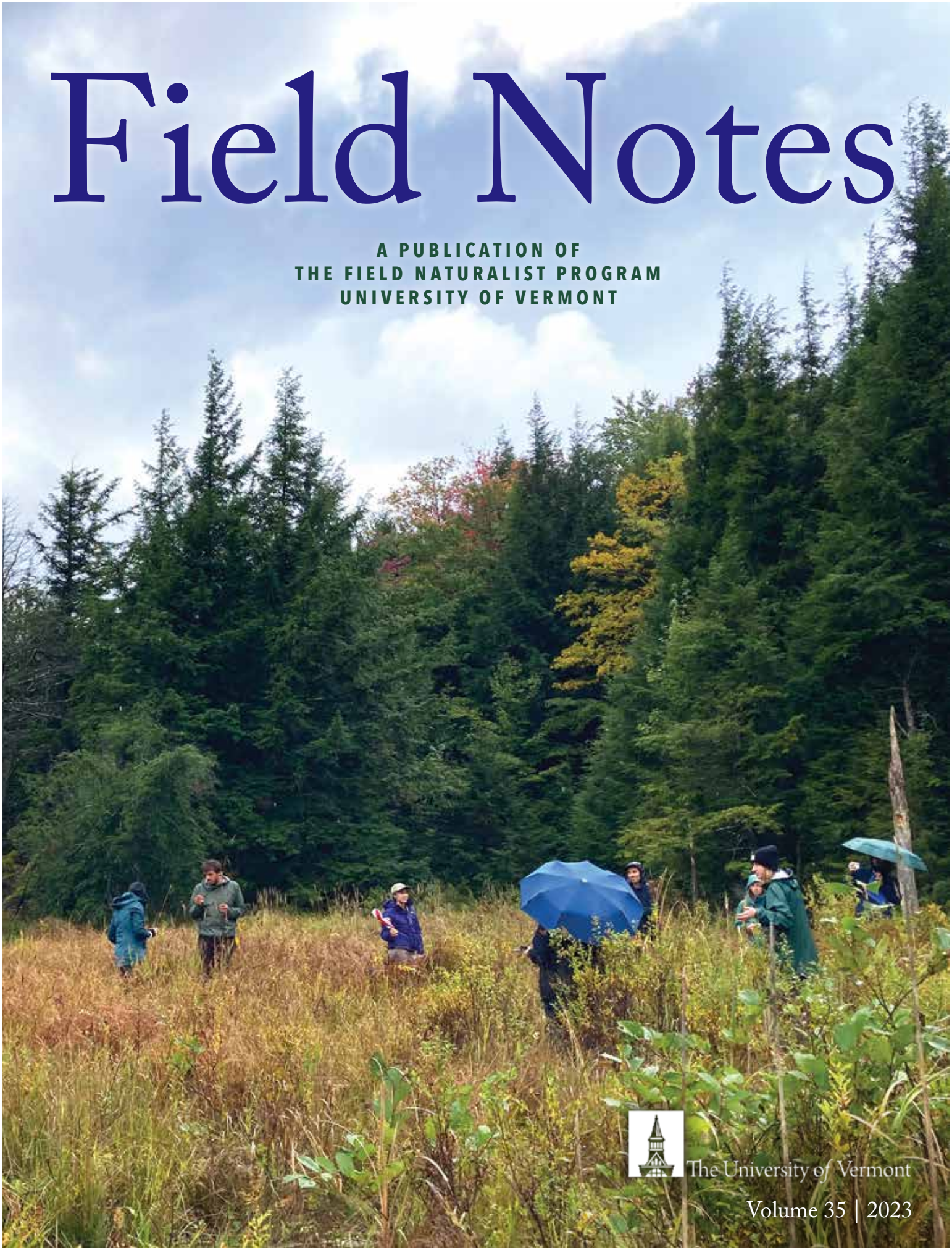
Field Notes

A PUBLICATION OF
THE FIELD NATURALIST PROGRAM
UNIVERSITY OF VERMONT



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EDITOR'S NOTE

CATHERINE WESSEL

Artwork: Lee Toomey

We *Amanita muscarias* like to consider all possible options. We find it hard to land on one answer. So much so that in the final hours before winter break, with the fire crackling and snow falling at Zero Gravity, we had yet to pick our name. It was time to make a decision. As the 39th cohort of the Field Naturalist Program, alphabetically we were known as the AMs. It is tradition for each cohort to select a mascot with the same initials as its Latin name. We had been circling for a while, weighing pros and cons and penciling in more possibilities even as we told ourselves and others that we were narrowing it down. Though the stunning spotted red mushroom won, the rigidity of a single answer didn't sit right with us. We hated to rule out the equally enticing spotted salamander (*Ambystoma maculatum*) or spotted sandpiper (*Actitis macularius*), so we named ourselves the Spotties. Like all good naturalists, we seek out circuitous routes. After all, we had spent the fall wandering talus woodlands and beaver wetlands, discovering a joy in asking every stump, dead end, and gall: Is there another question here? Is there a different interpretation?

We're not particularly interested in a single answer—finding one seems less interesting than finding more questions. Perhaps more than just acquiring knowledge, the role of a naturalist is to seek understanding. And so, we ask: What can come when we put aside our first impressions and look more deeply? We'd like you to explore an abundance of options with us in this edition of *Field Notes*.

In the following pages, we share questions that continue to poke us—weighing a rare buckwheat against lithium mining, and reflecting on our relationship with invasive species. We guide you through what sunrise means to a plant and several ways we can observe succession. We search for the legendary creatures with whom we share the valley and mountains, and consider communication beyond our own species. We invite you to join us in not always deciding and instead to celebrate the space before or beyond an answer. We feel this is a place where more meaningful questions come from. Thanks for being here with us.

Image: Michelle Giles

This issue of Field Notes *is dedicated to Dr. David Barrington and Dr. Cathy Paris for their decades of commitment to the Field Naturalist Program and leadership at UVM.*

WALTER POLEMAN

There are events in life—the arrival of a newborn, the wedding of a couple, the passing of a loved one—when we gather in community to honor and celebrate that which we value. In the lifeline of the Field Naturalist Program, there was a remarkable convergence of events over four days in late April that brought into focus the people, relationships, and mission that make this program so valuable.

It began on a Thursday afternoon, just before the Plant Biology department's weekly Marvin Seminar, with the unveiling of a portrait of Hub Vogelmann on the third floor of Jeffords Hall—our program's home base at UVM. The portrait was a gift of photographer Bob Klein, who shared that during Hub's tenure as Botany department chair, he founded not only the FN Program but also the Vermont Chapter of The Nature Conservancy (TNC), to which Hub appointed Bob as the first director. With so many FNEP alums currently working for TNC around the country, I smiled to think that this UVM-TNC connection was integral to Hub's vision 40 years ago when he launched the program: to train professionals with the knowledge, skills, and moxie to serve on the front lines of conservation science. It was fitting that these capacities were on full display in two masterful FN student seminar presentations that followed that afternoon: Hayley Kolding featured her TNC-sponsored research on riparian ecosystems in eastern Oregon, and Sonya Kaufman shared her timely fire ecology research on forests of the Northeast. Hub would have loved it.

Images: Walter Poleman

These events served as a prelude to a weekend marked by further celebratory convergence. As the Northeast Natural History Conference got underway, dozens of alumni also poured into town to celebrate our program's 40th anniversary at a Friday reception hosted by UVM and the FNEP Alumni Association. It was an emotional evening as naturalists from across four decades reunited with cohort members and faculty mentors, and it was a joy to welcome folks from as far back as the B Team. Old bonds rekindled, and new relationships formed as people shared stories of past field adventures and present-day conservation projects. The evening also provided an opportunity to honor in song the memories of members of the FN community who have passed on (Cathy Bell, Elizabeth Farnsworth, Lillian "Porky" Reade, and Hub).

The natural history conference featured compelling talks by several alums and many current FNs. Alicia Daniel did a superb job facilitating a series of talks entitled "Bedrock to Birds: Dispatches from the Field of Natural History Education." Our graduating AL Cohort (*Actias luna*) gave command performances of their master's project presentations in a session appropriately called "Connecting Conservation Needs with Moxie." Shelby Perry, now an ecologist with Northeast Wilderness Trust, spearheaded a thought-provoking session on the possibilities of catamount restoration in the eastern U.S., and celebrated author Thor Hanson (of the O Team) gave a brilliant conference keynote on the biology of climate change. Each time these and other FNEPs spoke at the conference, I was reminded of the power of combining an integrative understanding of field science with a passion for clear and compelling communication. These underlying values have served the program well in its first 40 years and will no doubt be a key part of our storyline for the next 40. As this remarkable weekend came to a close, I had the honor of sending a note of welcome to the six incoming FNs recently selected to comprise our 40th cohort. I can't wait for you to meet them!

Walter Poleman (Cohort K, '95), is the program director and teaches Landscape Inventory & Assessent. He is the founding director of the PLACE Program and co-coordinator of the Greater Burlington Sustainability Education Network. He is also a faculty member in UVM's Rubenstein School of Environment & Natural Resources and teaches ecology to lawyers-in-training each summer at Vermont Law & Graduate School.

Morning in Kingdom Plantae

MICHELLE GILES

Image: Aleksandra Jovanic

Beneath the bucolic skies of daybreak, plants must try to survive the rigors of dawn. Plants need the sun, but physiological necessities keep them chugging along after sunset and then amping up for sunrise. With the strawberry plants of Vermont's fields and woodlands as our guides, we explore some of what plants get up to in the morning while you are shaking the cobwebs and starting your own routine.

Why do plants wait until morning to open their petals?

Since the evolution of flowers, plants have developed intimate relationships with their pollinators. Daytime bloomers, like the strawberry, attract bees and butterflies. With bees in their hives and butterflies resting on the underside of foliage overnight, there is no need to keep petals parted after sunset.

Closing blooms overnight also helps to protect the strawberry's genetic investment. The precious pollen begins to lose viability otherwise, and soggy pollen is harder for pollinators to take on a flight. Petals act as anther armor, protecting pollen from becoming weighed down with dew.

How do plants release water when stomata (leaf pores) are closed for the night?

Image: Fred Clark

Guttation—from the Latin *gutta* for drop—works the early morning shift, shuttling excess water through portals at the vein tips of leaves. These specialized holes are known as hydathodes. About the size of a human teardrop, guttation drops sit along the margins of leaves and fronds where hydathodes open to the environment. More than simply H_2O, these droplets contain valuable minerals, carbohydrates, and proteins. Guttation draws in pollinators by providing a food source for them outside of nectar season.

Can't get out to Strawberry Fields in the morning? Peek at your houseplants for an example. Pythos and monsteras make beautiful drops. Once you have gotten an eye for these beads of fluid, they become easily distinguishable from the minute and indiscriminate drops of dew.

What do plants do when they can't photosynthesize?

Overnight, when there is no light to stimulate photosynthesis, another biological pathway breaks down sugar to make energy for plant cells. This oxidative pentose phosphate (OPP) pathway also plays a critical role in keeping plants from poisoning themselves at every sunrise.

Dawn creates a flick-of-the-switch metabolic imbalance that could collapse plant tissues. While photosynthesis starts up immediately when the first light hits, the cycle that uses the energized electrons from these light reactions—to make the carbon molecules plants need to build their bodies—is slower to wake. The lag time results in an excess of electrons, which bond with oxygen molecules and create unstable molecules called reactive oxygen species (ROS). These little terrors can build up and kill cells. During this tense dark-to-light transition, the OPP pathway steps in, soaking up excess electrons to break down sugar—and prevent dangerous ROS from forming.

How do plants follow the sun?

Strawberries, like many plants and naturalists, are highly responsive to the sun and its position in the sky. As dawn breaks, their leaves will fully fan out, semi-erect and facing east. You may love to start your day with yogic sun salutations, and plants have a way of performing these stretches as well.

Auxins—critical plant hormones linked to many circadian-regulated functions—accumulate on the dark side of the stem of the plant. The presence of the hormone causes the cells to stretch from top to bottom. This elongation on one side of the stem pushes the flower or leaf in the opposite direction. The strawberry will continue to stretch sunward until dusk. Overnight, the plant will again engage the OPP pathway, use their petals to wrap up their reproductive bits, sweat out excess fluids and minerals, and shift to face east in preparation for the next morning.

Michelle Giles (Cohort AM, '24) enjoys mornings and strawberries. She has a highly sensitive awe/aww detector.

Recipe for a Field Biologist

MEG LOWMAN

Meg Lowman is an arbornaut (canopy explorer) and ecologist studying tree conservation and plant–insect relationships. Known worldwide as "Canopy Meg" for her passionate public speaking and engagement on behalf of conservation and education, she is dedicated to making science and the outdoors accessible for all. The TREE Foundation, which she founded in 1999, is committed to creating canopy walkways and opportunities for learning, so that everyone can get up close and look more deeply at canopy life. She'd like to share with us these points from her book, The Arbornaut: A Life Discovering the Eighth Continent in the Trees Above Us*, which leads us to consider a divergence from convention and charting a new path forward:*

Image: Will Durkin

I began by following the conventional recipe for a field biologist: Read. Observe. Ask questions. Keep a journal. Conduct field research. Follow up with laboratory experiments. Sample with statistical accuracy. Collect enormous datasets. Publish. Revise. Resubmit manuscripts. Design experiments to perfection, controlling every outside variable. Publish. Write grants. Rewrite grants. Collect more large datasets. Compete for tenure. Write more grants. Collect more data. "Publish or perish" has long been considered the mantra of a successful career scientist.

But mid-career, my trajectory changed to reflect a new infusion of actions, urgently needed if we are going to save the very forests that we scientists are studying. I asked, "What can be done to conserve our best planetary assets?" and came up with:

- Make sure all humans have a chance to encounter the awe-inspiring wonders;
- Be mindful of your financial spending and how you (perhaps inadvertently) contribute to loss of biodiversity;
- Become a citizen scientist;
- Read all you can and share your knowledge;
- Become a steward—all the creatures in your community will be so grateful you are safeguarding their home.

And from this emerged a new recipe: Educate kids about trees. Explain ecology to the public. Engage diverse stakeholders. Write for mainstream media, not just technical journals. Seek direct actions to conserve forests. Shout about it. Train the next generation of conservation biologists. Engage women as environmental stewards. Forge alliances with priests, corporate leaders, and other community members. Share stories about ecosystems. Mentor girls in science. Collect data. Partner with citizen scientists. Build walkways to save forests. Write about it. Study forests where no one has funded prior research. Give tree books to Indigenous kids. Teach students to become future arbornauts. Talk about it. Share ideas with anyone who will listen.

In the end, my grandchildren may not read or even appreciate my arsenal of technical publications or my 25-page resume, but I fervently hope they appreciate the native forests of Ethiopia or marvel at the view from a canopy walkway in Florida, Vermont, Australia, or Malaysia. I have dedicated almost six decades to a lifelong passion for plants. Maybe my misadventures will encourage readers of all ages to look differently at a treetop and appreciate the complex protocols of how field biologists study them. Even as an adult, I am labeled as the eccentric client in the local bank who, when a hurricane is bearing down, brings her bugs—in vials—to the vault while everyone else is lined up to safeguard diamond jewelry. My children tease me to switch titles from arbornaut to arbornut, because the world of forest conservation is so downright depressing and riotous. But never underestimate the power of one. I am only one arbornut, and I can only do so much. But I do know the world needs more citizen scientists to marvel at the workings of forest ecosystems, more communities to save big trees as their most venerable residents, more arbornauts to share their expertise in underexplored places, and more inclusivity of all the diverse voices calling for conservation. If I'm right, with hard work, a whole lot of luck, and a willingness to believe that we're all in this together, one arbornut can seed a forest of citizen scientists ready to stand tall for their beloved trees.

Image: Will Durkin

Red Pines of Northern New England

BRETT ENGSTROM

Pinus resinosa, the red pine, is a truly beautiful tree, in part because of its oft craggy homes in our region, but also because of its distinctive reddish bark. With age, the bark breaks up into flakes like puzzle pieces, and reddish is a poor description for the colors ranging from rich purple-reds to bright reddish-oranges. Red pine's specific epithet, *resinosa*, is aptly chosen for its resin-rich wood, especially heartwood, and around scars it has a strong piney pungency.

Gracing cliff brows, perched on rock domes, scattered along rocky or sandy lake shores and bluffs, inhabiting coarse sandy and gravelly soils of glacial outwash, kame, and old delta terraces: these are the most common native habitats of red pine in this landscape of ours. Yet, perhaps most familiarly, it is seen in Civilian Conservation Corps–era red pine plantations along our highways and in our state parks. Scattered throughout northern New England mostly below 2,000 feet in elevation, it is not a rare tree, but it is not common on the landscape level. This scattered distribution, often in conspicuous yet wild and incorrigible sites, as well as its special relationship with fire, is what attracted me to the study of red pine some 35 years ago while a graduate student in the Field Naturalist Program. How does *Pinus resinosa* persist in a landscape overwhelmingly dominated by northern hardwoods, spruce, fir, hemlock, and other trees?

Red pine is a denizen of the Northern Forest, that broad belt of eastern temperate forest between the boreal spruce and paper birch forest to the north and the forests with oak and hickory to the south. The Northern Forest ranges between 42-50 degrees latitude, from Maine and Nova Scotia to the east and Minnesota, western Ontario, and northern Minnesota to the west. The southern extent of native red pine in New England pretty much stops at the northern border of Massachusetts, though there are outlier populations in Massachusetts, Connecticut, and the Appalachians as far south as West Virginia. Red pine is replaced by jack pine to the north and pitch and other pines to the south, and it is strongly associated with white pine throughout the Northern Forest. *Pinus resinosa* reaches its greatest importance in the forests of the Great Lakes region, where the climate is drier and more extensive glacial outwash and water-worked sandy soils occur.

Almost all the native red pine I have cored in Vermont and New Hampshire over many years have been under 200 years old. The oldest tree I have encountered in the region, 30 years ago, was just under 300 years old. The oldest *Pinus resinosa* listed in Neil Pederson's "oldlisteast" online database is a whopping 500 years old, from far western Ontario near Lake of the Woods. The next ten oldest are reported at 340-433 years old, all from Ontario and northern Minnesota. Such longevity has important implications for long-term population maintenance where regeneration is episodic.

Here's the striking facet of red pine's natural history: throughout its Northern Forest range, red pine largely depends on fire for

regeneration, because its germination requires a mineral seedbed and young plants need moderate to high light intensities to mature. More sunlight reaches the ground after a severe fire due to the death of understory and canopy trees, especially of other tree species more susceptible to scorching. While it lacks some adaptations to fire such as cone serotiny, found in at least some populations of jack and pitch pines, it is a fire-resistant species due to older trees having thick bark that guards the cambium, and to its ability to heal scorch wounds.

Through tree-ring analysis of fire scars and tree cores, my fire-history and age-structure study of six red pine stands on Resin Ridge in the Bolton Notch area of eastern Vermont shows that, from early 1800s to the 1920s, non-lethal surface fires occurred at 3-50-year intervals, while more intense fires that killed canopy trees occurred at intervals of 50-100+ years. Taking place after European settlement, this fire history likely represents an unusually high fire frequency. Visits to red pine stands throughout the region over the last 30 years, including a recent revisit to the Resin Ridge stands, show red pine regeneration is very scarce, probably in response to a lack of fires.

Pine stands are small on Resin Ridge, ranging from less than one-tenth of a hectare up to two hectares, with numbers per stand ranging from 50 to 2,200. Based on a statewide survey I did on red pine in Vermont preceding my Resin Ridge study, these are fairly typical sizes. By far the largest red pine stand in Vermont is 13 hectares. In New Hampshire, Maine, and adjacent New York, there are larger stands in the more rugged, rocky country found in certain parts of those states.

The biogeography puzzle is how a species like red pine persists in a landscape where the moist, fine-textured glacial till soils are dominated by a vigorous and self-perpetuating forest composed of northern hardwood and shade-tolerant conifer species. Vermont has the nickname of the asbestos state because of its resistance to burn. Our long winters make for short burn seasons; our climate is moist with ample summer precipitation, thus precluding good drying of fuels. Plus, in contrast to red pine's coarse needle litter, the hardwood broadleaf litter is poor fuel for carrying fire because of its sheet-layered structure and because it does not dry out in the deep shade produced by the forest canopy. In this fire-resistant landscape, however, there are islands of fire-prone habitat. The high and dry cliff brows, rock domes, steep and rocky south-facing slopes—these are the red pine redoubts where a lightning-ignited fire occurring once every 50, 100, or maybe 150 years can produce the right soil and sunlight conditions to regenerate red pine stands.

There is excellent current research on red pine in northern New England happening at UNH-Durham. Finishing her Ph.D. research in 2021, Maria Adele Fenwick studied fire regimes and stand development in rocky red pine natural communities in the White Mountains of New Hampshire. As a Ph.D. candidate, Michael J. Simmons focuses his research on the factors and interactions associated with decline of red pine forests in New England. They have both observed red pine decline in some study sites located primarily in New Hampshire and Maine. Lack of recent fire has led Fenwick to conclude that red pine stands in the White Mountains will likely be compromised if prescribed fire management is not taken.

While alien red pine scale has been implicated in the demise of some plantations in New York, southern New England, and more recently southern New Hampshire and coastal Maine, the cause of decline in northern New England is yet to be determined. I witnessed quite extensive red pine decline, including many dying or recently dead trees, on Bald Cap Peak in Shelburne, New Hampshire, during a recent field inventory. Furthermore, in Vermont I have noted over the last decade the demise of two very small red pine stands, one among northern white cedar in the Winooski Gorge in South Burlington and another on Stimpson Mountain, a rocky knob a little east of Bolton's Resin Ridge.

And what if a red pine stand does not get burned in 150 years? Red spruce, hemlock, or even beech is usually there in the understory waiting for the red pine canopy to disappear so it can become the shady overstory. Coupled with essentially no red pine regeneration, this unburned stand maybe blinks out. In the case of the stands on Resin Ridge, I see just this scenario playing out. The canopy trees are now reaching 150+ years old, and there has not been a fire on the ridge for close to 100 years. There is attrition in the red pine canopy: windthrows, snaps of trees with rotten heartwood, and death from unknown causes. Plus, there is a century's worth of needle-, twig-, and branch-litter accumulation: all very combustible detritus for fueling that lightning-strike fire, especially during a drought.

While tempting to think that prescribed fire management is the best solution for regenerating red pine, perhaps it is even more important to have forest managers at all levels—municipal, state, and federal—embrace a let-burn policy whenever possible, so that ignitions that occur naturally are given a chance to blaze.

Image: Brett Engstrom

Brett Engstrom (Cohort C, '87), is a freelance field naturalist who lives beneath Drew Mountain in Marshfield, Vermont.

Artwork: Meredith Nemirov

Interview: Linda Hogan

CATHERINE WESSEL

Linda Hogan is a writer, poet, environmentalist, and Chickasaw storyteller. Author of many novels, short stories, and essay collections, she has also written poetry books such as Seeing through the Sun *and* Dark. Sweet.*, and the script for the PBS documentary* Everything Has a Spirit. *At the heart of her writing is the ecological, the personal and political, and native spirituality and knowledge.*

What was the beginning of your relationship with the natural world? Are there any early formative memories that stand out or inform where you are today?

I was born in relationship with the rest of the natural world. We are part of it, and it is part of us. Many people have this consciousness, or understanding, from their earliest years. In addition, my grandmother had a large, ancient tortoise that lived outside the home, and she spoke with it. The tortoise understood what she was saying. If she told it dogs were in a certain direction, it would turn around in its journey. But I learned years later, also, that my horse, a mustang rounded up probably in Nevada, could know what was in my mind and anticipate my actions before I even reached her. So there is a form of communication that takes place, perhaps a form of knowledge, between human and all the rest. Now trees and even house plants are being studied for the same kind of communications.

Image: Michelle Giles

We know too little about the world around us, yet four-legged and winged, even leafed creations seem to know more about us. I study daily and find the new understanding of our earth and lives to be the most fascinating ways of knowing we can learn in our lives.

Did you have any childhood heroes or naturalist inspiration growing up?

No. I thought my grandmother the best, but did not think of anyone as a hero. And wouldn't have known what a naturalist was. All the elders truly were naturalists with their knowledge of ecosystems and the world around us, but it was from years of experience and none of it from books.

What was your path to writing and to poetry?

When I discovered contemporary literature, I was excited and began writing immediately and I have never stopped. I try to write daily. It is like exercise and works best for me when I do it often. There are days I would write all day if given the chance or time. It is still exciting to me and I have been doing it since 1977 or 1978. Some things take so many years and still are wonderful to keep creating. Others may never work. Some come more easily and then it is time to move on. I learn something new and then, also, I may wish to write about it. Say, about an insect or a certain kind of plant behavior. This is one life and I am living it so fully, constantly a learner, a reader, a listener, and holder of new knowledge. We live in an amazing world, and I am always discovering it a bit more.

What does being a naturalist mean to you? Do you call yourself one?

Once it meant people who lived in communities where they were all naked. Really! I would more likely call myself an ecologist/environmentalist. My first book of poems was about the animal life and plants around us in Oklahoma. It was about our lives there, which forced us to know the environment. Since then, I have tried to keep up with those who study the natural world and Indigenous science, which has been practiced for many thousands of years. European science has struggled to keep up but has moved in a different direction. Combining the two is best and helps with our understanding of each thing or life that exists in our world, and in the universe.

What intrigues you the most about the natural world?

The lives in soil. The ways of birds, including their migrations. The sentience of all things. We live, as I said, in a world of magic. Humans also intrigue me. I watch people. It is interesting how their lives move and how easily we are affected by trauma—how hard it is to grow into real human beings, how much is never enough for some people. We are fascinating beings, but we have ways to speak it, the words. The ways of other creations may not speak their lives but are able to convey them and communicate in other ways. That makes them also intriguing.

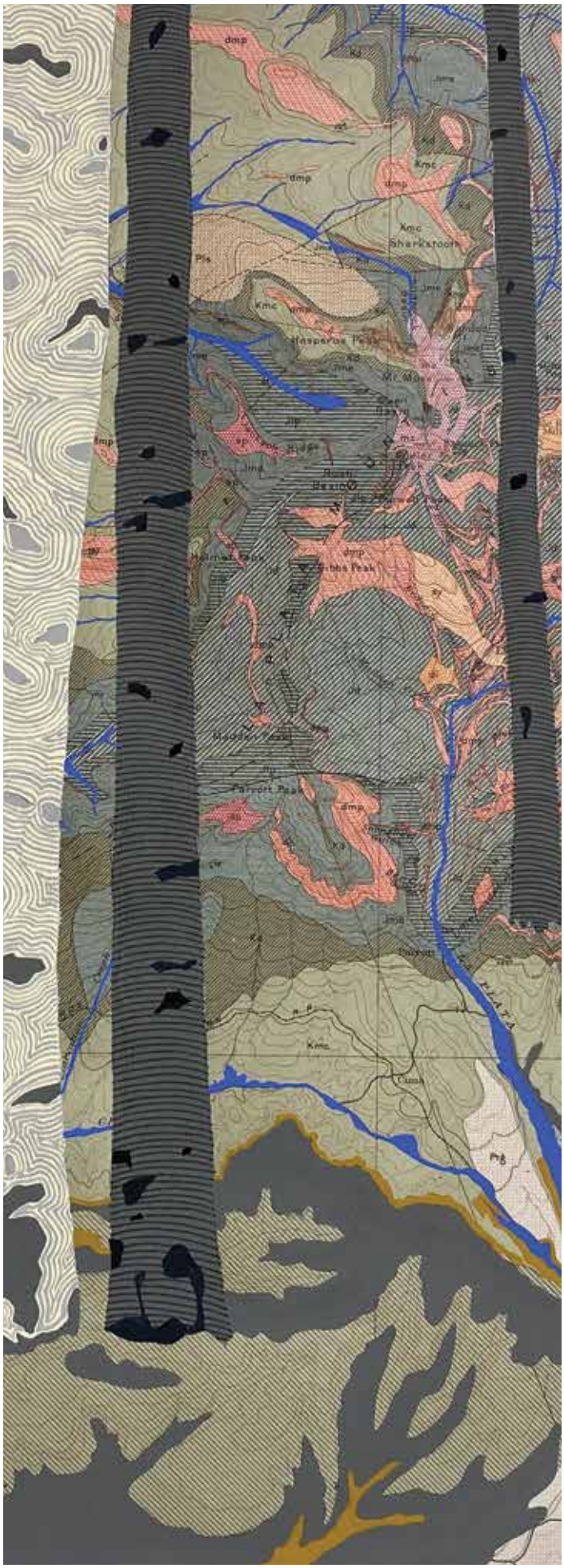
How do you feel being a writer and being an ecologist interact with each other?

My writing is more intelligent than I am. It is my teacher. I follow where it wants me to go. And it does become reciprocal. If I can remain open to what wants to be spoken, I learn from what's beneath the surface. Not just the surface of a world, but beneath the surface of what I think I know. This sounds more complicated than it is. We all need to think of our work as our teacher. It is that easy and also that difficult. I think it is one of the things I really do love about writing.

It all fits together, and the more I work at both, the more whole I become as a human being. I want to learn this contented wholeness, the love of our world, of one another, and how to reveal it in the work I do. Sometimes I fail. Sometimes I step up one more rung of the ladder and feel shining and truly alive.

Thank you so much for your time, Linda.

Thank you for the great questions. I am hoping for great lives for all of you on this beautiful planet. Let's work to keep it this way and better: improved, healed, and alive.



Artwork: Meredith Nemirov

Catherine Wessel (Cohort AM, '24) likes considering the unknowable and a good pair of socks.

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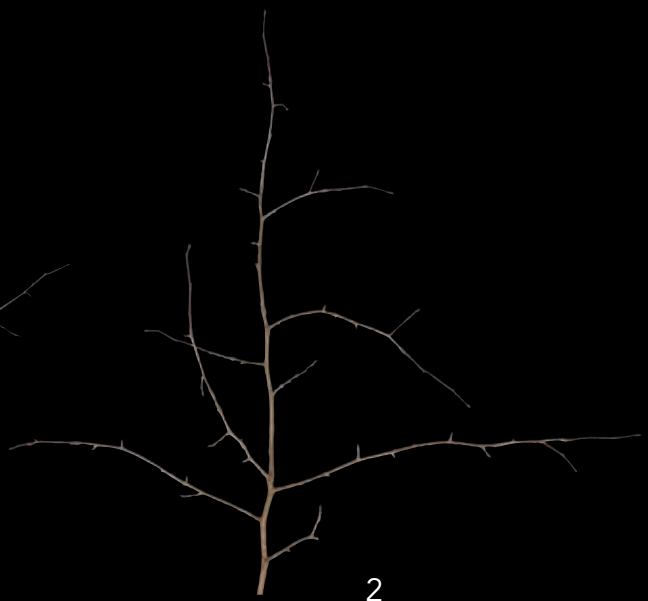

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BOTANY QUIZ: BOREAL SILHOUETTES

Eight nice plants from the lowland boreal of the Adirondacks, gathered at Heron Marsh and Barnum Brook and shot and stacked in the Visitor Interpretive Center at Paul Smith's College with Canon lenses and an RRS tripod and head. For you to guess, and, extra credit, say why they are what they are. Brought to you by the Northern Forest Atlas Project; another 8,000 high-resolution botanical images are available for free download and use in our Digital Atlases, at https://northernforestatlas.org.

Text and Images: Jerry Jenkins

1 Beech; 2 Mountain holly; 3 Yellow birch; 4 Balsam willow; 5 Tamarack; 6 Speckled alder; 7 Velvet-leaf blueberry; 8 Sweet gale

Bad Species

DAVID MORONEY

Image: B Jefferson Bolender

I learned early on that there are good species and bad species. The good species make for excellent stuffed animals and cereal box mascots: tiger, bear, honeybee. They can be heroes like the bottlenose dolphin or victims like the American chestnut. For years, my favorite animal was the peregrine falcon—the fastest bird in the world—and I still have the t-shirt to prove it.

The bad species are fewer but loom larger in everyday life: *weeds* in the garden, *pests* in the house, *poison* ivy. I've known many a New Yorker who loves to hate a subway rat.

My relationship with bad species goes back to childhood in San Diego, when my mom would turn me loose in the yard with a special mission: eradicate sea-lavender. My weapon of choice was a weeding fork with a long wooden handle. It was designed to lift plants out of the ground from below, but most often I wielded it as a sword. As the garage door drew open, spilling sunlight into cobwebbed corners, I imagined myself a jedi going to battle with an alien foe. My Pop-pop had told me that plants can sense others of their own kind and that if you cause enough damage to a few, it will discourage the rest from growing. So I spent afternoons mindlessly hacking away at terrible, menacing, beautiful purple flowers waving above lettuce-like foliage. I left my victims on the battlefield as examples to their terrified comrades. Ironically, I proved to be an efficient disperser of sea-lavender seeds, but I only saw their continued proliferation as further evidence of villainy.

Many years later I learned I had been up against no ordinary adversary, but rather a member of a special club that makes a profession of badness. If garden weeds are the common criminals of the species world, invasive species are the mob bosses, the megalomaniacs, the supervillains bent on global domination.

Discovering invasive species supercharged my relationship with the natural world. Suddenly, on every street corner and in every park, I was on the hunt for villains and their victims. This goldenrod isn't a weed. It's a native species! What's this cute plant trying to charm us with its pendulous white blooms and soft green foliage? Thank god I know that it's actually an INVASIVE SPECIES! Rip it up! Dig it out!

The more I obsessed, the more I was drawn into an astonishing universe of rogue superorganisms that somehow thrive despite our best efforts. The wicked problem of invasive species grew in my mind, until I reached an unexpected impasse:

What if there are no supervillains in this story? What if there are only random plants and animals just trying to do their best to survive and reproduce in a world beset by rapid environmental change?!

* * *

It's early March, and I'm in Burlington's Centennial Woods with naturalist Teage O'Connor. As we descend into the leafless forest, I can't help starting a list of offending species that catch my eye: burning bush, bittersweet, barberry…I know them better than I know the trees.

"Common buckthorn is incredible in its ability to persist in heavily disturbed soils," Teage says. "But if we end our curiosity towards it by labeling it, we stop figuring out what makes it so incredible at what it does."

Snow crust crunches underfoot as we walk, and Teage recounts random acts of violence he's seen perpetrated against buckthorn: "It's like this knee-jerk reaction against a species you've been told shouldn't be anywhere. If your primary relationship with invasive and non-native species is adversarial, there is a barrier against you appreciating the landscape for what it is." I remain silent—he could easily be describing *me*.

We arrive at a patch of tall reeds, where a small clearing on one side of the trail betrays secretive work. Teage is building a phragmites canoe—he plans to paddle it down the Winooski River from Salmon Hole to Lake Champlain. "The nice thing about invasive species is that nobody cares about them, so you can harvest with impunity." He grasps one of the tan-colored stems, pulls up, and kicks the base of the dry reed, popping it cleanly out in one piece.

He reminisces as he works; this area used to be a flooded beaver pond with boneset, jewelweed, and dozens of hummingbirds during the autumn migration. "That's all been crowded out by phragmites now that it's gotten drier," Teage laments.

I wonder which came first: the departure of the beavers or the invasion of *Phragmites australis*. Regardless, the spread of invasive species across Centennial Woods has become entangled with Teage's emotional response to the loss of past experience in this landscape. But instead of cultivating animosity, he is busy finding ways to shift his relationship with these living symbols of undesirable change.

Teage started making Norway maple syrup after observing the local squirrels biting holes in the bark, as they do with native maple trees, to force sap to flow and sugar to concentrate through evaporation. It's turned into a sunny afternoon, and as we scramble down a wooded slope in search of a squirrel-tapped tree, we find that the temperature has climbed into the upper 30s, just enough to start the sap flowing. The taste is mild, with only a hint of sweetness, but I still feel a twinge of new appreciation for Norway maple—a plant that I've hated for over a decade.

By prioritizing positive engagement with invasive species, Teage hopes to inject greater nuance into the conversation about their management. "I want people to be able to ask if it is really effective and necessary in each situation to get rid of them, and the ecological impacts weighed against all of the other ways of connecting with and experiencing a non-native species."

"I wish, from a pop science perspective, that the term invasive species would just go away, because it becomes too easy to demonize groups of vastly different plants and animals without any context or scientific literacy. Most people couldn't even identify the species they're supposed to hate."

* * *

Charles Elton, famed English ecologist, lived through World War II. When he published *The Ecology of Invasions by Animals and Plants* in 1958, it was filled with the imagery of military conflict: "It is not just nuclear bombs and wars that threaten us… there are other sorts of explosions." In its pages, Elton wrote about "ecological explosions," rapid proliferations of organisms, often those displaced from historic ranges. Malarial mosquitoes from Africa to South America, chestnut blight from Asia to North America, sea lamprey into the Great Lakes through the Erie Canal: translocated species can pose serious threats to human health, biodiversity, and economic interests. Elton framed the struggle against invasive species as a battle for the fate of the world, a conflict that ecologists might ultimately decide.

But while introduced pathogens and pests may create harms that are easy to define and quantify, such as decreased agricultural yield or increased illness, most introduced plants and animals produce ecological impacts that are harder to qualify as wholly bad or good. In recent decades, some scientists have challenged the assumption that invasives are intrinsically harmful and have urged peers to eliminate biased characterizations of invasive species in scientific literature.

Nevertheless, public perception of non-native species is strongly influenced by a half-century of research that follows from Elton's war-like framing of invasion biology—research that largely focuses on negative impacts of introductions and excludes benefits such as food and fuel production, climate change attenuation, and cultural value.

The language of invasion biology is itself a source of public confusion, as regular scientific use of loaded terms like "alien," "exotic," and "invasive" obscures the objectivity present in much invasive species research. These terms readily map onto xenophobic patterns of speech, either fueling hatred of non-native species or mistrust of seemingly prejudiced scientists.

Furthermore, deciding what constitutes an invasive species is not straightforward. While scientists have historically used "invasive" to describe the biological behavior of introduced populations of organisms, governments define invasive species based on a perceived likelihood to cause economic or environmental harm. Even the terms "introduced" and "non-native" sometimes fail to provide clarity, as some invaders, like the barred owl in the Pacific Northwest, were not spread by humans but merely expanded their natural range in response to climate change and landscape alteration.

For those who consider embracing a position of tolerance towards non-native plants and animals in the wild, another complication exists: introduced species usually undergo a significant lag time before becoming invasive, leading to guessing games about the long-term impact of species that have yet to prove problematic.

So where does that leave land managers, conservationists, and concerned citizens? When do we act to control introduced species and when, if ever, is it okay to stop meddling in the uncertain outcomes of invasion processes?

* * *

All along the Winooski River, silver maple branches arch gracefully downward under the weight of a wet spring snow. The forest floor is buried, and only a few stems of last year's growth hint at what lives in the understory. Duncan Murdoch is the Intervale Center's natural areas stewardship coordinator, and he was here in 2015 on his first day on the job, cutting through a thick stand of Japanese knotweed. Over eight years, that stand has been replaced by a diversity of native plants. I ask how he managed to beat the notoriously persistent weed.

"Oh, knotweed is still here," Duncan says. "So we just need to keep coming back, but the stewardship is getting less and less every year. We harvest it in the spring to make knotweed ice cream." A downy woodpecker lands on a snag nearby and we pause to watch.

"I don't think we'll ever be able to eliminate them from the land… why should we?" he continues. "But we should watch them and we should control their populations sometimes, and I think the big reason is biodiversity."

Duncan sees invasive plants as teachers, bringing people into closer relationships with the land. "They're saying, 'Pay attention! Look at your influence and how you are interconnected.' We're not here just to conquer the natural world but to take care of it and be part of it."

We follow a pair of ski tracks downstream to another restoration site, and Duncan rattles off the lengthy list of invasive plants that he's found on-site. "It's like a combination of art and science, and it's up to the land-user to figure out. How do you choose what to address? I'm trying to be comfortable not knowing the answer, and it's humbling."

Duncan launches a snowball into the air, and we watch it drop into the river with a satisfying plop. I'd like to ask the Winooski what she thinks about knotweed and native species, but she doesn't stop to talk. The river flows ever lakeward with a swift, silvery boil in the morning light.

"Some of these plants have naturalized…when does that happen?" Duncan asks. "Is it just because we kind of like the plant and are all right with it?" Naturalized, invasive, alien: when released from the curated confines of academic papers, scientific definitions blend with intuitive meanings, and each word becomes no more than one person's best attempt to describe a part of the messy natural world as they see it.

Image: Lee Toomey

Duncan sees a middle ground.

"Goutweed is the entire forest floor in some areas, and I don't see how we can do anything about it. So, we're starting to do research around the relationship between natives and invasives, and I'm reintroducing ostrich fern. What native plants can compete?"

Shifting away from a paradigm of necessary eradication towards one of managed co-existence feels like a sea-change for me. Demilitarizing my relationship with invasive species doesn't necessarily mean embracing apathy or denying scientific consensus—but it does mean changing my expectations of what is included in a natural community.

"Nature will work itself out," Duncan muses. "It's just a matter of how it impacts us humans and our feelings about that. We're here in such a small period of time, but nature thinks on such a grander, mind-blowingly slower scale, so really…it's selfish I think… We're doing this for our own good. To feel good. To be in an environment on our planet that feels right for us."

The dirt road that bisects the Intervale has been plowed, and the snow is already melting off as we weave our way back around muddy potholes. As we pass farms and gardens, I automatically start another tally of invaders lurking in their hedgerows: burdock, bittersweet… but this time I stop. These bad species are the reason I'm out here, and I owe them a debt of gratitude.

David Moroney (Cohort AM, '24) really does still have a peregrine falcon t-shirt. He is a former science teacher.

How It Seems to Me

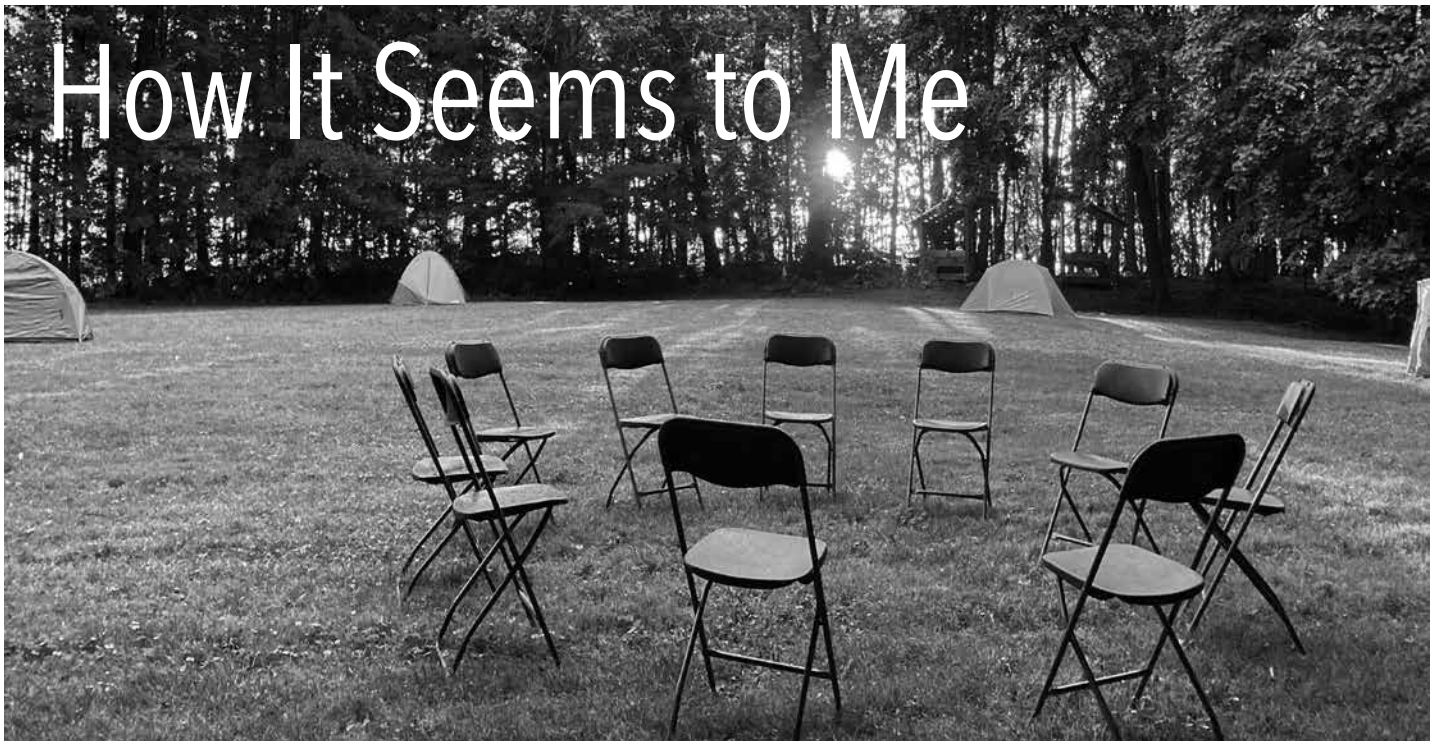


Image: Lee Toomey

DAVE BARRINGTON

You show up in your old car and walk up to the field, sit in a circle of folding chairs in the August morning sun. You meet the people who will be your friends for the rest of your life. You listen to us talk of the day, of the joy of beginning with all of you on your time here as a Field Naturalist. Perhaps later that day, your whole team goes off with us to some bit of wilderness in our valley, tumbles out of the cars, and immediately descends on the weeds in the parking lot. You are beginning the discoveries you will make together, perhaps starting with a monarch caterpillar on the milkweed nearby. We are decades older than you, expect you to reach the summit long before we do, but we get there first—you have been constantly distracted by the natural world as you learn how to be together, which you will be so much of the time in the months to come.

Then there are the days in botany boot camp. You set out for the wealth of places in this countryside where you now live—so many Official Course Plants, day after day, all day long, rain or sun. You join me in Smuggler's Notch, where I try to convince you that ferns are possible to tell apart even though they love to hybridize, intent on tricking you. I am taken by the intense focus that you have, the manifest hunger to come to know everything about the natural world—you and every Field Naturalist I have ever known. When Field Botany is over, often you all gather at our house for dinner to celebrate the time together. Sometimes you bring your guitar or banjo with you; once, a big accordion. You teach me new songs, songs I still sing years later, like Wagon Wheel.

You go off to other courses, to Bernd's cabin, choose a project. Occasionally, you show up in my office and I end up being your advisor or on your committee—I'm honored. You and your team disappear for the summer—the FN space is quiet now. Sometimes I end up at your field site with your committee members, dubbing about in a bog or a forest to help you think about the place and the process. You have taken ownership of your project; you are metamorphosing before our eyes.

Back you all come to UVM, begin to make sense of your summer's work. When I go to the computer room in Jeffords on an errand, I see you there with one or two of your team, going at your writing and mapping and statistics. So much to do. Then it's the home stretch. There is a field final scheduled, we get the directions to your site, end up in some swamp or woodlot or soggy slope looking for little bits of the natural world to bring back, hoping to stump you in your field final—sometimes we do. Once, in a soil pit, you left me a beer.

Then you all give your seminars; yours goes well even though you thought it wouldn't. The final copy is miraculously put together, and the sponsor is pleased. Then, the day in May comes that we go down to Shelburne Farms (or years ago, up to Hub's house) and celebrate your success, speak to your accomplishments, accept your appreciations, and you get your little shovel. Then you disappear. I do not understand this part; you have become our fast friends, shared so much with us, completed your ecdysis to our delight—and you simply disappear, filling your old car with your things and going off to your job. It seems as if you were only here for a couple of weeks. I wish it had been longer.

David Barrington has been a professor at UVM and Director of the Pringle Herbarium since 1974.

Image: Lee Toomey

A Tribute to Cathy Paris: Our Teacher in the Language of Botany

ALICIA DANIEL & GRACE GLYNN

On a clear, calm day in the mid-1980s, Cathy Paris scouted the Northeast Kingdom's dark spruce-fir forest from the window of a small plane. With UVM Environmental Studies professor Ian Worley as the pilot, the focused graduate student was on the hunt for unmapped serpentine outcrops that might host the Green Mountain maidenhair fern (*Adiantum viridimontanum*), the species that Cathy would soon name and describe.

Meanwhile, in the small city of Burlington, Hub Vogelmann had just launched the UVM Field Naturalist Program. Unbeknownst to anyone at the time, the evolution of the FN Program and the arc of Cathy's professional career would intertwine like two strands of DNA.

Cathy has taught Field Botany for Natural Resource Professionals—a foundational course of the program—for over 20 years. Alongside her colleague Liz Thompson, she assembled an iconic line-up of exemplary natural communities across Vermont, from the remnant sand dunes at Alburgh to the clayplain forest at Williams Woods. Under Cathy's tutelage, generations of students have carefully noted Official Course Plants, studied indusia through their hand lenses, and successfully keyed out goldenrods. Cathy has also served on the graduate committees of around fifty Field Naturalists, advising them through completion of their master's projects. Cathy is known for her meticulous and skilled editing, thoughtful questions, and responsiveness. She holds students to a high standard and is deeply kind and generous.

A natural teacher, Cathy speaks with an eloquent precision that leads botany students directly into the magic of the plant kingdom. The way she describes plants—a tubercle like a child's party hat, a swamp full of nodding cottonsedge like a galaxy of stars—makes us all want to lean in and look closely, to speak the language of botany. Cathy keeps a jar of clubmoss spores close at hand, and many FNs have gathered 'round to witness her mischievous look as she pours the flammable reproductive material onto a lit match, and the spores alight in a sudden, fiery flash.

Through all the years of the Field Naturalist Program, Cathy's generosity has extended beyond the classroom: she and Dave hosted an annual post-Field Botany celebration in their home for about 15 years in a row. As the pandemic caused shutdowns in 2020, the two superheroes even hosted Cohort AJ's graduation in their own backyard as the wood frogs chorused on.

Though she is beginning to transition away from her full-time faculty position, Cathy continues to mentor, guide, and delight us. Her own delight in plants never fades, and she approaches the natural world with a contagious joy and playfulness. This summer, another cohort of Field Naturalists will follow Cathy around with their hand lenses as she shows them a persistent calyx here, a shining stipitate gland there. She'll be one of the first friendly faces to welcome them, and they'll follow her up the winding Long Trail into the rich cove forest to learn how to see and describe the flora of Vermont. And long after the semester ends, Cathy will still be an anchor for the Field Naturalist Program, inviting us to marvel at plants with her and keeping the spore-fed fire burning bright.

Image: Grace Glynn

Alicia Daniel (Cohort E, '89) directs the Vermont Master Naturalist Program and has taught FNs for 33 years. **Grace Glynn** (Cohort AJ, '20) is Vermont's new State Botanist.

A Tribute to Dave Barrington: Our Guide to the Complex and Diverse

WESTON TESTO

Images: Lee Toomey

When Dr. David Barrington joined the faculty of the University of Vermont in 1974, he was hired as the Director of the Pringle Herbarium and Assistant Professor in the Department of Botany. Dave would focus his research on the holly ferns (*Polystichum*), a genus with hundreds of species that, as Dave remarked in a 1985 paper, is "complex and poorly understood." In the years to follow, hundreds of Polystichum from around the world fell to Dave's pruners and plant press. He quickly became the world's expert in this group, which to this day remains complex but not quite so poorly understood.

Dave and his students pursued a remarkably diverse set of research projects, both in Vermont and around the world. With so many engaging study ideas to take on and Dave's support for student research, it is no surprise that his lab has long been a hub of plant diversity science. During his 49 years on the faculty, Dave directed 21 graduate theses and dissertations, advised dozens of undergraduates who conducted research in his lab, and worked closely with a long list of Field Naturalist and Ecological Planning students.

Countless other students and naturalists who have been fortunate enough to spend time in the forest with Dave certainly can relate to the tale of the first time that I met him. I was a second-year undergraduate when I attended a pre-conference field trip to see the local fern flora during the Botanical Society of America's annual meeting. As we drove to the field site in the woods of Rhode Island, my then-advisor filled me in on the Who's Who of fern researchers. I remember distinctly that he told me, "Dave Barrington is here somewhere." Now that I look back on it, I suspect that Dave was taking a nap on one of the seats in the back of the bus.

When we arrived, I ambled through the forest with dozens of botanists. We stopped to look at virtually every plant, no matter how common. Interrupting this very slow walk was a puzzling sight: a tall, lanky man sprawled on a giant rock, encircled by a captive audience. From his seemingly uncomfortable position, the man plucked two leaves and waved them back and forth while saying something about them. My advisor ushered me forth. The leaves were from two different species of our familiar rockcap fern, *Polypodium*, and the man was Dave Barrington.

The effectiveness of any teacher is perhaps best measured by the impact that they have on their students. Dave's students have gone on to pursue successful careers in biology and beyond. I, for one, will never forget Dave lying on those rocks with his Chewonki hat askew and a smile on his face. Two years later, I started my Ph.D. studies with him. Many colleagues of mine can tell similar stories of how Dave has inspired them through his ceaseless enthusiasm.

The Botany department's name has changed more than once since his start at UVM in the '70s, but Dave has remained a constant. Thankfully, we will still see him around campus as he transitions to retirement. He plans to keep coming in to work at the Pringle Herbarium, contributing to our understanding of plant diversity and continuing his study of those pesky holly ferns.

Congratulations, Dave!

Weston Testo is the Assistant Curator of Pteridophytes for the Field Museum of Natural History and will be joining UVM's faculty as Director of the Pringle Herbarium this fall.

Image: Teague Embrey

The Curious Case of *Eriogonum tiehmii*

WILL DURKIN

If you were standing on Rhyolite Ridge in Nevada on September 12, 2020, it would have felt hot. Ninety-two degrees Fahrenheit hot. On this far western edge of the Great Basin, the largest North American watershed with no outlet, with the sun blasting and your feet shuffling across shattered plates of a chalk-white rock, you'd likely come across a delicate, yellow-flowered perennial forb, buzzing with a frenzy of pollinators: Tiehm's buckwheat. This sliver of public land in Esmeralda County, Nevada's least populous region, is the only place on earth home to this buckwheat, *Eriogonum tiehmii*. Standing there that day, in the Silver Peak Range, you would have instead discovered holes where plants used to be—in fact, almost 60 percent of the only known global population was missing. The suspect? Ground-dwelling squirrels, some biologists speculated, but many conservationists pointed their fingers at the international mining corporation prospecting the site. You see, the entirety of this fuzzy-leafed, mat-forming buckwheat's population is located on a highly prized deposit of searlesite, a lithium-boron ore left behind by an ancient Pleistocene lake. Lithium is an essential ingredient for green energy technology, and, from Maine to California, a 21st century gold rush is taking place to extract the element. Rhyolite Ridge happens to be one of the largest searlesite deposits in the world, guaranteeing a huge payout for the eager developers and offering political gain for domestic energy initiatives, putting the future of *Eriogonum tiehmii* on unstable ground.

I first heard of the heated story surrounding Tiehm's buckwheat while living in Reno, 167 miles northwest of Rhyolite Ridge. Rodents blamed for digging up rare plants on a billion-dollar mine? This botanical whodunit immediately caught my interest. I was just finishing my first field season in Nevada, and, having only moved to the Battle Born state from the Green Mountains a few months prior, I was still getting used to the cattle, feral horses, and cowboy hats dappling the treeless landscape. I was working as a contractor for the Bureau of Land Management, surveying plants and digging soil pits in rugged and remote rangelands across the state. I grew increasingly fond of the *Eriogonum* genus over the field season, recreationally collecting different specimens in my plant press and even acquiring the nickname "Buckwheat Bill" from my field crew. Their miniature six-petaled flowers in dense ball-like clusters, often a sulfuric yellow or rosy white and perched on long stalks rising from blue-green leaves, charmed me.

To Ioneer, the Australian company mining the site, this buckwheat was not charming. It was standing in the way of their proposed 2,300-acre open pit mine at only six inches tall. Since the discovery of lithium at Rhyolite Ridge in 2017, Ioneer has been investing tens of millions of dollars into the project. This mine was expected to turn out enough "white gold," or lithium, to allow production of 370,000 electric vehicle batteries annually for over half a century, increasing U.S. electric vehicle manufacturing by nearly 90 percent, until a whistleblower inside the BLM alerted local conservationists to a blatant lack of federal oversight. In late 2019, buckwheat advocates, worried that mining activities would continue without an environmental impact analysis, urged the Fish and Wildlife Service to list the plant under the Endangered Species Act. Ioneer promised to back off further exploration and, in an attempt to pass the buck on their buckwheat problem, funded research to see if the plant could be moved to a different site. Their research only confirmed that Tiehm's buckwheat is edaphic to the searlesite of Rhyolite Ridge, meaning, over the course of its evolution, it has specially adapted to the unique heavy-metal soil conditions on the site. It simply cannot live anywhere else on earth. Ironically, the lithium-boron minerals that gave rise to *Eriogonum tiehmii* may also be the reason for its demise.

Almost four years of public land controversy boiled to a head, that September morning in 2020, when botanists came across more than half of the Tiehm's buckwheat population destroyed. Federal biologists suggested the culprit was thirsty rodents, given the recent drought. They collected DNA from the root nubs like crime-scene detectives. Conservationists called it a calculated conspiracy, cataloging photos of what looked like human footprints near the unplugged plants and roots perfectly cut by the mouth of a spade. Ioneer clapped back, blaming conservationists for peddling propaganda and trying to meddle with the project. Even botanists from the *Eriogonum Society* who built their careers studying these plants were doubtful of the rodent theory, having never seen that happen to wild buckwheat, especially given the magnitude of the disappearance.

Representing 0.002 percent of the earth's crust, lithium is used for the batteries in our smartphones, the laptop I type this on, solar energy storage, and all the electric vehicles on the roads. The U.S. produces less than 1 percent of the global lithium supply, all from one small mine in Nevada a few miles south of the Silver Peak Range, while 90 percent comes from Australia, Chile, and China. As global lithium extraction skyrockets, quadrupling between 2012 and 2022, the supply gap deepens further from the rate of demand—the current administration has their eyes set on increasing electric vehicle and battery manufacturing to achieve domestic energy independence under President Biden's ambitious American Battery Materials Initiative.

As I see it, the United States faces two crises with lithium extraction: climate change and species extinction. In the curious case of *Eriogonum tiehmii* vs. lithium mining, how can we choose? The extirpation of this species by uninhibited mineral extraction at Rhyolite Ridge will allow the U.S. to grow its current lithium production by over 1,000 percent, increasing our capacity to mitigate climate change and help save other vulnerable species just like the buckwheat. On the other hand, saving this species might continue to enable a poorly regulated global market and long-distance transportation of lithium, emitting more fossil fuels as well as stoking American NIMBY hypocrisy. And yet, even if this mine is going full bore, the U.S. will still only control mere pebbles of the global supply of lithium compared to the mountains of reserves that other countries hold. Will this mine in Nevada make enough difference to warrant endangering a rare species? After all, once the Teslas of the world are drained of their lithium juice, where do all the benefits of green energy go? The further I dig into this story, the more I feel that upending Rhyolite Ridge is a façade of sustainability and a greenwashed political and marketing stunt.

After years of litigation and feud, Tiehm's buckwheat was finally listed under the Endangered Species Act in December of 2022, codifying protection of this Nevadan endemic to the utmost degree the federal government can offer—right? Not exactly. Even though a 4.6-acre protective bubble is delineated around the buckwheat, mining operations could still proceed just over the line. The BLM and Ioneer are currently in the Environmental Impact Statement phase of the NEPA process, and the proposed maps of disturbance activities in their draft report show quarrying, facilities storage, and road construction within 30 feet of the habitat-exclusion zone. This battle-born victory for biodiversity felt short-lived to frustrated conservationists, who believe that mining operations on the ridge will lead to the demise of *Eriogonum tiehmii* from the introduction of invasive species and disruption of monophagous pollinators who exclusively feed on the buckwheat. Elsewhere in Nevada, a similar lithium land debate is happening 280 miles north of Esmeralda County in Thacker Pass. There, a 5,700-acre lithium mine just broke ground in March, despite years of appeals to the courts citing violations of Indigenous land rights, groundwater pollution, and destruction of habitat for the greater sage-grouse, an already fiercely debated species in population decline. The U.S. Department of Energy and the automotive industry have their eyes set on Nevadan lithium, with General Motors investing $650 million into Thacker Pass and the Department of Energy promising $700 million to Ioneer for the development of Rhyolite Ridge.

> What is the point of a sustainable future if there is nothing left to sustain?

It's Sunday, April 23, and I broke my phone. It hit the floor at a moment of wrangling this storyline and my morals of personal lithium use. My phone's demise came as no surprise, as a hand-me-down from an old roommate three years prior, but all smartphones, like all the batteries in electric vehicles, are temporary. Why should we accept permanent extinction of a species or destruction of a landscape for an ephemeral energy solution? I feel bad for *Eriogonum tiehmii,* and other species like it in the wake of the lithium wave—caught in the middle of a land fight between fevered conservationists, federal policy initiatives, and dubious international corporations. Don't get me wrong, I'm in favor of sustainable technology development, but instead of diving headfirst into this sea of green energy potential, we should be taking time to fully understand the impacts of lithium and other rare mineral extraction. What is the point of a sustainable future if there is nothing left to sustain? Despite being 2,300 miles away, I feel as if I am lost on Rhyolite Ridge, scrambling on plates of searlesite, loving Tiehm's buckwheat even as I decide to buy another lithium-powered phone.

Will Durkin (Cohort AM, '24) likes to go birding and play rugby, sometimes at the same time.

June 2022
Sicily, Italy
10,900 ft

Mama Etna

For 500,000 years, fountains of lava have been exploding on Mount Etna—first under the sea and now more than 4,900 ft into the air. Eruptions simultaneously build the summit and scorch the earth. Ash clouds billow around the peak and puff from the surface vents.

Maurizio

Me

ROCK TYPE

Iron-rich basalt filled with vesicles (holes) from where gas fizzed out of magma, like solidified beer foam.

Buried trees, boiled alive, stand petrified—frozen in time.

Rumex scutatus

The sole plants up in this volcanic desert dance like little flames.

Maurizio, Sicilian volcanologist

Mama Etna creates life, and she takes it away.

My ancestors left Sicily in 1898 for a better life in America.

I return (four generations later) to uncover their roots.

I look for them in our ancestral town of Termini Imerese, at their fishing pier, their Sunday church, Duomo di San Nicola di Bari...

...and (multiple times) in the Granita Café. But they are nowhere to be found, and the town clerk's office is closed.

Meanwhile, lower on the volcano, black turns to green. Plants begin to regrow on top of each other in tiny mountains of their own.

Tanacetum siculum

Cerastium tomentosum

Astragalus siculus

Then, the insects return.

I had a fantasy of wearing floral shirts and speaking Italian with my long-lost relatives. Instead, I go home to my Boston apartment and make some granita.

Grapefruit Granita

MAKES 4 CUPS

1/3 cup sugar

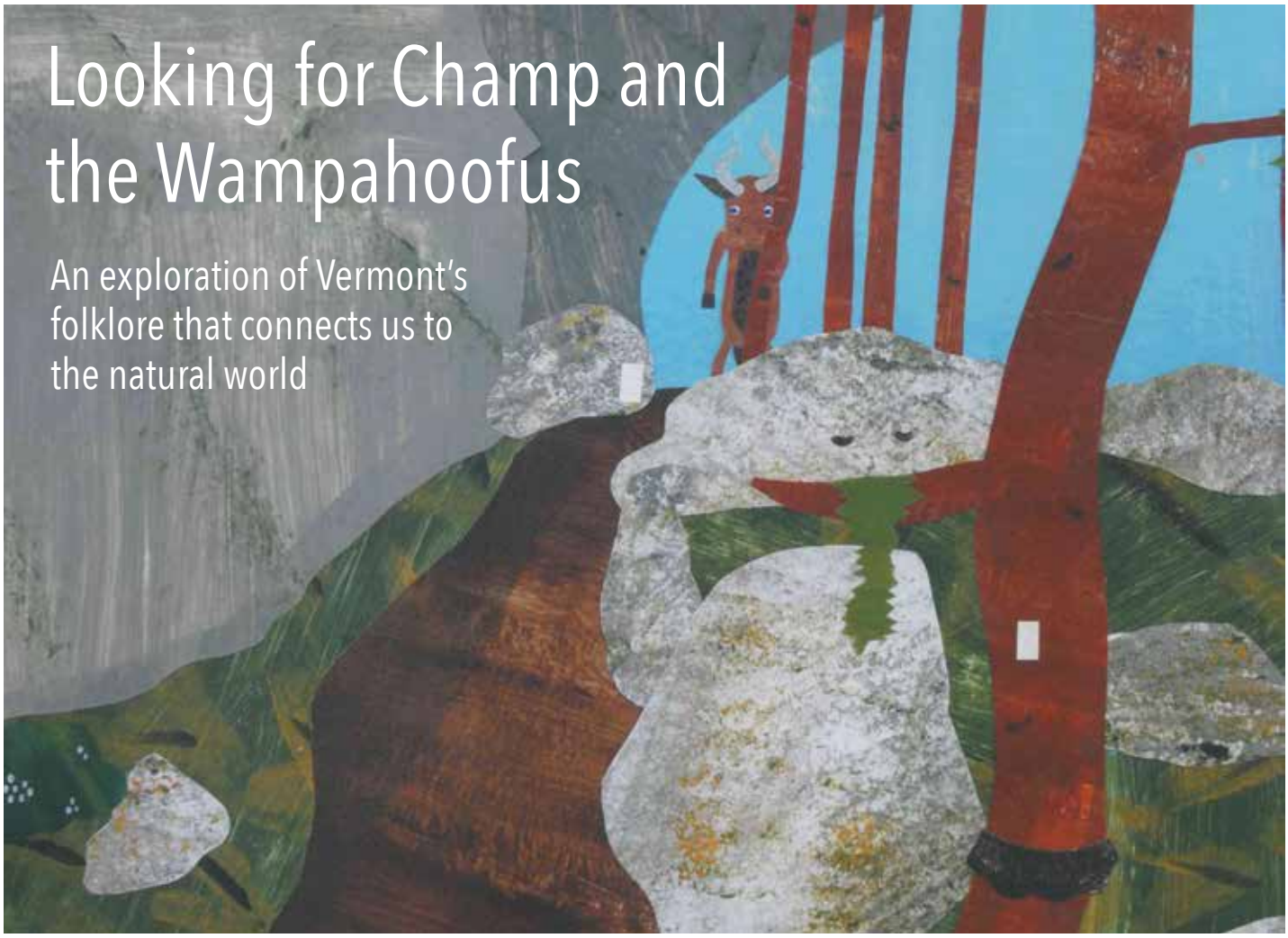
2 1/2 cups grapefruit juice

In a medium saucepan, combine sugar, 1/2 cup water, and bring to a boil. Add fruit juice and stir. Transfer to a metal or plastic container, freeze for 3-4 hours. Every 30 minutes, think of your ancestors as you scrape with a fork and mix the granita so it does not freeze solid. It should be completely frozen but still easily spoonable. Keeps for 1 month, covered.

Lee Toomey (Cohort AM, '24) enjoys exploring outside and sitting inside, and vice versa. They adapted this recipe from one by Joanne Chang.

Looking for Champ and the Wampahoofus

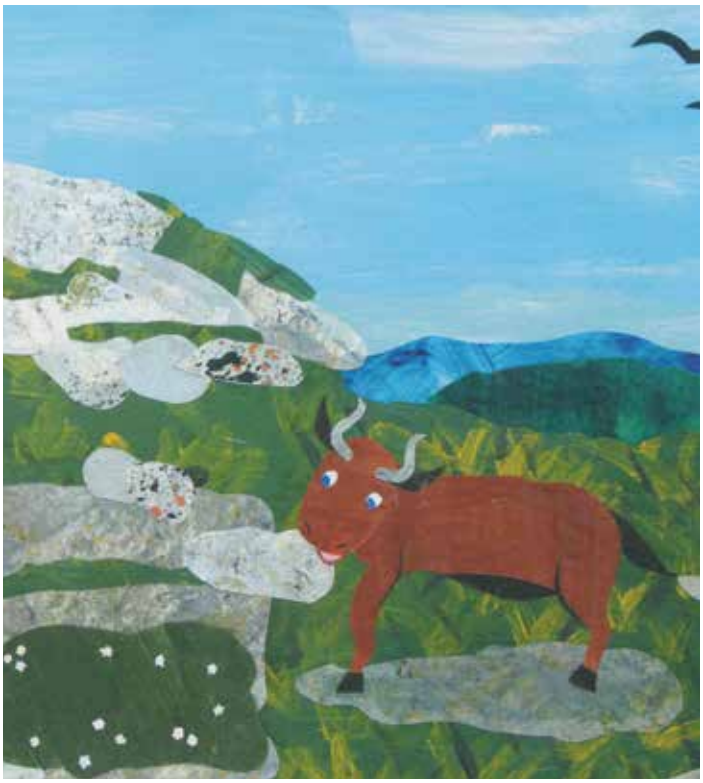
An exploration of Vermont's folklore that connects us to the natural world



Artwork: Zoe Linton

EVAN HORNE

On a windy March morning, I left my vehicle at the entrance of Underhill State Park in the foothills of Mt. Mansfield and set out on the hunt for a wampahoofus. What, you ask, is a wampahoofus? A wampahoofus is a kind of sidehill gouger, a fearsome hillside creature with sharp, intimidating horns. Technically, a wampahoofus is a cross between a moose, a bear, a deer, a goat, and a boar—complicated genetics for sure. Other recent studies describe a wampahoofus as a small, docile, herbivorous animal similar to a porcupine, but that's a dubious claim.



Whatever the taxonomy, the wampahoofus evolved in Vermont and now roams between 2,600 and 3,200 feet in elevation around Mt. Mansfield. It has legs that are shorter on one side than the other, an asymmetrical adaptation unique to the natural terrain of a steep mountain. A wampahoofus can only move in one direction—turning around would cause it to fall over and tumble down the mountain to its death. Males and females have opposing shorter sides, right for males and left for females. That means males move clockwise around the mountain while females move counterclockwise, meeting at opportune moments to mate.

I looked but did not cross paths with a wampahoofus. There was no sign after hiking along the mountainside—no diagnostic hoof-like footprint. I found only tracks of snowshoe hare beneath red spruce and balsam fir. Some claim that the wampahoofus has gone extinct due to breeding difficulties. However, a rock outcropping on Mt. Mansfield that looks like a wampahoofus reminds hikers of the beast. And the loud noises echoing from the Ethan Allen Firing Range sound like its deafening call, so it's hard to be sure.

After failing to find a wampahoofus, I decided to chase down Champ, the famed lake monster swimming in the depths of Lake Champlain. There is a delight to the mysterious, and there may be something out there to find. Still optimistic, despite not seeing anything on the hillside of Mansfield, I decided to call in an expert on my quest.

Dr. Ellen Marsden, a fisheries ecologist and professor at the University of Vermont, is no stranger to Lake Champlain and Champ. She's been studying the waters off the shores of Burlington for more than 20 years. Admittedly, Dr. Marsden is tired of people asking her questions about Champ since she first reported on it in the early 2000s for ECHO, a science and nature museum on the Burlington waterfront. After all, easier-to-find monsters need our attention, like the lake sturgeon, which many states list as endangered, Vermont included.

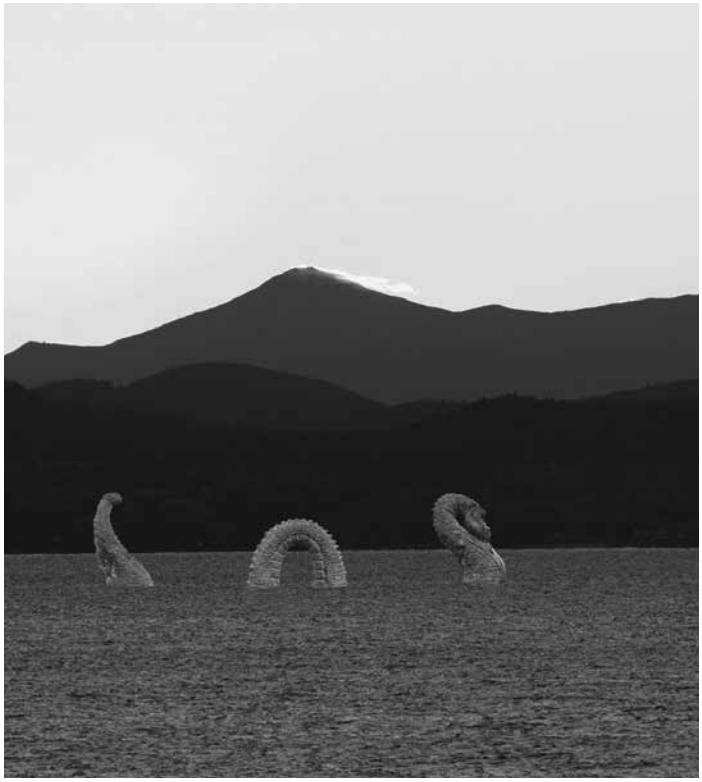


Image: Lee Toomey

Champ is said to look like Nessi in Loch Ness: a plesiosaur with a long neck, a humped serpent-like body, and large fins. In a recent article, Dr. Marsden addressed these physical characteristics and showed how the typical lake monster fails to hold up to science. But the biggest problem is that people identify only one individual in reports and sightings—this lake monster must be ancient if there is only one of its kind.

> Believing in these beings is an attempt to protect something worth keeping.

Conservation genetics research shows there should be more than 5,000 Champs to sustain populations over generations and avoid inbreeding (also problematic among wampahoofi). Thoroughly studied food-web models would not balance if a large population of unknown organisms was present. Dr. Marsden also noted that long necks characterize these monsters as air-breathers required to lift their heads above the water. If 5,000 Champs must surface to breathe at least 12 times a day (based on the absolute minimum of a whale), then the population would have been seen by now. Did you say, "Test for environmental DNA"? Interesting idea. With that evidence, there is even less of a chance of proving Champ exists.

So, if the probability of a population of monsters living in Lake Champlain is essentially zero, why do sightings of Champ keep happening? Stories of a monster in Lake Champlain began long ago, with Abenaki legends about a giant creature inhabiting the waters, believed to be a horned serpent. The Abenaki term for the monster is "Gitaskog," and the Abenaki warned colonizers not to disturb it. Early reports often credit Samuel de Champlain, the lake's namesake, as the first European to spot Champ, but his accounts show that he saw something near the St. Lawrence River. Other sightings appear throughout history, most notably in the 1800s when a boat captain claimed to see a monster in Bulwagga Bay.

With no actual method or plan, I picked a warm, sunny winter day and sat on the rocks at Oakledge Park in Burlington for hours, trying to scour every meter of the lake in my view. Some common mergansers dove underwater, but that was the only excitement on the lake. With the sun shining, I thought I might get lucky and see one sign of Champ. But I did not have high-tech underwater cameras, hydrophones, or a boat to scan the lake bottom with sonar. I did not see a lake monster or find any evidence. Otherwise, you likely would have seen it in the *New York Times*. As it turns out, Dr. Marsden said that all "sightings" occur in poor light conditions or fog.

There are countless dramatized videos across the internet of cryptozoologists and investigators documenting the "movements" of Champ in the lake. Dr. Marsden believes that "with one bit of mass hysteria, there is often buy-in," and people will believe something is out there. Humans are amazingly complicated. "To disprove something, we have to explain every meter of the lake," she said. But Dr. Marsden is convinced most rational people know legends are not real.

I did not expect to find a wampahoofus or Champ. And I didn't. Despite the resounding evidence against the existence of these creatures, Dr. Marsden gave a glimpse of hope—she reminded me there is no harm in educating kids about the Lake Champlain monster or other fabled creatures. If searching and learning about these legendary beasts excites people to go for long walks in the woods, "they will see everything else out there. It's all good. It introduces children to question[s of] what could or could not be."

I used to walk through make-believe doors as a child. Portals transported me to fantastical worlds with fantastical creatures, making the ordinary world seem magical too. I no longer see them as an adult. But growing up doesn't mean I have to lose my sense of wonder. My backyard has an endless cabinet of curiosities to explore, where mysterious beasts lurk in the dark forests and deep lakes of the Green Mountain State. There are cryptids, creatures whose existence is scientifically unproven, that live beyond stories. These legends should encourage adults to wonder about the natural world the same as children.

Zoe Linton, a former graduate student at the University of Vermont, wrote a children's book about the wampahoofus for her master's project. Drawing inspiration from her time as a summit caretaker on Mt. Mansfield, Zoe used the wampahoofus as the main character to make alpine plants and animals more fun. She loves the name of the Wampahoofus Trail: "It provides an angle of mystery for other hikers, and they believed [they heard] the call of a wampahoofus. It adds to the experience of hiking Mansfield."

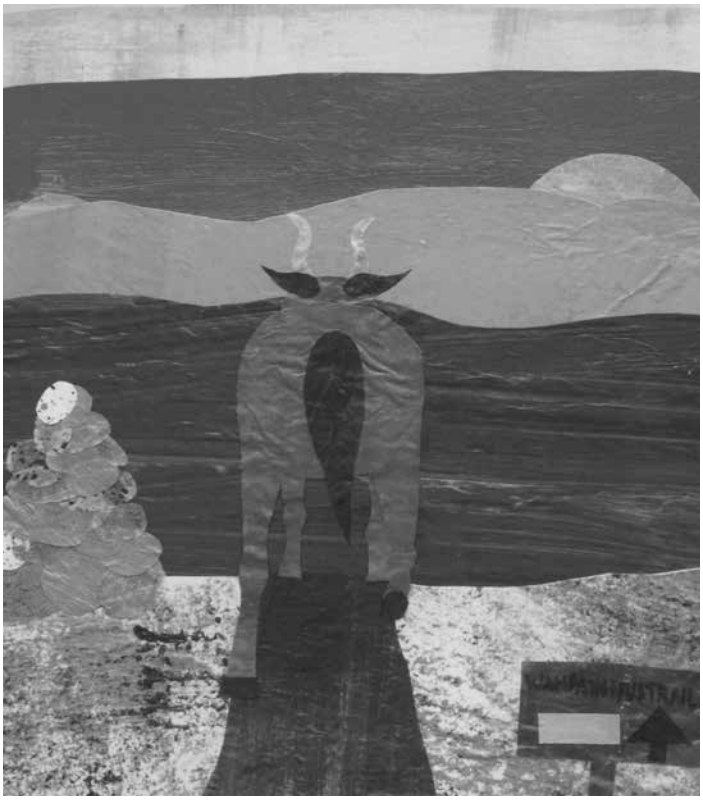
Zoe grew up in Vermont, connected to the local culture and close to the land. She's interested in cryptids, "the weirdest supernatural subjects," and has a similar sentiment to Dr. Marsden regarding legends. "I'm hopeful that Vermont will keep these legends alive." The wampahoofus "enhances the curiosity of the mountain. Any baseline understanding expands curiosity, and curiosity breeds discovery [of] the responsibility to care for and conserve natural spaces."

In Iceland, it's relatively common for adults to at least entertain the possibility of the existence of elves. A recent book, *Looking for the Hidden Folk* by Vermont author Nancy Marie Brown, explores how Icelanders use stories of elves to express their concern for their environment. Elves represent a special connection with the natural landscape that can be difficult to explain, altering our perceptions of the environment. The mountains and rivers hold significance as elven homes, and believing in these beings is an attempt to protect something worth keeping. Suppose there were a place in the United States with a similar connection to legendary beings to that in Iceland. In that case, Zoe says, "Vermont has a good shot [at] using the supernatural for environmentalism."

If we found a lake monster skeleton or wampahoofi scat, they surely would make excellent company for the Charlotte whale—rewriting the history of evolution around here. I want to believe in wampahoofi. I want to believe in Champ. I want to believe in every cryptid that lives in beautiful lakes and forests across the planet.

There is humility in the struggle to know. Dr. Marsden believes, "It's nice to know everything, but we just don't. We haven't even begun to discover everything out there. Legends add a little mystery and a little humility to the adventure." Science does not support the existence of Champ or the wampahoofus. And that's okay. But disbelief should not be the default.

The more knowledge I gain about the natural world, the more amazed I am at how much greater mysteries become. I will not allow others to deride my sense of wonder or disenchant my world. Chasing after the wampahoofus or Champ reminds me of the spiritual richness that nature provides. Legends can integrate the human world with the not-so-human. Just as I did as a child, I need the magical atmosphere these stories create.



Artwork: Zoe Linton

Evan Horne (Cohort AM, '24) is fascinated by all things outdoors. He is currently working on his Sasquatch call so he can find the legendary Bigfoot.

MEET COHORT AM:

THE AMANITAS - *Amanita muscaria*

Image: Sonya Kaufman

(Left to right) Lee Toomey, Catherine Wessel, Will Durkin, Evan Horne, Michelle Giles, David Moroney.

Dichotomous Key to the Field Naturalists

MICHELLE GILES

1a. Locally wise, Vermont generalist, likes to be outside or in a den (woodland creature).....**2**

2a. Lover of hemlocks, tree nibbler, often napping.....**Quilliam the Porcupine**
2b. Lover of caves at Raven Ridge, skilled hunter, often elusive.....**Robert the Bobcat**

1b. Locally wise, University of Vermont generalist, likes to be outside (naturalist).....**3**

3a. Unanimously decided on a singular representative mascot.....**Cohorts AA – AL**
3b. Loves too many representative species to choose a single mascot.....**4**

4a. Wears binoculars and a hand lens, well-developed interest in birding.....**5**

5a. Field lunches consist of entire jars of peanut butter and whole cans of stuffed grape leaves, affinity for eBird.....**Will Durkin**
5b. Takes it all in through owl eyes, affinity for walking up streams and floating things down them .....**Lee Toomey**

4b. Wears a hand lens, asks to use others' binoculars, developing interest in birds.....**6**

6a. Holds sphagnum moss above all other ecosystem builders.....**7**

7a. Skilled in spotting the little things and slow walking, dreams of being a bog creature .....**Catherine Wessel**
7b. Skilled in cartography and word play, dreams of being accepted into a porcupine family.....**Dave Moroney**

6b. Needs to pet all the trail dogs.....**8**

8a. Mimics bird songs and pop songs, botanizes at bus stops.....**Michelle Giles**
8b. Lover of the Appalachian Trail, skilled in tree identification, strong desire for adventure.....**Evan Horne**

NOTES FROM THE FIELD

COHORT AL: THE LUNA MOTHS - *Actias luna*

CHARLOTTE CADOW

The emerald ash borer (EAB) is an invasive beetle that causes high mortality in white, green, and black ash and was first detected in Vermont in 2018. Black ash *(Fraxinus nigra*) is a cultural and ecological keystone species that is deeply important for many Indigenous peoples of northeastern North America, including the Abenaki. This corky-barked tree also regulates hydrological regimes and nutrient cycling in forested wetlands. To better understand the community connections, distribution, and current condition of black ash in Vermont, Charlotte Cadow worked with the Vermont Urban and Community Forestry Program on research and outreach. Throughout the summer, Charlotte visited forested wetlands on state lands where she established long-term monitoring plots. In each plot, she collected data on basal area, herbaceous species, canopy cover, hydrology, microtopography, trunk condition, soil pH, and tree regeneration. This baseline data will be used to monitor changing forest dynamics and to inform future management of black ash.

DYLAN O'LEARY

Dylan O'Leary's project took him to the sage steppe of southeastern Oregon where he worked with The Nature Conservancy and Oregon Desert Land Trust to develop a restoration plan for 500,000 acres of public and privately owned land heavily impacted by the exotic annual invasive cheatgrass (*Bromus tectorum*). Cheatgrass is spreading across the intermountain west, causing disruptions to the ecology by outcompeting native grasses and providing a fine continuous fuel for larger, hotter, and more frequent fires. His focus was on developing methodologies for interpreting satellite-derived cover maps of perennial and annual grasses in ways that lead to conservation action. Dylan surveyed hundreds of vegetation plots across a diversity of landforms and elevations to determine the accuracy of the cover maps. He then produced four mixed-model geospatial layers to address the likelihood of restoration success based on biotic and abiotic conditions, the spatial configuration of habitat patches, trends in vegetation composition, and climate adaptation and resilience.

ERICA HAMPLE

Erica Hample collaborated with the Montpelier Parks Department and the Montpelier Parks Commission. She conducted a new ecological assessment of Hubbard and North Branch River Parks to inform an original combined management plan. Through a fine-grained field inventory, she delineated 39 occurrences of 22 natural communities. Erica created tailored management recommendations based on the assessed ecological condition of each occurrence.

She also spearheaded a community engagement event series with the Montpelier Conservation Commission and North Branch Nature Center. Based on input from community members, she curated 10 events to increase opportunities for connecting people and the landscape. These PLACE (Place-based Landscape Analysis and Community Engagement) events connected various organizations, stakeholders, governing bodies, and individuals. The culmination of these was a field walk where Erica informed 80 visitors on the natural history of Hubbard Park.

HAYLEY KOLDING

Trout Creek Ranch sprawls in the dry corner of southeast Oregon, spanning over half a million acres of high desert habitats. Conserved by the Oregon Desert Land Trust (ODLT) in 2021, the ranch is managed as a "wild and working landscape"–a mosaic of ecosystems stewarded for habitat integrity and connectivity while keeping ranchers and their cows on the land. Hayley Kolding homed in on the riparian-wetland areas of perennial creeks, springs, and meadows, which are disproportionately important as water resources for both wildlife and cattle in a desert landscape–especially in late summer, when seasonally intermittent streams dry up and upland forage resources are scarce. Sponsored by The Nature Conservancy, Hayley identified priority sites for assessment by factoring in remote sensing data, landowners' values, and logistical details. Then she took to the ground, analyzing vegetation, channel structure, hydrology, and disturbance patterns to diagnose and rank the ecological value and management needs of 125 springs and meadows and 16 creeks.

SONYA KAUFMAN

The Southern pine beetle is moving north, putting globally rare, fire-dependent pitch pine ecosystems at risk. As part of a United States Forest Service and UVM regional assessment of northeastern pitch pine barrens, Sonya Kaufman spent the 2022 field season in three pitch pine forests: the Ossipee Pine Barrens in New Hampshire, the Waterboro Barrens in Maine, and the Green Mountain National Forest in Vermont. She collected vegetation data in stands that were categorized into four restoration and stewardship options: prescribed fire only, mechanical harvest only, mechanical harvest and prescribed fire, and no management. She dipped her toes into dendrochronology as she collected, mounted, and sanded 1,024 tree cores. Sonya spent much of this year counting tree rings and comparing the effects of restoration type on forest composition and mesophication. Her results underline the need for continued active management in pitch pine barrens: burning and thinning are crucial for supporting forest health and preventing devastation by the Southern pine beetle.

A World View on the World

DEANE WANG

In our globalized, internet-connected society, whatever you choose to do with your life, it helps to pay attention to the broader world. Ideas, both bad and good, can go global and have a way of connecting right up to you.

I recently joined a group of my college's alumni called ClassACT, which aims to get the 1992 Convention on Biodiversity signed by the U.S. Treaties take a two-thirds vote in the Senate, which failed to ratify the global treaty back in 1993. The U.S. shares the company of Andorra, Iraq, and Somalia as the only countries that have not signed.

The good news is that the "Conference of the Parties" has met periodically since 1992 and made some headway on the protection of nature, an idea so close to our hearts and, for many of us, our daily employment. In 2016, E.O. Wilson planted a seed that has since manifested as the target 30X30: 30 percent of land and oceans conserved by 2030.

Our local expression of the idea is the Vermont Alliance for Half-Earth. Maybe the seed is now a small tree. Its strong roots, capable of raising concrete sidewalks, might even lift the U.S. Senate.

1992: Convention on Biodiversity signed by 150 nations at the Rio de Janeiro "Earth Summit"–subsequently ratified by 191 parties, excluding the U.S.
1999-2000: Cartagena Protocol on Biosafety: started at a Conference of the Parties in Colombia, ratified in Canada.
2010: 10th Conference of the Parties (COP 10), Japan: Strategic Plan for Biodiversity 2011-2020, including the Aichi Biodiversity Targets.
2016: COP 13, Mexico: Cancun Declaration on Mainstreaming the Conservation and Sustainable Use of Biodiversity for Well-Being.
2016: E.O. Wilson publishes *Half Earth: Our Planet's Fight for Life*.
2018: COP 14, Egypt: Declaration on Investing in Biodiversity for People and Planet.
2019: COP 14, Germany: Towards the Vision 2050 on Biodiversity: Living in Harmony with Nature.
2019: COP 14, India: The New Delhi Declaration: Investing in Land and Unlocking Opportunities.
2019: 30X30 proposed in *Science Advances*.
2021: COP 15, Canada: Promoted the inclusion of 30X30 in the final biodiversity treaty.
2021: COP 15, China: Kunming Declaration on an effective post-2020 global biodiversity framework; President Xi pledges $230 million for biodiversity protection in developing countries.
2021: U.S. committed to 30X30 in Biden's Executive Order 14008: Tackling the Climate Crisis at Home and Abroad.

Deane Wang (Associate Professor Emeritus) is the Founder and former Director of the Ecological Planning Program.

JEFFREY HUGHES

First an update on my book, *An Environmental Leader's Toolkit* (Cornell University Press): it's *finally* out, with FN alums Ben Lemmond and Carolyn Loeb contributing terrific illustrations. I'm more than pleased with how it turned out because everyone in the FNEP community, knowingly or not, made the book what it is. Thank you all!

A different book update and an invitation: I've been toying with crafting a short, FNEP-relevant primer on "Landscape Chemistry in the Field" to help chemistry-fearful environmentalists read landscapes with the help of chemistry. (Survivors of my class probably recall how I mercilessly pushed you to wonder and think through *why* things in nature are the way they are: *why* sphagnum makes bogs acidic, *why* calcium-rich sites harbor many species, *why* heavy metals are bad for you, *why* soggy spots have oily films on the surface, etc.) Let me know if you want to become rich (?) and famous by writing this book with me (jwhughes@uvm.edu).

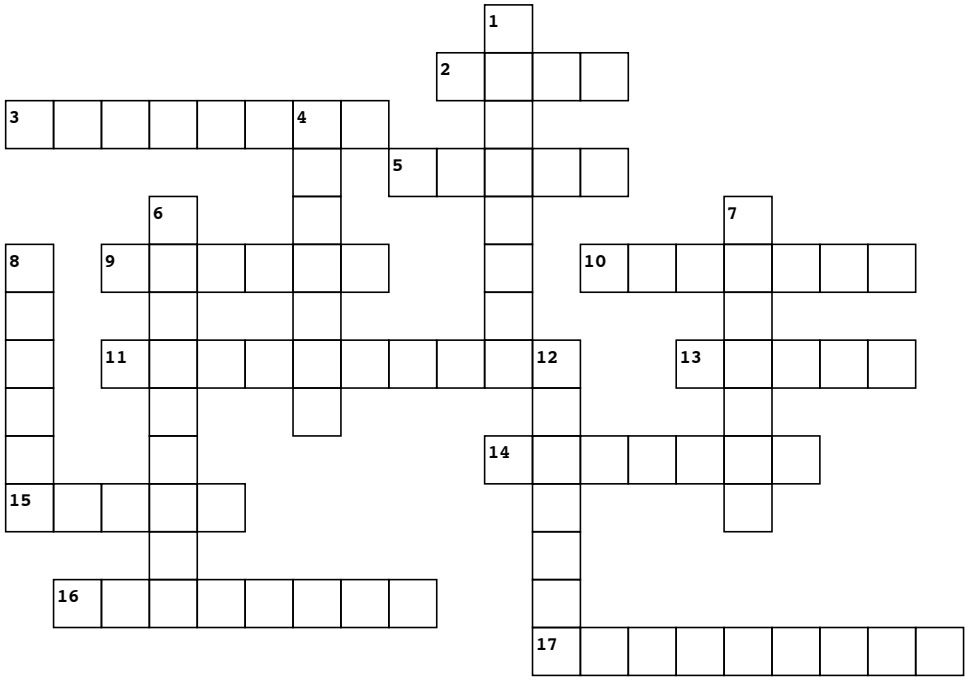
Another update: the editor of my book *Environmental Problem Solving: A How-to Guide* has proposed a second edition. I don't want to take it on alone, but if someone's interested in working on it with me (and being first author) I might be talked into it. Let me know if you might be that someone.

The fourth (but most important) update: Walter Poleman (Director), Jeanne Harris (Plant Biology Chair), and the FNEP Alumni Association have been doing a fabulous job moving the FN Program to bigger and better places. It's amazing what they've accomplished in such a short time—thank you from all of us!

Jeffrey Hughes (Associate Professor Emeritus) is the former Director of the Field Naturalist Program.

Cross(word)ing the Forested Landscape

Artwork: Bernd Heinrich



Across

2. What farmers and glaciers have in common

3. Timberdoodle

5. The messiest log cabin, for a beaver

9. Jeff Hughes's big lesson, often in chicken form

10. Ancient ocean named for the father of Prometheus

11. Winter sheet for North America, 20,000 years ago

13. The anniversary for the Field Naturalist Program

14. Topographic growth spurt

15. Weathered cliff bits

16. Bog maker, with leatherleaf

17. Alpine plant, recently rediscovered

Down

1. One W in WWW

4. Softserve, Vermont-style

6. A very sweet forest

7. Bound again? Isostatically

8. Nickname for Robert Feline

12. What the glacier dropped off

Image: Lee Toomey

FIELD NATURALIST & ECOLOGICAL PLANNING

ALUMNI ASSOCIATION

The FNEP Alumni Association seeks to build the relationships, skills, and ideas necessary for tackling the big environmental issues of our time. Our active network connects students and alums with professional opportunities and matches partners with FNEP expertise. First and foremost, we support the rigorous, relevant education and training of Field Naturalists at the University of Vermont. And we'd love for you to get involved!

BECOME A MEMBER

Membership dues enable us to host gatherings and conferences, support current students, provide alums with grants, and more. Members receive access to our alumni contact database.

BECOME A MENTOR

We pair students with alum mentors working in desired career trajectories. We are seeking more mentors and alums interested in assisting with mentor-mentee matchmaking.

JOIN THE BOARD

We meet virtually four to six evenings per year to plan gatherings, award grants, and advance our support of students and alums.

Please visit fnepalumni.com for more information.

ALUMNI MINI GRANTS

The FNEP Alumni Association provides small research grants to support alums pursuing "passion projects" that advance conservation, ecology, or other areas in which FNEPs make a change. We hope these funds enable alums to expand beyond the boundaries of their day-to-day jobs. The fund is small, but your ideas and impacts don't need to be.

Inquire and apply by contacting us at fnepalumniassociation@gmail.com. Applications are reviewed and awarded on a rolling basis. We look forward to seeing what ideas you have waiting in the wings!

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Need Ecological Assistance?
Partner with a Field Naturalist

Backed by the resources of the University of Vermont, our graduate students can help your organization accomplish its mission – in the field, in the office, in our communities. We are now accepting pre-proposals for Field Naturalist partnerships during the 2024-2025 academic year.

Whether your needs involve fire ecology or citizen engagement, natural community mapping or landscape restoration, application is simple: Briefly summarize your project in an email to our program director, Dr. Walter Poleman. Describe the site for any field work and what you hope to accomplish. We will work to pair you with a Field Naturalist, whose research will form the core of a master's project and provide a practical solution to your needs. The application window closes November 15, 2023.

Winning proposals call for a $6,000 partner contribution to support students during the field season. Your partnership includes:

- More than a year of collaboration, beginning as soon as early 2024
- Literature and other academic research to support your project
- Field work extending from early spring though fall of 2024

Continued collaboration culminating in a draft by December and a final report by spring of 2025
Questions? Contact Dr. Walter Poleman by email (walter.poleman@uvm.edu) or at (802) 318-8441