but we have a lot of battles to win along the way." Newell's optimism is reflected in Cohen's New Deal research as well, where he concluded in October 2020 that "With Joe Biden, There's Still a Case for Climate Optimism," citing Biden's commitment to "1.5m new units of green affordable housing [and] 4m building retrofits (half commercial, half housing)," as well as his promise to "fund green retrofits of schools and electrify school buses [and] to decarbonize the postal service." These changes, while potentially lofty, could result in the decarbonization of building materials and the greening of global supply chains in ways that go hand-in-hand with rights and justice for marginalized and currently impoverished groups. Cohen concludes that Biden's environmental aspirations and claims, if followed through, would provide "huge" benefits for workers, unions, and worker cooperatives.

There are certain to be challenges in embracing green housing, like convincing the wealthy that it is worthwhile to invest in poorer communities, overcoming the preconceived notion that green housing is "too expensive," and redirecting government funds toward a modern system of living. But it's what we must do, and the good news is it's more than possible.

Kalyn Nowlan is from Champaign-Urbana, Ill. She graduated from the University of Illinois in May 2021 with a B.A. in English Literature and the Certific te in Environmental Writing, and is now working on her Master's of Library and Information Science at the iSchool. She hopes to pursue a career in academic librarianship with a research focus in sustainability.

WHO SPEAKS FOR THE TREES

By Miranda Johnson

Credit: Shutterstock

No piece of artwork can rival the beautiful simplicity of brilliant, sun-kissed green leaves against a pale blue sky. Especially in the neatly manicured, uninspired suburbs of the Midwest, elements of well-placed nature make the view out your window worth seeing. As a child, I'd stand in awe of the beautiful trees on my cul-de-sac, not even fully grown, but radiant still, dotting the streets and bringing color and movement to the landscape. Trees serve a number of important ecological functions, but those of us who grew up on the flat plains of the Midwest have an especially intimate relationship with them; we were sheltered by them, we watched them stretch their limbs across the entirety of the sky, and host birdsong in the mornings and playful squirrels in the afternoons. But over the span of three years, from 2011 to 2014, I watched the trees on my parkway die from the top down, leaves crumbling, leaving gray, stark branches on the crown.

I had seen videos of deforestation in the Amazon and other major forests, but this was happening right outside my bedroom window in Aurora, Ill. Shiny green insects, each no bigger than a penny, had burrowed snaking pathways through the thick trunks, decimating the former beauty of the once-green streets. Only one glorious ash tree remained after the fall of the others of its kind, safe behind my yellow brick house, dripping with vibrant red leaves.

Aurora was not the first town to lose its ash trees. No one knows exactly how or when *Agrilus planipennis*, the emerald ash borer, first arrived in the United States. The scientific community generally accepts that it made its way from China, a deadly stowaway concealed within wooden packing materials shipped to the States. The first emerald ash borer in the United States was officially declared present in North America by the United States Department of Agriculture in 2002 near Detroit, Mich. Experts believe that the borer was likely present for 12 years before it was first noticed in Michigan, and probably worked its way unnoticed from coastal shipping points to the Midwest, as evidenced by the widespread damage that it inflicted prior to its official identification. In the nearly two decades since, the emerald ash borer has become one of the most destructive invasive species in the United States.

The bright green beetle has decimated tens of millions of ash trees since the turn of the century. The mark that it has left on the landscape of at least 30 states is permanent. It only took two decades for the beetle to infect trees in more than 30 states, as well as numerous territories in Canada. Reaching a maximum size of only 0.33 inches long and 0.063 inches wide, or about a third of the length of a paper clip, adult beetles do little more than nibble on leaves. Their larvae, however, create deep chasms and pathways within the trunk of ash trees, killing from the inside out, and from the top down. The tiny emerald ash borer can take down trees that are 60 feet tall. Ninety percent or more of America's ash trees are expected to eventually succumb to the emerald ash borer. Mercifully, the tree in my backyard has so far eluded the destructive larvae.

According to my neighbor, who vividly remembers the fateful day in 2014 when the trees were taken, removal seemed to have come out of nowhere. One minute the city tagged a tree, the next it was gone. My neighbor remembers being told by the contractors removing the trees that the wood was to be burned in an effort to mitigate the spread of the ash borer. But this contradicted information put forth by local and federal government.

The emerald ash borer, an invasive species responsible for widespread loss of ash trees across Europe and North America. *Credit: David Cappaert, University of Georgia Center for Invasive Species and Ecosystem Health*

A report from the city of Woodstock, Ill., in 2009 states that when an infested tree is being removed, wood must be chipped to a size smaller than 1 inch. The Illinois Department of Agriculture also lists methods of disposal, noting that chipping ash debris to less than 1 inch in two dimensions will destroy any hidden EAB larvae and is therefore a proven control method. Why, then, would the tree removal company admit to disposing of them in a way that would release substantial quantities of localized pollution into the area?

I spoke to Aurora's Superintendent of Streets to find some clarity, and he shared a completely different story. According to him, Aurora did not burn its trees. "Our trees were chipped up into mulch by the city and a mulch company. … We also did send some of the trunks of the trees to the sawmill to be made into lumber." In this instance, it's comforting to hope that all of the removed ash trees were used as either mulch or lumber.

Despite this, other municipalities have records of trees being burned for disposal. Take Hennepin County, Minn., for example, where all diseased material is removed outside of the growing season and is chipped and burned at private facilities in Plymouth and St. Paul. It's unclear why any county would choose to burn the removed trees. Whether it was a lack of research or a financial decision, it's difficult to ignore the absurdity of burning thousands of freshly cut trees. No matter what removal method a municipality used to combat the emerald ash borer, it seems that the best thing that cities can offer their residents is a wealth of information as the situation unfolds. Surrounding cities and municipalities have public statements on their websites from the height of the emerald ash borer infestation in the 2000s and 2010s. Aurora's municipal website, on the other hand, only states that it has implemented a strategic removal and replanting program to mitigate the impact of tree canopy loss due to the emerald ash borer, with no further report to be found. Over the course of the past decade and a half, the city has consistently promised residents of my neighborhood that it would replace the felled trees. Despite this, the parkway on my street remains treeless.

There is certainly an emotional response to deforestation, but recently scientists at the World Agroforestry Center have asked a poignant question: When we lose an ash, what are we losing? Ash trees have a monumental environmental impact. They improve the quality of air and water by absorbing many pollutants, including sulfur dioxide and nitrogen dioxide. Ash trees also provide necessary habitats for wildlife. One ash tree with a trunk diameter of 25 inches intercepts 6,205 gallons of stormwater runoff every year and reduces atmospheric carbon by 736 pounds per year. Stormwater runoff is a harmful conse-

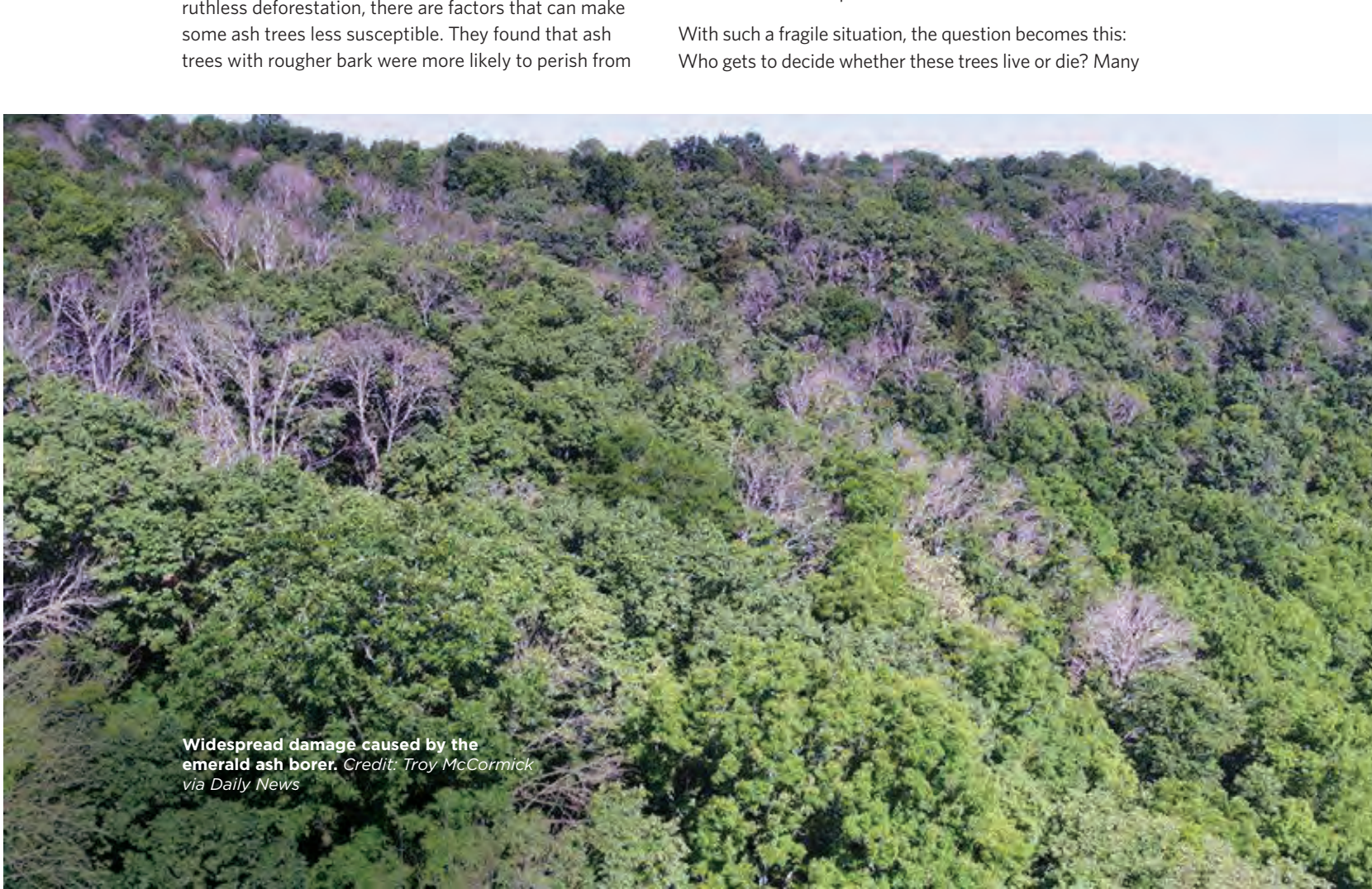
One ash tree with a trunk diameter of 25 inches intercepts 6,205 gallons of stormwater runoff every year and reduces atmospheric carbon by 736 pounds per year.

quence of deforestation. It contributes to erosion and the movement of pollutants like pesticides and fertilizers into nearby bodies of water. Ashes also have a light and strong wood that, from a manufacturer's perspective, is ideal for goods like hockey sticks, baseball bats, and canoe paddles. Though ash trees were harvested for these purposes prior to the ash borer outbreak, they were mainly planted in residential areas because they're inexpensive and hardy under normal circumstances. As with any plant or animal, these trees are integral members of the ecosystem. If they disappear completely, the impact on the surrounding biome will be serious.

The Midwestern deforestation caused by the emerald ash borer has prompted research into methods to alleviate the damage. Ecologists at the University of Notre Dame have devoted incredible time and effort to the study of the potential survival of ash trees in the face of this infestation. An important element of their research is that, contrary to the popular belief that all ash succumbs to the ash borer's ruthless deforestation, there are factors that can make some ash trees less susceptible. They found that ash trees with rougher bark were more likely to perish from larvae living within them. A monumental discovery such as this provides evidence that the species may be able to survive the infestation in North America. This study provides a baseline for future ecologists to investigate which environmental factors impact the likelihood of an ash succumbing to the emerald ash borer. It also raises the possibility that some asymptomatic ash trees are destroyed unnecessarily, when instead we might help them survive because they do not threaten other trees.

The outlook seems to be even more bleak, since, according to the Aurora Superintendent of Streets, "this will end up being like the Dutch elm trees. Most had to be removed, but we may end up with a few trees that find a way to survive. We had two Dutch elms that I am aware of that made it through and are down to one maybe that is on private property." The intention of ecologists and arborists is to preserve as many trees as possible, so having some frame of reference for why ash trees might survive the infestation is imperative to avoid total extinction.

With such a fragile situation, the question becomes this: Who gets to decide whether these trees live or die? Many



Widespread damage caused by the emerald ash borer. *Credit: Troy McCormick via Daily News*

cities and municipalities throughout the Midwest and Northeast made the decision long ago to tag and eradicate all ash trees to eliminate the spread of the borer. In Homewood, Ill., it was a rapid decision. After the first infection was detected in the town in November 2007, the village implemented an ash tree removal practice in spring 2008, resulting in 2,582 cut trees by November of that year.

The tree removal was misunderstood as some sort of panacea and has negatively affected ecological research that relies on having large sample sizes of trees to study. Because a large number of ash trees were removed from an area, those surviving represent a relatively small portion of the original ash population and this proportion is difficult to estimate. Researchers from The American Midland Naturalist looked at 290 ash trees and found 80 had died as a result of the emerald ash borer, but they make a point of noting that their results should be taken as very conservative estimates since they can't account for trees that had been rapidly removed before they conducted their study. The extermination of trees that might have survived has clouded the science needed to understand the impacts of both the emerald ash borer and deforestation as individual issues.

Such broad eradication creates a whole new thread of complications. When healthy trees are removed along with the infected ones to mitigate the spread, the population of ash trees in an area is decimated. Thus, the sample size shrinks to a quantity that's difficult to analyze scientifically. In an ideal situation, ecologists would be able to conduct research on all of the ash trees in an infected area, whether they were healthy or not. Unfortunately, trees are notoriously difficult to study because they take a long time to grow to adulthood; thus mature trees that are destroyed and replaced with new growth cannot be analyzed. Without clear reports detailing which of the removed trees were infected versus healthy, ecologists can't get a clear sense of what the most affected zones looked like at the peak of infestation.

Biological controls are one way that ecologists can combat invasive species. By intentionally introducing predators into an environment, the population of a non-native or overgrown native species can be reduced. When searching for solutions to an issue like the emerald ash borer, ecologists ideally want to rid an area of the species as naturally as possible. Introducing natural predators is a common strategy, and was utilized in Michigan in 2011 where two species of parasitoid wasps were approved for release. These wasps, the *Oobius agrili* and *Tetrastichus planipennisi*, were officially deemed safe for release in the Huron-Manistee National Forests by an environmental

Smaller than the radius of a nickel, the larval ash borer's tunnels through trees are enough to topple forests. *Credit: Virginia Cooperative Extension*

assessment that declared they would not be dangerous for humans or other species besides the borer, making them an ideal tool for population control.

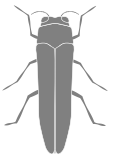
Unfortunately, releasing natural predators can take many years to yield results, so numerous ash trees will still fall prey to the borer as the parasitoid wasps slowly build up in numbers. Because of this timeline, we don't know whether this approach has been successful. In the meantime, other natural strategies can be attempted to save the trees, such as wound closure and insecticides. Wound closure is ideal for trees that have not yet been severely attacked, as it repairs the damage done by the borer in the bark and phloem, and allows the trees to be repeatedly infected and survive attacks in the future. Local insecticides, on the other hand, have also yielded promising results. They are also preferable to many arborists as they are applied directly onto the infected tree in a small area, so they are unlikely to harm the surrounding ecosystem. The most successful attempts at saving ash trees usually come from a combination of treatment methods. This could include using insecticides alongside the introduction of natural predators, which may enhance the efficacy of natural enemies by reducing overall emerald ash borer densities and focusing woodpeckers and parasitoids on untreated infested trees. Attacking the invasive species from multiple angles in this way increases the likelihood of tree survival. Unfortunately, such attempts to save trees require resources, time, and money, which may prevent some municipalities from taking action.

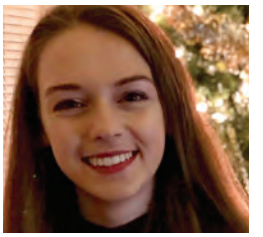
Another way to encourage the survival of ash trees is to breed them for resistance. Ecologist Jeff Mulhollem of Pennsylvania State University brought a research team to a group of ash trees in 2012 that survived the emerald ash borer's infestation to discover why there existed this field of "lingering ash," as he calls it. His work with the U.S. Forest Service has found that some ash trees have certain amounts of genetic resistance to the emerald ash borer. This allows the tree to withstand infection, or at least delay the infection longer than more susceptible varieties. Mulhollem was able to find evidence that genetic variation could be captured in a breeding program to improve resistance to borers in ash trees of multiple species. This is a remarkable find because it allows the evidence of genetic factors influencing ash tree survival to be used as a guide to breed resistant trees. The difficulty with working with trees is that it takes many years for them to mature. Because of this, the reintroduction of ash trees that have undergone a breeding program remains a very distant dream, but a worthwhile goal nonetheless.

The emerald ash borer will cause long-term changes to North American ecosystems. In Aurora, the Superintendent of Streets explains that the city is "still removing Ash trees at this time, (and) about 25,000 to 30,000 trees have been removed." Not only are ash trees disappearing, but the ensuing reduction in shade alters the growing patterns of other native plants, detrimentally impacting the area's biodiversity. Animals such as woodpeckers, chickadees, herons, fishers, and salamanders all rely on ash trees in North America. Native biodiversity, and trees especially, are vital to our ecosystems, and the only way to begin to restore this natural balance is by planting new trees in place of the removed ash. Cities and municipalities all across North America included replanting in their emerald ash borer mitigation plans, because of the environmental, ecological, and economic loss that comes with widespread tree removal. The city of Aurora also promised to eventually replace the ash trees with a different species. Named a Tree City USA in 2019, the city must replant trees to maintain its status. Residents also had the option to expedite the replanting process ... for a fee of $300. My neighbor who paid for the expedited service waited more than a year for the city to follow through on its promise. Others attempted to treat their trees themselves with the options that were available at the time. But due to the novelty of the emerald ash borer in the region, none of those options were particularly effective and my neighbors were unsuccessful.

Now when I return home, I tend to spend some time with the beautiful ash in my backyard, a pillar of grace and perseverance, proof that these trees may have deserved a chance. The parkway remains bare*, save a few crabapples and other species that didn't face the grim fate of the ash. My family's mighty backyard ash is a magnificent reminder of what was, what could have been, and what could be. Maybe it has something those other trees didn't. In any case, this tree stands as radiant, silent testimony that nature is more resilient than we think.

** EDITOR'S NOTE: The City of Aurora finally replaced the parkway tree outside Miranda Johnson's residence in 2021 — seven years after the ash was removed.*

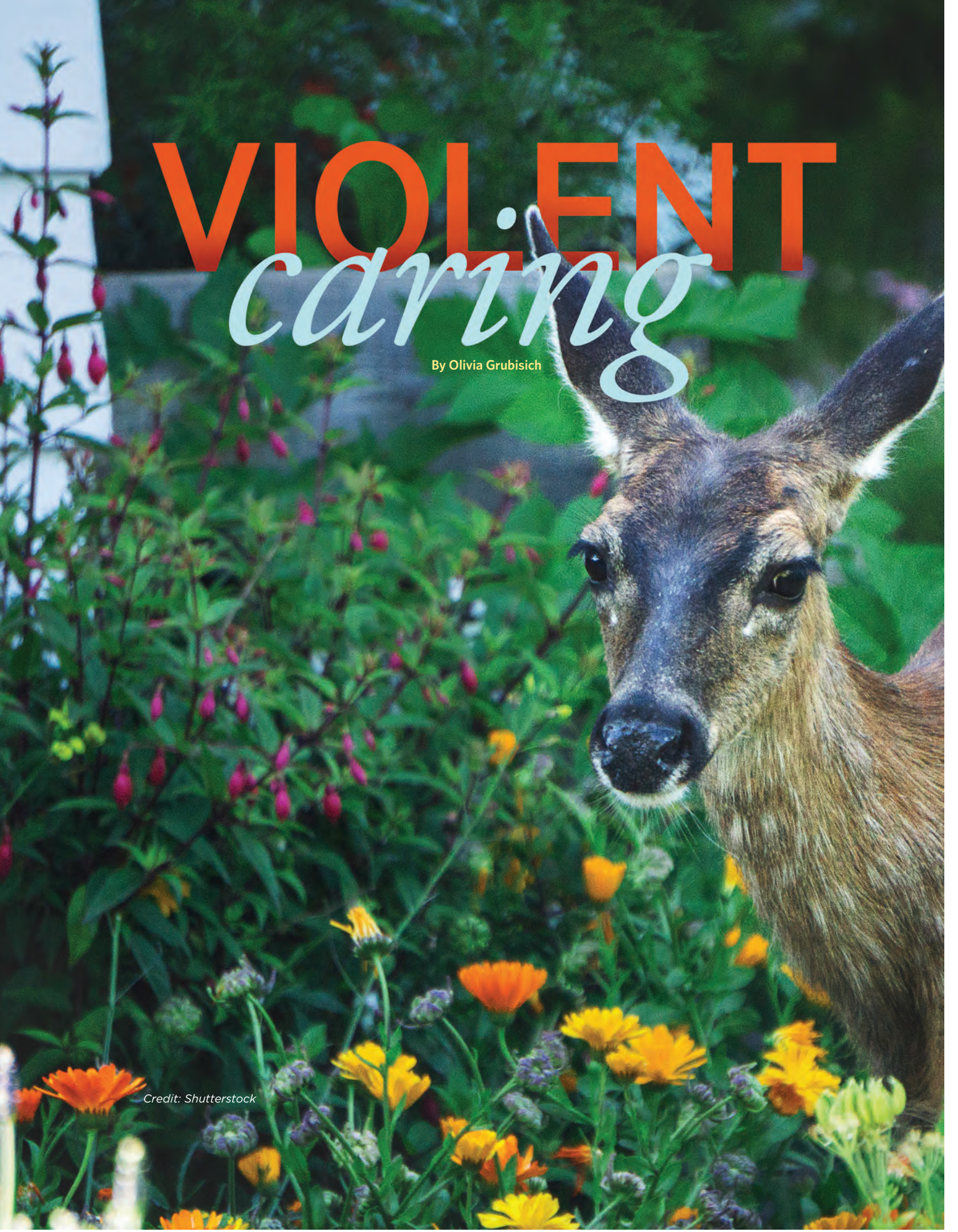




Miranda Johnson graduated in May of 2021 with a degree in Earth, Society, and Environmental Sustainability, as well as a Certific te in Environmental Writing and a minor in Business. She is originally from Aurora, Ill., but has since moved to Seattle, Wash. after graduation. She will be working as a STEM Coordinator at the Institute for Systems Biology starting in September, and hopes to continue her career in environmental non-profit ork in the future.

VIOLENT *caring*

By Olivia Grubisich



Credit: Shutterstock

On an acre of land in a quiet neighborhood where mature oaks shadow the road, my house acts as a buffer between the sidewalks of suburbia and the adjacent forest preserve. This January morning, the yard looks peaceful under a blanket of white snow. But while I was resting, the forest was not. Tracks stitch the ground, weaving intricate patterns through the field of white. Deep indentations near the house and a clear path from the woods mean the deer have come in droves. I enter my kitchen to get some water but stay to watch 10 deer creeping through my yard. Smaller members of the herd lurk near the back line of trees and stretch their necks toward branches of evergreens, while older members reap the benefits of approaching the house. After a snack of low-growing bushes requiring no reach, they lie down to rest on the grass over the septic tank, warming themselves in a way the woods never could.

New Lenox, Ill., 40 miles south of Chicago, constitutes the border between farmland and built-up suburb. My neighborhood, one of the quietest areas in town, serves as a gateway for the deer. As of 2019, the white-tailed deer population in the state of Illinois reached 670,000, the largest recorded since 2012. It's not a population size outlandish for the state, but in the Will County area, residents have noticed increasing deer presence near their homes. Throughout the year, the woods provide little sustenance for the deer. When food becomes scarce, gardens and landscaping are easy options to stave off starvation. Assurance of food and a lost fear of people leave deer with no reservations about exploring neighborhoods. They are easiest to spot in the winter, when their brown coats stand out against the white ground.

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In the cold months, bushes bordering the brick exterior of my house are a relief from scarcity, but even in the springtime deer find the neighborhood plants more appealing than what the woods have to offer. Every year, fences grow higher around my dad's vegetable garden, nestled in the back corner of the yard, while the yield declines. His frustration has grown to the point where, for several years, the plot has remained empty.

The most direct damage caused by overbrowsing in the forest preserve is to the plant community. As early as 1993, the Illinois Deer Census showed indications of long-term harm. The report concluded that "white-tailed deer exist at densities well above levels that can be sustained by the preserves without resulting in severe degradation of the ecosystem." The preserve has since begun conducting vegetation studies to corroborate the findings of the census. One of these studies, completed in 1997, showed negative change to the forest structure in areas over-populated by deer. An additional study from 2007 found a complete absence of large-flowered trillium, a native plant, in study plots exposed to deer browse. Overall, the results showed what researchers suspected all along: Consumption of seeds and buds by deer hinders, and sometimes eliminates, plant reproductive abilities.

Overbrowsing endangers not only native species but other components of the ecosystem. Loss of ground vegetation accelerates erosion of forest floor, increasing runoff into rivers and streams. This encourages flooding and degrades water quality, which harms aquatic life. The forest floor becomes bare, and the deer wander further from their home toward mine in order to sustain themselves.

Data collected from these studies eventually led to the Will County Forest Preserve's implementation of a deer culling season. The program began in 2010 with the goal of returning the deer population to a size compatible with the ecosystem of New Lenox and the surrounding area. Since then, anywhere from 85 to 226 deer have been taken annually. In the 2020-21 season, the preserve proposed removal of deer in five separate forests across the county, and 200 deer were killed by county sharpshooters.

People who imagine culling as a bloody free-for-all might be interested in the perspective of Joseph Albanese, a wildlife specialist for the U.S. Department of Agriculture

(USDA) Wildlife Services. Albanese participated as a sharpshooter in several government-sanctioned deer culls in the Long Island area, and in a 2014 blog post details what actually occurs during deer culls performed by the USDA. Wildlife specialists most often use two methods. In the first method, mobile units drive through designated areas with elevated deer populations. Among members of the unit are sharpshooters stationed on the vehicle roof and spotters who use infrared cameras to scan the terrain for deer while the unit creeps through the darkness. Mobile units lose effectiveness in crowded suburbs, where a significant portion of encroachment occurs, so stationary units take their place. These methods involve close monitoring of deer activity via site scouting and trail cameras. Sites with the most traffic are then baited by shooters in an effort to concentrate deer in a single area. Shooters wait poised on high platforms to strike.

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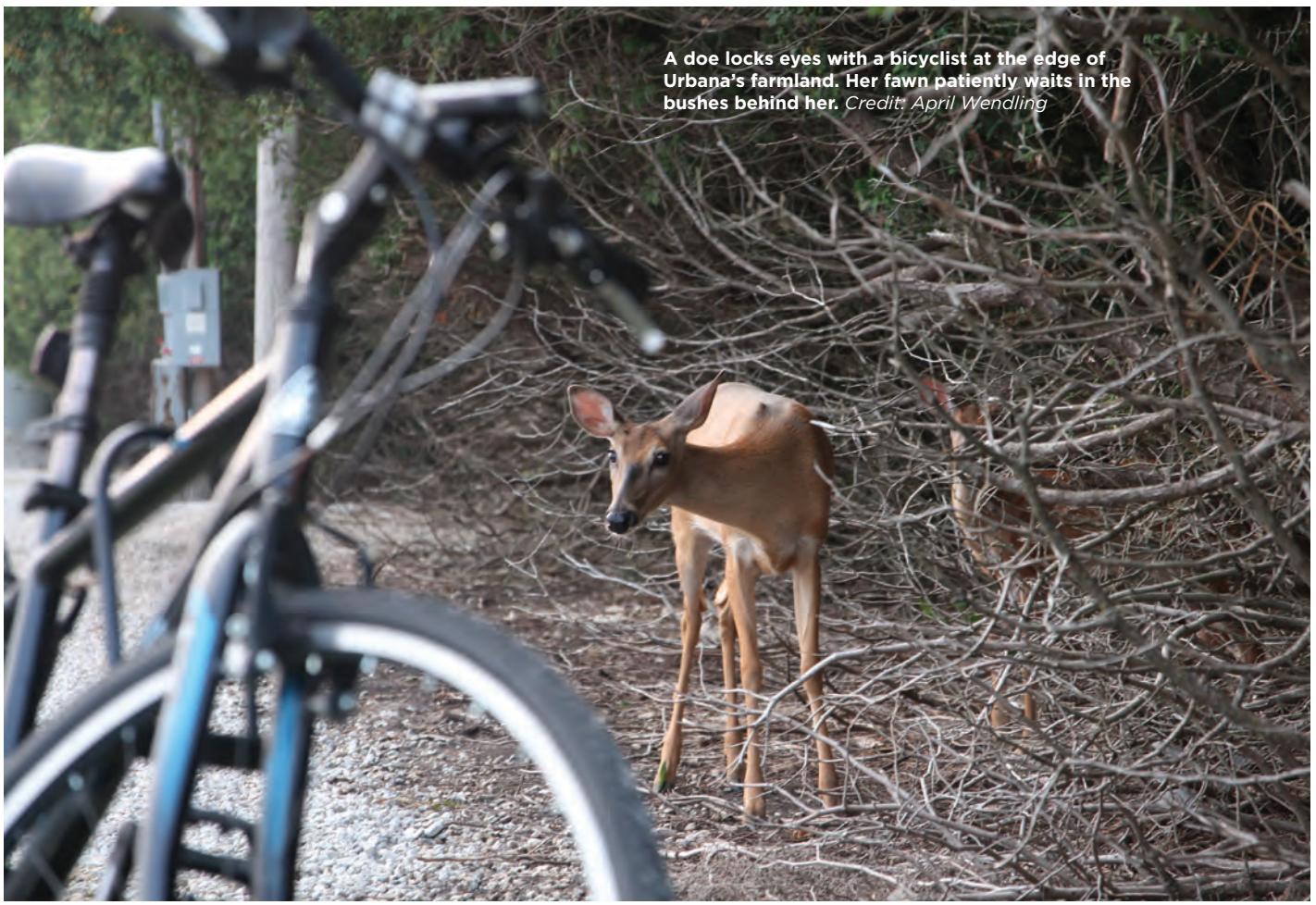
Long before the presence of animal activists and livestock farming, hunting was a necessary cultural norm. Mass animal breeding for commercial purposes rose to prominence in the early 20th century with the invention of refrigerated railroad cars, but until that point individual homesteaders provided for their own. Today, hunting is no longer a survival necessity, but remains a large part of modern culture. In 2020, 162,575 deer were killed over the course of Illinois' different hunting seasons. Considering the statewide population of close to 700,000, this number seems incredible. In the past year, hunters took approximately 24 percent of the total population, yet more deer than ever traipse through the suburbs. Continual resurgence despite such large numbers taken suggests hunting may not be



A doe locks eyes with a bicyclist at the edge of Urbana's farmland. Her fawn patiently waits in the bushes behind her. *Credit: April Wendling*

such a disruptive force to the wildlife as people might think, but a genuine piece of nature's greater puzzle.

Animal rights activists take issue with hunting, regarding its place in modern society as unethical, despite respect held for hunting cultures of the past. They don't understand hunters' motivations, and even more so misunderstand the mindset of agencies claiming to protect wildlife who sanction more killing. But Albanese asserts that all sides involved in the conflict around culling want the same thing. "At face value it would seem that government wildlife control agencies, hunters, and animal rights groups are all at odds, but in the end, they all want the same thing: a healthy, sustainable deer herd. Sometimes, a government deer cull is the only way to accomplish that." In instances like these, the needs of greater environmental systems outweigh the needs of individual deer. Even for those who lose out, the situation need not remain tragic. Head and neck shots ensure quick kills. Meat from Albanese's Long Island culls was donated to Hunters for Hungry, and meat from the annual Will County hunt feeds hundreds of people through the Northern Illinois Food Bank. Since 2015, the Will County Forest Preserve has donated 29,475 pounds of ground venison to people in need. As so often goes unnoticed in nature, death provides life.

Miles away from my quaint corner of the Earth, other places feel the same unsettling deer presence. In some cases, the conflict traces back much further than 2010, when the Will County purge began. To get to these places, the deer must journey farther than the short path from forest preserve to my backyard. Off the coast of Portland, Maine, for example, several islands have a large enough deer problem that they, too, have implemented a hunting season. Imagine years ago, the blue water shimmering between the Portland Harbor and Peaks Island. Now see the brown hair of a white-tailed deer bobbing on the surface as it glides through the water away from the harbor toward what will become its new home.

Three of these islands — Peaks, Cliff, and Great Diamond — face similar damage from overpopulation as New Lenox. Maine has a turbulent history with hunting practices. In 1972, Portland instated a complete ban on firearm discharges. The deer were present on the island at this time, but never at an overbearing level. Deer began swimming from the mainland to the islands back in the 1990s, and once word got back home of lush gardens and unguarded greens, more came in droves. Because of the small land area, the increase was tangible to those who lived on the islands. The war in backyard gardens became fierce, with fences stretching skyward around each plot in an effort to protect the product of human toil. Like the four-legged friends returning to my home night after night, the deer turned to the household gardens of Maine because there was nowhere else to go after they had decimated the forest floor. At this time, an estimated 100 deer populated each square mile. This pushed the ecosystem to its breaking point and put more than just hobby gardens at risk. Because of overbrowsing, several native plants lost their stake in the ecosystem to invasive species like barberry and honeysuckle variants, both of which are overlooked by deer. These marauders took advantage of the vacancies and struck at the opportunity to further their campaign into foreign territory. At the ecological limit, even the stalwart trees on the island had trouble regenerating. In response, the city reinstated hunting season in 2000.

The people of Maine did not find the urge to fight back against their deer invaders simply because they missed the ornamental color of blooms in spring. As deer crept into their backyards near children and pets, on their backs rode the threat of Lyme disease. Subtle changes in plant life went unnoticed by residents, and warnings from environmentalists fell on deaf ears. But Lyme disease made residents notice how close the deer had come, and they wanted a quick solution. The deer themselves do not carry the disease but carry the infected ticks into civilization. Fear of Lyme disease peaked when the deer population exploded in the early 2000s, and that solidified deer culling in the fabric of Maine wildlife maintenance. Gerry Levigne, of the Maine Department of Inland Fisheries and Wildlife, comments on the ideal island population size: "On islands we recommend 15 to 20 deer per square mile," he says. "That would allow herbaceous plants and wildflowers to flourish. At 30-50 deer per square mile, you start seeing damage. If you really want the complete mix of native flora, you have to keep deer below 20. Not many have that low a density." Levigne first made these comments in 2002 when the deer population had reached its pinnacle, but the principle remains nearly 20 years later, as does the danger of Lyme disease. In 2019, a study through the University of Maine tick lab showed that 40 percent of deer ticks in Maine tested positive for Lyme.

Continual resurgence despite such large numbers taken suggests hunting may not be such a disruptive force to the wildlife as people might think, but a genuine piece of nature's puzzle.

Despite comfort found by residents in the reduction of deer numbers, some evidence indicates immediate removal of deer does not actually result in immediate reduction of tick populations. Tamara Awerbuch is an instructor in the Department of Global Health and Population at the Har-

vard School of Public Health and specializes in emerging epidemics. Her research on the life cycle of deer ticks in relation to Lyme Disease suggests disease-carrying ticks will not be so easily terminated. Similar to the life cycle of the deer, the ecological progression of Lyme disease is complex and cannot be erased with one change. Ticks contract the disease from their first natural host, white-footed mice, and later in life upgrade to a home with bigger blood supply. Once on the deer, ticks lay their eggs and die. According to Awerbuch's research, deer are an important part of the tick's life, but reduction of the deer population in the short term only increases the number of ticks per deer. She conducted a survey in Crane Beach, Mass., and the primary results showed that while deer were reduced from around 400 in 1983 to just over 100 in 1991, "Lyme disease kept growing. … We killed deer, but people still got Lyme disease." The biggest lesson learned from observing the lives of the deer is that all social, biological, and ecological systems are inherently complex. The more interconnected the web is woven, the longer it takes for change. Awerbuch addresses this in her research as well, stating about the effectiveness of deer culls in connection with Lyme disease, "Our research showed that if you leave fewer than eight deer for the Crane Beach area, the tick population will start to decrease, but it will take many, many years."

In our overstimulated society, lack of short-term gratification discourages continuation. The culls do not immediately eliminate the threat of Lyme disease, yet this does not negate their worth. Long-term culling eventually mitigates the tick population, and although plant preservation did not motivate desire for culls, native plant species re-emerge when not threatened by overbrowsing as well. The Chinese philosopher Lao Tzu said, "Nature does not hurry yet everything is accomplished," and the result of Awerbuch's study confirms these ancient words. Just as deer damaged the ecosystem gradually, rehabilitation only occurs when the environment sustains improved conditions over many years. Establishing a healthy population size ensures nature heals on her own time.

> From a layman's perspective, deliberately killing animals appears inconsistent with a desire to protect the environment, but alternative non-lethal options like relocation inflict psychological trauma on the deer during capture and transport. This often results in death of the animal anyway.

Despite its intentions and benefits, a designated culling program still paints a certain picture in the minds of some activists, one that accuses the forest preserve of harming the ecosystem rather than trying to help. A few years into the Will County culling program,

A white-tailed deer passes by the Agricultural and Biological Engineering Farm Research and Training Center at the University of Illinois.
Credit: April Wendling

Lawn ornament or menace?
Credit: StockSnap via Pixabay

a local animal rights group, Showing Animals Respect and Kindness (SHARK), took issue with the city's handling of growing deer numbers. The group's president, Steven Hindi, claimed the deer program utilized unethical methods, such as leaving wounded deer for minutes after shooting, and went so far as to question the necessity of the program as a whole. "Surely we can do better than to simply slaughter innocent animals," Hindi argued. "Is there a deer problem? If so, use non-lethal options ..." From a layman's perspective, deliberately killing animals appears inconsistent with a desire to protect the environment, but alternative non-lethal options like relocation inflict psychological trauma on the deer during capture and transport. This often results in death of the animal anyway.

In a study published in *Environmental Humanities*, Thom Van Dooren describes the phenomena of prioritizing the health of a whole ecosystem over one individual species as "violent care." In this case, the deer suffer in a meditated effort to return the ecosystem of Will County to a state fit for supporting all participants in the environment. To Van Dooren and myself, as someone with an up-close view of the environment the deer are in, violent care exhibits the sometimes cruel yet always profound way all species are connected to one another in "the inescapable troubles of interconnected existence."

Before I go to sleep, the last thing I do is look out my bedroom window. Scattered throughout the yard, eight deer sleep curled up against the cold. From my home in New Lenox to Maine and Long Island, culling seems to have become the standard in deer population control. With the success of maintaining herd sizes and promising ecological resurgence, it appears the logical fix. Yet the place I live seems just as much theirs as mine. Maybe their fate comes from human-driven "violent care," or maybe the ebb and flow of individual prosperity epitomizes nature itself. I know I am the same as the deer in at least one way: I am connected to everything.

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