



Q MAGAZINE

**THE PRICE
OF BLACK CARBON**

Q's first op-ed points out the need for better education — not just new technology — to solve a major greenhouse gas problem.

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**SKIN
DEEP**

The booming online market in Asian elephant skin and blood is not only gruesome, but also threatens their extinction.

— Page 28

TWILIGHT ON THE
GILA

VOLUME 2 / ISSUES 1 & 2

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



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NOW THE SITE OF A WAR FOR RESOURCES — Page 38**

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About This Publication

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

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

Students submit their work 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 learn about the latest scientific research on the environment and how to communicate that research effectively to the public. Certificate courses offer students the opportunity to write about environmental issues they are passionate about, and to engage the latest research in sustainability science. Whether dropping in to take one of our courses, completing the full three-course sequence, or even embarking on a travel assignment funded by our gracious donor, Janelle Joseph (right), students work with dedicated professors, meet enthusiastic students from other 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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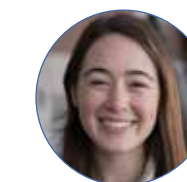
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Editor's Note

Welcome to the second print volume of *Q Magazine*, a showcase for outstanding environmental writing by undergraduates at the University of Illinois Urbana-Champaign. The passionately researched and meticulously constructed articles featured in *Q* are written for courses in the new Certificate in Environmental Writing at Illinois. By turning data into narrative, students share their musings and reflections on important environmental questions.

In this volume: Wilderness has been generous with its riches, but will conservation and justice finally have their moment? What animals might survive, or even thrive, on our human-engineered planet?

As you flip through the magazine, brace yourself for a jarring journey into the wild. Look both ways as you reflect on your relationship with a natural world that's present and persisting — in coursing riparian habitats where conservation and justice must be hard won, in the elusive creatures that dart through city streets, in ecosystems that change alongside us.

So, take a deep breath, and let's dive into *Q* Volume 2!

April Wendling

Student Editor
and the *Q* Editorial Team

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

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THE 7 WONDERS OF THE ANTHROPOCENE

By Jenna Kurtzweil



Standing in the shadows of the Great Pyramids, a man named Herodotus set the Seven Wonders of the World in motion. If he could have predicted the modern calendar, he'd have dated his entry 440 BCE; if he could have predicted his future fame, he might have titled his musings something more grandiose than *Histories*. But, in that moment, the man now considered “the father of history” simply looked at what he saw before him, raised an astonished eyebrow, and began to write.

This was the pattern of the early Wonders of the World — not to exist as “wonders” at all, but instead as what a recent book on the subject refers to as *theamata*: “things to be seen.” And this was how Herodotus approached the Great Pyramids of Egypt, and the city of Babylon, and other ancient sites by which he was equally enchanted. With little thought for the clickbait monster he was creating, the father of history initiated one of history’s most captivating canons.

Over the centuries, Herodotus’ observations snowballed into a fully formulated list, the earliest version of which was recorded just over a century prior to the Common Era. However, the “Ancient Wonders” — Giza’s Great Pyramid, the elusive Hanging Gardens of Babylon, the Statue of Zeus at Olympia, the Temple of Artemis at Ephesus, the Lighthouse at Alexandria, the Mausoleum at Halicarnassus, and the Colossus of Rhodes — first debuted as a cohesive, published collection in the Renaissance. And while all but the first wondrous sites have since faded into dust and memory, humankind’s desire to drum up and disseminate similar lists has not.

Generations of list-makers — from scientists, scholars, and travel writers to conservation societies and news outlets — have put pen to paper (or fingers to keyboard) and promoted their top seven with gusto to their respective milieus. As such, Seven Wonders lists have gradually become less *theamata* and more pseudo-cultural commentary that shamelessly showcases what any given group deems worthy of veneration.

With a tsunami of environmental crises un-

folding, many of the more serious lists of the late 20th century centered around conservation and the natural world. Case in point: The 1989 Underwater Wonders were assembled by scuba-diving organization CEDAM (Conservation, Education, Diving, Awareness and Marine Research) International to spotlight at-risk aquatic attractions from the Galapagos Islands to the Great Barrier Reef to Russia’s Lake Baikal. The winning seven were decided upon by marine biologist Eugenie Clark and announced by none other than *Sea Hunt*’s Lloyd Bridges. A decade later, CNN’s 1997 Natural Wonders list likewise glorifies the Great Barrier Reef alongside locations like Victoria Falls and Mount Everest.

Now in the 21st century, we are told, the Earth

has fully entered the Anthropocene era — a new geological epoch defined by humankind’s destructive planetary impact. So the time has come to update Herodotus’ ancient tradition and compile a new list of *theamata*. But fair warning: the Seven Wonders of the Anthropocene, according to my fresh take on the genre, won’t necessarily be awe-inspiring to behold. From the modern Great Pacific Garbage Patch to the prehistoric Island of Rapa Nui; from ancient civilization’s breadbasket to today’s most revered fast-foodery; from the rapidly disappearing Brazilian Amazon to swaths of new growth in China; these new-age “things to be seen” aren’t classic tourist sites, but rather windows onto a destructive side of human civilization that we either overlook, or might well go out of our way to avoid seeing at all.



The Great Pacific Garbage Patch. Credit: Richard Carey, Adobe Stock

1 The Great Pacific Garbage Patch

The Great Pacific Garbage Patch is the most iconic, mythologized monument to the human-trash love affair. Comprised of everything that instills our lives with meaning — from toothbrushes and discarded toys to fishing nets and food wrappers — the Patch also symbolizes our avidity for creating waste. So maybe less love affair, more infatuation. Or can 87,000 tons of ocean-soaked trash be considered a form of love?

As its name suggests, the Patch is an accumulation of non-decomposable debris treading water off the California coastline, guarded by the ever-circling North Pacific Gyre (we call it a “Patch,” but in reality it has two nuclei — one closer to Japan, and one off the U.S. west coast). One of five such systems worldwide, the Gyre churns with a current that slowly stirs the Pacific Ocean clockwise. And in the center of the Patch is what the NOAA Marine Debris Program’s Dianna Parker tastily calls a “peppery soup.”

Much like love, the Great Pacific Garbage Patch is all about the little things — far from the junkyard-esque islands of burning

rubber that evoke a classic garbage dump, the oceanic version appears more murky than downright apocalyptic. The Patch is our post-personified trash, when sun, salt, and sea have worn larger artifacts down into bite-sized pieces called microplastics, which saturate the surface or sink to the bottom in an undersea, all-you-can-eat buffet.

The Pacific Patch is the Anthropocene’s Everest — most recognize its name, fewer have been there, and just a scant selection of brave souls know what it looks like up close. But one major difference exists between the two: even if Everest wasn’t identified as a wonder of the natural world, its presence would remain undeniably known. Not so for the Patch, which — courtesy of too-small-to-see, “peppery soup”-y microplastics — is tough to discern whether you’re waving from a West Coast beach, floating in outer space, or even sailing a boat directly through its center.

Therein lies the Patch’s claim to Anthropocene fame — it’s not only a physical representation of human trash production, but a titanic testament to our “out of sight, out of mind” mentality. We reduce, reuse, and recycle the much-sensationalized plastic bottle, but some of the Patch’s most notorious pollutants

are actually the beads in exfoliating facewash, so microscopically tiny that they slip under even the most avid environmentalist’s radar.

Like any relationship, the first step toward resolution lies in identifying the problem. This Patch — and others like it — will continue to wax on the waves unless drastic actions are taken to cut waste streams and clean up what’s already there (which, as of now, not one country is stepping up to do).

On the plus side, beachgoers, boaters and astronauts alike might be able to check this first wonder off their sightseeing lists much sooner than expected.

2 Henderson Island

Plotting a course dead south from the first Anthropocene wonder will take you straight to the second.

If the Pacific Patch is a monument to the magnitude of human wastefulness, Henderson Island is a testament to its far-reaching wingspan. Despite being uninhabited for centuries, this second wonder of the human era boasts the world’s highest debris concentration.



Henderson Island beach. Credit: Jennifer Lavers



Henderson Island hermit crab. Credit: Jennifer Lavers

3 Rapa Nui (Easter Island)

The Seven Wonders of the Anthropocene might be a creation of the 21st century, but its contents certainly aren’t. Many of climate change’s effects have been simmering for centuries and are just now becoming visible to the naked eye. As it happens, the Pacific Ocean is a hotspot for Anthropocene wonders big and small, young and — in this case — quite old.

Rapa Nui, the indigenous name for what Dutch travelers christened “Easter Island,” is Henderson Island’s culturally rich counterpart and next-door neighbor 1,000 miles to the west: just as remote, but inhabited since 300 A.D.

The Chilean island’s renown rests with its head-shaped moai statues, scattered impressively over a UNESCO Heritage Site that encompasses nearly half the island. These watchful guardians, composed of volcanic tuff, were dedicated as shrines for tribal leaders from 900 A.D. into the late 1500s, when the Rapa Nui civilization ground to a halt in what National Geographic describes as “an environmental catastrophe of their own making.” Years of palm tree deforestation took their toll, sparking a devastating ecological shift and “expos(ing) the island’s rich volcanic soils to serious erosion.” When Dutch travelers made landfall in 1722, they bore witness to an island in ecological turmoil.

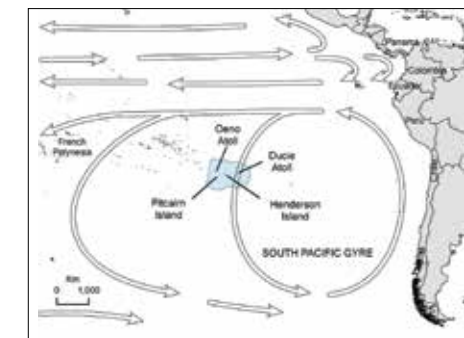
Three hundred years later, coastal erosion is surfacing as a potentially terminal threat to the island’s cultural legacy. Once again, the source of the ecological turmoil is human-driven: sea-level rise. As is the case for countless Pacific Islands, coastal erosion and rising tides are steadily creeping up on Rapa Nui. UNESCO’s 2016 “World Heritage and Tourism in a Changing Climate” expresses mounting concern for the moai, precariously

Henderson Island takes up its remote residence in the heart of the South Pacific. It’s a member of the Pitcairn Island Group, of which Pitcairn is the sole inhabited pinprick of land. Henderson ranks largest, however, its northern and southern coastlines stretching a comfortable fun-run length of 5K.

As a raised coral atoll, Henderson’s fortress-like limestone and coral-covered cliffs have historically served two purposes: creating a unique environment to foster endemic species (life forms that do not occur anywhere else), and protecting the island from both human and natural erosion. Indeed, a 1980s Smithsonian report on Henderson Island remarks that “of the 20 or 30 such ‘oceanic’ islands or groups of islands, most have been greatly altered by long-established human occupancy, or phosphate mining, or both. ... only Aldabra (an island in the Seychelles) and Henderson remain reasonably unaltered.”

While today’s Henderson does still boast a robust portfolio of flora and fauna, it can no longer be considered “unaltered.” The reason for this relatively rapid shift? It has the bad luck to be situated directly in the path of the South Pacific Garbage Patch. While the North Pacific Gyre herds trash like cattle, its oceanic neighbor to the south slyly disposes of waste onto unwilling island drop-sites like Henderson. Over time, the current’s daily deliveries have accumulated to a staggering 38 million

Henderson Island map



discrete plastic pieces.

Like the Pacific Patch, Henderson’s debris are saturated with microplastics, with other recovered items including toy soldiers, Monopoly pieces, and the ubiquitous fishing nets. These artifacts come from all corners of the globe — if you throw something away in Chile, China, or Japan, there’s a good chance it will end up littering Henderson’s shores. And just in case the scope of damage is still hard to grasp, a recent study chillingly concludes that “the 17.6 tons of anthropogenic debris estimated to be present on Henderson Island account for only 1.98 seconds’ worth of the annual global production of plastic.”

While not as near to the public eye as the Pacific Garbage Patch, Henderson Island is a clear and present reminder that the tendrils of human impact have ensnared even the globe’s remotest locations.



Entangled turtle. Credit: Francis Perez



Easter Island. Credit: Wikipedia

perched as they are on the island's edges. These stoic statues are threatened by aggressively rising waves, which are predicted to wear away at their foundations with increasing vigor in coming years.

The moai are not only cultural artifacts, but also anchors for the island's economy, which relies heavily on its \$70 million-per-year tourism industry. In 2017, Rapa Nui hosted 17 times the amount of tourists as there are permanent inhabitants.

Together, the lopsided, Bermuda-triangle geometry of the Great Pacific Garbage Patch, Henderson Island, and Easter Island signal an alarming reminder that the Anthropocene's effects consist not only of uncountable plastic bottles and carbon-clogged skies, but are also deeply woven into the global fabrics of tourism, travel, history, economics, and cultural identity.

4 Ephesus

World Heritage Sites are feeling the heat of the Anthropocene from the South Pacific to the Mediterranean: on land, at sea, and especially on coastlines where the two converge. Iconic coastal

regions, the cradles of civilizations large and small, are under siege by the same erosive waters that threaten ancient islands like Rapa Nui. One such site is the city of Ephesus, located in present-day Turkey.

This once-vital political and commercial locale — the first city of the Roman Empire in Asia — now teems only with tourists, who pour in from planes, trains, and near-daily

cruise ship excursions. They come to marvel at the freestanding ruins of the ancient metropolis, which compete for real estate with cheap restaurants and traffic-snarled roads. One of its largest claims to fame is the Temple of Artemis, an original Wonder of the Ancient World. The destruction of the city at the hands of the Goths preceded a centuries-long decline that essentially wiped



Ephesus Tourists. Credit: Travelling Runes

golden-age Ephesus from the map until its modern rediscovery in 1869.

Now, just 150 years after archeologists uncovered its ruins, Ephesus is at risk of being lost again. In October 2018, Nature Communications published a study of coastal Mediterranean World Heritage Sites under threat from rising tides in the immediate future. Ephesus — on Turkey's vulnerable western coast — is at the top of the list.

Proximity to the Mediterranean Sea, the quality that makes Ephesus an ideal tourist location, also puts the city in danger of coastal erosion. Even when compared with other Mediterranean Heritage Sites — 47 of which face similar dangers — Ephesus is one of two locations rated a risk index of 9 out of 10.

The Ephesian fate is not isolated. By 2100, two more sites on the list will join the ranks of a level-9 risk index, and the high-end scenario estimates for sea-level rise include all sites within 100 meters of the Mediterranean coast. While the more mobile (think lighthouses and free-standing statues) could potentially hitch up their skirts and shuffle inland, this option isn't available to Ephesus, a city already in a scattered, half-collapsed state of ruin.

But take heart: If great Ephesus plunges beneath the waves, its ruins will be immortalized in not one, but two collections of world wonders for years to come — ancient and anthropogenic.



Temple of Artemis, Ephesus. Credit: Flickr; Sylvain Friquet

5 Your Friendly KFC

Not every location on this list requires rafting the South Pacific or visiting a World Heritage Site.

To witness the Anthropocene's fifth wonder, simply hop into a car and drive to your local KFC.

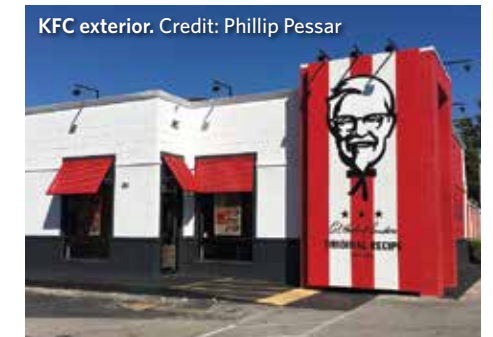
Our human era might look like stacks of beach-bound garbage and sound like seawater crashing against crumbling moai, but it tastes most decidedly like chicken. Specifically, the broiler chicken, a species whose very name betrays the close nature of its relationship with humankind. A November 2018 study in Royal Society Open Science deems the white-feathered, beady-eyed dinosaur descendant the most profound physical evidence for our entering the Anthropocene. Why? These chickens are everywhere.

Broilers (the colloquial name of chickens bred for soups, salads, and sandwiches) have risen to unparalleled numbers in just a few short decades. In 2016, the Anthropocene's feathery mascot reached a headcount of 22.7 billion (that's three chickens per person on Earth).

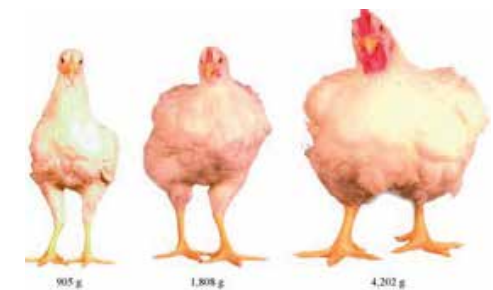
Chickens were domesticated as early as 2500 BCE, but the bird first achieved retail acclaim in the 20th century's latter half. With thousands of poultry-peddling locations in more than 130 countries, the modern KFC franchise exemplifies the broiler's post-war ubiquity. As the so-called Great Acceleration upped its relentless, mechanized course, a combination of farming efficiency, selective breeding, and (this isn't a joke) the 1950s "Chicken-of-Tomorrow" program, ensured that a half-century later, the chickens of today would be monstrous in both size and number. Our chickens are five times larger than their pre-Industrial predecessors. If every other avian species on the planet (including ostriches) piled onto a scale, they still couldn't top the weight of Earth's 23 billion broilers.

That said, it is bones, not simple mass, that proves the starkest differentiator between 21st-century flocks and the ghosts of chickens past. Factors like size and osteopathologies (bones ill-equipped to carry increased weight) are like neon signs that flash to scientists: These are not your grandma's chickens.

Bone composition in particular — specifically, collagen concentrations of carbon and



KFC exterior. Credit: Phillip Pessar



nitrogen — is critical to chickens' role as a sign of anthropogenic times. If chickens died in the wild, their skeletons would decompose naturally. But because broilers exist for our consumption alone, their bones are taken out with the rest of humanity's trash. Recall the KFC chicken wing, unceremoniously tossed away: that bone will likely end up in a landfill, preserved alongside plastic and polystyrene for centuries to come. With our KFC addiction, we are creating what geologists call a "biostratigraphic marker" that will be the hallmark of our epoch: a buried layer of discarded broiler bones spanning hundreds of countries and composed of billions of birds.

So if you don't have the free time or funds to visit the Smithsonian, but you'd still like to see a fossil or two ... you know where to go.

6 Amazon Rainforest

The Anthropocene isn't just defined by what humans add to the Earth (pollutants, plastic, poultry), but by what we take away. Most notably, trees. Right now, they are not only the most valuable currency in the fight against climate change, but one of the most threatened as well.

There's no better stage on which to set the global deforestation epidemic than the planet's most massive tropical forest. One of Earth's most biodiverse biomes, the Amazon's ecosystem of rivers, jaguars, and broad-leafed



Amazon clearcutting. Credit: Rhett A. Butler, Mongabay.com

palms (oh my!) was sprawled across northern South America's landmass long before political borders were invented. But now, Brazil is the Amazon's primary steward, claiming roughly 60 percent of the 2.1 million-square-mile jungle.

Unfortunately, Brazil's current government is more exploiter than steward of this vital global resource. Recently elected President Jair Bolsonaro staked his campaign on plans to accelerate agricultural development and cattle ranching in the rainforest. This disastrous policy will only exacerbate Brazil's current deforestation rate — already "responsible for ... a third of all tropical forests lost between 2000 and 2012."

Industrial destruction of the Amazon is an outrage to both conservation and social justice. Brazil's indigenous population, who live in heretofore protected rainforest territory, face likely doom. As reported in the *New York Times*, Bolsonaro's Amazon policy has been deemed by the Indigenous Missionary Council "a flagrant violation of Brazil's constitution that defends indigenous rights to their ancestral lands."

Where does deforestation on this scale fit in our anthropogenic reckoning? As Dr. Seuss' stump-dwelling Lorax would probably attest, it all comes down to the trees themselves.

Trees, like most plants, are carbon sequesters — they siphon carbon from the atmosphere and offset the emissions that our cattle, Cadillacs, and airplanes cough out each day. Just one tree has the muscle to sequester 48 pounds of carbon per year and up to 1 ton of carbon in 40 years; with all of the Amazon's 390 billion leafy tenants breathing in unison,

it's no surprise that the area is nicknamed the "lungs of the planet."

Globally, rainforests like the Amazon sequester 5 billion tons of carbon per year, nearly equivalent to what the U.S. alone produced as recently as 2004. So when it comes to the issue of carbon emissions as a climate change driver, the Amazon emerges as something of an ecological swing vote. The recent fires raging across Amazonia as of summer 2019 serve as a dire reminder that this ecosystem is as vulnerable as it is valuable — and the more we exploit it through deforestation, the more fragile it will become.

Who will win out in the global tussle for a healthy atmosphere: the monetary capital produced by putting one-tenth of the world's species through the shredder, or the ecological capital and quality of life that trees provide for free?

Maybe it's a toss-up. Maybe it shouldn't be. Either way, it's in everyone's best interest to keep an eye on the "lungs of the planet."

7 China's Three-North Shelterbelt Program

Anthropogenic Wonders 6 and 7 might be considered sister sites — one a biodiverse oasis suffering from mankind's voracious appetite for development, the other a reactive, reparational attempt for that ongoing horror.

Zooming out from the Amazon to the world at large makes things seem a bit brighter — and a bit greener. A recent *Nature Sustainability* study concluded that the Earth is currently the "greenest" it's been since the

millennial turn. The greatest contributors? China and India.

Teach people to plant a tree, and they'll plant 66 billion. That's what's happening in China, where prolific forestry projects like the Three-North Shelterbelt Program (TNSP) are contributing to a belated worldwide re-afforestation.

The TNSP's name is easily decodable. "Three-North" refers to the project's location, China's arid northern regions, while "shelterbelt" refers to a strategically placed wall of greenery which serves as a bulwark against climate change's close comrades, desertification and erosion.

The self-described "World's Best Ecological Project" was implemented by China's government in 1978 and is slated for completion in 2050. The project's 73-year road map involves engineering a \$1 billion sylvan rampart to not only sequester carbon dioxide à la the Amazon, but to keep at bay the ever-expanding Gobi desert, which erodes land with each ponderous step it takes to the south. This high-caliber desertification is responsible for poor air quality and harsh winds, but its most problematic impact is agricultural, threatening China's vital grain output.

When complete, this "Great Green Wall" will guard against the Gobi over a 2,800-mile span (imagine Route 66 stretching from Chicago to California, then tack on a few hundred miles.) But the TNSP's impact extends well beyond the limits of the Three-North region and the borders of China itself. In the past two decades — even as the Amazon canopy topples and falls — Earth has regained enough greenery to equal the rainforest's entire area. And while six continents have observed a year-by-year increase in "green leaf area," China mostly champions the cause, contributing a quarter of that on its own.

But as always, environmental advances should be assessed with caution. Just as one below-zero day doesn't invalidate global warming, trees planted in China don't replace trees uprooted elsewhere. Despite the best of intentions, the Chinese endeavor's weakness lies in its attempt to manufacture a natural phenomenon. Many of the (non-native) trees hastily planted since 1978 were either poorly chosen for carbon sequestration, or



Shelterbelt Planting. Credit: Daily Mail

ill-equipped to survive a plant-it-and-leave-it approach.

For all that, might the 66 billion trees of the TNSP be an indicator of better things to come for the Anthropocene?

Wrapping Up (Like a Chicken Tortilla)

Seven Wonders lists are a testament to humanity's two true passions: monument-building and list-making. We categorize and we quantify. We carve our ancestors into stone statues and marble mountainsides, and stake

flags everywhere from Mount Everest to the moon. And that's the way it's always been: The architects that sculpted the Artemiseum, chiseled life into the moai, and coaxed man-made forests from unyielding soil are the same hands that will one day dig up countless remains of the Chickens of Tomorrow. For better or for worse, whether we're planting a billion trees or razing rainforests, it appears that wherever humanity is concerned, the spectacle will out.

This is not to say that wonders lists are inherently harmful. On the contrary, their goals,

more often than not, are noble: to honor, protect, and raise awareness. But, at the risk of resorting to the age-old mantra about actions and words, is documentation in itself really a form of rescue? The Great Barrier Reef would likely shake its coral locks at the suggestion, as would the countless undersea ecosystems already faded out of existence without a eulogy.

So, while the above list is intended to highlight seven discrete case studies of the Anthropocene, it's equally important to acknowledge that when discussing the planet's environment, we can't limit our discussion to lists of locations, no matter how magnificent, at-risk, or visually stunning they might be.

10, 20, 50 years down the road, as new Seven Wonders lists are inevitably churned out via mass media events and worldwide balloting blitzes, perhaps the hope shouldn't be to merely generate awareness. Maybe the hope shouldn't be to generate anything, except for a world that still has a vast assortment of wonders to choose from — a world that still has theamata, "things to be seen" that we ourselves didn't create or uncreate. If we spend more time making lists that quantify the world than we do saving the world, Seven Wonders lists like this one will become ever more common, and tragic.

To quote two notable historians of the Seven Wonders phenomenon, which already spans millennia: "Of one thing we may be sure: today's masterpieces will tomorrow be the fragmentary relics of the world that we know — the lesson of the Seven Wonders is a lesson for all time."



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Gone with the wind

Three-North Shelter Forest stretches about 4,480 kilometers from east to west and is 1,460 km at its widest point. It was designed to keep sand and topsoil from blowing away.

■ The major routes of sand and dust weather ■ Coverage of the Three-North Shelter Forest



Source: China Meteorological Administration, State Forestry Administration CHINA DAILY

It has finally arrived! The talk of the village for the past month is at last in Sita's hands. The women in her Nepalese village are excited to receive this "gift" from the United States government — a new electric cookstove, a shiny piece of portable technology that looks instantly out of place against the clay walls and dirt floor. This miraculous device promises no maintenance, faster cooking, fewer chores and, best of all, cleaner air.

In five minutes, however, Sita will carry the new stove out the back door and leave it there, never to be used. Instead, she will sit back down next to her traditional clay cookstove (called a chulha) as she always does, and boil the morning's water as a health precaution. Then she will add more wood to the flame, even as a wave of thick black smoke spouts into the room. To provide for her family, Sita must disregard the health dangers — and the carbon load she is releasing into the atmosphere.

The Price of Black Carbon



Op-ed

By Charlee Thompson

Black carbon that is deposited onto light surfaces absorbs solar radiation more effectively. In the arctic, this instigates a positive feedback loop where ice melts at a faster rate, exposing the darker subsurface and consequently increasing the melting rate further. Credit: Konrad Steffen Research Group, University of Colorado



Former University of Illinois Professor Tami Bond is one of the world's leading researchers on black carbon and its impacts on human health and the environment. Credit: WFMT Blog

brick production, and Sita's cookstove. What Bond's research helped identify is black carbon's unique ability to absorb solar radiation and thus warm the atmosphere. And that makes it an influential driver of global climate change.

One would think that, as a critical factor in global warming, black carbon would be a major topic of conversation in mitigative international climate policy. But this is not the case. Regulating black carbon emissions is rarely discussed among the policymakers and scientists who are under pressure to create policies that will alleviate global warming and meet standards for human health, while maintaining a thriving economy. Even the policies that do exist don't directly address black carbon, providing opportunities for loopholes in meeting carbon emission standards.

Notably, the United States has a particulate matter standard that at first glance might put the average health-aware citizen at ease. But behind this comforting policy lies the unnerving truth that companies can meet this standard with any particulate matter they choose. So long as the overall sum of particulate matter is under the limit, the quantity of black carbon being emitted doesn't have to change at all.

Fortunately, productive conversations about direct regulation have gathered steam in the past decade. In 2012, the United Nations Economic Commission for Europe took on new standards to target black carbon as a significant component of particulate matter. In 2017, the 14 nations and indigenous organizations that sit on the Arctic Council founded the Fairbanks Agreement, adopting an aspirational "collective goal to cut black carbon 25 to 33 percent by 2025." Preventative policies are finally emerging around the world, renewing hope for the future of the planet.

Village scenes such as this have played out across India, Nepal, and the developing world for decades now, as the search continues for the perfect, low-emission cookstove to reduce premature deaths from inhalation and mitigate global warming from black carbon. But technology will always fail without effective education of its importance and practical use. Better education about the dangers of black carbon, directed to mass audiences in both the developing world and the West, is vital in the fight against pollution-related disease and global warming.

Tami Bond, former Professor of Environmental Engineering at the University of Illinois Urbana-Champaign, is one of the world's leading black carbon researchers. In 2013, Bond and a team of researchers found that black carbon has twice the direct climate impact than previously reported and that it ranks as the second most potent greenhouse gas after carbon dioxide. This discovery made waves in the science world, prompting further research into black carbon, its sources, and how it is affecting Earth's radiation budget.

Solid fuel combustion (burning wood, coal, or corn) emits high concentrations of organic gas pollutants as well as tiny solid and liquid particles known as particulate matter. When particulate matter is suspended in the air and mixes with other organic substances containing carbon, it forms a concoction of gas known as a carbonaceous aerosol. The resulting household air pollution from carbonaceous aerosols and other byproducts of combustion is the fourth-largest contributor to the global burden of disease — and a particularly potent contributor to global climate change.

This black carbon is a threat hiding in plain sight, a constant presence in the atmosphere emitted from everyday sources such as vehicles, fireplaces, forest fires,



Chulhas are open biomass-burning cookstoves traditionally used in developing Asian countries. Credit: Flickr

As the industrialized world pushes forward with regulations, it remains unclear if strict regulation on underdeveloped countries, like Nepal, is the right course of action. In order to become the technology-driven, high GDP nations they are today, western countries have taken their turn polluting without regulation and overusing resources without remorse. Is it fair to tell developing nations that they cannot do the same to develop themselves?

Here's where technology, if accompanied by proper education programs, can make a real difference. To reduce the effect of carbonaceous aerosols in regions like Nepal and China, Western stove programs are attempting to reduce household air pollution by distributing more than 100 million "clean" cookstoves. But, as our opening scene with Sita in her Nepalese village demonstrated, this massive program isn't producing the hoped-for results. Better technology isn't always a panacea, especially when the stakeholders are uneducated about the purpose of the technology. Traditional cookstoves are well-assimilated with the Nepalese diet. Sita has learned the recipes for common dishes like dal bhat (lentils and rice) and ghee (butter) from her mother, who learned them from her mother. Nepalese recipes are passed down from generation to generation, and the methods of preparing these foods are passed down with them.

While offering an alternative stove appears to be an efficient solution to policymakers because it sits well with scientists, it simply is not working. This strategy doesn't effectively consider what people want. How would it feel if a stranger came to your home, gave you a new stove, and demanded you change your habits by using it? Many of us would behave like Sita, that is, express some mixture of gratitude and embarrassment, then set the contraption aside and carry on with our lives.

Johan Rockstrom's frequently cited 2009 article, "A Safe Operating Space for Humanity," proposed 10 "planetary boundaries" that define how human life on Earth can be sustained. The only planetary boundaries with uncertain statuses are "Atmospheric Aerosol Loading" and "Chemical Pollution," both of which are directly related to black carbon.

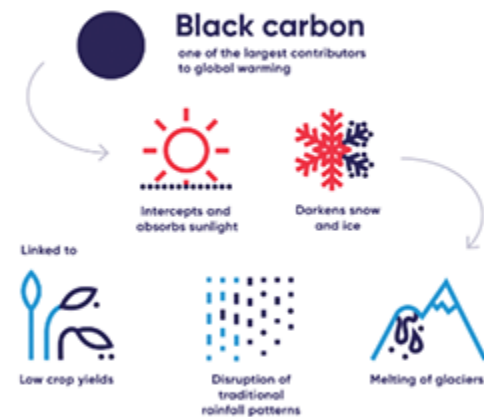
Uncertainty is a part of science; it sparks curiosity and pushes innovation. But it is also a barrier that takes advantage of a widespread lack of education.

As we move forward, we cannot rely solely on new technology to solve the challenges that black carbon and climate change will pose. We must also educate those affected so that they will willingly change their habits, and empower them to demand better climate policies from their leaders.



Our air and our climate

Many air pollutants have important impacts on the climate.



Beat Air Pollution | World Environment Day | UN Environment | #WorldEnvironmentDay

While black carbon has a short lifetime, it has negative impacts while in the atmosphere and after deposition on surfaces. Credit: United Nations



Black carbon is emitted globally with particular concentrations in Asia. Credit: Wikipedia



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Engineering and a minor in Sustainability, Energy, and Environment. She was accepted to the M.S. program in Environmental Engineering at Carnegie Mellon University. At Illinois, Charlee participated in the Society of Women Engineers and Illinois Student Government.



Energy Futures

We've got the (Green) POWER

By Nidhi Shastri

Looming in front of me is a massive field of wind power. Each light sits atop a 212-foot pole, with blades stretching 116 feet and rotating at 180 miles per hour. Terrifyingly tall yet intriguingly close, hundreds of these turbines span our Midwestern cornfields.



As I squint above me, I notice a ladder stretching from the top of one red light and disappearing halfway to the ground. I wonder how workers manage to climb so high — to reach all the way to the top and see Illinois stretched beneath them. I wonder what they think as they see the rolling fields to the horizon and know they are at the forefront of history, powering the Land of Lincoln to a clean energy future. These wind turbines provide more than electricity. The booming wind industry employs hundreds of people each year and powers thousands of homes and businesses with clean energy. It powers Illinois' job market and economy. It empowers our people.

Switch scenes to a barren lot in the heart of Champaign, Ill., a hundred miles or so down

I-57. Yellow dandelions and brown-green grasses have popped up around the wire fence that cuts the area off from the houses and apartments surrounding it. Below the fence, a trickle of water from the dew-sodden grass makes its way onto the curb, mixing with the gutter water in the street. This negligible stream of water then takes a detour from the curb, running into a nearby yard. From that moment, lives are at risk. The lot this water seeped from used to house a coal power plant owned by Ameren, a natural gas and energy provider in central Illinois. The water contains high levels of toxic chemical compounds of coal ash that enter the soil, building up over time. Once dried, these dust particles will be blown up by the wind and into the lungs of children playing in the yard or passing by on the street.

With a little trust, some much-needed research, and dedicated investment in clean jobs, Illinois can lead economic and environmental change for the whole nation, and potentially the world.

Central Illinois, digging deeper into the history of environmental hazards in my college town of Champaign-Urbana, while researching clean energy economics for a summer internship. What I found was a uniquely 21st century American story — one of how with a little trust, some much-needed research, and dedicated investment in clean jobs, Illinois can lead economic and environmental change for the whole nation, and potentially the world.

The Dirty Truth

In the fall of 2018, I wrote for a class blog about a Champaign neighborhood known as Fifth and Hill. This low-income, largely African-American community is the scene of the “toxic lot” narrative above. At Fifth and Hill, residents have had their water and soil poisoned by coal ash for more than 20 years by Ameren and its predecessors. The area was said to be scrubbed and cleaned up in 2011 in response to pressure from local organizations.



Can utility companies atone for past mistakes, while helping launch an energy revolution? Credit: Midwest Energy News

Wind farms and a toxic lot ... What do these two scenes have in common? Though they initially seem unconnected, one scene provides a solution for the other. With investment in wind farms, the need for coal plants that pollute communities will shrink. It's a win-win proposition: replacing coal with clean energy will not only purify our air and water, but also help low-income communities that are hurt by pollution the most.

Over the past year, I have become interested in this intersection of renewable energy and environmental justice in

(“Scrubbing” names the process used to remove carcinogenic byproducts of coal ash and tar that come from power plants, which cause severe health problems in people of all ages and severe asthma in children.) But the reality suggests otherwise.

Though Ameren agreed to scrub the soil in one specific plot tested, the company failed to clean up surrounding houses, parks, and schools. Just as bad, many residents of the Fifth and Hill community who once lived about five blocks south of the plant were driven by the expanding University of Illinois and construction of luxury apartments to live in cheaper housing closer to the plant — a classic case of gentrification, and environmental injustice. According to the U.S. Environmental Protection Agency (EPA) and the National Park Service, the permissible amount of coal ash-derived compounds in drinking and bathing water is less than 1 part per million (ppm). Worryingly, a University of Illinois study revealed in 2010 that the Fifth and Hill community had levels dangerously higher than that — about 1.5 million times higher than the acceptable amount of just the compound toluene alone.

Cases of headaches, fibroids, and an odd tingling in people's hands and feet began popping up. Fifth and Hill residents began to develop rare, aggressive forms of cancer. One of the most heartbreaking cases I learned of was a 19-year-old boy who passed away after battling an extremely hard-to-treat cancer, leaving his single mother to mourn him.

The residents of Fifth and Hill knew that something was wrong — it was more than just bad luck. Reports of foul-smelling water reached local news networks and prompted testing in the community in October 2016 — five years after the area was considered scrubbed and safe. Many in the community speculated that the delay in testing was due to the failure of government entities to provide proper resources to a low-income minority neighborhood.

This case is not unique to Champaign, nor to Illinois. The issue of environmental justice rose to national attention most recently with the Flint water crisis, and communities around the country have begun speaking up about the injustice related to toxic waste and unsafe water systems that aggregate in poor communities of color. With the recent introduction of U.S. Sen. Cory Booker's Environmental Justice Bill to Congress, which targets communities impacted by this type of pollution for government funding, hopes have been raised for tangible change at the national level.

Environmental injustice occurs when low-income communities are disproportionately affected by environmental pollution and hazards, which in turn creates a health crisis — such as young children developing the rare, aggressive forms of cancer spiking at Fifth and Hill. The political dimension of toxic waste arises when environmental hazard and racial injustice intersect, when low-income

Environmental injustice occurs when low-income communities are disproportionately affected by environmental pollution and hazards, which in turn creates a health crisis.

While these organizations do great work, government mandates and legislative action are still lacking. Statewide progress on environmental justice issues is slow in Illinois, which means that major polluters are not only operating without restrictions, but affected citizens likewise continue to struggle without aid or protection.

The principal issues surrounding government and corporate inaction are these: first, although some legislation has been passed, commitments on environmental injustice have not been maintained by government departments such as the Illinois EPA. Second, there is a lack of responsibility on the part of companies and contractors who import the pollution industry into low-income, vulnerable neighborhoods like Fifth and Hill. Third, companies seeking to do the right thing often have to tiptoe around property rights when scrubbing private homes, yards, and water sources. This lowers incentives for action to clean up contaminated neighborhoods.

Looking to Solutions

But what if we didn't have to clean up the contamination in the first place? We know that less coal power means less pollution, which means less toxic runoff in surrounding areas. If Illinois industry can transition away from coal power and clean up already polluted areas, we can look to solving this dimension of environmental

communities of color are made disproportionately more vulnerable.

As someone who has lived in and around Chicago my whole life, I know the toll low-income Chicagoland communities are experiencing at the hands of major polluters and large-scale power plants. Organizations such as The Black Youth Project in Waukegan and the Little Village Environmental Justice Organization (LVEJO) in Chicago's Southwest Side are rising up to fight pollution in their communities.

injustice altogether.

Wind turbines already serve as a symbol of a transition to clean power, and the workers who build and maintain these massive generators empower the economy and this new chapter of our environmental history. Illinois is already one of the leading states in clean energy jobs. When we have wind turbines and solar panels powering entire counties — not to mention clean forms of heating, cooling, and ventilation — the need for coal plants rapidly diminishes.

As that inverse relationship suggests, with fewer power plants will come fewer disasters such as Flint, or Fifth and Hill, and these communities can begin to grow and thrive beyond their histories of environmental disadvantage.

So, how can Illinois be at the forefront of such landmark progress? First, the state is piloting policies that benefit clean energy. Second, growing cooperation between local businesses and local government is driving our Midwest clean energy revolution.

In fact, Illinois now leads the nation in solar-friendly communities, ahead of California. In addition to government investment, installing solar or wind power has become a serious hobby for many Illinois homeowners, helping lower thousands of energy bills. Meanwhile, huge Chicago



Credit: Karsten Würth, Unsplash

Clean energy job programs are gaining traction in Illinois as a bridge between the dying coal industry and the clean tech boom, targeting locations with closing power plants, and working to transition the workers who would be laid off into training programs in clean tech.

grid as the future of the U.S. energy economy.

My experience at E2 and the NRDC changed how I saw

suppliers such as Commonwealth Edison (ComEd) are launching programs to reduce energy consumption and incentives to use smart thermostats and appliances to reduce usage and output.

In summer 2018, I saw firsthand how clean energy and social justice are closely tied. I helped research and write a report titled “Clean Jobs Midwest 2018” for the Natural Resources Defense Council (NRDC) and Environmental Entrepreneurs (E2). Based in Chicago, the team compiled data on 13 Midwestern states and their role in the battle for clean energy for all. The E2 in conjunction with the NRDC is working with other organizations to put this data and more on the table, and their sights are set on a sustainable and renewable

Illinois in the battle for clean energy. In writing the clean jobs report, we broke down complex environmental topics such as climate change and environmental justice for legislators, business people, and interested citizens to digest. We worked in conjunction with the Clean Energy Trust (CET) to write detailed profiles of what types of clean energy jobs are available, and how they are benefiting the Illinois economy and environment. Over the summer months, I investigated where the biggest growth for clean energy was happening, tabulated locations of coal and natural gas plants, and tracked where plants were closing.

Job security, of course, remains a sticking point. I found that many of the aging coal plants were in low-income communities, and as these plants close, some people will lose their jobs — including low-income workers who rely on coal jobs as a main source of income.

How do we justify investing in clean energy to people who will lose their jobs in this inter-generational industry of coal power? Clean energy undoubtedly benefits the Illinois population at large, but the economic burden falls unevenly on lower-class workers employed in the carbon energy industry.

The answer is clear: clean energy job programs. Such programs are gaining traction in Illinois as a bridge between the dying coal industry and the clean tech boom, targeting locations that have power plants closing, and working to transition the workers who would be laid off into training programs in clean tech. All we need is a little trust — and



The signs of the energy revolution are everywhere, from wind turbines along the highway to glossily packaged research on its benefits. Credit: NRDC

After the passage of the 2016 Future Energy Jobs Act (FEJA), the Illinois economy grew 2.4 percent overall, with clean energy jobs at a trailblazing 4 percent growth rate.

In more good news, clean energy jobs in Illinois are growing faster than Illinois jobs overall. According to the report, “only 33,970 workers in Illinois were employed in fossil fuel industries such as coal, natural gas, and oil,” compared to the 123,247 workers employed in clean energy and tech.

Bottom line: The energy industry in Illinois is already experiencing an irreversible shift. If we can harness this potential, our state can pave the way for the entire Midwest, and possibly the whole country.

One of the most important methods for developing clean energy jobs in Illinois is with government assistance and subsidies. These help to transition those who lose their jobs in the fossil fuel industry — as well as those who are affected by environmental injustice — into job training for clean jobs instead. Enrolling those who have lost their jobs in coal power into paid job training programs creates an economic cushion.

Job prospects are bright for those who enter the clean tech and energy industries. Because of the demand for trained employees and the need to maintain and expand energy farms (wind and solar), people who enter the industry can expect decades of job security. Instead of the boom-and-bust found typically with coal powered jobs, this clean energy bloom will foster long-term economic growth and allow the employment sector in Illinois to blossom.

The 2016 Future Energy Jobs Act (FEJA), which passed in Illinois under Gov. Bruce Rauner (and puts Illinois on track for 25 percent of the state’s energy to be renewable by 2025), shows the progress we are already seeing in the economy. After the passage of FEJA, the Illinois economy grew 2.4 percent overall, with clean energy jobs at a trailblazing 4 percent growth rate.

Furthermore, communities affected by environmental injustice will begin to see change immediately, such as lower costs for energy and the shutting down of nearby polluters. The more we invest in clean technology, the more the Illinois environment, economy, and polluted communities will thank us: It’s a win-win-win situation.

It’s time for Illinois to make the full-fledged transition to

a big push — to ensure the training programs function effectively in the communities that need them.

According to Clean Jobs Midwest 2018, Illinois led the Midwest in renewable energy jobs (such as solar and wind power), as well as in energy efficiency jobs (heating, cooling, and ventilation). The future of these jobs is bright: energy employers anticipate an 8.5% growth rate in hiring in 2019 alone.



clean energy — for the economy, for the environment, and for our citizens. This includes addressing the deep fear of thousands of Illinois workers that they will lose their jobs during the energy transition. To alleviate this anxiety, we need proper education on the availability of job training programs as well as a positive public image of the clean energy industry. We need to ensure that we have well-educated staffers and politicians who promote green policies that protect against environmental injustice. We need to make sure that the power industry transitions from fossil fuels to clean tech rather than abruptly switching or leaping from one to another. If we focus on the intricate connections between environmental injustice, clean tech, and the economy, we can make this transition smoothly.

The job market is booming, with clean jobs at the forefront. Illinois is on the rise as an economic and environmental world leader. Clean energy is no longer a thing of the future — it is something we are harnessing right now. The story of our carbon fuel-free destiny is being written, and it is in our hands to ensure that it reaches a prosperous and just ending.



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and Political Science in May 2019. She earned the Certificate in Environmental Writing and hopes to go into the field of environmental policy and communication. This article was researched and written for ESE 498, the CEW capstone course, in Spring 2019.



Scrubbing the Skies

By Zack Fishman

For more than half of its 150-year history, the Urbana-Champaign campus of the University of Illinois has relied heavily on Abbott Power Plant for on-site electricity and steam generation. Today, the university receives three-quarters of its power needs from the aged brick building, a structure that would blend well with the classic campus architecture if not for its towering twin chimneys spouting steam.

Yet Abbott's reliability might soon become a liability for the campus, which has pledged to eliminate all on-campus carbon dioxide emissions by 2050. Despite being promoted as efficient, safe, and EPA compliant, the plant produces significant carbon dioxide emissions by burning natural gas and coal, constituting 61% of the university's direct carbon output. The U of I is looking for a way to phase out its dirty power and, in 2015, university researchers proposed implementing a technology that could nearly eliminate its emissions: carbon capture and storage (CCS).



Abbott Power Plant.
Credit: Raymond
Cunningham, Flickr

Credit: Shutterstock.com

CCS technology turns fossil fuel plants into largely clean energy sources. The technology takes many forms, but its standard operation involves removing CO₂ from a power plant's smokestack and injecting the gas thousands of feet underground for permanent storage. CCS has existed for decades but remains stuck in research and development limbo, seeing relatively little action at the large scale. Implementation at Abbott, according to its supporters, would prove CCS viable for wider deployment.

The initiative to clean up Abbott was spearheaded by Kevin O'Brien, Director of the Illinois Sustainable Technology Center (ISTC), a division of the campus' Prairie Research Institute. The sustainable energy expert and his team were funded in 2015 by the U.S. Department of Energy (DOE) to study the plant, where they "learned a great deal about how to retrofit this technology on a traditional working power plant," O'Brien wrote in an email.

But building equipment that can pull greenhouse gases such as CO₂ from the air is challenging because of the molecule's highly stable, neutrally charged nature. CO₂ can only be captured by being either reacted into a more easily captured compound or physically separated from other gases, while the final collection of gas must be nearly pure for later transportation and storage. The process is inevitably energy-intensive and expensive.

ISTC's proposed solution would have employed CO₂-bonding chemicals to capture 90% of Abbott's greenhouse gas emissions and then release it into a diverted stream, to be sent away for underground storage.

O'Brien's 2016 proposal for further funding ultimately

fell through; no CCS project was funded by the DOE that year. "This occurred during the transition to the Trump administration when clarity on administration priorities was not yet established," ISTC Communications Director Jim Dexter said. The group failed to receive funding for a similar plan in 2017. O'Brien now leads a carbon capture project at a power plant in Springfield, Illinois. For now, Abbott will remain dirty, and campus will need to find another way to go carbon-free.

'Fantastic Geology'

This is much more than a local story. ISTC's inability to secure necessary funding is a plot line familiar to that of many other CCS projects — and one that may have global consequences in climate change mitigation. A 2018 special report from the Intergovernmental Panel on Climate Change (IPCC) states that the world must completely eliminate CO₂ emissions by 2050 to avoid the greatest environmental and societal harms — a gargantuan task, considering the world's annual (and accelerating) production of 37.1 billion tons of the greenhouse gas. Out of the four outlined pathways to achieve a carbon-free 2050, three rely on significant deployment of CCS. That's a high bar of expectation for a chronically underdeveloped technology.

Many obstacles stand in the way of meaningfully implementing carbon capture, which captures only 0.1 percent of today's global emissions. The technology is largely unknown to the public and remains poorly funded relative to both fossil fuel and renewable energy systems. Its operation costs are currently too expensive to be commercially viable. Advocates say sufficient research and



Participants look over an injection well head during a tour of the new Illinois Industrial Carbon Capture and Storage Project on Sept. 22.
Credit: Jim Bowling, Herald & Review

development could elevate CCS as a key factor in combating climate change; opponents claim it is a money sink that diverts investment from more effective renewable energy infrastructure. Whether carbon capture will play a key role in stopping climate change is uncertain, but the debate over its implementation is crucial to saving the planet from an intolerably hot and polluted future.

Greater success for CCS in the field can be found in Decatur, Ill., 50 miles southeast of the Urbana-Champaign campus. The Illinois State Geological Survey (ISGS), another division of the Prairie Research Institute, has been involved in one of the first successful storage sites in the United States. The ISGS-affiliated Midwest Geological Sequestration Consortium (MGSC), alongside agriculture business giant Archer Daniels Midland (ADM), initiated a storage project in 2011 that captured 1 million tons of CO₂ from ADM's nearby ethanol plant and injected the gas more than a mile underground. ADM — the top employer in Decatur, a Fortune 500 company and a top-100 polluter in the U.S. — reopened the operation in 2017 at full capacity and will store another 5 million tons by 2022, equivalent to the annual emissions of nearly 200,000 cars.

Sallie Greenberg, ISGS Associate Director and a co-Principal Investigator at the MGSC, said the Illinois Basin underlying most of the state has “fantastic geology” for carbon dioxide storage. Within the basin, a thick layer of porous sandstone is prime filled with highly compressed CO₂, and capped by dense shale rock, which prevents the gas from seeping to the surface. Trapped by the shale,

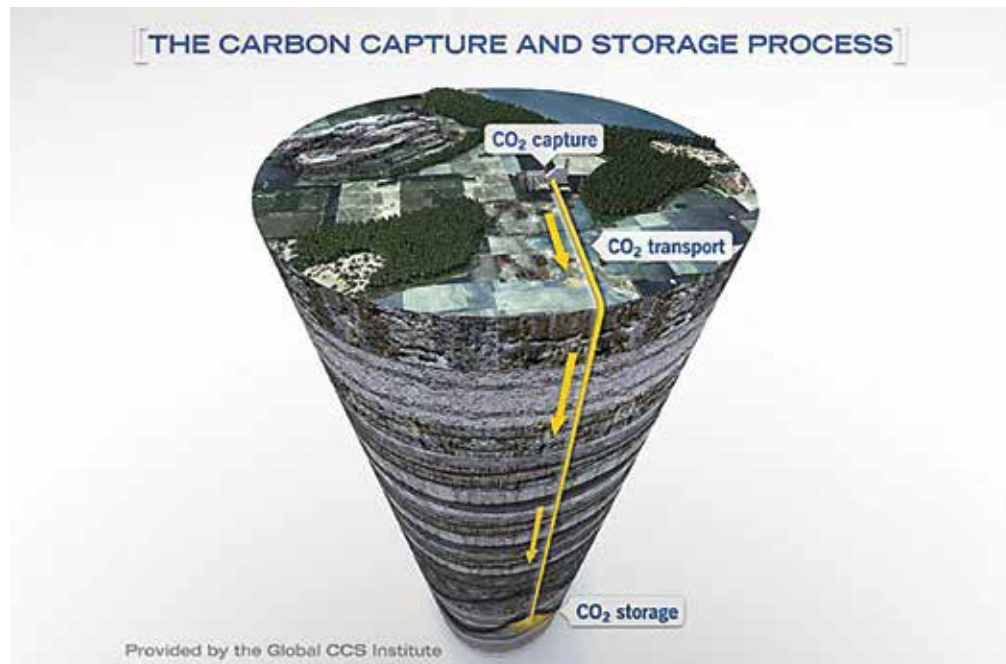
the CO₂ is permanently stored in the sandstone. MGSC has monitored the injection site for leaks — CO₂ erupting from the surface could contaminate groundwater and even suffocate people — and found it to be safe. According to the Global CCS Institute, the underground storage space of the United States is sufficient to safely sequester the world's CO₂ production for centuries.

Storing greenhouse gas deep in the ground is far from a new practice. Since the early 1970s, enhanced oil recovery has been used to significantly increase yields of crude oil by injecting CO₂ deep into oil fields. Producing the black gold is a great economic incentive for CCS research but obviously undercuts its purpose for emission reductions. More than a billion tons of CO₂ have been stored with enhanced oil recovery, but an increasing number of sequestration projects, such as in Decatur, are storing carbon without producing oil.

Greenberg also foresees greater interest in geological storage due to a change in the 45Q tax credit, which now gives a tax break of up to \$50 per ton of stored CO₂ to companies that choose to pursue sequestration.

“It has made the possibility of carbon storage more viable because industry and investors can start to see how you could both do a project and cover the cost of a project by getting tax credits,” she said, noting increased interest from industries that historically have not engaged with carbon sequestration. “I think it's likely the next round of projects will be industrial plants or other ethanol plants like ADM.”

The ISGS-affiliated Midwest Geological Sequestration Consortium (MGSC), alongside agriculture business giant Archer Daniels Midland (ADM), initiated a storage project in 2011 that captured 1 million tons of CO₂ from ADM's nearby ethanol plant and injected the gas more than a mile underground.



One option for reducing greenhouse gas buildup in the atmosphere is storing it deep underground. Lab experiments confirm that carbon dioxide is effectively trapped when injected into basalt formations. Credit: U.S. Department of Energy



Cleaning the Skies. Credit: Climeworks

Unlike traditional CCS, DAC could potentially power a future of negative emissions, in which more CO₂ is removed from the atmosphere than is emitted.

Direct Air Capture: The New Frontier

Successful or not, industrial projects like the power plant and storage sites in Illinois represent only one, official side of the CCS development world. Another plays by its own set of rules: a carbon capture “Wild West” inhabited not by public university researchers but risk-taking entrepreneurial leaders seeking to make CO₂ capture affordable through market-based products. These businesses often rely on private investment more than government funding, and they capture CO₂ straight from ambient, “normal” air rather than from a smokestack — a technique dubbed “direct air capture” (DAC).

Swiss company Climeworks is one of the biggest players in the DAC arena. Surrounded by rich green fields outlined by the Alps, its Zurich plant features a towering array of large fans — resembling jet engines — overlooking the idyllic view. The fans take in enormous quantities of air and capture most incoming CO₂ with a patented filter. Climeworks sells the pure gas for a variety of uses, from geological storage to greenhouses to beverage companies.

Unlike traditional CCS, DAC could potentially power a future of negative emissions, in which more CO₂ is removed from the atmosphere than is emitted. Louise Charles, spokeswoman for Climeworks, elaborated on its importance. “By using our direct air capture technology to both serve markets in need of CO₂ and also remove CO₂ safely and permanently from the atmosphere by storing it underground,” she wrote in an email, “we facilitate a sustainable way to reach negative emissions — and to reach the Paris climate goals.”

But Climeworks' technology must extract from ambient air the relatively sparse CO₂, which is 400 times less concentrated than in smokestacks. As a result of such

technical challenges, removing one ton of CO₂ currently costs the company \$600 to \$800, a prohibitively high cost for large-scale employment. Charles projected the price to decline to \$100 per ton in the future, citing Climeworks' “detailed cost roadmap” and some modeling inspired by solar panels.

“The price of a solar panel per watt in 1975 was roughly \$100 but it has declined to 37 cents at the end of 2017 (a factor of 275 over 43 years) because of economies of scale and tech development,” she said. “We expect similar for DAC.”

Other companies exist in this private CCS space. Carbon Engineering, a Canadian company, has recently claimed in a published report that its cost to perform DAC can be as low as \$94 per ton of CO₂, while Icelandic company CarbFix injects CO₂ into underground basalt rocks on the premise that 95 percent of the gas reacts into permanent stone within two years.

Although these groups seem to be gaining significant traction — Carbon Engineering recently received \$68 million in private funding, an all-time high for a DAC company — their success will be limited by the surrounding policies. Carbon taxes, which set a cost to emitting CO₂, would highly incentivize businesses to invest in these companies' services. But carbon taxes and similar pricing policies are only sporadically implemented worldwide, with none currently found in the U.S.

“If carbon pricing mechanisms were in place, it would definitely play in our favor long-term,” Charles said. “It is important for these regulations to allow negative emission technology including DAC to flourish.” She said Climeworks will still be able to conduct business without widespread carbon pricing, albeit with limits in its growth.

Equipment used for a Carbon Capture Program, which is developing novel solvents to better capture carbon dioxide from coal-powered plants. Credit: U.S. Department of Energy



The comparison between industrial CCS and entrepreneurial DAC is a challenging one to make, and it is difficult to declare one or the other as the better approach. Do we want the technology to rely primarily on public or private funding? Do we store CO₂ in the ground or turn it into fuel? Should we try to reduce power plant pollution for the following decades or implement negative emissions for the following centuries?

Is CCS a 'False Hope?'

For many people, scientists and activists alike, the answer to these questions is "none of the above."

Greenpeace has used particularly colorful language in its opposition to CCS, variously calling carbon capture a "false hope," a "scam," and a "corporate boondoggle." Its news releases might overemphasize the risk of underground leaks, but environmental groups also express legitimate complaints over the tech's excessive costs and inability to compete in today's electricity markets.

These concerns are echoed by two University of Michigan researchers, Dr. Sarang Supekar and Professor Steve Skerlos, in a 2015 article published in *The Conversation*. The two mechanical engineers calculated that carbon capture equipment would consume between 45% and 60% of a coal plant's own power generation, which would significantly increase the cost of already struggling coal-powered electricity. To Supekar and Skerlos, renewables are simply cheaper and more reliable. (The analysis has stirred some controversy: another group of scientists called the study's findings flawed and its numbers exaggerated. The Michigan researchers fired back with their own claims of incorrect analysis.)

Michael Bernard, who writes about low-carbon technologies online, also thinks CCS siphons money away from wind and solar energy, and he crunched some numbers to demonstrate his point. In his analysis, he concluded that if the money spent on large-scale carbon capture projects since 1972 had instead been spent on wind energy, 43% more CO₂ emissions would have been avoided. Furthermore, because solar and wind energy annually displace 35 times the emissions that CCS projects have in their 40-plus-year lifetimes, he dismissed the technology as "a rounding error in global warming mitigation."

The technologies Bernard compares are on an unequal

playing field in regards to development — CCS is less mature than wind and solar, so money spent on it produces less efficient results — but he makes clear that he would rather commit to renewable energy generation than gamble on slow-moving tech.

At the center of that gamble is much uncertainty. The cost to capture CO₂ in the future is uncertain. Its relative value compared with renewable energy sources is likewise uncertain. Whether carbon taxes will be passed, and where — again uncertain. CCS's lack of technological maturity exacerbates these problems. Dozens of variations are being developed in the CCS space, but none yet can be deployed on a wide scale.

Researchers and corporate interests alike compete for millions in R&D funding to prove their CCS invention is the winning formula, but a plethora of imperfect choices makes it difficult to throw support behind any of them. And given the stakes of any decision about CCS tech — where to spend billions of dollars toward the goal of saving the planet — the uncertainty is doubly daunting, even prohibitive to many.

Briefly putting aside the bitter argument over its economic feasibility, CCS provides several enticing benefits. Carbon-neutral gasoline sourced from the air could clearly accommodate any non-electric cars of the future. "Clean coal" may be more politically viable in the short term than a call for the fossil fuel industry's extinction. And negative emissions in a 100% renewable world could further mitigate the disasters of climate change after all the fossil fuel plants have been closed. But for anything to happen, the stars — financial, technological, and political — must align. It's an alignment that may never come to pass.

Choosing a side in the carbon capture debate at a critical time in CCS development is challenging. But Greenberg, who supports further CO₂ storage research and implementation, believes in the importance of continuing the dialogue even with those who oppose the technology.

"I think there are as many different perspectives as there are people, and what is important is a robust and integrated stakeholder engagement process around a project or around a subject like carbon storage," she said. "That process has to have room for people who agree and people who disagree."



Zack Fishman is from Park Ridge, Ill. He is a 2019 graduate in Engineering Physics and is now pursuing an M.S. in Science Journalism at Northwestern University. While at Illinois, he also contributed to *The Daily Illini* and *The Green Observer*.

 Living World

Birds Count

By Vivienne Henning



Among the dense shrubbery in a patch of prairieland in central Illinois, a sing-song warbling echoes out from the grass. Partially hidden by the branches of a bush, a bird called

the Bell's vireo energetically chatters its little song. The Bell's vireo's body, small enough to fit into the palm of your hand, bobs up and down as the branch sways in the breeze. It takes off, its gray-drab wings excitedly flitting up and down, its yellow-white belly exposed in flight. The bird is off to meet its friends in a neighboring shrub. They've been working hard to build their nests as they prepare for their baby chicks to be born.

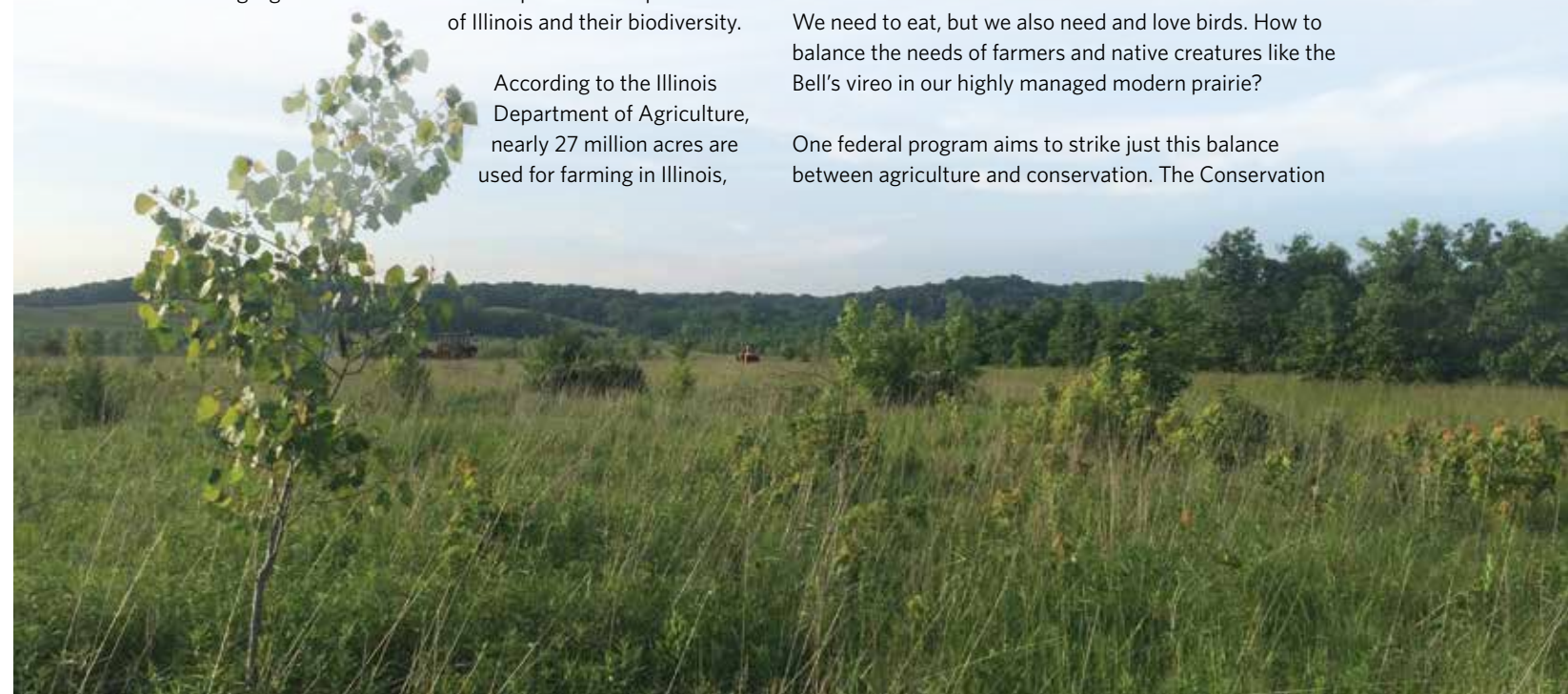
But from the time of first European settlement in the mid-1800s, the prairie habitat the Bell's vireo calls home grew ever smaller as agricultural demand drove the wholesale conversion of natural prairie into cropland. As is obvious to anyone driving down Interstate 57, the vast reach of Big Agriculture has swallowed up the natural prairie lands of Illinois and their biodiversity.

According to the Illinois Department of Agriculture, nearly 27 million acres are used for farming in Illinois,

made up of approximately 72,200 farms. This adds up to 75% of the total land area of Illinois. Not just impressive in its scope, the state's agricultural industry is highly lucrative, generating about \$19 billion annually, with corn accounting for 54% of that profit.

We need to eat, but we also need and love birds. How to balance the needs of farmers and native creatures like the Bell's vireo in our highly managed modern prairie?

One federal program aims to strike just this balance between agriculture and conservation. The Conservation





Field sparrow. Credits: Rob Kanter



Northern bobwhite.



Flycatcher.



Bell's vireo.



The team focused on four bird species: the field sparrow (*Spizella pusilla*), northern bobwhite (*Colinus virginianus*), willow flycatcher (*Empidonax traillii trailli*), and the Bell's vireo (*Vireo bellii bellii*).

Reserve Enhancement Program (CREP) focuses on productive land conservation, and is overseen by the Farm Service Agency (FSA). According to U.S. Department of Agriculture's website, here's how it works: "In exchange for a yearly rental payment, farmers enrolled in the program agree to remove environmentally sensitive land from agricultural production and plant species that will improve environmental health and quality." The ultimate goal of the program is to deter soil erosion, protect and reduce the potential loss of wildlife habitat — as well as to refine water quality.

Bryan Reiley, an avian ecologist and former Illinois doctoral student, has devoted four years of fieldwork to researching the impact of CREP on prairie biodiversity. Reiley got involved with this research as a University of Illinois Ph.D. student. He explains that the program "pays farmers to leave land fallow, and turn it into some kind of natural habitat." The research was conducted in coordination with the Illinois Department of Natural Resources to track the effectiveness of CREP.

The team focused on four bird species: the field sparrow

(*Spizella pusilla*), northern bobwhite (*Colinus virginianus*), willow flycatcher (*Empidonax traillii trailli*), and the Bell's vireo (*Vireo bellii bellii*). Of the 57,000 hectares of restored prairie land in Illinois, the team randomly surveyed 172 fields in 10 different counties across central Illinois during breeding seasons from 2012 to '15.

Reiley said the birds are easy to track since they broadcast themselves with their chirps and calls, and that it's likewise easy to figure out population and species variety. "It's a good proxy for biodiversity," he said. Reiley and his team examined birds whose populations were declining, then quantified the birds expected to inhabit CREP habitat in the state, and finally utilized a randomized sampling method to extrapolate numbers.

Out in the field, Reiley and his team quickly fell into a rhythm. They would load up their van before dawn, drive out to the prairie, wade through the grasses, then race to the next location to get the best results of bird activity before midday. Once in place, they adopted an appealingly simple method. Team members would stand in a randomly chosen field, and listen and write down every

individual bird they heard. Reiley learned how to identify more than 130 species by sight and sound.

There were times where the roads and conditions were muddy, and they would get stuck and have to walk to farmers' houses to ask for help. In upstate New York, where Reiley is from, farmers would often grow irate with roaming research teams. But this was the Midwest.

"Almost every person in Illinois was always nice," he said. "If they couldn't help you with moving your car out of a ditch they would go out of their way to find someone who could help." Despite all the driving, the mud, and an unfortunate incident where he got stung in the face by a bald-faced hornet, Reiley found being out in the fields conducting research to be very rewarding. Bell's vireo, for example, build their nests relatively low to the ground in shrubs, and by following the bird calls, he could find their nests. Sometimes, he would find a male Bell's vireo singing his little song while incubating tiny eggs.

The Bell's vireo provided a ray of hope to Reiley and his team. Their most surprising finding was that the Bell's vireo has experienced the highest recent upsurge in population numbers, even doubling their numbers — a stark contrast to their long historic decline. Pondering the data, Reiley believes the increase in the Bell's vireo population in Illinois has been due to land conservation efforts.

"We found that private land conservation efforts in Illinois are probably effective in achieving state population goals for some rare species, such as the Bell's vireo, which prefers shrubby areas near grasslands. They also may help other species with similar habitat needs, like the willow

flycatcher, which we estimated to be at 92% of the goal," Reiley told the University of Illinois News Bureau.

On the other hand, some of the other bird species Reiley examined didn't fare so well. The field sparrow population only increased by 33% of the desired CREP goal — and the northern bobwhite population only 6%. Reiley and his team concluded that there would need to be a land restoration increase of at least 5% to help harbor a productive increase in willow flycatcher population numbers, and the amount of restored lands would need to increase very substantially for field sparrows (118%) and northern bobwhites (598%) to flourish.

The results have been mixed, but CREP efforts will continue, as they have proven to help with species native to Illinois like the Bell's vireo. Reiley suggests that focusing on the population goals themselves may not be the most effective way to ensure some vulnerable species are able to survive. It's important to consider "not just where birds are at historically, but how much land is actually available for birds on the landscape." He emphasizes the need for more research into how the land can be better utilized, and what's realistic in a state dominated by Big Ag.

But he's optimistic overall about CREP across the country: "Interestingly, all the species we studied, and probably many others not studied, would likely rebound to historic levels if 1% of the agricultural land in Illinois was restored through CREP. This program is clearly important to populations of declining wildlife — not only in Illinois, but also in the other 26 states where it operates."

So, there's hope that agricultural impacts on the environment can be mitigated, even if the numbers and the goals seem small at first. After all, small things shouldn't be overlooked — or underestimated. The palm-sized, delicate, and chirpy Bell's vireo has certainly proved that it wants to thrive. Hopefully with stronger conservation efforts and more proactive and mindful agricultural practices, the Bell's vireo will continue to flit around from shrub to shrub in a prairie near you, beneficiaries of a productive landscape hospitable to both birds and corn.



Decline of Prairie Acreage in East Central Illinois

County	1820	1976
Iroquois	651,000	48.0
Kankakee	406,700	7.8
Ford	297,100	6.4
McLean	669,800	5.0
Vermilion	449,500	4.1
Coles	218,800	3.1
Livingston	633,400	2.4
Champaign	592,300	1.0
Douglas	223,100	1.0
Christian	398,300	0.0
Logan	336,500	0.0
Macon	322,700	0.0
Edgar	257,600	0.0
Piatt	254,000	0.0
DeWitt	206,900	0.0
Moultrie	163,300	0.0

Estimated prairie acreage in East Central Illinois counties during the rise of Big Agriculture. Credit: Changing Illinois Environment — Critical Trends, 1994



Vivienne Henning is from Oak Park, Ill. She is a May 2019 Illinois graduate with a B.A. in English, earning a high distinction for her honors thesis. She also received the Certificate in Environmental Writing (CEW). Since graduation, she has been working at a nonprofit organization while pursuing a publishing career in Chicago. This article was written for the CEW 498 capstone course in Spring 2019.

It's no secret the ivory trade has been historically responsible for the brutal poaching of African elephants. After China banned all trade in ivory at the beginning of 2018, conservationists hoped for decreases in demand for ivory, and life has indeed improved for African elephants.

But as the world celebrates stemming the ivory trade by making it more risky and less profitable, a new, lucrative market has emerged in elephant parts: skin from Asian elephants. This gruesome new trade is centered in Myanmar, one of the three sides of the infamous Golden Triangle, with Thailand and Laos. Elephant dealers in Myanmar enjoy a profitable combination of high supply without shipping costs and an already well-established black market. Their success means that the 2,000 Asian elephants of Myanmar, of a global population of 50,000, are in grave and immediate danger of eradication. "The new skin trade is so serious that if it's left unchecked, Myanmar's elephants could disappear by 2030," believes Christy Williams, director of the World Wildlife Fund.

SKIN

By Haley Ware

DEEP



Conservation



Credit: Shutterstock.com



With the newfound popularity of Asian elephant skin, the jungles of Myanmar have played host to unspeakable crimes. Credit: The Elephant Family

Beginning in 2014, the nonprofit organization Elephant Family led a full-scale investigation into the Asian Elephant skin trade. Their original focus on the live elephant trade shifted abruptly on their discovery of countless skinned elephant corpses in the forests of Myanmar. Released last April, this 24-page report describes the full dimensions of the skin trade and its

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Since elephants don't reproduce quickly and commit many years and resources to raising their offspring, slaughtering females and babies can mean a fast track to extinction.
.....

impact on Asian elephant populations in horrifying detail.

A Cruel Business

Every elephant has skin, so poachers in Myanmar aren't fussy about the type of elephant they target. Male elephants roam alone in the rainforest, while the unprotected herds of female elephants and their calves are simple to quarry. But indiscriminate hunting can be a self-defeating practice, long term.

A female elephant is pregnant for almost two years, while her calf isn't weaned until age three or four. Since elephants don't reproduce quickly and commit many years and resources to raising their offspring, slaughter-

ing females and babies can mean a fast track to extinction.

The upshot: experienced poachers can wipe out an entire herd in under an hour, meaning the Asian elephant faces an uphill battle to survive. If the skin trade continues to grow, 60 years from now the Asian elephant will not walk among us: It's nothing short of elephant genocide.

To call the killing of Asian elephants grisly would be a criminal understatement. Since the skin is so valuable, crude weapons like shotguns cannot be used. Instead, poachers shoot elephants with poison darts stuffed with pesticide. The poison takes days to slow the elephants' nervous system. A pack of men stalks the elephant victim until it falls from

the intense pain.

While the elephant is still alive, the poachers slide their knives under the skin to separate the fresh blood-filled flesh from the breathing animal. It's vital for poachers that the fallen animal still has blood coursing through its veins in order to bring to market elephant flesh suitable to be transformed into the sought-after jewelry. Once the prey is skinned, the poachers load their bleeding bounty into wooden carts and leave the bare elephant carcass to rot where it fell.

The Smithsonian Institution tracked the dead Asian elephants to monitor poaching activity, and the results are startling. "In 2010, four elephant carcasses were found in the wild," states a report on the elephant skin trade

in Myanmar released last year. "In 2013, the number was 26 and by 2016, it was 61. So far, government statistics for 2017 record 59 wild elephant deaths and confirm that most were poached."

Accessorizing Elephant Skins

Even as pictures of butchered African elephants circulate the web and outrage millions, new pictures of skinned Asian elephant carcasses still require



Elephant skin roll. Credit: Klaus Reisinger and Compass Films

a deliberate search. Sadly, China refuses to recognize Asian elephant poaching even after agreeing to bans on African elephant imports — and China is the global center of the new trade.

While elephant skin holds no known medical benefits, Chinese buyers continue to believe in its ability to treat skin fungi, infections, and intestinal diseases. The false belief in elephant skin medicine is encouraged by major drug companies in China, which stand to gain from the illicit trade.

According to the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES), commercial trade of any part of an Asian elephant is illegal. However, CITES only monitors international trade so domestic laws and claiming non-commercial uses for animal products serve as loopholes for the illegal elephant skin trade.

For instance, China’s State Forestry Administration (SFA) issued a notice in 2015 allowing elephant skin for pilot production in select hospitals. The SFA functions as China’s CITES Management Authority, intended to administer licenses for animal distribution. As a result, the biggest buyers of elephant skin are big pharmaceutical companies in China. The Beijing Huamao Pharmaceutical Co., part of a Chinese state-owned enterprise known as China National Traditional and Herbal Medicine Co. Ltd, is the main seller within the elephant skin pharmaceutical industry.

Outside of Chinese Big Pharma, raw, dried skin of the elephant is also sold online in different grades depending on whether the buyer is interested in medicinal or gemstone use. When used medicinally, the elephant skin is crushed into a powder and sold in bulk or 100mg pills. Meanwhile, elephant skin

boots, jackets, and other leather clothing items attract high-end buyers.

But while medicinal elephant skin has been traded since time immemorial, it is the booming new market for elephant-derived jewelry that threatens ultimate extinction for the Asian elephant. A unique technique designed to create bracelets labeled as “blood beads” aligns with a recent spike in poaching.

Blood Beads and Bloody Markets

When The Elephant Family investigative report on the skin trade sent multiple undercover investigators to black markets in Asia, they determined that the majority of the new jewelry trade in elephant blood beads actually takes place through online forums. The report highlights one prominent internet seller with the simple moniker “Jaz,” who offers innocuous-looking handmade jewelry online. The translucent red beads with the gruesome origin look almost edible, like freshly washed ripe red grapes. Elephant bead merchants like Jaz work long nights to create attractive yet simple bracelets and necklaces.

After creating a stockpile of products, Jaz utilizes multiple platforms, such as Baidu, WeChat, and other Chinese forums, to advertise her wares. Scrolling through a macabre online marketplace, buyers can admire images of the blood beads complete with personal descriptions written by Jaz herself.

The website shows different steps in the



Blood beads — an ugly byproduct of illegal poaching. Credit: The Elephant Family

beading process, offering images of the raw material in different forms in addition to the finished bracelets. In Jaz’s workshop, for example, cutlets of elephant skin are strewn across a cold concrete floor. The photo focuses in on the dismembered mammal, highlighting little hairs poking from the epidermis. Jaz includes the caption “supply is long-term and non-stop” beneath another image holding the skin up sideways to the light. The deep red subcutaneous layer of the recently slaughtered animal glows before the camera’s flash, revealing the fresh blood vessels and nerves. Circles are drawn on the layer, an outline for the artisan to begin making the sought-after jewelry. This square of skin will be cut and folded and rolled into blood beads and the top layer skinned to polish into a pendant before being sold on the black market.

The redder the elephant blood beads, the more expensive and desirable they are. Jaz’s smart marketing techniques have paid off and her business continues to grow. After starting her business in 2014, Jaz, by her own report, can’t meet the demands of her buyers due to



The African elephant enjoys new protections — but remains in dire threat. Credit: Wikipedia

her runaway success. As the products of elephant jewelry dealers like Jaz continue to gain popularity, blood-bead-styled items may become the new ivory. These little balls interring within them stories of such immense pain and suffering are examples of wenwan (or “toys of culture and sophistication”) in Chinese culture. The most common forms of wenwan are carved ivory statues and other handmade products. But since “wenwan” symbolizes education and tastefulness to the upwardly mobile, the growing Chinese middle class continue to find novel forms of wenwan to advertise their status — such as elephant blood beads. Jaz thus faces stiff competition in the blood bead black market. She insists her product is the original and best even as new retailers begin popping up around the web undercutting the price of her blood beads. She uploads photos and updates regularly from the Myanmar-China border, boasting, “I even go to Myanmar and source the raw material myself.”

As popularity for new elephant products rises, Jaz expands her enterprise. In 2017, she posted photos of fresh and dried elephant trunks, with the caption that these were the food of emperors. Invoking the packaged meat industry, her photos variously show “allocating stock” and bulk items “ready for distribution.” When uniquely intelligent, sentient beings like the Asian elephant, already rare, are reduced to “stock” that is “ready for distribution,” an unthinkable extinction can and will happen.

In addition to the thriving online market in Asian elephant skin and its attractive

byproducts, the bloody trade can be found in traditional markets throughout the Golden Triangle. In the border towns of Mong La in Myanmar and Xishuangbanna and Guangzhou in China, market stalls display beautiful jewelry in long glass cabinets. Small hand-carved ivory trinkets lined up like toy soldiers decorate the case’s bottom shelf. The lively traders beckon buyers closer through the bustling, loud crowds.

“They won’t send it all the way from Africa. It’s all Southeast Asia. All elephants are from Southeast Asia,” a Mong La trader explains to an undercover researcher.

Outside of Myanmar government control, Mong La attracts prostitution, drugs, gambling, and an illegal wildlife trade that brings in avid consumers from around the world. Cutlets of elephant skin rest on open displays while hundreds of skin pieces lie waiting for purchase in back storage areas. Even though the majority of these elephant skin traders offer medicinal remedies, all are aware of the fashionable blood beads hitting the market.

Just over 50 miles away, Xishuangbanna’s traders have begun to develop their own elephant beads. Digging through boxes, a trader pulls out a bracelet with wooden-like beads. They’re rough to the touch and appear nothing like the blood beads; but they tell the same disturbing origin story.

“There is someone in Myanmar who can produce it, but their price is too high,” a trader told the undercover researcher. Unfortunately for them, the blood beads require specific manufacturing techniques that most Chinese traders lack.

In the wealthy city of Guangzhou in China, the distant sounds of seabirds and boat horns

echo across the nearby buildings. Crowds of consumers move through jewelry boutiques and medicine shops along the streets, hiding the inconspicuous dealings of the black market.

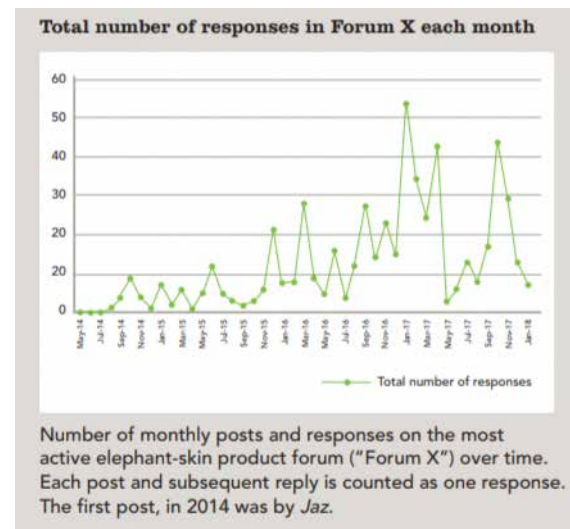
Elephant skin pieces are hidden away until a buyer shows interest. Unlike the cities closer to Myanmar, traders don’t sell blood beads. The humidity causes the orbs to slightly melt and lose their finish. To make up for this, traders boast of their large quantities of raw skin material.

“I can easily supply 10-20 kg,” a dealer told an investigator. He convinced him of the authenticity of his skin by showing the difference in hair follicles compared to a cow or hippopotamus. Traders confirmed the elephant skin was sourced from Southeast Asia, probably Myanmar.

What, beyond outrage, can we take from the horrifying fate of Asian elephants? If the fashion for blood beads and other elephant skin exotica continues to build, the Asian elephant will be extinct in our lifetime. The fate of thousands of elephants already fallen has been sealed into little, red beads. But the fate of those that remain relies on international action to curb the trade, just as restrictions on the ivory trade have halted the demise of the African elephant.

The motivation to stop this brutal trade relies on a simple enough human act: recognition. Recognition that the shiny red beads are made from blood. That the blood was once pumping through the veins of an elephant. And that these gentle giants have as fundamental a claim as we do to live and thrive on this planet.

An elephant never forgets. And neither should we.





LIFE IN THE DEAD ZONE

By April Wendling

In an abandoned village in northern Ukraine, not far from the town of Pripyat, Mother Nature has taken back what was once hers. At the entrance, like many empty villages in the area, a stone is painted with the town name and the number of people who once called it home. Without their owners, buildings have fallen into disrepair, ravaged by wildfires and snowstorms. Aging fruit trees bend under their own weight, collapsing onto rooftops. These settlements remain on maps, but are marked as НЕЖИЛ — “uninhabited.”



The Chernobyl nuclear power plant and evacuation (inset) soon after the accident in 1986. Credits: The Associated Press

These villages aren't quite uninhabited, however. Badgers, boars, and even bears harvest the orchards, looking for a hearty meal. Wild horses feast on the abundant grasses and brush. Even wolves are occasionally spotted looming between the trees. Without any people around to disturb the peace, this place seems like a perfect sanctuary for wildlife.

But this place is no sanctuary by design: It's the notorious Chernobyl Exclusion Zone.

The Soviet Breadbasket

Long before nuclear disaster struck Chernobyl three decades ago, the area that would become the Exclusion Zone was home to playful wolf packs, hard-working beavers and their carefully constructed dams, and wild horses, to name only a few. But even before the fatal spring of 1986, most of these wild animals had already been killed or driven out by human activity. Wolves, in particular, were hunted ruthlessly in the early decades of the 20th century. Everywhere they roamed, they found themselves staring down the barrel of a gun. Reproductive females were targeted, wreaking havoc on the population's age structure and gene pool.

And yet, hunting wasn't even the biggest threat to wildlife.

An all-out agricultural assault on the landscape in the late 1920s and early '30s demolished much of the area's biodiversity.

Rather, an all-out agricultural assault on the landscape in the late 1920s and early '30s demolished much of the area's biodiversity. In a massive national effort, complete with obligatory heroic propaganda featuring images of bountiful harvests adorned with captions like “Day of Harvest and Collectivization,” the Pripyat marshes were drained and deforested. Thousands of miles of canals were built, and tens of

thousands of people arrived to work on the new collective farms.

This so-called land improvement had a single goal in mind: to turn the region into the Soviet Union's breadbasket. Even today, the land just outside the Exclusion Zone looks the same as it did 90 years ago — wheat fields and drainage canals as far as the eye can see.

Coping with the Fallout

Sixty years after this agricultural leap forward, the Chernobyl ecosystem was devastated again in the accident that has become a global byword for the dangers of nuclear energy. Early in the morning on April 26, 1986, as part of a safety test meant to simulate an outage, engineers cut power to components of the Chernobyl Nuclear Power Plant's No. 4 reactor, reducing cool water flow. Due to breaches in protocol while conducting this test, reactivity within the core escalated, causing pressure to build inside as water turned to steam. The operators attempted to halt the reaction by inserting control rods into the reactor, but due to a design flaw in Soviet-era reactors, reactivity spiked. An explosion of steam exposed the reactor's core, and the air that rushed in stoked a fire that raged for 10 days. Plumes of radioactive fallout were carried by wind and rain westwards across Europe. The total amount of radiation released equaled that of 400 Hiroshima bombs.

The next day, Soviet authorities ordered an evacuation of the 49,000 people within a 10-kilometer radius of the Chernobyl power plant. About a week later, the decision was made to expand the Exclusion Zone radius from 10 kilometers to 30 kilometers, and a further 67,000 people were uprooted.

When people living in the Zone were displaced, they were initially told they could return home in a few days. With this expectation, many left their possessions behind. Valuables were stolen by thieves over the years, but old stuffed animals can still be found in children's rooms. Pairs of shoes still await their owner's return on front doormats. The estimate of when the Zone would be safe again changed from several days to thousands of years as



Przewalski's horses. Credit: Michael Kötter



An abandoned schoolhouse in the Pripyat ghost town at the Chernobyl Exclusion Zone. Credit: Adam Jones

realization of the situation's severity dawned on the world at large.

As people fled, other life in the Zone choked on radiation. Directly downwind of the reactor, a large pine forest changed color almost overnight from verdant olive green to rusty umber. Killed by acute radiation, it became known as the Red Forest. Populations of invertebrates declined, initially killed by acute radiation, and later devastated by toxic fallout that settled into the soil where they lay their eggs.

In the following months, Soviet soldiers, called liquidators, were brought in to clean up the contaminated landscape

During her studies of Chernobyl carnivores, Shkvyria has also found numerous toppled trees in the Zone — the handiwork of beavers. In the absence of humans, they've reappeared on the stretch of the Pripyat River that lies within the Zone.

around the reactor. This job was originally delegated to remotely operated machinery to avoid unnecessary radiation exposure. But the intense radiation caused the machinery to break down rapidly, prompting Soviet leaders to send in soldiers who would not "break down" from radiation-related illness until months or years after they'd finished their work.

In areas near the power plant, abandoned machinery is entangled with the landscape — it's unsafe to remove such contaminated equipment from the Exclusion Zone. This is its final resting place. As for the

liquidators, they returned home, but life for them was never the same.

In her book, *Voices from Chernobyl*, Belarusian investigative journalist Svetlana Alexievich shared the stories of countless people whose lives were forever changed by the 1986 disaster. As one liquidator recounts, "I got home, I'd go dancing. I'd meet a girl I liked and say, 'Let's get to know each other.' She'd say, 'What for? You're a Chernobylite now. I'd be scared to have your kids.'"

Others felt more than just the social stigma of radiation. Valentina Timofeevna Panasevich, the wife of a liquidator, describes what became of her husband and his crew: "The first one died after three years. We thought: Well, a coincidence. Fate. But then the second died and the third and the fourth. Then the others started waiting their turn. That's how they lived. My husband died last."

Nature Strikes Back

Once the liquidators had finished their jobs, all that was left in the Zone were the skeletons of old machines and ghostly memories of happier times. But, gradually, like dandelions pushing through the cracks of a suburban sidewalk, the flora and fauna of Chernobyl have reclaimed the land that was once theirs.

In his article, "Animals Rule Chernobyl Three Decades After Nuclear Disaster" in *National Geographic*, John Wendle details an expedition through the Exclusion Zone with Maryna Shkvyria, a wolf expert and Lead Researcher at the Shmalgauzen Institute of Zoology.

As they approach an abandoned village in the Zone,

With the landscape's return to its ancient marshy state, amphibians, fish, shellfish, insects, otters, moose, and waterfowl have returned as well.

Shkvyria scans the landscape, looking for the tracks of large carnivores. In the loose sand, she finds the imprint left by a wandering wolf's toes.

Shkvyria has been studying wildlife in the Zone since 2002. In that time, she's developed unconventional yet effective methods for locating wolf packs.

"We came down here late last spring and howled, and the young wolf pups howled back from the top of that hill," she tells Wendle.

While the Exclusion Zone may seem empty and lifeless, the wolf tracks and feces Shkvyria finds littered about suggest otherwise. The question is, are these wolves really thriving in the Zone, or do wolves from elsewhere come to the Zone and die there?

In another more recent interview, with the BBC's Victoria Gill, Shkvyria noted, "After 15 years of studying them, we have a lot of information about their behavior, and the Chernobyl wolf is one of the most natural wolves in Ukraine."

By "natural," she means that the wolves eat very little human food.

"Usually, wolves are around settlements," she explains. "They can eat livestock, crops and waste food — even pets."

In the Exclusion Zone, however, the wolves hunt for wild



prey. The wolves of Chernobyl are known to feast on deer and fish, while camera traps have captured their more secret, omnivorous habits, such as eating fruit from abandoned orchards.

"Natural" doesn't mean safe, however. In the Exclusion Zone, radiation has settled into the ground on which mushrooms grow. Voles eat the contaminated mushrooms, and the radiation becomes concentrated in their bodies. Then a larger predator like a wolf will come along and eat the voles. This is where the radiation ends up — at the top of the food chain. If radiation is affecting the wildlife, the wolves would be the first to let us know.

As reported in her paper on Chernobyl wildlife from 2012, Shkvyria has found that there are at least six wolf packs, composed of 30 to 40 individuals, living in the Zone.



Animals rule Chernobyl 30 years after nuclear disaster. Shown are trees toppled by beavers. Credit: John Wendle



Fruit in the Chernobyl Exclusion Zone. Credit: Andy Miah



Chernobyl Exclusion Zone forest panorama. Credit: ArticCynda



BELOW: A pack of wolves visits a scent station in the Chernobyl Exclusion Zone. The photograph was taken by one of the remote camera stations and was triggered by the wolves' movement. Credit: National Geographic; Jim Beasley/Sarah Webster

RIGHT: Maryna Shkvyria. Credit: Shkrvyria Lab





A dosimeter reading taken outside of the destroyed Chernobyl unit #4 reactor building. After 30 years, radiation levels just outside of the plant are still high, but not harmful for short periods of time. Credit: Simon Smith, Flickr

These wolves are not migrants from outside the Zone, but rather individuals born and raised within it, indicating that this contaminated area is not, contrary to popular belief, a population sink — at least as far as wolves go.

During her studies of Chernobyl carnivores, Shkvyria has also found numerous toppled trees in the Zone — the handiwork of beavers. In the absence of humans, they've reappeared on the stretch of the Pripyat River that lies within the Zone. Thousands of them have been hard at work, year after year, damming up man-made canals and restoring the marshes. With the landscape's return to its ancient marshy state, amphibians, fish, shellfish, insects, otters, moose, and waterfowl have returned as well. The Pripyat marshes were once so vast they stopped the army of Genghis Khan. Although Soviet-era agriculture cleared them out, the swamps are now back, thanks to the largest, busiest rodent in Europe, and a nuclear reactor.

And it's not just wolves and beavers that are flourishing. Wild horses have returned to the Zone, though not in the way you'd expect. The last species of wild horse left on Earth is the endangered Przewalski, which have only survived in captivity. In 1998, however, a herd of 30 Przewalski was released in the Zone, in hopes that they would graze overgrown areas and reduce wildfire risk. About 60 of these wild horses are now dispersed throughout the Zone, and it's thought that their population could be upwards of 200 if not for Ukrainian poachers.

These horses are native to the wide-open plains of Mongolia, so it seemed unlikely that they'd fare well in a forest habitat dotted with abandoned buildings. "But they're really using the forests," Shkvyria says. "We even put camera traps in old barns and buildings and they're using them to (shelter) from mosquitoes and heat."

Shkvyria's studies also indicate that lynx populations in the Zone are rebounding, and she's even confirmed the visitation of bears to the Exclusion Zone.

Mike Wood, an Environmental Scientist and Radioecologist at the University of Salford, is also studying the resurgence of wildlife in the Zone. Like

Shkvyria and many other researchers seeking to better understand the Exclusion Zone's fauna, he's finding that despite radioactive contamination, wildlife is thriving in the absence of humans.

"We're not saying that radiation is not as dangerous as we thought. Rather, it is possible that in the absence of humans, the stress of radioactive contamination is a manageable one for wildlife populations," Wood said in an interview with *The Telegraph's* Roland Oliphant.

In other words, it's easier for wildlife to cope with living in the shadow of a nuclear disaster than living alongside humans. Jot that down as another sobering lesson of the Anthropocene.

Breaking Down the Zone's Borders

Yes, the animals of Chernobyl are back, but there's an unsettling epilogue to this wildlife redemption story. The Zone's ecosystem now faces a new yet historically familiar threat: the reestablishment of another species — *Homo sapiens*.

Radiation is not uniform throughout the Zone. Just as there are hotspots of radiation in places like the Red Forest and near the reactor itself, there are



Exclusion Zone. Credit: Joshua Smith



also cool spots, especially around the Zone's edges. As the wind carried radiation across the land after the 1986 explosion, some places were spared. Some of these, like the town of Narodychi in the Ukrainian part of the Zone, are being slowly reclaimed for human habitation.

In February 2019, scientists, community members, medical experts, and officials who manage the Zone gathered in a school in Narodychi to discuss redrawing the Exclusion Zone's boundaries. Three decades of research have concluded that much of the outer Zone is safe for food growth, land development, and permanent residency. Most of those at the meeting agreed: It's time to redraw the map.

Outside, a chorus of excited chatter echoes around the school during recess time. Kids are playing on swing sets and seesaws in the sunshine. A picket fence painted in bright rainbow colors surrounds the playground — it sticks out like a sore thumb against the blocky gray buildings looming nearby.

This leaves us with an uneasy question: If human beings return to parts of the Exclusion Zone, what will become of the animals that call this place home? It's hard to say...

It's worth noting that most of the villages that could potentially be removed from the Exclusion Zone are already inhabited by a small number of people. Many of those who, at the time of the explosion, lived at the outer edges of the Zone, and even a few who lived deeper in the Zone, have returned during the last 33 years. As research has shown, wild animals already tend to avoid populated

areas like those slated to be removed from the Zone, so perhaps this change may not greatly affect them. Perhaps.

The Chernobyl Exclusion Zone is currently home to at least six wolf packs, 60 Przewalski horses, thousands of beavers and their dams, otters, moose, many species of fish and waterfowl, at least a few lynxes, and a wandering bear or two, all of which share an uncertain future if human settlement is to once again curtail the wildlife habitat within the Zone. The Chernobyl Exclusion Zone is also currently home to the handful of families who came back to their homes after they were forcibly uprooted by a nuclear disaster. It remains to be seen if the people and fauna can all coexist — though history suggests the answer is no.

But perhaps we can do better this time. After all, sooner or later, we'll all have to learn to coexist with our wild neighbors — not just in the Exclusion Zone, and not just in Ukraine, but everywhere, from Chernobyl to Champaign-Urbana.



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Kindergarten in the Exclusion Zone. Credit: Jemma Cox



TWILIGHT ON THE GILA

By Jenna Kurtzweil

The day dawned cool and overcast in the Gila National Forest in New Mexico, its fingers crossed for the late-blooming monsoon. But the serenity of the scene did not extend to me and my traveling companion Taylor Jennings. While the season's first true rain sent locals running excitedly for their gauges, it offered less-than-ideal conditions for two Midwesterners taking their first pass at mountain driving. Fortunately, the summer rain turned out to be just that; the sky cleared as we took the switchbacks at a brisk 15 mph.

Our hand-drawn map led us northbound on Route 15, a road that could only be breathtaking from the passenger's seat — for a driver, it was all white knuckles, hugging the inside lane, and stealing glances at the quilt-like sprawl of hazy blue mountains and green canopies below. We paused with the windows down at every outlook and overhang, soaking up the silence and sagey high-altitude aroma. Philip Connors, a veteran fire lookout on the Gila, has written about “those mornings of fresh-scrubbed serenity that made the forest look like a world at the dawn of time.” This was one of those.

A view of the Gila National Forest from Route 15.

We more or less stumbled into our first close-up encounter with “New Mexico's last major free-flowing river.” We were passing through a secluded campground, sequestered from the casual tourist by two hours of hairpins and cattle guards. Tucked away between tree trunks and beneath rocky ledges, patterned with the shadows of circling turkey vultures, a modest slice of the 650-mile-long waterway wound into view. For us, it was a low-key introduction to the iconic Gila River, a cherished natural resource of the West now subject to a controversy that has brought centuries of political wrangling and cultural conflict to a boil. We were here to trace the history of that controversy, which turned out to be as sinuous and rich as the river itself.

‘Wilderness with a Capital W’

In 1924, famed naturalist Aldo Leopold coined the term “Wilderness Area,” referring to spaces devoid of roads, today's cell towers, and any lingering ghosts of the Industrial Age. In the same year, the U.S. Forest Service protected an unprecedented 500,000 acres to form the first-of-its-kind Gila Wilderness. The adjacent and aptly named Aldo Leopold Wilderness was designated in 1980.

Fast-forward to 2019. The Gila National Forest is home to not only America's first Wilderness, but its most threatened river. According to *America's Most Endangered Rivers of 2019*, two threats contribute to the Gila's vulnerability. The first is climate change: rising temperatures threaten to shrink the mountain snowpack that feeds



A monarch butterfly along the Gila River.

the Gila's headwaters, disrupt the region's indispensable monsoon, and catalyze extreme wildfires (which Connors calls “the most photogenic expressions of the Anthropocene”). The second — and most immediate — reason we had taken up our sunscreen and ventured southwest is a proposed dam diversion on the Upper Gila that would not only put the river itself at risk, but the myriad flora and fauna it sustains.

As rain resumed pelting the windshield, we headed back to our night's lodging, weaving in and out of spruce-fir forests, potholes, and spotty cell reception, already won over by America's First Wilderness and the river that wound through it. It was easy to understand Connors' description of the region as “Wilderness with a Capital W,” and equally easy to see how so many communities — human, flora, and fauna alike — had a stake in its future. Exactly what those stakes were, though, we as yet had only a dim understanding. In the days that followed, the Gila community gave these two students from faraway Illinois a crash course in environmental politics we won't soon forget.

Damn the Diversion!

Silver City, a vibrant New Mexico community just south of the National Forest, was our home base for the week and the place to be for all things Gila.

Our first meeting was with Adam Mendonca, USDA Forest Supervisor of the Gila National Forest. A Silver City local, he had served on the Gila Fire Crew before transitioning to fighting bureaucratic blazes in the office. Mendonca explained that the Forest Service's role is often to mediate from “the middle of two polar opposites” — between interest groups ranging from mountain bikers and horseback riders, to ranchers and American Indian tribes, to the state and federal governments. Our request for a “simple summary” of the Gila River dam diversion was met with raised eyebrows that clearly said, *good luck*.



The Gila River in Cliff-Gila Valley, N.M. Credits: Jenna Kurtzweil

Mendonca emphasized that the forest service’s management goals are “based on communities’ connections to the landscapes they live around.” The more conversations Taylor and I had, the more this point crystallized: Stakeholders on the Gila River differed wildly in mission and motivation, but were united in their drive to engage with the landscape in the way they thought was best (“best” being the contested and highly subjective term).

Attempts to optimally allocate Gila water have been underway for years, but the most relevant legislation occurred when President George W. Bush signed the Arizona Water Settlements Act (AWSA) in 2004. Then, in 2015, a total of 15 New Mexican water users representing agricultural interests — the so-called NMCAP Entity — assembled to implement a major project that involved a Gila River dam diversion. The NMCAP Entity had been allocated \$66 million and 14,000 acre-feet of water per year, with \$62 million tacked on should the project involve diverting the Gila and/or San Francisco rivers. Diverted water would be used for local ranching and farming irrigation, with excess either stored for times of drought or (more controversially) sold.

Taylor and I didn’t have to travel far in Silver City to find passionate opponents of the dam diversion scheme. The Gila Resources Information Project (GRIP) office, wrapped quaintly within downtown Silver City’s mural-patterned storefronts and eclectic antique shops, was identifiable not by the sign swinging from the doorframe, but by the DAMN THE DIVERSION bumper sticker emblazoned on a car parked outside.

In the little office, we found representatives of GRIP, the Upper Gila Watershed Alliance (UGWA), and the Gila Conservation Coalition (GCC), who have joined forces to defend the Upper Gila River Basin’s wilderness areas and their rivers. Seated at a wooden table piled high with maps and brochures, we posed a question to directors Allyson Siwik and Donna Stevens: “Why are these areas worth protecting?”

Stevens’ response was succinct and immediate: “Because they’re there.” She added, “The river can’t speak for itself, and it needs defenders.”

The Gila diversion has driven a stubborn, highly ideological wedge between groups like the GCC and the NMCAP, a wedge so polarizing, claimed Stevens, that reconciliation might be impossible: “The water that we have, we have to treat it with respect! And the people on the CAP Entity don’t look at it that way, they look at it as a resource.”

Siwik and Stevens consider “the most junior project on the river” to be solely motivated by the government’s subsidy. Without the government dangling a \$62 million carrot in front of the NMCAP, the diversion wouldn’t — and shouldn’t — happen. According to them, it would be better to use those funds for climate change resiliency and help with resource management for local communities. (Similar reallocations are demanded of New Mexico Gov. Michelle Lujan Grisham, who publicly opposes the diversion.)

The exasperation in the room was palpable. At one point,



The GRIP office in Silver City, N.M.

Siwik asked: “Can’t we as a society say the Gila is a special place? It’s one of the last special places we have in the state.”

Ninety-five years ago, Aldo Leopold posed the same question. His famous

“land ethic,” published in 1949 to encourage respect toward nature, was holy writ in the GRIP office 70 years later. Taylor and I left with a stack of informational materials in hand, and a fast-growing realization that this issue ran deeper than we could have ever imagined.

“Go jump in the river!” Stevens called as we passed the DAMN THE DIVERSION bumper sticker. “You’ll be charmed by it, I expect.”

‘Dollars and Cents’

Western New Mexico University (WNMU) sits on a hill overlooking Silver City, and it was there that we turned for answers on our last full day in town. With Stevens’ and Siwik’s impassioned testimony fresh in our minds, we pooled our curiosities and asked Sam Schramski — current Ph.D. student, social-ecological researcher, and climate change expert — the impossible question. Who is right, and who is wrong?

Schramski painted the situation as a spectrum. Far to one side are the GCCs, UGWAs, and Leopolds of the world, defenders of the cottonwoods and willow flycatchers, who, like Connors, equate the diversion to “the death of the river below the dam.” On the other end is the “crude dollars and cents calculation.” But, Schramski cautioned, “It’s not just a dollars and cents conversation.”

Throughout the trip, we struggled to understand the dam proponents’ position on such a spectrum. Typically, the NMCAP — composed mostly of farmers and ranchers — aligns with the financial short term rather than the environmental long term, their priority being the upcoming growing season. This is especially true in the American Southwest, where farming in itself is not particularly lucrative. So, why do it?

Sam explained: “The ranching identity, independent of how lucrative it is, is huge.” Ranching on the Gila watershed traces to the mid-19th century’s mining boom. Seven-odd generations later, many of those families still farm the same land. Staunch environmentalists and economists alike might objectively question the use of Gila resources to sustain such a small (and, as statistics suggest, aging) cluster of heritage farms. But for the farmers themselves, it’s anything but objective — it’s their life.

As the binary of the impassioned environmentalist vs. crude economist dissolves, a right-and-wrong conversation quickly sours. Earlier in the summer, Taylor and I had connected via email with an NMCAP representative from the Gila Farming Irrigation Association, who expressed



USDA Forest Supervisor Adam Mendonca at the Silver City Ranger Station.



Western New Mexico University Ph.D. student Sam Schramski.



The Nature Conservancy's Martha Cooper takes the authors on a tour of the Gila River Farm.

that the organization's endgame desire was to ensure the river's protection — an opinion that would surely have been contested back in the GRIP office.

Clearly, this issue's gray area spreads far and wide — making it not only more difficult to digest, but more difficult to arrive at a crowd-pleasing conclusion. "In an ideal world," Sam offered, "you displease everyone a little bit." It's the classic compromise: everyone succeeds and everyone suffers. But right now, it was all too clear that the suffering party was the river itself.



Downtown Silver City.

Down to the River

Taylor and I left WNMU and headed to the Cliff-Gila Valley in Cliff, N.M., one of the three proposed diversion sites. Our brains cycled through reflections on cows, compromises, ranching, and rivers as we motored toward a mirage-like spine of mountains looming low in the distance.

A half-hour outside Silver City, we pulled onto Box Canyon Road and counted mailboxes: one, two, three ... turn right. We'd arrived at the Gila River Farm, a property of The Nature Conservancy (TNC), and were greeted by Martha Cooper, a TNC Field Representative. Like Stevens and Siwik, Cooper spoke fondly of the Gila's riparian landscape and the organisms that call it home. Like Mendonca, she occupies a role of supposed official objectivity, as the TNC has hands in irrigation and environmentalism alike. Like Sam, she sees the sore need for compromise between the two.

"People were pretty cordial and friendly early on (when the AWSA passed), and this has been so contentious," she said. "At times, it's made these relationships seem really fragile, because people pick sides. ... That, to me, is just a lost opportunity. You have a wad of federal money, like what an opportunity to do great things! And instead it's just like 'no, let's just spend our energy fighting.'"

After our chat, Cooper suggested we refill our water bottles and "go on down to the river." Despite the heat and mosquito warfare, she graciously treated us to a walking tour of the property. But when we arrived at the river site,

ready to take Stevens' advice and jump in, there was no running water to be seen — just a crater-like puddle in the center of a dry riverbed. The Cliff-Gila Valley, Cooper explained, is a hotbed for over-irrigation, and the Gila River Farm is a prime example. Two irrigation ditches in the vicinity had realized one of TNC's worst fears for the Gila: low flow rates. Proposed diversion action could result in further dewatering — a problem exacerbated by the effects of climate change and the increasingly tardy monsoon.

We weren't the only ones surprised by the Gila's less-than-riverlike state. Recently, the Children's Water Festival was held at this location to allow Silver City fifth-graders to experience the river. "The weekend before the Water Festival," Cooper said, "the irrigators redid their dams and dried up the river. At the end of the day one of the kids (asked), 'When are we going to the river?'"

Truth be told, Taylor and I felt much the same way.

On the sun- and sweat-drenched trek back to the farm, we picked our way around gopher holes as Cooper explained what she found most compelling about the current controversy. Urging us to steer clear of the political weeds, she expressed that she is "way more interested in the place, and what it has to offer to nature and people. ... To me, it's the story of the place that is threatened by both climate change and the AWSA." She paused to pick up a plastic bottle cap that had fallen onto the path. "People love this place," she added, thoughtfully stowing the piece of trash in her pocket. "That's true whether you're enviro or whether you're descendants of a homesteading family.

And I think there is a commonality that we completely ... forget about because our values are so different. But people love this place."

We left feeling emboldened, inspired, and — thanks to Cooper — more hydrated than we had been when we arrived. With our shoes muddied and skin sunburned, we felt like we'd really "met" the Gila that day ... even though we hadn't seen much of it at all.

As we raced mounting storm clouds back to Silver City, we hopefully dialed one last phone number: Joe Saenz, a member of the Apache Nation and owner of the local store Wolfhorse Outfitters. Saenz had returned from leading a week-long pack trip through the Gila Wilderness accompanied by just one fellow hiker, their two horses, and what supplies they could carry. We were able to get in touch and arrange a meeting for the next day.

'It's Our Homeland'

Like most of the West, New Mexico's water policy is allocated according to prior appropriation: "first in time, first in right." On that basis, one could argue that the seeds of today's controversy were sewn thousands of years ago. Certainly, there can be no discussion of the Gila River without foregrounding the indigenous communities who have historically relied on the river's resources for survival.

On our final day in Silver City, Taylor and I pulled up chairs in the front yard of Saenz's home, which doubles as his place of business. We were lucky to end the trip



Joe Saenz discusses the Apache Nation's historical homeland along the Gila River.

with beautiful weather: sparrows hopped around our feet; crickets chirped from nearby trees and grasses; the small herd of horses snorted from their enclosure out back, restless for their next adventure. Saenz began the conversation by discussing his role as a representative of the Chiricahua Apache Nation, whose ancestral territory lies at the convergence of northern Mexico and the southwestern U.S.

"It's our homeland. This is our traditional country. The history that you have been told has been a lie, regarding our occupation and our presence here. ...We have been here much longer than anybody realizes," he said. "Our history, and our understanding, and our knowledge, and our relationship with this land has never changed."

"What we believe is that there is a reason why the Gila is the last free-flowing river in the state, and why the Apaches here were the last tribe to be settled."

The Gila Wilderness — "center of the 'northern stronghold' and traditional 'summer grounds'" for the Chiricahua Apache — was permanently colonized by Europeans in the late 1800s. After centuries of conflict with Mexican, Spanish, and European forces, 20 years of intense warfare with the U.S. military, and Geronimo's surrender in 1886, "the Chiricahua tribe was evacuated from the West and held as prisoners of war ... in Florida, in Alabama, and at Fort Sill, Okla." Now, "greater numbers (return) to (the Chiricahua Apaches') traditional territory every year." Saenz considers himself a part of this return, bound for reclamation and recovery.

"We're trying to come back to the area to establish that standard of relationship with this land. And it's been really

difficult," he said. "People are nervous. ... There's three major Apache organizations now in the area that are all trying to establish (ourselves), and use our history and empirical knowledge of what this land is about."

Recognizing historical parallels is crucial to the Gila's current situation, riddled as it is with miscommunication. "The philosophies were so different that it led to war," Saenz said of 19th-century colonization. "But that war was between two different cultures, and what we see right now is a war within a culture. ... What we see is a culture that has two extremes, and that's why this fight over this land and over the resources (is) going on."

While groups like the GCC are allied to the cause, the battles are slow-going and fraught with opposition. "The problem with a lot of this perception of this country is (that it's) sacrifice country," Joe explains. "Not that many people are out there, or the people out there don't matter much."

"That's going to demand a lot of pushback, and that's where we are. We're here to push back, we're here to complain, we're here to make noise."



A Gila River farm.

The Gila Box Riparian Preserve in Safford, Ariz.

With Saenz, we felt traces of the exasperation present in the GRIP office; we also felt the same resolve. Saenz outlined the odds he sees himself up against: "The American corporate mentality is ... take, take, take, and if it falls apart, who cares?" Clearly, he not only cares deeply, but is determined to pass on his conviction to others. Amid inequities, marginalization, and racial oppression still rampant in the region, Saenz campaigns from the courthouse and with his business for fair treatment of the land and its occupants. "Our effort here is to restore balance," he summed up. "Cultural, social, economic."

After returning our lawn chairs to their rightful locations, we strolled over to the horse enclosure, where the interested herd ambled our way. Whenever the horses turned their backs, Saenz reassuringly patted them on the rear (it's how they're trained not to kick). "We're pretty stubborn," he concluded, giving a black-and-white horse named Oreo a gentle pat. "We don't want to give up."

For better or for worse, we thought, driving west out of Silver City for the final time, this is a community of people who don't want to give up.

For the remainder of our trip, we traced the Gila's path back to Arizona in the most well-traveled vehicle ever rented from Tucson International. We spent a 105-degree afternoon at the Gila Box Riparian Preserve in Safford, Ariz., where the river left a blue-and-green snail trail on the otherwise arid landscape. We passed through the San Carlos Apache Reservation, home to the Gila-fed San Carlos Reservoir and one of the communities that "refus(es) to be a party to virtually any aspect of the (dam diversion) project". Our westernmost stop was Gila Bend, a small town built circa 1872, named for the river that gave it life. We cruised through deserts, saguaro forests, mountain passes — seeing traces of the Gila at every turn. Nobody wanted to give up, it seemed, not even the river.

Saenz spoke of a war for resources, a war between factions of a culture divided. The Gila is only one of this war's many battlefields. Several interviewees referred to the river as a microcosm, a signal river — for New Mexico, the Southwest, America, the world. An example of what's happening elsewhere and a harbinger of what's to come. And the Gila's future is no doubt coming soon. Maybe, as Connors hopes, 2020 will bring "the death of the dream of a dam on the Gila." Maybe not. Either way, the outcome will ripple across the worlds of water management, conservation, and environmental justice far beyond this watershed. In the meantime, the words of one of the passionate defenders of the Gila echoed in my head:

"Go jump in the river! You'll be charmed by it, I expect."



A dry riverbed at Cliff-Gila Valley.

EDITOR'S NOTE: It's good news for the Gila! As of Dec. 20, 2019, the U.S. Department of the Interior officially rescinded the NMCAP Entity's right to the \$50 million for the dam diversion project. By rejecting the Entity's requested extension to their timeline, the DOI has effectively stalled development indefinitely.



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Communications Intern and the *Q Magazine* Student Editor for Volume 2, Issue 1. In September 2019, iSEE hired Jenna as a Communications Specialist — and she now serves on the *Q* Editorial Board.



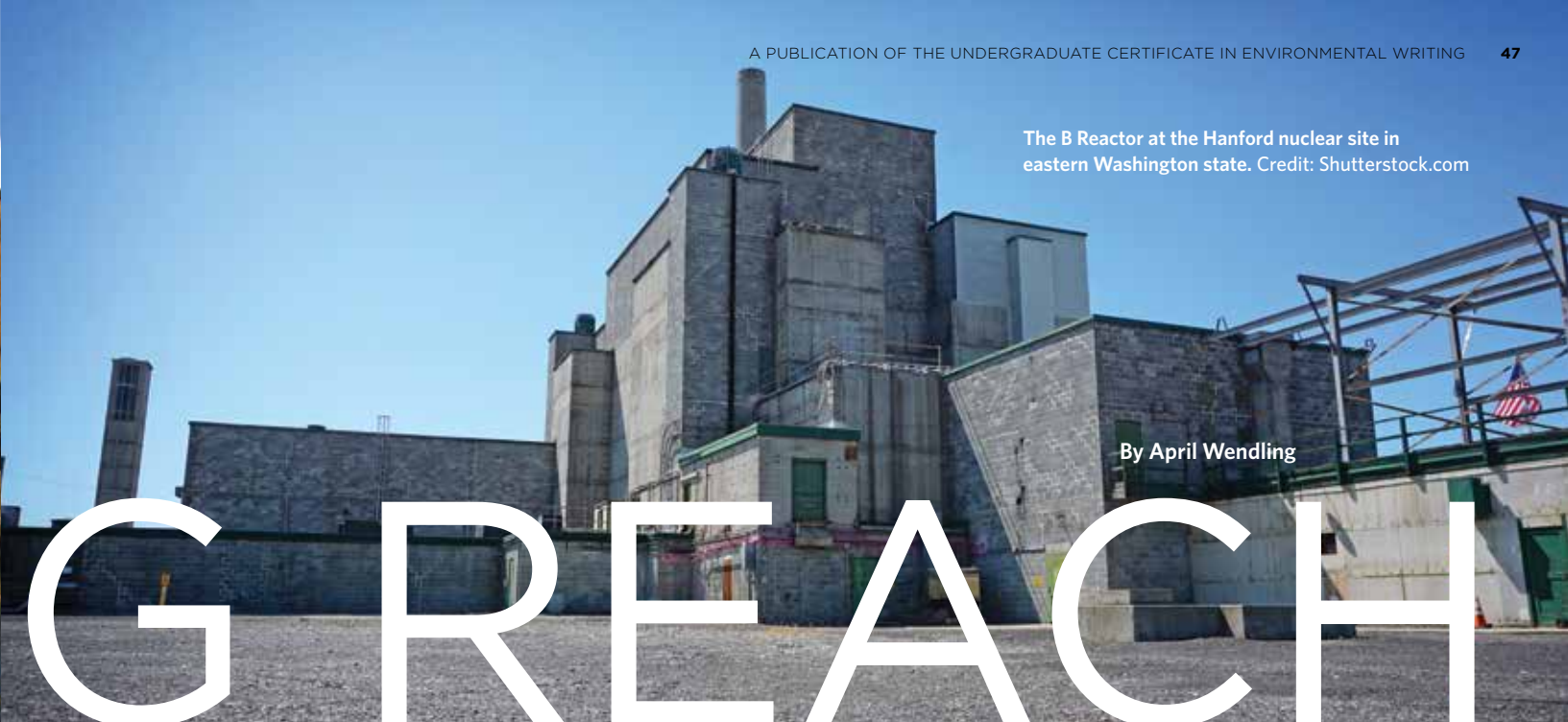
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Jenna and Taylor's research trip to the Southwest was sponsored by a generous donation from Janelle Joseph.



White bluff cliffs on the Columbia River Hanford Reach area. Credit: Shutterstock.com



The B Reactor at the Hanford nuclear site in eastern Washington state. Credit: Shutterstock.com

By April Wendling

THE LONG REACH

As sunlight dawned over Richland, Wash., townsfolk bustled about, eager to start the day. In the faint chill of the early morning October air, I wove through the streets on my bike, navigating past the Atomic Ale Brewpub & Eatery and a mall with an outsized atomic logo. Richland's close identification with the nuclear age was, I knew, no accident.

With Google Maps as my guide, I set out that first day from Richland on a 43-mile expedition to the famous Hanford Reach National Monument. The mighty Columbia River intersects the monument, giving the area a

variety of habitat types and richer biodiversity than is typical for Washington's temperate desert landscape. The contrast with "atomic"-themed Richland was stark, but that was precisely the attraction. I had come here to understand better how this great, fertile river played its part in the creation of history's most destructive weapon, and how it suffers still from that toxic association.

My reward that first day was meager. After a four-hour ride, I found myself standing before a locked gate and a sprawling metal fence. Nearby, a bull snake retreated at my approach. Here the reputedly public Hanford

Reach National Monument was actually not open to the public — only researchers had clearance to enter.

Atomic age secrecy, it seemed, dies hard at Hanford.

The following day, sore as I was from my previous eight-hour biking escapade, I rode out to a small building on the highway called the B Reactor Museum. The B Reactor was the world's first large-scale nuclear reactor and, today, I'd be taking a tour.

All the tour-goers filed into a van, and we drove back along that endless expanse of

road I'd biked the day prior. Our tour guides gave us a crash course in the B Reactor's history as we drove.

The Manhattan Project West

"Back when World War II was raging on with no end in sight, the Manhattan Project was set in motion to produce the world's first nuclear weapons," one guide explained. "Tension was high, as suspicions had arisen that Nazi Germany was also trying to create an atomic bomb."

On Dec. 2, 1942, the first man-made, self-sustaining nuclear chain reaction was initiated in Chicago, during an experiment led by Enrico Fermi. Using uranium, it produced a new, more potent element: plutonium.

With this success, the hunt was on for a remote location to house full-scale plutonium production. The site would require a large supply of water, ample electricity, and an expansive, lightly populated area.

The small agricultural community of Hanford, Wash., fit the bill perfectly. The adjacent Columbia River provided plenty of water that could be pumped through the reactor core to keep it cool. Upstream was the Grand Coulee Dam, which could provide power for the site. In early 1943, only some 2,300 people — mostly farmers — lived in the Hanford area. Residents received the stunning notices in the mail: They had three months, at most, to vacate their homes. Because of the secrecy surrounding the Manhattan Project, explanations for their eviction were vague at best. When the farmers who lived in Hanford were ordered to vacate their homes on such

short notice, they were given compensation for their land. But it was often insufficient. Appraisals frequently left out valuable assets such as fences, irrigation systems, and even entire buildings. These were forgotten home-front victims of the U.S. nuclear program.

Construction workers were brought in immediately to the newly christened "Hanford Engineer Works." Power loops and substations, piping systems, sewage facilities, and construction camps for workers were hastily assembled. Crews began work on the first full-scale plutonium production reactor, called the "B Reactor," followed by reactors D

and F. To maintain secrecy, few workers even knew the reactor's purpose.

After the B Reactor's completion in September 1944, loading of uranium fuel into the reactor began. Plutonium derived from the B Reactor was used in the first atomic bomb test in New Mexico during the summer of 1945. The subsequent bombings of Hiroshima and Nagasaki in August 1945 killed about 200,000 people, mostly civilians. Five days later, Japan surrendered and WWII was over.

The Hanford Site continued operation through the Cold War. At the peak of Hanford's



The Columbia River at Richland, Wash. Credits: April Wendling

I had come here to understand better how this great, fertile river played its part in the creation of history's most destructive weapon, and how it suffers still from that toxic association.



Rattlesnake Mountain.



The B Reactor control room.



B Reactor core.

production, the site featured nine nuclear reactors and five large plutonium processing complexes. As the demand for nuclear warheads dwindled, most of the reactors were decommissioned during the late 1960s and early 1970s.

The Aftermath

What does retirement look like for a wartime nuclear reactor?

These days, the majority of Hanford's reactors are sealed to allow radiation levels to safely decay before the reactor is dismantled. The B Reactor, however, remains intact, and has

been cleaned up to accommodate tours such as the one I was on. Just to be safe, I had brought a dosimeter — a device that measures radiation levels.

Approaching the Columbia River, we took a turn into the gated-off Hanford Site. A blocky gray building with a towering exhaust stack gradually came into view: the historic B Reactor.

As we exited the van and walked into the reactor building, I checked my dosimeter — I was absorbing no more radiation than I would back in my apartment in Illinois.

Towering before me was the reactor face. "Back when it was in operation, this is where workers would insert new fuel rods into the reactor," our guide said. "It measures 36 feet tall by 28 feet wide and was cooled by 75,000 gallons of water per minute."

At the end of the tour, we were given time to scout the rest of the building on our own. Many of the rooms featured old signage from when the reactor was operational. Radiation zone warnings, work procedures, instructions for the handling of hazardous materials ... you name it. One genre of sign in particular caught my eye: "Silence means security — For the safety of all, don't talk." Definitely a wartime atmosphere.

The next day, I toured what little remained of the town of Hanford. Most of the buildings had been demolished to make room for the Manhattan Project West, but the town's bank still stands.

Not far away I came to the remnants of the local high school; only the walls are standing. It was hard to imagine that the entire town was displaced over the span of a few short weeks in the early 1940s.

A Contaminated Ecosystem

So, I had seen human traces of the Hanford project decades ago. But what about the "long reach" — less visible legacies of the atom bomb for the Hanford Reach ecosystem and its residents?

The Reach is teeming with life. Stands of green and grey rabbitbrush and bluegrass

blanket the landscape, along with other bunchgrasses, shrubs, and wildflowers. Closer to the river, bitterbush and sagebrush dominate the sandy shores with their sturdy roots. Below ground, badgers and coyotes dig their dens while, high in the sky, migrating birds make a stop at the Reach to snag fish from the river. Particularly abundant are salmon, which migrate up and down the Columbia each spring.

As winter melted into spring, the pre-settlement indigenous tribes of the Columbia River basin used to gather where the river itself converged. Although they lived apart for much of the year, these tribes shared a language and culture. The salmon harvest was a time of meeting and celebration. It was also a time for hard work as they caught, cleaned, and dried enough fish to last throughout the year.

Unfortunately, this landscape would be lost to the tribes in the years to come. When Euro-American farmers settled the area, they displaced the indigenous people and treated their own crops with hazardous chemicals. These chemicals poisoned the landscape so disastrously that they still pose a threat to human health today.

Inevitably, things only got worse after the nuclear reactors were constructed in Hanford. Those who were downwind of the Hanford Site were exposed to radionuclides, particularly iodine-131, with the heaviest releases from 1945 to 1951. During the Hanford Site's early days, workers took little precaution with the disposal of nuclear waste — and

sometimes just dumped it into the soil. These radionuclides entered the food chain via dairy cows grazing on contaminated fields, eventually making their way into milk and other animal products. Studies have shown a connection between these exposures and preterm births along the Columbia.

Another source of contaminated food came in the form of fish from the Columbia River. From 1944 to 1971, pump systems drew in water from the river to cool the reactors. After its use, the water was held in retention basins for several hours before being released back into the river. Unfortunately, several hours is not nearly enough time for longer-lived radioactive isotopes to decay, so several terabecquerels entered the river every day. When the reactors were active, radiation became highly concentrated in the river's fish and permeated the food chain. This disproportionately affected the indigenous people of the area, as the Columbia's fish are a significant part of their diet and culture.

"There is evidence of a vast amount of cancers and related illnesses now in the Yakama people," Yakama Nation elder Russell Jim said in an interview with Cynthia Kelly for the Voices of the Manhattan Project by the Atomic Heritage Foundation. "The Columbia River is the lifeline of the Pacific Northwest. It has been such since the beginning of time. And now, for instance, you have a study by the Environmental Protection Agency that says, 'The indigenous people have one chance in 50 of getting cancer from the chemicals if we continue to eat the fish from the Columbia, especially around the Hanford area,' as

we have in the past. ... There is a concerted effort now by the Yakama Nation to influence the cleanup of the site. We know that it will never be returned to pristine status in the next 500 years, but at least there should be an effort to set the stage for cleanup."

Cleanup Efforts

Russell Jim is right. Decades have passed, and we're only just starting to tackle cleaning up all the nuclear waste — originally stored in underground tanks at Hanford. More than a third of the 177 tanks have leaked. Lurking below, an area of contaminated groundwater the size of Seattle has raised serious concerns in recent years. There are cleanup efforts in place — the basic idea is to process the waste into harmless glass logs — but they're far behind schedule. Construction of the processing plants was supposed to be completed by 2007, but that date has kept slipping further into the future, to 2011, then to 2019, and recently all the way to 2036.

That's not to say no progress has been made. Waste from the oldest tanks has been transferred to newer tanks that feature a dual-shell design, which offers extra insurance against leaks. And in 2015, workers treated 2 billion gallons of groundwater. But the vast majority of the contaminated groundwater still sits below the site.

In an ironic twist, some of the most chemically unsafe areas of the Hanford Site legally cannot be cleaned up by the Hanford cleanup teams. In fact, these chemically unsafe areas aren't even associated with plutonium



Hanford High School.



B Reactor historical signage.

production — they're the result of the potent chemicals farmers once sprayed on their crops, before the Manhattan Project even took shape. For their own safety, Hanford nuclear cleanup crews are forbidden to clean up agricultural waste.

Another problem is that we don't really have a good idea of how contamination has affected the Hanford Reach. Many modern studies of the Reach's salmon populations are inconclusive, and there's little documentation of contamination in terrestrial species. While it's true that other contaminated habitats tend to cope reasonably well with the threat

of radiation exposure, that's no reason not to study how Hanford's ecological community is holding up.

So what can we take away from Hanford? Like many other places around the globe, there's a deep and complicated environmental history here, but you'll only see it if you take the plunge into the past, both ancient and modern. The Yakama People and other tribes used to live in harmony with the land here, without fear that the food they ate might bring them harm. Farmers then made their living off Hanford's soil, but in doing so, they damaged the land with dangerous chemicals. And then

the government seized the land, both from the flora and fauna, and from the people who called Hanford their home, to advance the deadliest war munitions program in history. Radioactive waste dumps and leaks were frequent in those years and the decades that followed. Although cleanup measures are now being taken, they aren't nearly enough.

Even today, with World War II and the Cold War receding in our collective memory, there's a distinct lack of transparency when it comes to owning Hanford's contamination problems and funding solutions for its residents, both human and non-human.

The old signs I saw in B Reactor put it bluntly: "Silence means security."



Another view of the exterior of the B Reactor.



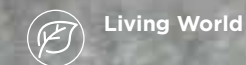
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April's research trip to the Northwest was sponsored by a generous donation from Janelle Joseph.

YOUR FRIENDLY NEIGHBORHOOD COYOTE

By Amber Volmer



Credit: Shutterstock.com

I don't remember the first time I heard the eerie, piercing yips of the coyote. Maybe it was when my father built a chicken coop at the end of our backyard near the wood line. I was charged with collecting eggs, their warm, hay-crustured surfaces resting gently in my palms as I ran up to the kitchen to present them to my mother. The chickens, heads jerking in time with their steps through the dirt, remained in the coop except during cleaning. It was important, my dad instructed, to keep the door secured. Animals in the woods — raccoons, foxes, the wily coyote — could snatch up roaming chickens as easy prey.

The coyote was no stranger to our wooded west Cincinnati suburb. Many a night, our neighbors would call. A coyote was lingering along their fence line, perhaps, agitating their dogs. They'd warn everyone: "Keep small pets inside; keep chickens secured." I remember hearing the howls — distinct from the baying of neighborhood canine pets — echoing through the stillness of the night, the coyotes themselves hidden in the darkness. One morning, our coop was nearly empty, feathers carpeting the dirt floor. A hole gaped where the chicken wire had been separated from the beams. A predator had broken in, and all the chickens were gone.

Years later, I was driving home from work at dusk — same neighborhood, different house — when a shape darted out of the trees alongside the road. A lean, furry body halted directly in front of my car, and I jolted to a stop. I swear it made eye contact, relishing its momentary control. I didn't know what it was at first. Doglike, but not quite a dog — its ears too pointed, its tail too bushy, its snout too narrow. The encounter couldn't have lasted more than a second before it broke away and dashed across the street into the trees, but it was several heartbeats later before I heard the internal whisper, *coyote*.

I gave a short, startled laugh, and eased my foot from the brake. I'd made this drive countless times before, never seeing more than a squirrel on the side of the road, or maybe a deer. I never expected to see a coyote so close to the city. I certainly hadn't thought about them in many years. My mind was occupied with the strangeness of what just happened, before zeroing in on a single thought: Was I really so different from that little girl collecting chicken eggs that I couldn't recognize a coyote standing directly in front of me?

A Natural-Born Survivor

A hundred years ago, coyotes were a rare sight on the streets of Cincinnati. Further back in time, records from the early Holocene — our current geological epoch — show that the coyote's native range encompassed much of the arid West and the Great Plains, but not the Midwest. The creatures roamed the West for more than 10,000 years before rapidly spreading across the continent in the early 1900s. What unleashed this sudden expansion?

As American pioneers eradicated forests, fragmentation resulted in more pastures and fields, open areas to which the coyote was well adapted. Even more auspicious, though, was the brutal war declared against apex

predators in the 1890s. With the virtual elimination of the wolves and mountain lions that regulated the coyote population, coyotes were no longer confined to prairie and desert. North, east, west, and south, coyotes breached forest habitat, extending their range to include the taiga, deciduous forests, and coastal temperate and tropical rainforests of North America.

Low populations on both sides — the diminishing wolves and the encroaching coyotes — resulted in interbreeding between the two species for survival. With new wolf genes, hybrid coyotes developed an altered, advantageous morphology. Larger body sizes made preying on white-tailed deer much easier, and the coyote's range expansion accelerated further. Today, the new hybrid coyotes flourish in North and Central America from the Atlantic to the Pacific and from Alaska to Panama, where the Darien tropical forests represent a flimsy last line of defense against a coyote invasion of South America.

Given the ease with which coyotes have conquered the wild areas of the continent, is it a surprise that they have invaded cities just as effortlessly?

Unlike the coyote's jump from the Great Plains to fragmented forests, the transition into city life was borne from necessity rather than desire. As a child, even I could tell that forest ecosystems — the coyote's newfound habitat — were being destroyed from under them at a rapid pace.

Living in the wooded suburbs, the short drive to my grandma's house used to be surrounded by trees. In my young mind, the woods stretched on for miles. I would peer out the car window, eyes straining into the green between the tree trunks, trying to catch sight of a fox, a deer, or some other forest animal hidden in the gloom. When the trees were clear-cut, it was a shock. Those "boundless" woods turned out to be a mere pocket of trees occupying valuable land between the road and the highway — fewer than 100 total acres.



A coyote wanders through Santa Monica, Calif. Credit: Wikipedia



The author and her brother climbing trees in their backyard 'forest.' Credit: Cindy Volmer

My suburban memory was far from singular. Since 1960, "urban" growth in the United States has mostly been in the form of sprawl — the development of farmland, golf courses, and woods into housing. It shouldn't be a surprise, then, that my life over the years became less and less wild, and more and more confined by stores and houses and parking lots. Wooded areas were divided, subdivided, shrunken. Meanwhile roads spread like spider webs, connecting houses and shopping centers, making more room for cars and less for the coyotes that risk their lives crossing in front of them.

When I visit my Cincinnati neighborhood now, all I see is the shopping center, people busily bustling from store to store, annoyed by the traffic of yet another harried day. Today, I can hardly remember the trees at all.

But That Coyote ...

Cincinnati, New York, Los Angeles, Tucson, Portland, Destin, Denver ... coyotes roam across nearly every city nationwide. Their numbers are almost impossible to pinpoint, but the Urban Coyote Research Project, which tracks coyotes in Cook County, Ill., estimated a population of 2,000 coyotes in the Chicago metro area alone back in 2010. Today, the population is conservatively twice that.

Counterintuitively, this is partly due to loss of natural habitat. Increased urbanization and conversion of wild areas into those more suitable for humans have increased wildlife-urban interfaces and forced coyotes to adapt.

Adaptation, though, comes easily for the coyote. They're generalists: their omnivorous diet includes rodents, rabbits, fruit, and deer. This flexible trait, paired with their small body size relative to other predators, allows them to find suitable habitat nearly everywhere. Coyotes have

constructed their dens in large drainage pipes and abandoned buildings, in parks and on golf courses, slinking by unseen in the darkness.

From small areas to networks of green spaces, coyote territories vary greatly depending on the resources present. And cities — with food set out for pets, fallen fruit in yards, stocked bird feeders, and roadkill — offer meals in abundance for this arch opportunist. Urban areas therefore tend to be more densely populated with coyotes than rural ones, where food availability varies seasonally.

City living is so beneficial, in fact, that the survival rate of coyote pups living in urban areas can be up to five times that of rural pups. All of this means that coyotes are very comfortable in urban areas and their surrounding suburbs, as I was surprised to discover that night behind the wheel of my car.

Coyotes and Humans: An Uneasy Pact

Looking back at that moment on the suburban road, looking past my surprise — maybe the encounter was more commonplace than I remember. I left a little late from work that day, the parking lot nearly empty. Maybe I interrupted the coyote in the middle of its routine. Ingrained in habit, it crosses the street. It stops, surprised by my presence. "Oh, what is that? That's not normally here." Then, just as quickly, its curiosity expires. It turns away and continues to follow its predetermined path, leaving me shocked in the car seat.

Even my nighttime encounter can be seen through the prism of coyote adaptation. Coyotes are naturally diurnal or crepuscular, active during the day or at twilight. Only when they migrated to cities did they become nocturnal. Like most wild animals, the ever-vigilant coyote seeks to avoid humans as much as possible. Hunting alone or in pairs despite living in small family packs, creating multiple



Whose right of way, exactly? Credit: Oregon Department of Fish and Wildlife



The American suburban coyote is increasingly bold — unafraid of open spaces or daylight rambles. Credit: Cindy Volmer

entrances to dens, and relocating at any sign of human trouble — coyotes have roamed darkened soccer fields and parking lots for years without attracting attention.

Over time, however, urban coyotes have become more daring than their rural counterparts, inevitably sparking conflict. Protected from the guns, poison, and traps of rural hunters, urban coyotes have begun to view humans as food-providing allies rather than enemies. As coyotes are increasingly habituated to humans, fear of us is reduced, a boldness that is passed on by coyote parents to their offspring. Coyote conflicts with humans have increased as a result, particularly during winter breeding months, when neighborhood dogs are seen as rivals.

Every day, ordinary citizens call local police and animal control to report coyote sightings like mine. Seeing a coyote wandering about boldly in the daylight brings to mind rabid, feral predators. The mental image isn't all that foreign: small dogs abducted from their yards, bloody coyote teeth piercing their necks as the formerly oblivious pets are dragged to the woods for devouring. But it's mostly a lurid fantasy. Pets are not a primary coyote prey, with studies finding cats and dogs in only 1 to 3 percent of scat samples.

In an effort to control the less-desired relative of man's best friend, hunters in 45 states have participated in coyote-killing contests, competing for prizes by obtaining the most, largest, or heaviest kills. Many states have banned these events, but with cash bounties at stake, hunting contests kill an estimated half a million coyotes annually in the U.S. Nevertheless, the methods used to decimate

the wolves will not succeed against the wily coyote. Where coyotes are concerned, indiscriminate killing can actually produce a result opposite of that intended.

According to David Quammen's book *Wild Thoughts for Wild Places*, unselective slaughter of coyotes eliminates non-reproductive adults, or monogamous alpha pairs that are no longer having pups. Younger coyotes — more fertile and daring — then fill the new void in territory, while females produce larger litters that take advantage of available fresh resources.

The result is a temporary increase of the coyote population in the area and of coyotes that are more likely to interfere in human activity, according to Quammen. Tenacious,

resilient, cunning — coyotes seem impossible to eradicate. We may demolish trees and erect our buildings, but Nature won't loosen her grip so easily.

More palatable than merciless slaughter, nonlethal management can be used to discourage coyotes from making themselves at home in residential areas. For communities determined to deter the coyote "menace," the first step is to eliminate access to trash and food that might attract a coyote — covering compost, cleaning up spilled bird-feeders, and fencing the yard.

Next comes hazing: using deterrents to prevent habituation. These deterrents encompass a wide range of strategies, from installing motion-sensing lights to yelling at and chasing coyotes, throwing rocks, or shooting them with a paintball gun. The city of Denver, in particular, has used hazing with success to reduce aggressive coyote behaviors and citizen complaints. Ultimately, with hazing,

coyotes relearn fear of humans. And if a problem coyote can't relearn that fear, lethal control is viewed as a last resort.

Whether by hunters, city animal control, or car accidents, humans are the cause of most coyote deaths. It wouldn't have been abnormal, then, for my suburban coyote experience to have had a different outcome.

Stopping for the coyote on the way home from work that day wasn't my first meeting with wildlife on the road — I'd had near misses with deer and geese and squirrels and once an opossum that didn't have so fortunate an end — but it was the first to make me view the drive home differently. I perpetually scanned the trees lining the suburban road, peering into the darkness for another glimpse of my wild neighbor, or any other interesting animal. I turned my gaze upward, too, admiring the graceful soaring of long-overlooked birds above. Their silhouettes were black against the dulled colors of the twilight sky, as the sun set long over the horizon.

I drove with the windows down, the gentle breeze carrying the fragrance of local wildflowers, and listened. The chirping of crickets, the odd vibrating croaks of frogs, the hooting of freshly-awakened owls permeated the night — all sounds which I had allowed to become strangers. The coyote, somehow, had brought my wilder senses back to life.

As a child in Cincinnati in the late 1990s, I spent a lot of time outdoors. My brother and I would run through the open grass of our backyard to the woods behind our house, a path well-worn in the dirt down to the creek below. I remember catching crawfish with my dad in that creek, pretending a log from a fallen tree was a giant alligator, making "soup" out of some foraged crabapples and a bucket, and defending our "fort" in the exposed lower-limbs of a giant pine tree. Our summer vacations involved camping and fishing trips.

There was nothing I loved more than hiking through the forest, admiring the leaves glowing bright green in the golden afternoon light that illuminated specks of dust

before seeping into the leaf-covered ground. One of my favorite sounds to this day is a late-afternoon bird call from the neighborhood of my youth. I still don't know which bird creates it, but the sound lightens my soul.

Somewhere along the route of growing older, in focusing on school and jobs and relationships, I forgot all of this. Sure, I still say I love the outdoors. My boyfriend and I go camping every few years. I visited Joshua Tree; I hiked through Yosemite. I follow nature photography on Instagram. And maybe that's the difference — the idea of the wild is still magical, but it's no longer part of my everyday reality. The playful rambles of my youth have been replaced with a never-ending list of Something More to Do. Time in nature has been relegated to rare, structured experiences.

Maybe nature, though, isn't quite what we thought. The coyote, a creature of the wild, is our neighbor. Just like us, he has spread across the continent, taking advantage of the landscape we've altered, and not just surviving — but thriving. Monogamous, an omnivore, with an in-born fear of the unknown but also a bold instinct for taking his chances, his life, and character, are not so different from ours.

There are doubtless costs to this busy life of the suburban adult, beyond fear of the unfamiliar. But nature, even a patch of suburbanized wilderness, can provide something unattainable elsewhere: the soul-lightening experience of birdsong, the peace of solitude on a sunlit path through the woods My relationship with nature has changed since childhood, but that doesn't mean it's gone — as I was so vividly reminded on that ordinary drive home one evening, when I came eye-to-eye with my neighborhood coyote.

We are the coyote, I thought. He is us. No matter how determinedly we separate ourselves from nature, our buildings will eventually crumble to become dens for wild creatures. Weeds will sprout along our roads, and coyotes will invade the concrete jungle we call home — as they are already doing. Nature will force her way back in.



Eyes locked with ours, what does the coyote see? Credit: Jitze Couperus



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and is currently pursuing an M.S. in Environmental Engineering. This piece was researched and written for ESE 498, the CEW capstone course, in Spring 2019.



No Vacancy

By Carly Hopkins

2054 W 71st St

Walking around the unfamiliar neighborhood of Englewood on the South Side of Chicago, my heart rate beat in time with the sounds of a fading siren. The words “be careful” from my parents and friends echoed in my mind. The rampant gun violence on Chicago’s South Side is common knowledge, and the media’s regular exploitation of this easy clickbait story reinforces the fear in people’s minds that these neighborhoods — and by default some of its residents — are dangerous. This media fearmongering also overshadows other struggles the residents face. The vacant lot where I stood, strewn with trash and broken glass, marked one of these less-publicized dangers.

Credit: Google Earth

Imagery Date: 4/30/2015 41°45'54.71"

Perfectly shaped white clouds dotted the bright blue sky above. Less picturesque was the vacant land below. The grass in the lot was decidedly dead, trash had become embedded in the metal fence at the far back of the property, and a few trees and puny shrubs were the only foliage to be found. The city of Chicago lists 2,000 vacant lots in Englewood and West Englewood — adding up to nearly 500 acres. That’s about two times the size of Disneyland, representing 20% of the city’s vacant lot inventory. Beyond Chicago, the particular vacant lot in Englewood where I stood is but one of hundreds of thousands of empty urban lots across America.

Creation of vacant lots stems from myriad historical reasons including divestment, white flight, suburbanization, real estate market downturn, industrial decline, and toxic contamination. Chicago’s vacant lot epidemic can be traced to a mix of these phenomena. The city has struggled greatly with population loss since the 1960s, with almost every ensuing census reporting lower numbers. So-called white flight saw thousands of people leaving the South Side. Businesses began relocating to the suburbs, a trend accelerated by the completion of the Dan Ryan Expressway. That, coupled with continued economic displacement and decline, created an ever more dire vacancy issue for the South Siders who remained.

The Chicago-based Large Lots Program (LLP), launched in 2014, is an ambitious initiative designed to return ownership and control of vacant land to residents. The three South Side neighborhoods targeted in the first phase of the program were Woodlawn, East Garfield, and Englewood.

The beneficial impact of LLP could be seen directly across from the empty vacant lot where I stood. There, a sleek,

jet-black fence lined the front perimeter and boasted a sign that read, “The Hammond’s Promise Land.” This reclaimed vacant lot is now owned and maintained by Tina Hammond, a first-round participant in the LLP. Well-kept grass, gardens overflowing with plants, and various artwork pieces beckoned warmly from within the lot.

“It’s like the before and after,” Hammond chuckled, gazing across the street.

The striking contrast between the two lots perfectly exemplified the power of the Large Lots Program. The question is: Does this program work large-scale, and can it solve the nationwide vacant lot problem?

The Problem with Vacant Lots

Vacant lots pose environmental concerns for a wide array of reasons, according to the U.S. Environmental Protection Agency. They often attract illegal dumping and can contaminate areas with lead, cadmium, arsenic, and asbestos. Rats often use them as breeding grounds.

Beyond environmental problems, economic and social effects on neighborhoods go hand in hand with vacant lots as they are associated with lower property values and increased crime rates. The U.S. Department of Housing and Urban Development cites studies that violent crime

The vacant lot problem is not a problem peculiar to Chicago. Detroit has 110,000 vacant lots. Philadelphia has 40,000 vacant lots. Cleveland has 35,000 vacant lots. I can go on and on. Largely it’s a Rust Belt thing, but around the world cities have problems with their land vacancy.

Bill Stewart



Vacant lots on Chicago’s South Side. Credit: Flickr

in particular is shown to increase with vacant lots — and worsens the longer a lot stays vacant. This snowballs into an environmental justice issue when one considers that there are significantly more vacant lots in lower-income communities than elsewhere.

Bill Stewart, a Professor of Recreation, Sport, and Tourism at the University of Illinois Urbana-Champaign, has conducted research on park development and community-based conservation for nearly three decades. Stewart points out that these unproductive areas of land burden urban landscapes across the world, and the city of Chicago alone has 25,000 to 30,000 vacant lots. The city owns about 11,500 of them, while the rest are privately owned.

Though this might seem like an enormous acreage of wasted land, he maintains that it is the norm for the great industrial cities of the last century.

“The vacant lot problem is not a problem peculiar to Chicago,” he said. “Detroit has 110,000 vacant lots. Philadelphia has 40,000 vacant lots. Cleveland has 35,000 vacant lots. I can go on and on. Largely it’s a Rust Belt thing, but around the world cities have problems with their land vacancy.”



A debris-strewn vacant lot on Chicago's South Side. Credit: Flickr

How to Solve the Problem?

Facing the question of what to do with the lots, many cities have embraced “urban greening.” Seen as both environmentally and economically beneficial, urban greening turns previously wasted land into productive areas for new complexes, well-kept parks, and other public green spaces. The urban greening concept is popular with city governments and non-governmental organizations (NGOs), but it might not always translate into effective policies, according to Stewart, if those designing the green spaces aren’t aware of the needs of the residents directly affected.

“There’s a more of a top-downness where the NGOs come in,” Stewart said. “They might, through the city land banks, purchase lots and make parks — and there’s nothing wrong with that — but how do you ensure against displacement?”

In other words, green space developments can have a downside if they open the door to gentrification of a neighborhood. When an area is newly provided with green space, and the pollution cleaned up, it opens up the possibility of a spike in real estate prices and wealthier people moving in, displacing poorer people who have lived there their entire lives.

Green displacement can be seen everywhere, for example in Sunset Park, Brooklyn. The Sunset Park redevelopment, begun in the early 2010s, seemed a great advertisement for green spacing — and the creation of cleaner, healthier communities. The city put in trees along streets, bike paths, and new pedestrian-friendly walkways. However, this improved green infrastructure caused a boom in real estate investment. So much so that the average price of condos in the area has increased by 67% — leaving some residents to choose between a healthy neighborhood and paying the bills.

The Large Lots Program

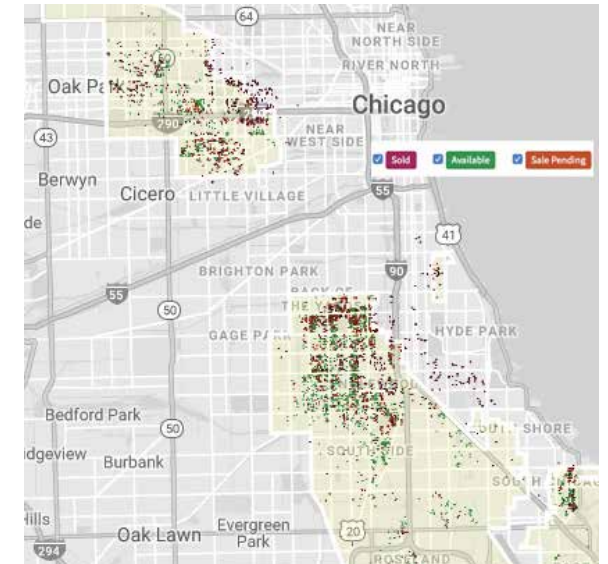
But not all urban greening is equal. Gentrification and displacement can be minimized if a program is designed and implemented properly. Demond Drummer was among the pioneering advocates for the Large Lots Program in Chicago. Talking with others in the Englewood community, Drummer realized people would be willing to buy these vacant lots from the city, but policy procedures made it nearly impossible for them to do so. From this sense of frustration, the LLP was born.

“Large Lots is a story of civic innovation from the bottom up,” Drummer said at a 2017 public lecture assessing the program.

First, Englewood residents came together through organizations such as the Resident Association of Greater Englewood (RAGE) and Teamwork Englewood. Together they decided that they were going to address the problem of city-owned vacant lots in their community.

Drummer used this bottom-up approach and then reached out the City of Chicago’s Department of Planning and Development. His idea tied into the existing Green Healthy Neighborhoods program, developed by the city for extensive neighborhood development. Repurposing vacant lots was a cornerstone of the new green urban policy in Chicago.

The Large Lots Program has a simple mission. It gives residents on the same block as vacant lots an opportunity to purchase them — for only \$1. This nominal price allows residents to gain control over neighborhood space, increase safety, build community ties, and raise home values.



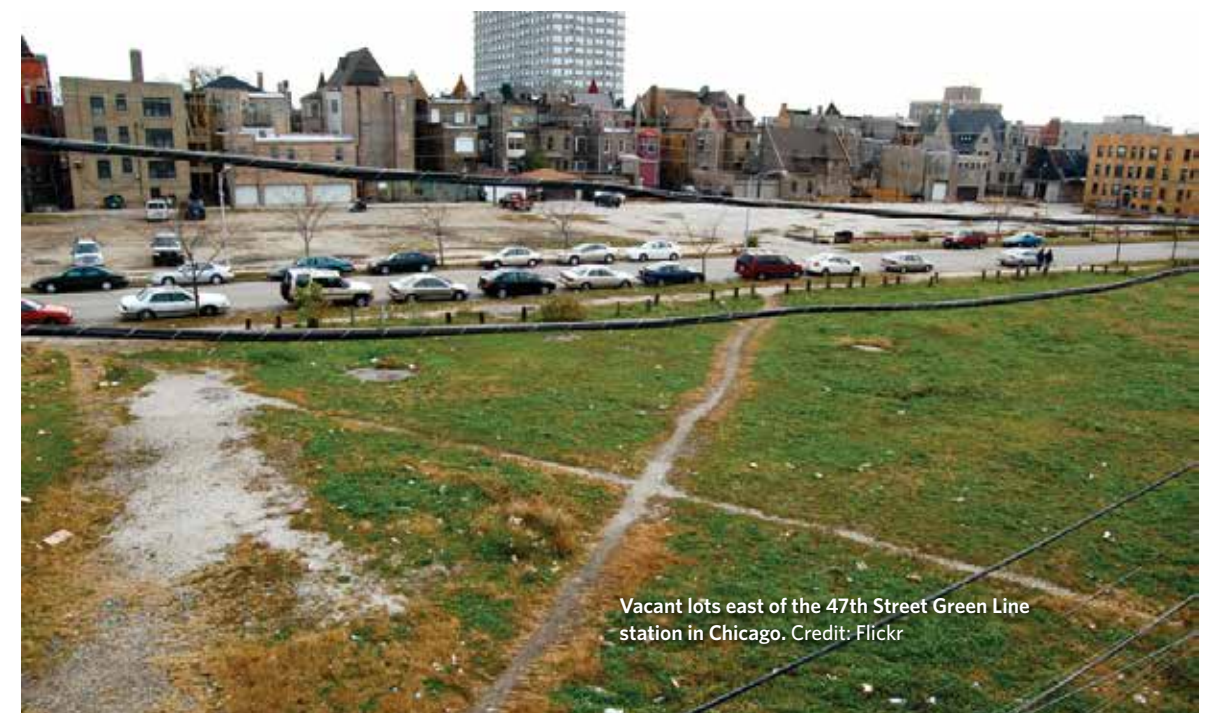
A view of hot spots in Chicago’s Large Lots Program, mainly in the East Garfield Park, Englewood, and Woodlawn neighborhoods. Credit: largelots.org

The LLP, however, maintains strict eligibility requirements and rules about what can be done with the newly acquired lot. One of the most important of these is that the applicants must own property on the same block as the lot they want to purchase, preventing big investors from swooping in to buy up the land.

Paul Gobster, a landscape architect with the U.S. Forest Service who researches impacts of the LLP, said this locals-only rule was particularly beneficial for the community: “One important factor in why it has worked (is preventing) anyone from any place being able to buy the



Longtime Englewood resident Tina Hammond at the entrance to her beautified lot purchased through Chicago’s LLP. Credit: Carly Hopkins



Vacant lots east of the 47th Street Green Line station in Chicago. Credit: Flickr

lot.” He says people who live on the block will naturally have more personal stake in the neighborhood, and in maintaining and improving its spaces.

Once the purchase is made, resident-owners have great freedom in choosing what they wish to do with the lot: They can build an extension to a house, or install garages, gardens, parks, yards, etc. The emphasis is on small-scale development, without the need for outside investment or building loans.

Reclaiming Space

Hammond, who welcomed me into her reclaimed vacant lot, is a true Chicago native. She was born on the West Side of Chicago and has lived in Englewood for 43 years, the last 17 as a homeowner. She manages and runs a home daycare. Tina joined RAGE early on and jumped at the chance to purchase a lot.

Hammond’s green lot could be a poster child for the Large Lots Program. To say she improved her parcel of land would be a gross understatement; she and her husband have completely transformed the space. The crown jewel of the lot is the back fence — where a mural with bold, swirling colors depicts scenes of people dancing. Fittingly, a wooden deck built for dancing with an overhead covering stands proudly in the center of the lot. Rain barrels, providing water for both her flower and vegetable gardens, line the perimeter. In her vegetable garden, she plants spinach and kale for smoothies, which she loves to make.

“It’s beneficial to us because we don’t have to worry about buying it in the summer time or spring,” Hammond said. “To just to be able to go there and do that is amazing because it shows the kids in the daycare that we can grow our own vegetables and that we know what’s in it because we grew it ourselves.”



Tina Hammond's refurbished lot.
Credit: Carly Hopkins

What was most important to her, though, was that she beautified the area.

“The kids need to see beautiful spaces in Englewood to know that they are worthy to have nice things,” she said. “We are worthy of that, we deserve that and so many times we don’t get that. So when this program came available, I was really excited because this is what we need.”

‘Cues to Care’

Those strong feelings about beautification echo the findings of research on the Large Lots Program. Stewart has studied how beautifying a lot influences the owner’s sense of community and place attachment. One respondent complained that vacant lots in their community had “overgrown brush, and then the wind blows and everything (trash) gets caught in the brush.” Another remarked on the proliferation of “used condoms, vile trash, hypodermic needles, empty bottles... .”

For these respondents, gardens and green spaces were the answer, while others thought the land could be used as a collective neighborhood resource by adding space for social gatherings and events. Still others envisioned once useless land given over for growing local foods, both privately and for the community.

Respondents said that they felt a duty to stay in the neighborhood and not move out, and that adding property to their name helped them feel even more rooted in the community. Researchers have shown that, in the work of beautifying their lots, residents increased their social interaction with one another and built stronger community relationships.

These findings show that the benefits of the LLP are primarily social — with environmental benefits just a bonus. For example, not all reclaimed vacant lots in Englewood and elsewhere have been turned into ideal green space. Some have been paved or built on. While this might make some environmentalists narrow their eyes, Gobster defends the diversity of development choices.

“If the ecologists are solely looking at ecological conditions without taking into account the people who actually live there, you could end up with a solution that may not fit what the neighbors want with a bunch of wild-looking spaces in the middle of their neighborhood,” he said.

Instead, Gobster says it’s about finding a balance between the idea of order in an urban landscape coupled with ecosystem services. Gobster’s research, in collaboration with Bill Stewart, uses both aerial and street photographs of lots in Greater Englewood and East Garfield Park to assess what he calls “cues to care.”

Cues to care reflect the overall public maintenance of a neighborhood. These cues included pavement

If there are a lot of cues for care it means that there are many eyes on the street — many local eyes — a lot of people are coming and going. It’s not an abandoned space. Criminals don’t pick these spots.

Sara Hadavi

condition, the number of healthy trees, social recreational spaces and, on the downside, evidence of dumping, vandalism, etc.

Gobster’s results

are good news for the Large Lots Program. He found that the LLP reduced bare soil exposure in Englewood while increasing garden space, turf and canopy cover. He was surprised to find an overall reduction in trees, but this loss mainly came from removal of trees already in poor condition (which increased the amount of shrubs and trees in good condition). He expects a bounce back for tree cover in upcoming years.

The reclamation and greening of vacant lots can also positively impact residents’ mental health and happiness. Sara Hadavi, an Illinois alumna who received a Ph.D. in Landscape Architecture from the University of Michigan in 2015, has long studied how proximity to green spaces positively affects mental well-being. For the LLP, she wanted to see, in particular, how the restoration of lots impacted the neighborhood crime rate.

West Englewood and Garfield Park were the areas targeted by Hadavi for analysis of different categories of crime ranging from burglary, to sexual assault, to vandalism and drug abuse. She found a measurable decrease in crime since the Large Lots Program was launched in 2014 — findings that will be published this year as well.

“Sense of safety and crime have a very strong relationship,” she said. “When a neighborhood or block has a lot of cues to care, it affects how those who want to commit the crime pick the area to do that. Whether it is drug dealing, violence, or whatever ... if there are a lot of cues for care it means that there are many eyes on the street — many local eyes — a lot of people are coming and going. It’s not an abandoned space. Criminals don’t pick these spots.”

When asked how these results could be used in future planning she said, “It’s been a great opportunity to show how involving people and communities can affect policymaking. The results relating to the visual quality and crime, for example, have a lot of messages for policymakers to consider green infrastructure and to engage people in the process in residential neighborhoods and not make decisions behind closed doors.”

Looking Forward

The spectacular results of the Large Lots Program speak for themselves. The LLP had sold 1,240 lots as of summer 2019 and has seen a tenfold increase in city-owned vacant lots sold to homeowners. In Englewood and elsewhere, community quality of life is up, and crime is down. Given its rapid success, the LLP can now be looked on as

a blueprint for revamping deteriorated neighborhoods nationwide.

A year after I first researched this story, I made a return visit to Hammond’s street in Englewood. She greeted me with a smile, sporting an “I Am Englewood” T-shirt. Her lot is still stunning, with the notable addition of a large, gray turtle sculpture her daycare kids have dubbed “Mr. Grumpy.”

We stood on her dancing deck and discussed the meaning behind various trinkets ornamenting her lot. Hammond spoke positively and confidently about the LLP: “We just hope, you know, it catches on. I tell people to do what you can afford and do what you can maintain.”

The lot across the street still sits vacant. She said a lot of people ask if she would ever buy that lot. She’s considered it — but would have to buy the house adjacent to it to qualify for a second vacant lot purchase. Besides, she is happy with her original lot, the “Promise Land” of her community.

She returns to the theme of beautification she raised at our first meeting a year before: “We want people to know that — yes we live in Englewood, but we are worthy of beautiful and nice things just like other communities. And that’s what we really push and want other people to know that we deserve this. We deserve this in our community. Every block that has vacant lots if the city did something for the lot, or if the residents do something for the lot, I think it would make our community look better ... if someone just took the initiative to get a lot and just do something to it.”

Vacant lots like the one across this Englewood street still stand empty, humbly waiting for purchase, but unquestionably this unique Chicago program has sparked a drive for change. Instead of symbolizing urban decline, the vacant lots dotting Chicago now represent spaces of opportunity for their future owners and communities — thanks to the Large Lots Program.



Carly Hopkins is from Marion, Ill. She graduated in May 2020 with a B.S. in Natural Resources and Environmental Sciences with a concentration in Human Dimensions of

the Environment. She worked as a research assistant for the Miller Research Group. She is now pursuing a degree in environmental law on a fellowship at Pace University and plans a career in environmental policy. This piece was researched and written for the CEW 498 capstone course in Spring 2019.



Q&A

By Maria Maring

EDITING NATURE: MEANINGFUL DECISION-MAKING IN THE SCIENCES



Credit: Shutterstock.com



In August 2019, Natalie Kofler joined the Institute for Sustainability, Energy, and Environment (iSEE) as the first Stuart L. and Nancy J. Levenick Resident Scholar in Sustainability

Leadership. She is a trained molecular biologist with extensive experience working with the controversial gene-editing tool commonly referred to as CRISPR (which stands for “clustered regularly interspaced

short palindromic repeats”). Now as the Founder and Director of Editing Nature, she concentrates her efforts on expanding the discussion on the ethical implications of CRISPR technology.

Fellow University of Illinois undergraduate Gwenna Heidkamp and I sat down with Kofler during the Fall 2019 semester to discuss her multidisciplinary platform that focuses on fostering more inclusion, integration, and innovation in the practice of science, and creating meaningful decision-making processes.

Q: Thanks for taking the time to meet with us. So, first and foremost, how did you get to where you are now?

While a Postdoctoral Fellow at Yale in the Department of Cardiology, I realized I had totally lost track of what was going on in the broader world; I was just studying these tiny little molecules in one single cell under a microscope. I felt as if only parts of me came into the lab, and there were huge parts of me that were being left outside. I was feeling fragmented and separated from important issues that our world is facing.

While hanging out at the Yale School of Forestry and Environmental Studies, I attended a talk on invasive species. There, I first wondered about genetic technologies in the environment — applications of CRISPR for public health issues, eliminating invasive species, or protecting threatened species. It was one of those “aha” moments where I realized this was a really unique space in which I understood the technical aspects of the science, and I really cared about it. I felt like this was a place where I could have an impact.

I finished up my paper in the research lab and moved to the School of Forestry. I had a year-and-a-half contract to build Editing Nature — a program that brought together interdisciplinary experts from all over the world to talk about genetically engineering the wild. We had some significant publications, and I was able to attend some top U.N. meetings to represent our perspectives and policy recommendations.

However, I was experiencing a lot of challenges at Yale. No one knew where I was coming from or what to do with me. I have a science background, but now I have on this ethicist/policy hat, even though I don’t have official training in those spaces. I’m starting to teach environmental ethics even though I have never taken an environmental ethics class in my life — which I think is good because it’s a new perspective, but the interdisciplinary nature of my work makes it hard to find an institutional home.

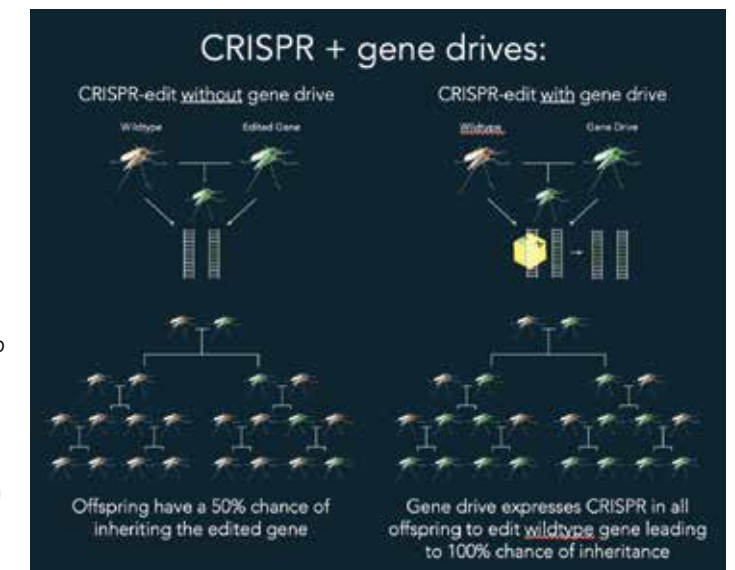
Then I was given this opportunity to come here (to the University of Illinois at Urbana-Champaign) for the year to continue building my ideas and figure out next steps. I’m in the process of figuring out what the next phase is. If I stay in academia, it will require a unique space where I can do this — or I have to try to create a position that would allow me to continue this work.

Q: This is some really complicated science you work with. Could you describe CRISPR in just a couple of sentences?

It is a molecular tool that makes genetic engineering easy, inexpensive, and precise. Historically, engineering genes was a pretty brute-force, sloppy process; you had

to incorporate or delete entire portions of DNA. CRISPR is able to change — at the single base-pair level — a genetic sequence.

CRISPR has also allowed for the engineering of a CRISPR-based gene drive. Say you want to introduce a mutation that would impair a mosquito’s ability to transmit malaria. Of course, you don’t want to do that in just one mosquito; you want to do it in the entire population. If you CRISPR-edited that mutation and released even hundreds of thousands of mosquitos, eventually through natural selection, they would get eliminated from the wild population. Then the normal, malaria-carrying mosquitos would continue to thrive. However, the gene drive is self-propagating, meaning it has the ability to continue editing the genes through generations with 100% inheritance. In only a few generations, the entire population can be transformed.



An overview of how CRISPR works. On the left, without gene drive, offspring have a 50% chance of inheriting the edited gene. On the right, gene drive expression leads to 100% chance of inheritance. Credit: Natalie Kofler

Q: Where do you draw inspiration?

Braiding Sweetgrass by Robin Wall Kimmerer. I read it while I was still in the lab, unhappy with what I was doing, but not knowing what I was going to do next. Kimmerer proposes an environmental ethic that is based on reciprocity — this idea of being in gratitude for all that Earth gives us. A way to show that gratitude is to use our own individual gifts to contribute to making a more healthy and flourishing society and planet.

I’ve also been really inspired by young people because they have this openness to doing things differently and making change in some really radical ways. That keeps me very optimistic and inspired. And I feel a responsibility to at least pave the way a little bit to make that job for you all a little bit easier. Because I think this next generation is going to be really shaking some stuff up.



Natalie Kofler presents a MillerComm Lecture during the Fall 2019 semester at the University of Illinois Urbana-Champaign. Credit: Jenna Kurtzweil, iSEE

Q: You've mentioned that you're still figuring out what your next steps are. What are your tentative plans for the future?

There are three branches on my tree of change.

- First: How do we start thinking about changing the culture of science? How do we change how we train scientists in order to elevate new sets of virtues in science and decrease ones that aren't working? Like humility instead of hubris, and cooperativity instead of opaqueness. We need to elevate inclusion and diversity.
- Second: How can we create meaningful communication in the conversation between scientists, the public, and regulators to improve how we make decisions? It's really about changing decision-making, dispersing power in decision-making, and including a broader set of perspectives in how we make choices.
- Third: How do we empower the voices that haven't been in these sorts of decisions? It's one thing to create these platforms that allow for more public deliberation, but if the voices we need to hear aren't heard, then the rest of it doesn't work. And that doesn't only include historically marginalized human voices like women, people of color, people from the global south, people with disabilities ... I'll go even further: Who will speak for nature or future generations? How do we speak for those who don't have a voice? I have the opportunity to amplify awareness for those who don't have a voice, figuratively or literally. This last year and a half, I've really just focused on changing the tone of that conversation. I've been really lucky to have opportunities to do that, and I think it is having some impact. But moving forward, I think now it's really about a

little less talking and a little more doing.

What's beautiful about all three of those branches is they require all hands on deck from many different disciplines — different places in the world. I see my role not as producing those answers, but being the person who can unite people to help create these solutions.



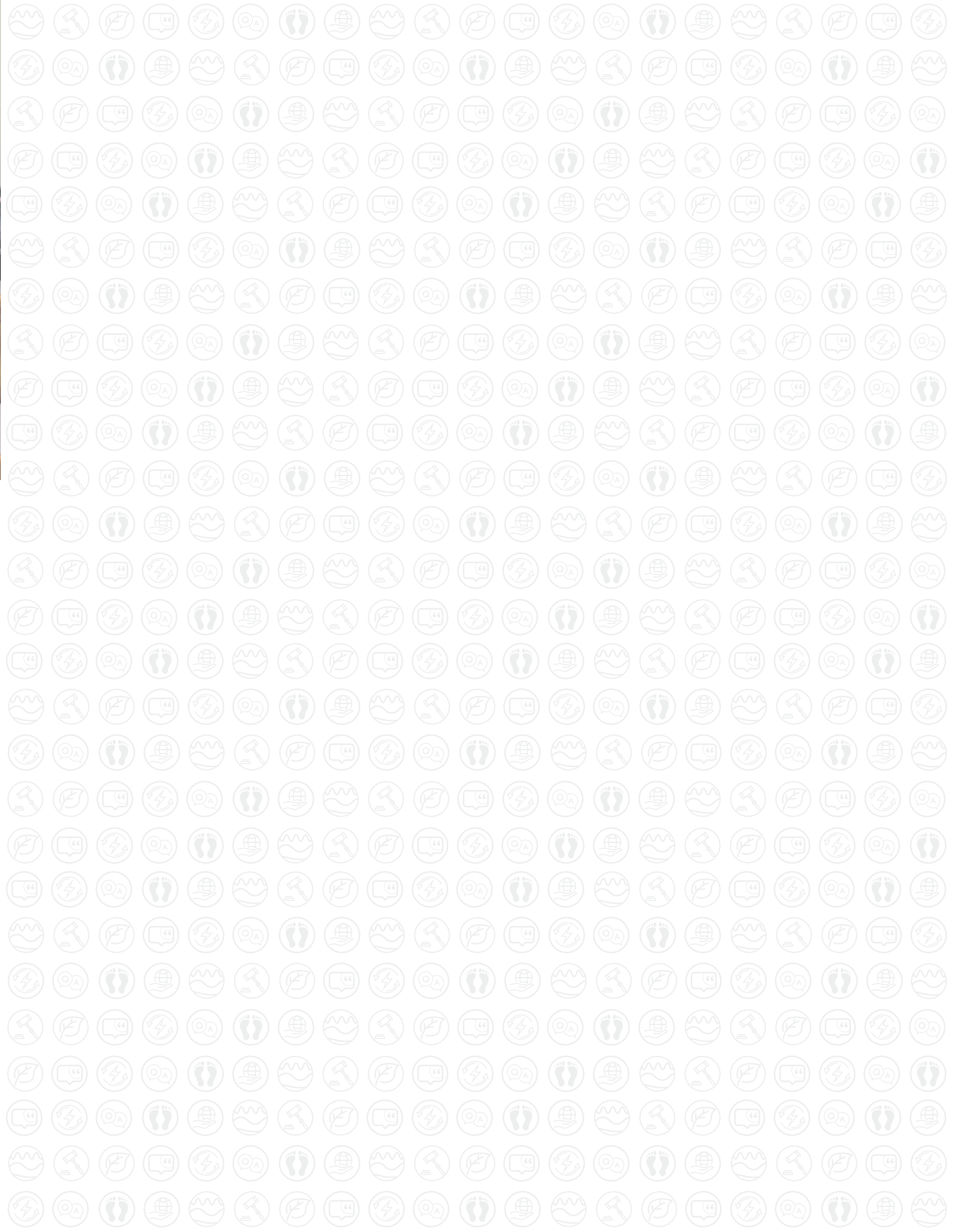
Maria Maring is a junior from Carbondale, Ill. She studies Earth, Society, and Environmental Sustainability (ESES) and Spanish — while also pursuing the Certificate in

Environmental Writing (CEW). In Spring 2020, she was hired as a Communications Intern with iSEE.



Gwenna Heidkamp is from Riverwoods, Ill. She graduated from the U of I in May 2020 with a B.S. in Earth, Society & Environmental Sustainability (ESES) and the CEW. She aspires in her

career to help create a more sustainable world. In 2019-20, she served as the Greener Campus Programs Intern for iSEE.



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