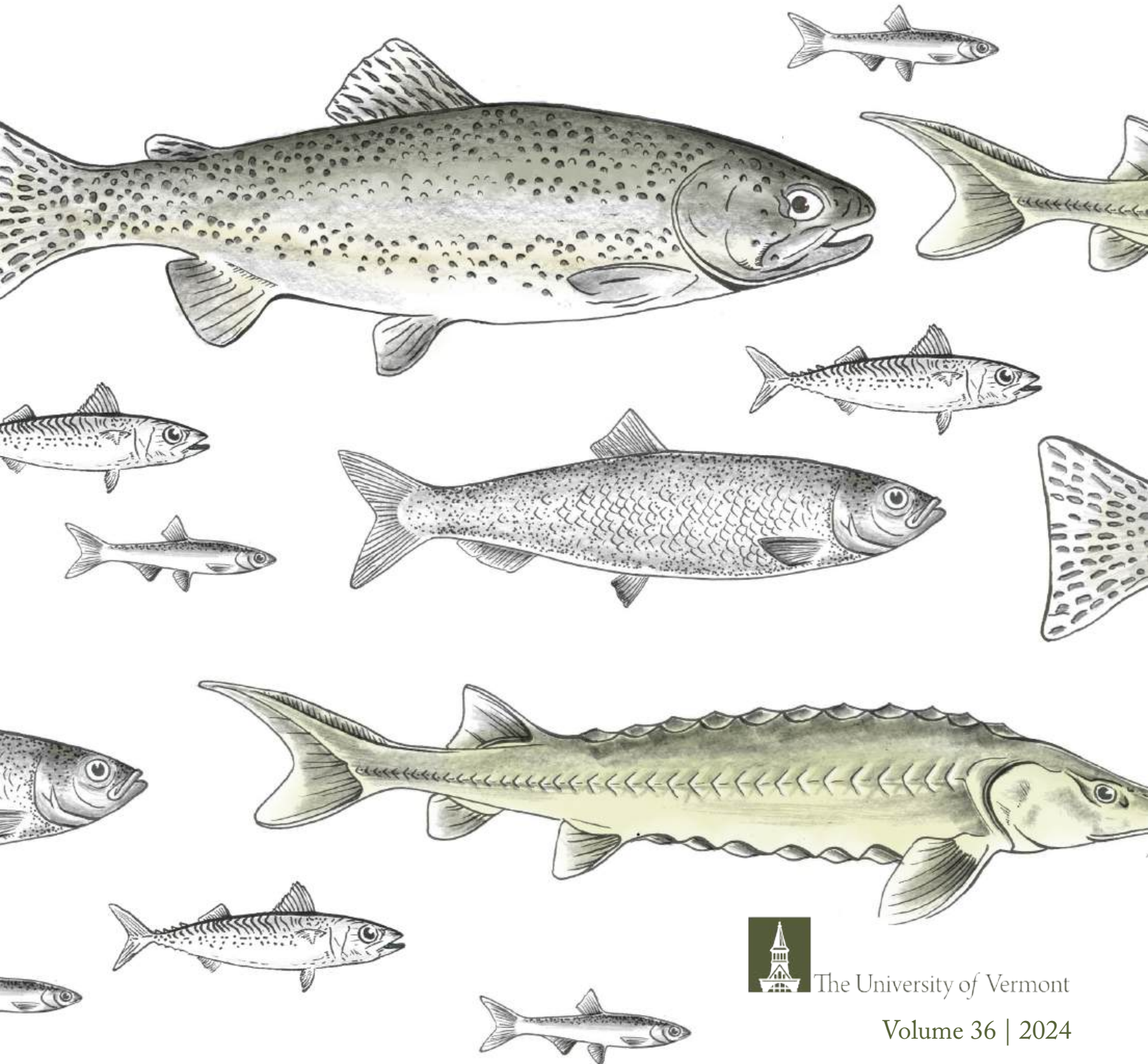


Field Notes

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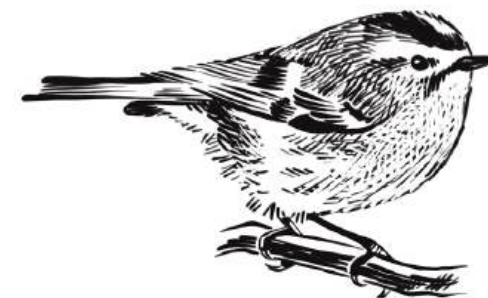
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ROBERT LANGELLIER



One of my pet peeves in science communication is when a drastic claim lacks any sense of scale. “Mosses contain 14,000 species,” for example, is a line I wrote in an essay for this magazine that was ultimately scrapped. So what? That sounds like a lot. Is it? The number is lost on its own. Fourteen thousand is a lot when compared to the 1,000 global species of gymnosperms. It’s not very much at all when compared to the 300,000 species of flowering plants. How about: “Grasslands store more than a metric ton of carbon per acre per year.” Great. Is that a lot? It seems like a lot, but it might be nothing, at scale.

The job of a field naturalist is not to funnel facts and figures into your eyeballs and ear holes. Your phone can do that for you. Our job is to synthesize these befuddling numbers into something that can fit into the human brain, armed with context.

That’s a difficult job. Permit me to make the grandiose claim that life usually feels either loaded with meaning or devoid of it – sometimes from one day to the next. Assembling meaning from something that doesn’t immediately beget it is no small task. In science that requires the use of both sides of the human brain. We might be the only master of science program in the United States that requires its students to take a creative writing class, for example. In these pages are essays by us, as well as by Field Naturalist alumni, and by talented practitioners who have shown us the way, each one carefully assembling meaning.

Veronica Magner escapes the present into deep time Utah. Steve Root reduces our biophilia to the smallest scale possible. Rachel Goland takes on the New England megafauna: bears. Hayley Kolding reincarnates; Keith Meldahl stacks geologic eras all the way to Buffalo; Jason Mazurowski collapses the Pleistocene. Each of these essays captures long, short, large and small things in their own ways. These ideas – be they on weird smells, pesticides, or diatoms – will be warped, shrunk, reimaged, rebuilt, redetroyed, set against a universal fabric, decorated and undecorated, confected and deconstructed, and finally set on the scale to be weighed.

We hope you enjoy them.

Image: Robert Langellier

Image: Walter Poleman

WALTER POLEMAN

When I first embarked on my learning journey as a Field Naturalist three decades ago, my eyes were opened to an approach for making sense of the world that exists at the intersection of two scales: spatial and temporal. The places we explored as members of the K Team offered endless opportunities to investigate spatial patterns at the landscape scale, while simultaneously contemplating the past, present, and potential futures of those places as parts of a dynamic timeline. I was also immediately drawn to the cyclical timelines of phenology, the lens through which we studied how life responds to the unfolding of the seasons (and the shifts in climate) in a given location.

In my present role as director, I’ve expanded my focus on this intersection of time and geography to include the Field Naturalist Program itself. One of my favorite moments in the phenology of the FN world occurs when a new cohort assembles for the first time in late summer along the shore of Lake Champlain for orientation at Shelburne Farms. It marks the beginning of a two-year odyssey in integrated field science and communication that have become the hallmarks of FN training for 40 years, with the landscape of Vermont serving as the primary classroom throughout.

The FN Program could theoretically take place almost anywhere, but it has flourished here in Vermont. Why? It’s at the right scale. A relatively small state with a diverse geography where nature and culture continue to intertwine and unfold through time in fascinating ways sets the stage for immersive opportunities to study the diversity of life and its conservation. It’s at a scale where environmental policy makers and government agencies (increasingly staffed by our program’s alumni) are accessible and responsive to the needs of communities and the interests of students. All of this combines in ways that make Vermont an incubator for innovation, especially when it comes to restoring ecological integrity in a changing world.

As we celebrate our 40th year as a program, our growing network of engaged alumni is truly our greatest asset for attracting a diversity of talented students from across the country, training them while they are with us in Vermont, and launching them back into the world equipped with the knowledge, skills, and leadership capacity to serve on the frontlines of the biodiversity crisis for many years to come.



Walter Poleman (Cohort K, '95), is the program director and teaches Landscape Inventory & Assessment. 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.

Time Scales

KEITH MELDAHL

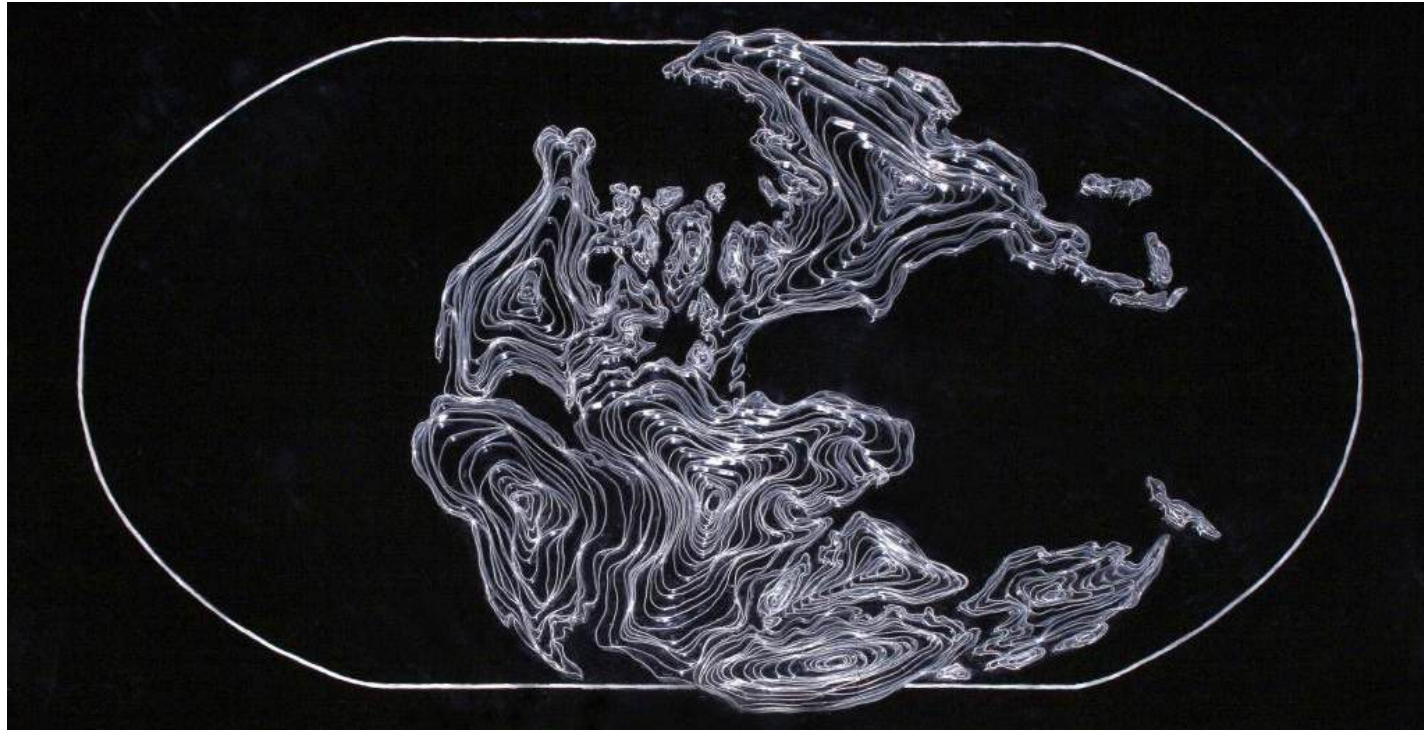


Image: Jacki McInnes

At a certain moment in year 2025, I will be 63 years, 153 days, 3 hours, 34 minutes, and 36 seconds old. I plan to celebrate with a bottle of champagne, while my wife rolls her eyes, because at that moment I will have lived exactly two billion seconds. If I'm very lucky, I might live past 3 billion seconds, not long after my 95th birthday. How about 4560 million seconds? It's not likely anyone will ever live that long; it's more than 144 years. I think we can agree: 4560 million is an overwhelmingly large number. The Earth is that old, in years.

Science gives us measurements for the Earth's age, but not easy comprehension. For that we have analogies. An eight-inch-thick stack of standard printer paper is about 2,000 sheets. If the top sheet represents this year, then Jesus of Nazareth was in his mid-twenties eight inches ago. 5000 sheets ago, the oldest pyramids had not yet risen from Egypt's sands. A 48-inch-thick stack will take us back to our Neolithic ancestors planting seeds at the dawn of agriculture. And that pretty much covers all of human history; it's four feet high.

Time is nature's
way of keeping
everything from
happening at once.
– John Wheeler

Flip the paper stack onto its side and add enough paper to get to 66 million sheets. You'll have to send it out the door, down the street, and maybe into the next town. Our paper stack, lying on its side, is now 4.2 miles long. Stand at the far end, 66 million years ago, and watch as an asteroid plummets from the sky to doom *Tyrannosaurus rex* and his dinosaur brethren. Add 21 more miles. There, 400 million years ago, watch your lobe-finned fish ancestors take awkward steps onto land, breathing Devonian air with primitive lungs. We're still less than 1/10th of the way to the birth of the planet. 4.56 billion (4560 million) sheets will stretch our paper stack 288 miles, about the distance from Burlington to Buffalo. One inch of that is American history.

Evolution and plate tectonics are the guiding theories of biology and geology, respectively. Neither generates much drama over human time spans. But over geologic time, they both produce stunning changes. Here are a couple of examples.

THE ANCESTOR'S TALE

When was the first human? The first bird? First fish? As Richard Dawkins points out, such questions, although arising naturally from our curiosity, miss the vital role of geologic time in evolutionary change. Tiny changes, generation to generation, accumulating over the immensity of time, can create spectacular transformations. Evolution has gone from a long-ago bacterium to you, all without ever producing a "first" of anything.

To visualize this, try the following thought experiment (adopted from Dawkins). Put a photo of yourself at one end of a very long bookshelf. Next to it, put a photo of your mother. Next to that, your grandmother, then your great-grandmother, and so on, back through the generations. (Male ancestors will do just as well.) Soon you'll go back past photography, but never mind, imagine pictures of your ancestors, in an immensely long row, going back many thousands of generations. Wander back in time along the row. Back past 100,000 years ago, your ancestors, although increasingly different from you, are all still clearly *Homo sapiens*. How about 1 million years ago? Now your ancestors, though recognizably humanoid, look quite different from you, with flatter skulls and prominent brow ridges. We classify them as a different species, *Homo erectus*. But all along the chain of your ancestors, each one was indisputably the same species as its parents, and its children. There never was a "first" *Homo sapiens*.

Keep traveling along the bookshelf of your ancestors. What did your ancestor 10 million years ago look like? An ape. Your ancestor 100 million years ago? A shrew-like creature hiding in the shadow of dinosaurs. 400 million years ago? A fish with limb-like fins. 1 billion years ago? An amoeba-like eukaryotic cell floating in ocean water. 2 billion years ago? A bacterium. At no point along the line was there a "first" of anything. Every one of your ancestors, in every generation, belonged to the same species as its immediate predecessor and descendant. Yet every generation also accumulated tiny changes – particularly ones that favored survival and reproduction. The result: dramatic evolution, thanks to the generous scope of geologic time.

Keith Meldahl is a retired professor of geology from Mira Costa College near San Diego and the author of several popular books about the geology of the Western U.S.

DANCING CONTINENTS

To us, continents appear to stay put. Viewed over geologic time, they drift like loose barges across the Earth. The North Atlantic is just five feet wider now than when the Rolling Stones first sang Satisfaction – but, like in evolution, tiny changes, accruing over vast spans, produce stunning results.

Imagine a continent traveling a mere one inch per year (slower than your fingernails grow, about equal to the separation rate of North America and Eurasia across the North Atlantic. In 10 million years, that continent will travel 160 miles. In 500 million



Image: Cardioceras

years, nearly one-third of the way around the Earth. The earliest continents formed more than 3 billion years ago. At one inch per year, that adds up to two complete trips around the Earth.

Watching animations of the wandering continents on YouTube is a bit like watching kids driving bumper cars at the carnival; the motions seem equally random and chaotic. But there is a pattern. Over time, the continents cluster into great masses called supercontinents, then tear apart, then gather again in new configurations. The pattern is roughly cyclic, like a grand minuet: together, apart, together, apart. As far as we can tell (it becomes harder to reconstruct continental positions further back in time), perhaps six supercontinents have formed and split up over the past 3 billion years. The most recent, called Pangaea, began breaking up 250 million years ago (nearly 16 miles of paper) as the Atlantic Ocean opened. Some 300 million years from now (about 19 miles of paper), as the Pacific Ocean closes and the two Americas crunch into east Asia and Australia, the next supercontinent will be born.



Carolyn Loeb (Cohort AI) is Stowe Land Trust's Stewardship Director and lives in Duxbury, Vermont.

Flyways

HAYLEY KOLDING

I lived a good life
and was reborn a sparrow.
Towhee-like
I scratched meals
on the ground
with both feet
but mostly I flew,
threading a needle
through dense thickets,
wheeling in legions
above power lines.
My breast was streaked
white and brown,
my bones
an invention of light.
Crossing low alone
in clearings I felt
I soared:
then a pane of glass
in what had seemed
a clearing.
So the reality
I meant only to pass through
contracted
to an instant
and killed me.

God had mercy
and remade me as
a blackbird.
In the marsh
it was sweet:
I built my nest,
wove a wet cup
about the cattails.
The walls
were bur-reed and rush
the bed inside
grass dry and soft. And oh
I loved the brood
with eyes tight shut.
For my baby
seed of the field,
damselflies
for my baby. But you
do not grow fat--
I paired again,
my mate distinguished
by song:
a choking,
scraping noise
made with much
apparent effort.

Expiring
without legacy
I begged to still
be winged An ivory
gull A plover
A thrush
And mercy
was endless
As a guillemot
I returned
starving slick
in my own color
as murre in
Alaska I starved
as one penguin
of 40,000
Then God blessed me
at last I was a sea bird
in Australia I floated
in the water
I ate everything
the world gave me
And then I was full
O Heaven Then
I realized my need
could not be met

Hayley Kolding (Cohort AI) explores, conserves and restores riverlands as Vermont River Conservancy's Southern Vermont Conservation Manager.



Ice Age in a Day

JASON MAZUROWSKI

Every glaciation starts with a snowflake – a spindly, ephemeral thing that by itself merely melts on a mitten. But given the proper conditions, that crystalline masterpiece will be compressed and transformed, merging with trillions of others to move mountains, carve valleys, and shape continents through a winter that spans millennia. Its original shape unrecognizable, that snowflake will remain locked away for an epoch before being released in a torrent back to a landscape that has forever changed.

In our little notch, nestled at the foot of the northern Green Mountains, winter feels like a miniature ice age. Snow arrives early, piles up deep, and lingers late into spring – advancing and retreating on a scale of months rather than centuries. To the north of our cabin, the Woodbury Range rises abruptly, looming 800 feet above the valley bottom. To the south, a steep, undulating ridge shrouds us in darkness through most of the winter months. Mountain air sinks and pools in these cold, dark hollows, where frozen creeks, fens, and ponds meander through spruce-fir forests.

For the few full-time residents here, winter is serious business, and preparations for next year begin almost as soon as the snow recedes. During our first full year off grid, my partner and I have become increasingly in tune with the local phenology as it governs day-to-day life. In late March, while spring is well underway at lower elevations, we're just reaching peak snowpack. On the 2023 vernal equinox, our stake reads 40 inches – the “glacial maximum” for that year. During these waning days of winter, we glide through the woods on skis, unencumbered by downed trees or boulders, the understory buried beneath us.

At the end of the last glaciation, a river rushed through this valley, cascading from dying ice sheets and emptying into a lake that covered much of Vermont. For a brief period each spring, that river returns as meltwater, resurrecting waterfalls and breaching beaver dams. What follows is a brief, riotous interlude of warmth: four frost-free months of sounds and smells and colors. Life springs from every crack and crevice. It seems impossible that within just a few short months the silence and stillness of winter will return.

But by late October, as the larches turn gold, the sun does not crest the ridge until 9:30 a.m., and the long, cold dark is approaching. On a frosty morning, we move our seasoned wood into the shed, each log coming to rest with a satisfying clink that echoes off the cliffs. A snowflake lands on my jacket, and I stop and grin, admiring its fragility for a moment before it melts. These first stray flakes of the season are a special thing, although they may amount to only a dusting and melt in a matter of hours – not even long enough to bend the goldenrod stems.

Still, it's enough to ignite my excitement for the season to come, and I wake the next morning thinking boreal thoughts. I head for the nearest mountaintop, ascending the steep, winding trail up through the spruces where the snow still clings to bent boughs, getting deeper the higher I climb. Above tree line the world is in grayscale, every surface coated in rime ice. I settle down with a thermos of tea in the foggy, krummholz dreamscape.

I imagine sitting on this mountaintop for 300,000 years watching the glaciers advance, witnessing the first dusting of snow collecting in the cirques and valleys, burying boulders, blanketing the slopes.

Image: Jason Mazurowski

A series of wet winters and cool summers would prevent the snow from melting entirely. Relict snowbanks would remain year-round as icy slush called firn. More snowy winters would continue to pile on, and the snowpack becomes more resilient with each new storm. As decades pass, firn would be compressed into ice, shifting and groaning under its own weight – a viscous fluid scouring the mountainsides. Centuries pass and it merges with other mountain glaciers to engulf the continent, advancing all around my mountain perch.

As I descend, I imagine the glaciers retreating – an ice age coming to an end. I hop from rock to rock across the felsenmeer barrens, traveling forward in geologic time as I go. I watch the snow and ice melt as lichens eat away at the boulders, forming pockets of soil in the talus slopes. Bryophytes take hold, and arctic plants poke up through the snow. The first trees emerge: crooked, stunted krummholz exposed to the wind and ice, confined to thin soils. The footing is a little easier now, the trail a little less steep, and I begin to run.

Image: Jason Mazurowski

I speed through the montane forest, hurtling through deep time, surrounded by a circumboreal assemblage of species. The sweet, acidic aroma of sphagnum and conifer needles permeates the air. The snow melting off in the afternoon sun causes creeks and rivulets to form in the trail, headed downstream to join the rising rivers. Hardwoods begin to appear among the spruces, and I'm approaching the end of the ice age. My stride opens and I'm grinning and laughing the whole way.

A startled hiker – the first other human I've seen that day – brings me back into the present as I bound down the slick, rocky trail. Within an hour I am back at the trailhead in shorts and a T-shirt, late-autumn leaves still clinging to the trees. I sit awhile watching the bumblebees forage on the asters and goldenrods, in stark contrast to the frozen, windswept ridgeline where I have just been. I have experienced all four seasons within a matter of hours. Satisfied by my snowy adventure, I'm content to return to our valley and wait for winter to arrive in earnest.

November brings more frosty mountain ridges in the morning alpenglow. The thin snow cover in early winter seems to amplify every contour on the landscape. Old logging roads, stone walls, and cellar holes emerge; cliffs and outcrops become more defined. Each snowfall lasts a little longer as the ground freezes and the nights stay cold. December brings several major storms of wet, heavy, cement-like snow, and within weeks we are at near-record snowpack. The contours of the hillsides are hidden, and the Woodbury Range is a rolling, white expanse. My neighbor Jon is skiing cliffs where he has not dared to venture for decades.

A thaw arrives in mid-December, bringing an early end to our “glacial maximum.” I am awakened by snow slumping off the roof and steady drips accelerating through the night. Dense fog has moved in by morning, as warm humid air meets the cold valley bottom. We remain soaked in for days, as gentle rain erodes the deep, resilient snowpack. On the afternoon of December 18 the sprinkles become a downpour, and temperatures soar to almost



60 degrees Fahrenheit. Nearly three inches of rain falls, and the remaining two feet of saturated snow begins to melt.

From the safety of our cabin, I watch helplessly as a megaflood of glacial proportions fills the ancient riverbed. Ice and debris rage into the headwaters of the Winooski River. Downstream, it rips up roads, inundates homes, and shuts businesses still recovering from the last major flood just months before. Waterfalls erupt from the cliffs overhead, and seasonal creeks swell. Suddenly the roar is deafening. The proglacial river of the late Pleistocene returns, sweeping through the alder swamp, chunks of ice scouring the banks, willows and alders snapping in half.

Again, I feel as if I'm hurtling forward in time through the end of a glaciation, only this time I'm not laughing. Something terrifying has been set into motion as eight billion social primates merge to move mountains, reshape rivers, and define an epoch. We've entered uncharted territory where seasons change within hours and an ice age ends in a day. Events that once transpired on the scale of geologic time are now occurring within a human lifespan – and my dreams and nightmares have become reality. In between the moments of despair, there are instants of beauty and awe as we witness something that no one has ever seen before.

Jason Mazurowski is an independent ecologist, FN alum (Cohort AI), and instructor in the Field Naturalist Program.

It's a Bear's World

RACHEL GOLAND

There's bear sign all across New England. The bear-marked beeches in the northern hardwoods, claws gouging a route up the smooth, gray trunks – relict evidence of mast years past. The bear wallows: Muddy, soft edges. Tangled vegetation. A snapped-off spruce alongside.

In the winter woods, there is no fresh sign, but the bears are here. They're in tree hollows, under brush piles, tucked beneath glacial erratics left behind 10,000 years ago. They're peppered across the landscape in sleepy stasis, under the blanket of ice and snow. Because most bear encounters are mere glimpses, so much of a bear's presence is assumed and imagined. Until it isn't.

Once, in seasonal housing in the White Mountains of New Hampshire, I woke to a bear with her nose pressed against the screen lining my open bedroom window. The bear was eagerly sniffing a Tupperware of snacks I had pushed up against the wall. She sounded just like my dog. Another time, I peeked out from my tent and watched a small black bear trying to puzzle open the tailgate of the truck where we had stored our food for the night. When I clicked on my headlamp the little bear dropped to all fours and, with indisputable sheepishness, ambled back down the road. A few years ago, while visiting my family in upstate New York, I saw a large bear struggling to reach a birdfeeder strung on a line between two trees. The bear stood up, bipedal, human-like, and stretched his arms above his head, neck craning. When he still came up short, he bent his knees and jumped.

I have always loved bears. Every glimpse I catch of one is a privilege. But not everyone feels that way. Bears can cause very expensive, very real problems. Beyond the petty crimes of pilfered hiker backpacks and tipped trash cans, bears do serious damage to property, livestock, and crops every year. According to a 2019 interview on Vermont Public about bears damaging corn in the town of Huntington, crop damage to a single farmer alone can cost tens of thousands in losses.

Bear damage changes year to year. In mast years, for instance, they're much less likely to seek out human food sources. However, incidents of bear-human conflict are generally on the rise in New England. This rise is in part the result of ample amounts of high-quality food in urban landscapes, combined with shorter



Image: Sean Beckett

hibernation periods due to climate change and the increased development of forested landscapes. Today, Vermont is home to between 7,000 and 8,500 black bears.

While this population is a high point for the state, according to Jaclyn Comeau, Vermont Fish and Wildlife's black bear project leader, it is not unprecedented. Continued population growth could trigger changes in the state's management actions, however. "We're watching closely," said Comeau in a phone interview in February.

There's something undeniably familiar about the black bear. Maybe it's the bipedal walk or the hand-like paws. Or maybe it's that, according to Ben Kilham's *In the Company of Bears*, "it's quite possible that pre-human and early human culture and communication looked a lot like a bear's."

While this may seem far-fetched, Dr. Kilham, a gunsmith-naturalist turned PhD researcher, has 30 years of field experience with black bears to back up his theory. He first began rehabilitating black bear cubs in the spring of 1993 as a licensed wildlife rehabilitator. Since then, over 600 bear cubs have passed through the Kilham Bear Center in Lyme, New Hampshire, before being released back into the wild.

In addition to giving black bear cubs a second chance at life, the Center has allowed Kilham unprecedented opportunities to study bears as they grow and develop. Rather than being solitary, bears, as Kilham told me in a phone call, "are social, like we are." According to his research, they even have friends. These unrelated bears often travel through the forest together, searching for and sharing food. When I questioned him about his use of the word "friends," he responded readily: "What else would you call it?"

In the spring of 1996, Squirty arrived at the Kilham Bear Center. Named for her then-diminutive stature, the 28-year-old bear now rules her home range in New Hampshire. Generations of female black bears, down to great-granddaughters, share Squirty's patch of forest. Squirty is a foundational subject in Kilham's decades of research and, according to *In the Company of Bears*, enjoys Oreos. In fact, he writes, he knows she can count to 12 because she always knows if there's a cookie missing from the sleeve. Their relationship is one built on decades of trust and paid for by food. Kilham claims she sees him as both a fellow bear and as her mother.

Through his work, Kilham has effectively upended scientific knowledge about the lives of black bears. In addition to having friendships, he's found that black bears are members of a complex and dynamic society – a society with relationships and social contracts, organized by matrilinear hierarchies in which a dominant female bear shares a home range with her female descendants. Bears, whose sense of smell is thousands of times more sensitive than ours, rely on what Kilham calls a "complex olfactory web" of information crisscrossing the forest to communicate with one another. In acts of reciprocal altruism, they often leave behind purposeful scent trails to share food sites with their fellow bruins. Sharing surplus food is a gesture of goodwill between bears and represents a favor that will, someday, be returned.

Unfortunately for all involved, humans leave surplus food, or food-scented things, everywhere. Dumpsters piled high. Grills that haven't been cleaned since the last barbecue. Birdseed dangling temptingly in feeders. Chickens stacked neatly in their coops for the evening. Unsecured apiaries and apple trees. A candy bar left in an unlocked vehicle. The list goes on.

Since humans don't effectively mark ownership over our food stores through scent signals the way bears do, they interpret what we leave out as up for grabs, a sign of interspecies goodwill. After all, according to bear-world social conventions, it is. This simple miscommunication results in the State of Vermont fielding 800 to 1,400 bear incident reports annually. Each year state officials end up euthanizing 15 to 40 bears whose unintended crimes have crossed the line of human tolerance.

Fortunately, according to Comeau, Vermont officials are extremely hesitant to take lethal measures against bears. "We're not going to

kill our way out of these problems," she said, expounding on the other tools wildlife managers use to deal with bears in the state. In addition to tweaking hunting seasons to curtail bear populations, managers may catch and frighten the bear with rubber bullets and loud noises so that the bear comes to associate humans with intense stress, a method known as "aversive conditioning." Managers and landowners also use dogs to scare off bears. On rare occasions, if the bear is young enough, Vermont officials might relocate it to a less populated area. But most of all, education is key. From coaching homeowners through dealing with a "problem bear" over the phone to town-level presentations, much of Comeau's work involves "trying to increase Vermonters' bear IQ" through outreach efforts on all scales. Kilham agrees with this priority. "You've got to spend a lot of time on education," he said. Often, in his experience, bears end up taking the blame for human negligence.

I find it reassuring that wildlife managers in Vermont are far from trigger-happy when it comes to managing bears, but the rising prevalence of bear-human conflict – a conflict humans can prevent – is disheartening. We know better. We can do better. Why don't we?

"We need to accept," Comeau said, "that coexistence is going to be messy, not perfect."

Our coexistence is messy. It probably always will be. Bear and human worlds are built upon different foundations. We speak different languages, have different customs, expect different things from our neighbors and friends.

But, as Kilham has demonstrated, it is possible for us to understand one another. It's at least possible for us to try. Gloria Dickie, in her recent book *Eight Bears*, describes human coexistence with bears as "an ongoing process of innovation, determination, and, ultimately, compassion."

It's so easy for me to look to pure science and numbers for an end-all solution. To forget that bears are not just a population of mammals, but a society of dynamic and creative individuals. I'm not quite sure how to hold science in balance with the practice of compassion, but maybe it's rooted in wholeheartedly considering that our human society is one of many, cobbled together across a constantly changing and fragmented landscape. Maybe it's time to decide that too much has already been lost in translation here in Vermont. That since the bears were here first, it's only right for us to be the ones to learn to speak their language.

After all, it's a bear's world. It always has been. We just live in it.

Rachel Goland (Cohort AN, '25) has a background in field work, conservation, and land management in New England and the Adirondacks.

Elfin Wings and Big Places

BRYAN PFEIFFER

Let's be honest about the genus *Callophrys*: with a few green exceptions, these aren't exactly charismatic butterflies.

Commonly known as "elfins and green hairstreaks," *Callophrys* butterflies invariably perch with their wings folded closed above their bodies, at which point they become about the size of a penny – and only somewhat more ornate.

The *Callophrys* (*KA-loh-friss*) have never inspired poetry or gained much traction on social media. They've not been a cause célèbre of demonstrations or protest marches. Nobody's out there shouting, "Save the *Callophrys*!"

Except maybe me, because I've come to admire the *Callophrys* as near-perfect insects. Tiny and gossamer, these butterflies nonetheless express big and enduring ideas in nature, including human nature.

First is intimacy. Once you locate a *Callophrys* species, perched on a twig or a flower, it will usually allow you to approach and sit in its good graces, which is unusual among butterflies. After some time your *Callophrys* will indeed depart the scene. But if you are like me, it will usually leave before you do because it is hard (perhaps heartless) to turn your back and walk away from one of these endearing butterflies.

Rarely are we so close and unobtrusive to wildlife, especially



Images: Bryan Pfeiffer

Callophrys
exemplify one
of the greatest
relationships in the
history of life on
Earth: the shared
evolution of insects
and plants.

among airborne animals. Sitting with a *Callophrys* butterfly, watching it sip nectar or lay an egg, seeing it interact in the most fundamental ways with the world, feels like some sort of guilty pleasure of which I might not be worthy. These encounters don't make insects any less different from us, but they certainly makes them less remote and otherworldly.

Next is diversity. Depending on whose unsettled taxonomy you prefer, at least three dozen *Callophrys* species live in the world (perhaps many more), mostly in boreal and temperate regions, including two dozen or so in the Americas. Some *Callophrys* species are generalists, laying their eggs on varied host plants, on which the caterpillars will feed and grow; others are specialists with but a single host.

Regardless of their dietary inclinations, or actually because of it, *Callophrys* exemplify one of the greatest relationships in the



history of life on Earth: the shared evolution of insects and plants. At its most basic, insects get food and plants get pollinators. As it turns out, moths and butterflies (order Lepidoptera) tend to prefer angiosperms, owing to their softer, more nutritious leaves for the caterpillars and greater floral diversity and nectar abundance for the adults.

But some *Callophrys* go for gymnosperms. Although rare among butterflies, the bond between *Callophrys* and conifers is perhaps my favorite thing about these butterflies. For one thing, it embodies the charm of the obligate, an intimacy between two organisms (although conifers in this case get little if anything from the relationship).

Hessel's hairstreak *Callophrys hesseli*, for example, lays its eggs only on Atlantic white cedar *Chamaecyparis thyoides*, and nowhere else in the world. You might find the cedar and no hairstreaks, but you will never find a Hessel's hairstreak far from Atlantic white cedar. I have encountered the two species together across the full extent of their shared range – a coastal plain and inland strip running from the Gulf of Mexico to southern Maine. Where most people might see a distribution lying within the megalopolis known as the Eastern Seaboard, I instead see the only terrain on Earth

where a little butterfly might find its essential tree.

Closer to the academic home of the Field Naturalist Program, one of the most elusive butterflies on the continent, bog elfin *Callophrys lanoraieensis*, is obligate on black spruce *Picea mariana* at woodland bogs across northern New England and adjoining Canada.

At the relatively few sites where it is known, bog elfin is virtually unknown – on the wing as an adult for only about two weeks from late May to early June. It spends the rest of its days on spruce at the bog as either egg, larva, or pupa

(chrysalis), all of which are also exceedingly hard to find.

As field naturalists, we define a natural community by the sum of interacting parts and processes – a synthesis that helps us know where we are and a synergy that offers us reason, reassurance, meaning, even story. A *Callophrys* butterfly is really no different. Although it eats only black spruce needles as a caterpillar and sips nectar from rhodora *Rhododendron canadensis*, leatherleaf *Chamaedaphne calyculata*, and perhaps a few *Vaccinium* species as an adult, a bog elfin is after all made entirely of the bog – and everything that conspires to be a bog.

And maybe that's all the story I need. A butterfly the size of a penny unwittingly tells me where I am in the world. Reclusive and rare, a bog elfin is more than a little brown butterfly. Made of needles and nectar, it is a living monument to a bog – from its glacial history to the orchids that will bloom on its mat in the weeks after the elfin and I have departed the scene. Though you can bet that I won't leave before the elfin flies off.

Bryan Pfeiffer is a field biologist and an occasional lecturer in the FN Program. Find more of his essays online at Bryan's Substack, titled *Chasing Nature*.

At What Cost?

LUCY GROSS

Between October 2 and 3 in 2009, a sea of dead mudpuppies, Vermont's largest salamander, floated down the Lamoille River into Lake Champlain. The final count reached 512 individuals, and all had died from a government-authorized pesticide release at the Peterson Dam. This devastating event was the highest mortality of the salamander in Lake Champlain's history of lampricide use. The pesticide, designed to kill larval sea lampreys, has been justified for this use to save lake sturgeon, the host of the parasitic lamprey.

Until the late 1960s, lake sturgeons were commercially harvested from Lake Champlain and soon thereafter were added to the endangered species list. Despite new legal protections and their high fecundity, the population in Lake Champlain has not recovered. One of the non-human factors decreasing lake

Equipped with evidence of high mortality rates among many of Lake Champlain's large fish species, including lake trout and land-locked Atlantic salmon, governmental conservation agencies proposed using a lampricide in their breeding tributaries. These same tributaries are home to mudpuppies, striking salamanders with feathery red gills. Mudpuppies are one of many amphibians affected by the lampricide, but fortunately, most other species are not dying in numbers as high as those tallied in the 2009 event. A couple of questions come to mind when weighing all the pieces of this restoration effort. Is saving the endangered lake sturgeon in Lake Champlain by reducing sea lamprey with lampricide worth potentially endangering mudpuppies and other amphibians? How do we weigh the value of one species over others?

The complexity of sea lamprey control resonated with me as an ecological restorationist. Although I never worked on managing animal species or in river ecosystems, it brings up questions that have been swirling in my mind for a number of years. Questions with no definitive answers. Deeply ethical questions about the consequences of restoring habitats with herbicide. In my restoration work, I saw many ecosystems where invasive species had replaced native ones. I managed the invasives in hopes of doing what was "right" for the ecosystem, and often this meant using herbicides.

I have seen ecosystems change drastically from proper herbicide treatments. A coastal pond surrounded by a monoculture of phragmites turned back into a basin of native plant species. In another instance, I treated a purple loosestrife-dominated wetland to aid in the re-establishment of monkeyflower, a critical resource for a native bee species that had not been seen on the site for a number of years. That bee returned the following growing season.

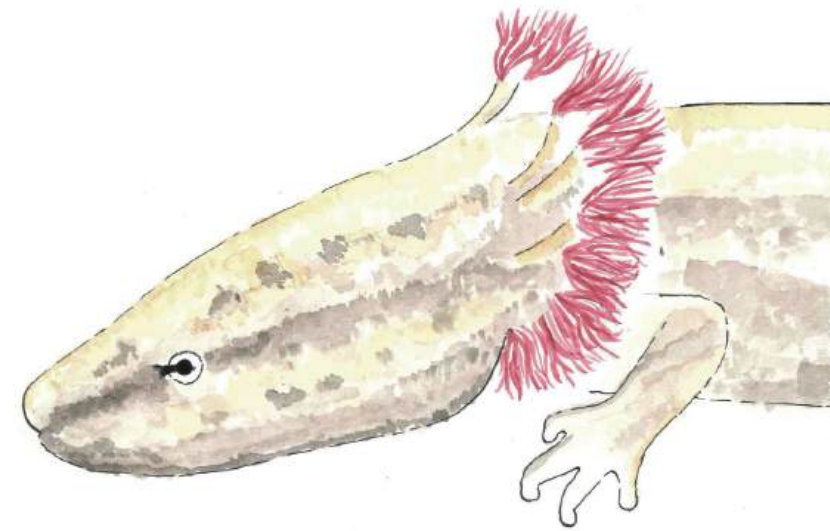
Unfortunately, with native habitat restoration come the consequences that are harder to see, which often go unmonitored due to lack of funding or observability. Few consider the native shrubs outside of the survey area that are affected by herbicide translocation through the soil or drift on a windy day. It is difficult to count the bees that visit the recently sprayed crown vetch.

Most restoration projects use post-vegetation surveys to analyze the benefit to the ecosystem. Most do not conduct amphibian and

insect population inventories before or after treatment – even in those studies that do conduct post-application mortality surveys, many amphibians will die at the bottom of rivers, never counted. Most projects do not collect soil samples to understand if the herbicide traveled away from the treatment area or its effect on microbes. The consensus within the restoration community is that the restored habitat will bring about more biodiversity than those species that were killed by the herbicide treatment. I have often sat with this statement and contemplated its truth.

Ask an expert about herbicide use in restoration, and they will talk about the importance of protecting umbrella species and using a variety of management methods. Scientists have made incredible strides in understanding how to use pesticides in effective, responsible ways by lowering the necessary concentration or shifting the timing to lower its effect on other species.

Dr. Ellen Marsden, a restoration ecologist working predominantly on lake trout and sea lampreys in the Great Lakes, said, "[Better use of pesticides] is going in the right direction. It's just achingly slow." Restorationists do what we think is right based on the data and then shift management methods when new research suggests better possibilities. Despite the methods being strongly rooted in current science, many restorationists still ask themselves moral questions about whether their efforts are benefiting the natural world. Most believe the benefits outweigh the consequences without knowing the true burden of the



consequences.

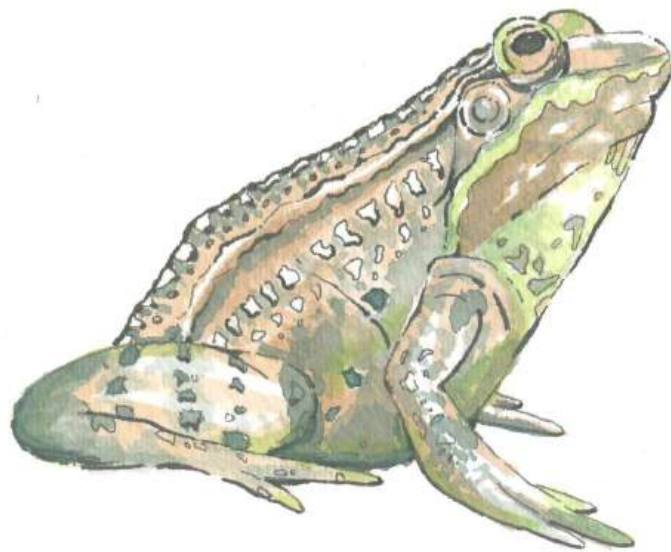
Since the 2009 event on the Lamoille River, mudpuppies have been suggested as an addition to the endangered species list three separate times. U.S. Fish and Wildlife has refused to conduct the required population inventory in Vermont, and mudpuppies' status has not changed since the first use of lampricides in the 1990s.

Although the lake sturgeon population continues to decline, Atlantic salmon and lake trout sustain far fewer wounds from sea lamprey, and their populations have recovered to a sustainable size. Yet lampricides are still being poured into Lake Champlain's tributaries, and amphibians continue to die. U.S. Fish and Wildlife will treat the Lamoille River in 2024 and 2028.

When asked if she expects the treatment of sea lampreys to slow, Dr. Marsden said, "The experiment of simply stopping lampricide applications is too scary. We suppress sea lamprey populations because we assume lake trout populations will collapse if we don't. But what happens if we didn't kill the larval lamprey? If we are wrong and we lose this hard-

won progress toward lake trout population restoration? That would be sad."

Lucy Gross (Cohort AN, '25) has worked in ecological restoration and land management in the Midwest and New England.



sturgeon's numbers is the sea lamprey, an eel-like ancient fish with a circular mouth ringed with teeth. It latches onto large fish to drink their blood and bodily fluids, leaving circular wounds on its host. Lake sturgeon with "naked," scaleless skin are especially vulnerable to sea lampreys.

Look Again, and Look Closer

SUSAN SAWYER



Artwork: Susan Sawyer

I spend a lot of time (some would say an excessive amount) looking at things, sitting down in a place so I can see what's around me, bringing things in so I can see them better. As a child, I almost became a believer in magic when I discovered the tracks of bark beetles, clearly a form of writing, and the imprint of the stigma on the spongy-thick innermost petal of a yellow pond-lily, which looks like a stamp of a radiant sun.

I am pretty old now and I've done a lot of different things for a living – milking cows, picking apples, pruning orchards, bagging clothespins, weaving yardage, making art quilts, instructing undergraduates and elementary school kids and teachers, teaching drawing (mostly to retirees), writing and illustrating natural history subjects for scientific and educational publications, and selling drawings and paintings. The constant is contemplation. Just staring at the world and taking it in. There is nothing better to do with the time I have on Earth, if you ask me.

I live next to two small post-glacial lakes, the King Ponds, near South Woodbury, Vermont. I've known them my whole life and spent a good deal of time around and in them. For years I've been drawing the things that live there. We walk around, human size, with the eyes we have, and we easily notice things that are in a particular middle size range, because we move too fast or we simply overlook what is small. We need first to slow down, then to

get out the hand lens, the dissecting scope, the compound scope. What is more surprising than the world under our noses?

The smallest organisms I've ever drawn are those on the opposite page – the large starry one is the diatom *Asterionella*. Each spicule is about 50 microns long, or one-twentieth of a millimeter. There's a *Mallomonas* in the lower left corner and an unidentified green alga in the upper left. I have a plankton net, good for the copepods and cladocerans that live suspended in the water by the zillions. But the tiny diatoms and green and golden algae go right through it. When a team of paleolimnologists visited in the summer of 2009, Bill D'Andrea, now at Columbia University, had the kind of fine-mesh net that catches the really little stuff. I borrowed some and put it under the compound scope. By holding the digital camera up to the eyepiece, I got photographs clear enough to draw from.

Silverpoint is drawing with a pure silver stylus, a medium from the Renaissance – not much used since the advent of graphite – a little finicky (paper has to be prepared, there's no erasing, it's never really dark), but I like it for its subtlety. The marks, with time, tarnish warmer and darker, and there is nothing that looks quite like it.

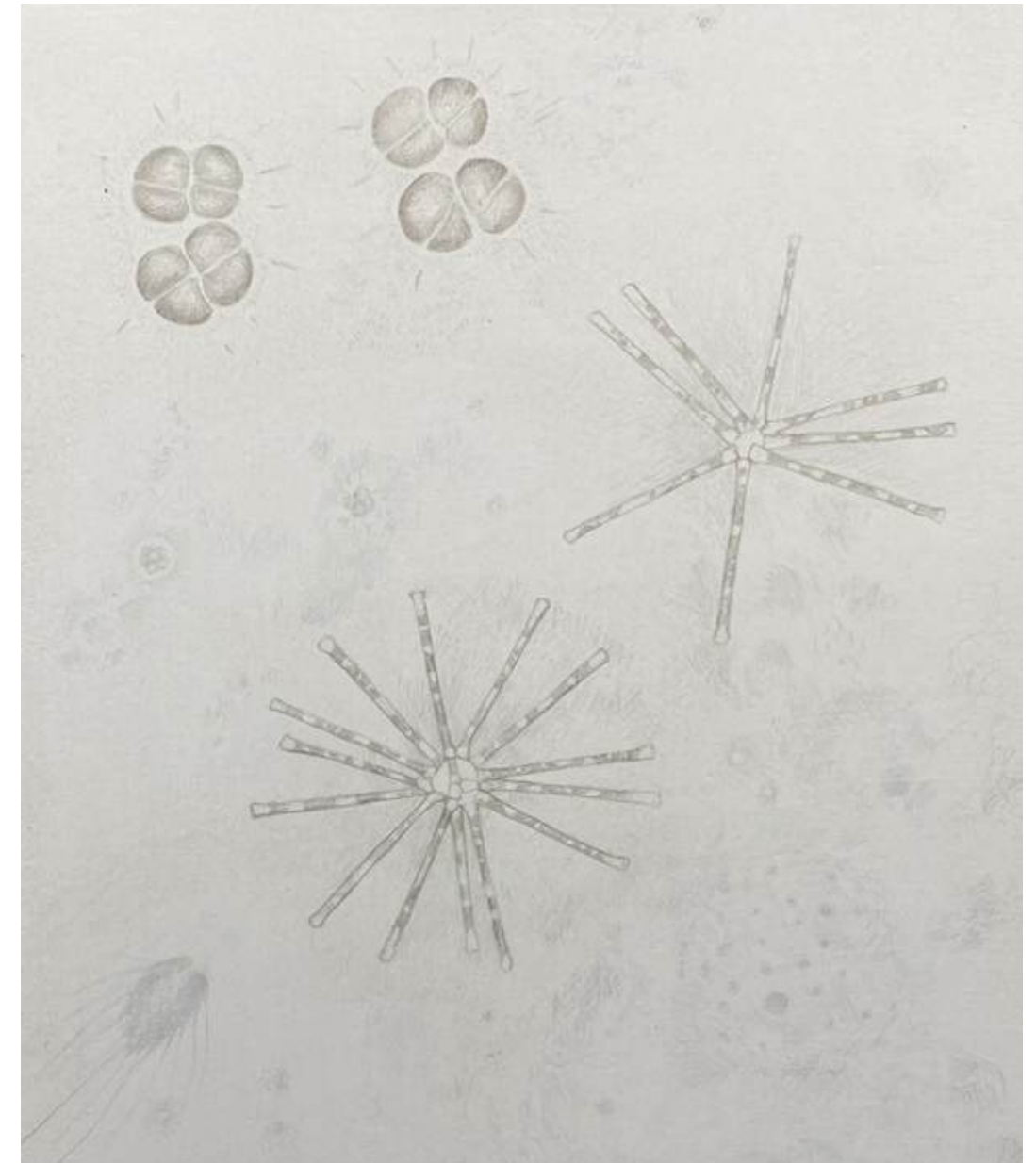
Scale is always an element in any representational work, as are

framing and composition. How big is your subject, and how big should your picture of it be? What happens when you go in closer, and stop looking at the whole? What subjects catch the imagination and make you want to draw them? What will you leave out, and not draw?

I look for pattern. Shapes, structures, repetition with variations – those catch the eye. Turn over a leaf to observe its venation. There's a spot at the edge of the upper King Pond where a west-facing slope covered with hemlocks comes down to the pond edge and there's enough light for a vigorous shrub layer of hobblebush and goosefoot maple. I made a series of drawings of them. Two are side by side on the facing page.

These are big, thin leaves – lots of surface for photosynthesis, too fragile to be out in the wind but perfect for a semi-shady spot. Looking at those leaves, you see that not just the mid- and lateral veins, but also that the veins connecting the laterals are striking. Leaves this size need more structure than small ones, and they have very different ways to solve the same problem. One with undulating cross-veins like waves, one with a system of segments from each lateral vein that meet in the middle and form an irregular honeycomb of polygons. The shapes are similar but never the same. A person could spend a long time looking at such a leaf.

Susan Sawyer is an artist, naturalist, and teacher from South Woodbury with a particular love of wet places and twigs.



Artwork: Susan Sawyer

On facing page, left: *Hobblebush Leaf*, *Viburnum lantanoides*, graphite on panel, 5"x5". On facing page, right: *Goosefoot Maple Leaf*, *Acer pensylvanicum*, graphite on panel, 5" x 5."

Above: *Planktonic Algae*, 5"x 6", silverpoint and gouache on paper.



The Era of Hybrids

ROBERT LANGELLIER

Last summer I worked as a field botanist in western Missouri prairies, identifying plants in 100-degree weather, usually with the closest shade tree in driving distance. We were studying patch-burn grazing, a type of land management being tested by the state that would combine cattle with prescribed fire. The idea was to imitate natural cycles of megafauna and fire in an economically profitable way.

It sounds great. It was a disaster. The prairies were in a state of ruin, overrun by blackberries, sumac, and other weedy species. Likely to blame were prescribed fires repeatedly set out of season, when native plant sap was already flowing. We botanized in a state of ecological grief, frustrated that land management agencies refused to shut the program down. My boss at the time, Justin Thomas, approached me while my face was nose deep in goldenrod at Diamond Grove Prairie – a prairie that was still in decent shape, but trending downward. “Want to see a cool hybrid?” he said.

He took me to see a panic grass, a cross between *Dichanthelium neuranthum* and *D. lanuginosum*. He also showed me both parents, growing a handful of meters apart. They were all only about a foot tall. Spread out next to one another, they appeared distinct. Had I seen them on my own, I would have never known the difference.

For centuries hybrids have spellbound some botanists and intimidated many more. Often, hybridity serves as a convenient offramp for botanists having trouble with a difficult specimen or group. Weird-shaped leaf? Hybrid. Inflorescence bracts not long enough? Hybrid. “Inability to determine a specimen does not indicate hybridity,” wrote *Rubus* specialist Liberty Hyde Bailey in 1941.

In 1948, the botanist Edgar Anderson published “Hybridization of the Habitat” in the journal *Evolution*. It was the type of scientific writing that flourished then and that you’d never see in the pages of *Science* today: descriptive, reflective writing that is enjoyable to read. In it, Anderson made an astonishing claim: for a hybrid to thrive in nature, it must need a hybridized habitat, one that is intermediate between the two habitats of its parent species. He gave the example of irises in Louisiana, which naturally created hybrid swarms in response to ditching, pasturing, lumbering, and road-building in the 1930s. The Mississippi Delta was laid out in such a way that farmers worked long, narrow plots of adjacent land, “with almost the precision of experimental plots.” Each farmer treated his land slightly differently, creating a variety of intergrading, unfilled niches for hybrid irises to take advantage of. As the hybrids shuffled their genomes around, each of their results seemed to thrive *somewhere* in the immediate area. What Anderson saw in those hybrid swarms was a form of wild, spontaneous speciation enabled by humans.

This rarely happens in nature, where all ecological niches are already filled. Hybrids often display exceptionally robust traits, such as large flowers or drought resistance – a phenomenon known as hybrid vigor – but without an available niche, they tend to sputter out. “The chance that that organism does better in a stable ecosystem than one that has been evolving for millions of years is almost none,” says Benjamin Goulet-Scott, who earned a Ph.D. on phlox hybridization at Harvard. Anderson, in 1948, was proposing that human disturbance was changing the nature of plants, providing rewards for hybrids over normal sexual progeny.

Anderson’s hypothesis was largely inductive, and as Western science distanced itself from conjecture, his claim was put into

the attic of scientific history. Anderson was considered a curious pioneer of ideas, but hybridization of the habitat lacked empirical support.

When I look at the more degraded prairies of western Missouri, I see ecologies in chaos, desperately trying to make sense of disorder. Misuse and abuse have broken fundamental ecological links, and many are spinning out of control, filled with simple, generalist species scratching out harsh, annual existences devoid of mutualisms. By contrast, intact prairies in the region radiate a musical sense of interdependence. Junegrass and marsh bristlegrass sway in islands of royal catchfly and blue wild indigo. Pollinators buzz in rhythmic pulses. Even if you lack an ecological vocabulary, you can feel the harmony of functional integrity when you’re inside it. This sounds like a pagan fantasy. It isn’t. It’s hard to see in raw data, but Thomas has developed sampling indices that highlight it in summarized form. High-integrity prairies have fundamentally different trajectories than disturbed ones.

He sees the narrative in individual plants, too. Coincidentally, Thomas is a world expert on *Dichanthelium*, a genus of panic grasses that hybridizes readily. In this weird little specimen we were looking at, he could see the abuse of land, biological chaos, and an attempt to seek order.

Hybridization is a short-term evolutionary gain – a way for plants to expand rapidly into new places when systems go haywire. It’s essentially spaghetti on the evolutionary wall, biology’s means of guessing at an answer on a test. “One way to think of hybridization is a massive simultaneous mutation,” Goulet-Scott says. Recent studies have shown that many invasive plants gain their invasive tendencies – like early flowering or increased seed production – through hybridization, both with native species and other non-native stock. The findings have helped spin off their own subfield of disturbance ecology. In 2014, a paper by Qinfeng Guo in *Biodiversity Research* finally showed empirical evidence for Anderson’s hybridization of the habitat.

Similar to mutations, the vast majority of hybrids in nature go nowhere (mules, for example, can’t reproduce). But when we bulldoze, mine, pollute, or otherwise misuse the land, they can represent a mad dash toward adaptation in a violent environment. Normal sexual reproduction – the kind you learned about in high school biology – is a

Robert Langellier (Cohort AN, ’25) is a writer and field botanist from the Missouri Ozarks.

Image: Robert Langellier

slower, more stable approach to evolution, with smoother narrative arcs over deep time. When habitats change in a geologic blink, as they have done in the Anthropocene, quick and dirty adaptation is an asset.

The last century has seen a drastic increase in hybrid plants in North America, with the epicenter in New England, one of the most heavily disturbed regions on the continent. As we continue to expand our populations into the Southwest, the Southeast, and Midwest, we can expect hybrids to follow us everywhere we go.



Myxophilia

STEVE ROOT

The gray-green fronds of a neglected staghorn fern drooped sadly down the sides of its pot, which was full of desert-dry soil. I wasn't sure it had a chance at revival, but I wanted to try. I researched its needs, watered it, and placed it in a south-facing windowsill. A few months later, bright green fronds unfurled from its center, reaching straight up in full vitality. As a naturalist and nature-lover, I beamed with joy at having succeeded in bringing this plant back to life.

This delight is rooted in biophilia: humans' innate love of living things. E.O. Wilson's 1984 book *Biophilia* popularized the term in the cultural lexicon, and innumerable anecdotal accounts of the phenomenon support its existence, despite the lack of quantitative proof that we have some hardwired love for nature. Naturalists, it would seem, are the equivalent of a type specimen for biophilia. I can recall so many moments of experiencing it in my life: flipping logs to find toads as a child in Florida, the salmon run in Alaska, my first hike through California's old growth redwoods. The wonder and awe were already within me.

I recently stumbled upon a study that has made me rethink my understanding of the term. In 2022, scientists from the University of Chicago designed a wrist-worn heart rate monitor that only works if a slime mold – integrated into its electronics – is properly nourished by the wearer. The study was investigating whether humans might develop a “care-based relationship” with the device if its function depended on an actual living organism. The slime mold is housed in a transparent case at the base of the device and integrated with the circuitry of the heart rate monitor. Users feed the slime mold by placing watery oats in a compartment on the side of the case. If left unfed for too long, the slime mold goes dormant, and the device stops working. The results of the study suggest that, yes, users do indeed care for the slime mold and the device, and therefore are likely to keep the device for longer.

Slime molds are in the kingdom Protista – a catch-all kingdom for eukaryotic organisms that are not plants, animals, or fungi. The species used in the study, *Physarum polycephalum*, might be familiar to you as the slime mold that, in a famous experiment, recreated the routes of the Tokyo metro system when presented with food arranged in the pattern of the actual stations. Despite being single-celled, it demonstrates incredible problem-solving abilities and social dynamics. In a group known as the plasmodial



Pictured: "Chocolate tube" slime mold, Stemonitis splendens.

slime molds (class Myxomycetes), *Physarum polycephalum* goes by the common name “the blob,” which refers to the bright yellow oozing appearance of the organism as it feeds on microbes and decaying organic matter. It's hardly an adorable creature.

The human capacity for biophilia is, apparently, so great that a single-celled yellow blob, completely isolated from its forest habitat, enabled caring relationships between people and heart rate monitors. Study participants called the device their “little friend” and “pet,” and all participants described feeling sadness when they were instructed to neglect the slime mold as part of the study. As a naturalist, I can understand biophilia for shrews, grassland hybrids, or even individual staghorn ferns. It blows my mind that a slime mold can have the same effect.

Perhaps this study's revelations on the reach of biophilia can help build a more engaged and understanding conservation community. Can naturalists help people access their own biophilia to reduce bear-human conflicts, or to save mudpuppies from death by lampicide? Can we go a step further, and harness biophilia to nudge people toward a better understanding of our collective reliance on biodiversity? Simply going outside and being face to face with the plants, animals, and slime molds of our local trails might be even more impactful than previously thought, if we allow ourselves the time to develop relationships with them. If the presence of a slime mold can convince people to care for a plastic watch, then I am convinced that biophilia can be better leveraged to grow the conservation community.

Steve Root (Cohort AN, '25) is a naturalist from California who loves wide-angle lenses.

Image: Steve Root

Making Scents of It

ALYSSA VAN DOORN

Scattered on the floor of a dying hemlock stand in Petersham, Massachusetts, are 100 aluminum live traps, similar in size to an elongated but squat tissue box. Walking the neat 10-by-10-meter grid, I kneel down to look for closed and open doors. Each closed door feels like a game of roulette, where a win is a pair of small round eyes gazing back at me. When my eyes meet theirs, I say, “Good morning” – it's the only polite thing to do given that the sun is still rising. My chipper greeting doesn't put the creature at ease.

As a fauna field technician conducting small mammal sampling, I always hoped for deer mice in my traps. With their rounded upright ears and deep brown, too-big-for-their-body eyes, they're adorable, and the target of my work. Not all forest-dwelling small mammals that find their way into traps have the charm of a mouse, though. The northern short-tailed shrew *Blarina brevicauda* doesn't look back at you with an endearing glimmer; its barely-there, poppyseed eyes can't distinguish more than light and dark. But eye contact isn't always necessary to know you're interacting with a short-tailed shrew. Your nose may tell you first.

This winter in Weld, Maine, during UVM's annual Winter Ecology course, renowned scientist Bernd Heinrich and I chatted about the northern short-tailed shrew. I excitedly asked him if he knew why they smelled so...odd. He looked at me puzzled but intrigued and said he had never smelled one. He then asked if I wanted to try to catch one with him the next day. I did, but inquired, “How would we do that?” His response was one only a naturalist would give: “I know where one lives.” Unfortunately, the next day – our last day in Maine – brought a severe winter storm, meaning no *Blarina* hunting for the two of us.

While Bernd may not have been familiar with the pungent scent of *Blarina brevicauda*, it is notorious among mammalogists. Their odor is often compared to maple syrup. That does a disservice to maple syrup: the scent is sweet, but sickeningly so, and musky. It sounds like it could almost be pleasant. It's not. It's what you might smell if you left a maple-syrup-soaked rag to get moldy in a damp cellar. The wonderful irony of this is that they'll never get a whiff of themselves because, like their eyesight, their sense of smell is terrible.



Image: Joshua Fischer

As a fauna field technician, I despised that scent. A wave of annoyance would wash over me as I approached a trap emitting it. Shrews were not a target capture species. I couldn't hold it, interact with it, or collect any meaningful data about it other than its existence. All I could do was put the shrew into a plastic bread bag, look at it, then color its back with an extra-fat sharpie, hoping the color would stain the fur long enough to know if it was recaptured later. Then I would let the critter go and watch its newly blue butt scurry away, ducking into the closest ground hole it could find. I'd begrudgingly put its dirty trap in my bag, knowing I'd endure the smell again when scrubbing it out with bleach later.

My early disdain for shrews came from a fundamental misunderstanding of their nature. Their scent isn't for marking territory or attracting a mate. It's a defense mechanism. Their putrid odor makes them a far less appetizing meal. Under normal conditions short-tailed shrews aren't particularly fragrant, but that changes when they're under stress – stress in the form of being hunted, or captured in a metal tube with no way out. The scent is fear.

Alyssa van Doorn (Cohort AN, '25) has a background in GIS and forest science; she loves a good map.



In Transit

VERONICA MAGNER

Standing with a backpack on each arm, I am dwarfed on a roadside in East Denver. It's 2019. The world is loud and an impulse has taken me out west – by plane, by train, and now by foot. I wait to cross an enormous four-lane boulevard as vehicles blur past, blocking the view of the Rockies. An empty tractor trailer hits a pothole, producing a thunderous boom that suggests it'd be best to take on a vehicular shell of my own and move at pace with the rest.

A football field away, the walk symbol blinks on. Ten minutes to make it to the Hertz office, rent a car, and deliver myself swiftly up from this midwestern grid and over the rocky passes to Utah. I've been called out of the cramped, metropolitan forests of the east, where time moves erratically, where I dreamed of an open, unmuddied place.

For weeks, the blue light of the *Wikipedia* screen had been glowing long into the night as I learned the names of desert places: San Rafael Swell, Zion Canyon, Basin and Range Province. The small frames afforded to images of these places still manage to convey the immense scale of multicolored canyons and valleys. I read that the San Rafael Swell in Utah is a giant dome-shaped anticline of sandstone, shale, and limestone, pushed up during the Laramide Orogeny 60–40 million years ago. The terms orogeny and shale glance off, but 60–40 million years sends a beam into the depths. Not one of us can claim to comprehend such a number, but it still staggers. Out of these numbers and images on a *Wikipedia* page

came an urge to enter a landscape written in the language of that vast span of time. It's led me to Utah, and to the strange comfort of imagining the geologic timescale – a way out of the pinhole of the present.

I-70 winds through the Rockies as a narrow ribbon of asphalt. The sun dips low as I cross the state line, blurring the distinction between reddening land and reddening light. By the time I pull off the highway in Green River and find a place to camp, it's nearly dark. I step out of the car into such total stillness that for a moment I hardly move. A band of light lingers, high up on a nearby mesa, a vibrance so intense as to nearly break the silence. There is no one around for miles, yet as I scramble up a slope to get a better view, I try to remain quiet. The dust and rock beneath my hand is drier than any soil I've known. Held by no roots, it gives way easily, sliding downhill. I think of the *Wikipedia* article:

"Since that time, infrequent but powerful flash floods have eroded the sedimentary rocks into numerous valleys, canyons, gorges, mesas, buttes, and badlands."

Since that time. That time the Pacific oceanic plate slid like a spatula beneath the western half of the continent, raising the land I'd spent an entire day crossing by car like the fold of a cookie that wouldn't budge from the pan. As that uplifting pressure finally abated, the days passed just the same as they do now. The force of water arrives every so often to whisk some weathered grains

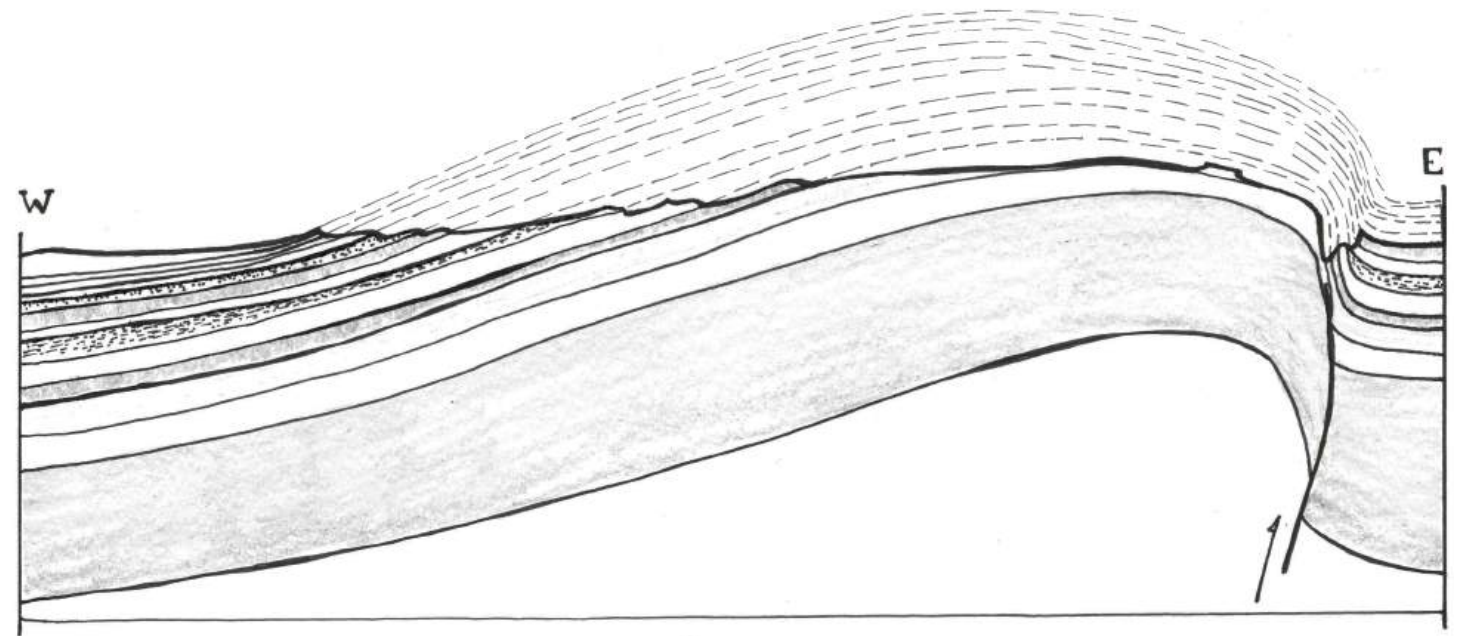


Illustration: Veronica Magner

of silica a few yards down a rivulet. I realize why reading the article wasn't enough to comprehend this process – I had to arrive physically in this place and throw the numbers up against the landscape's apparent permanence, for half a shot at understanding.

The sun dips behind the high edge of the mesa, and quickly the air begins to grow cold. I sit out in the air, in the absence of rock, and imagine filling a cup with the dust at my feet and taking a long walk to the Gulf of California. Pour it out, walk back, repeat. The watery work of millennia. There is near-total assurance that this work will go on pushing rock into the troposphere and carving it down again, grain by grain. A time scale at which the crust of the earth is entirely mobile – colliding, expanding, splitting at the seams. Nothing is flat, no iteration final. To think of solid earth that way brings a sublime fear mingled with a sort of relief, an assurance I can bring back to the metropolis with me, that there is something leagues more powerful than humankind. That the thundering semis too are dwarfed.

Perhaps what these landscapes have provoked in some is not relief but an urge to rail against this reminder of impermanence and relative frailty. The deserts of the west have been subject to the full extent of physical might we can muster. We've detonated 928 nuclear bombs in the Basin and Range Province of Nevada. Over a million miles of barbed wire have been strung across the open range, metropolises wrenched into existence through the damming of broad canyons. All in the name of putting a halt to

something or other. And still the rains arrive.

Morning breaks, silent as ever, and I remember how near I am to the San Rafael Swell. I grab coffee and rejoin the highway, heading west across the high plains. As the horizon slowly presents a shape like a rippling wave, I think of something Rachel Carson once wrote about the ocean, another realm here on earth that is physical, present, yet unmatched to our perception of time and scale, and so remains beyond comprehension. "The ocean has nothing to do with humanity," she says. "It is supremely unaware of man, and when we carry too many of the trappings of human existence with us to the threshold of the sea world our ears are dulled and we do not hear."

The rippling wave of rock grows larger, and I pull off to a parking area to shed the car. This wave is the jagged edge of the San Rafael Swell, all that remains after 60 million years of whittling. It stands now in clear view, stretching out like a fortress in both directions. The enormity of it doesn't quite land until a truck emerges from a gap in the rock; then the size of each in contrast sends a thud, a delight. The domed anticline that once was rises outward in imagination from the jagged edge, tracing the arc of the vast subtraction we have been graced, in a moment, to see.

Veronica Magner (Cohort AN, '25) is an architect-turned-ecologist from Philadelphia.

A Question of Scale

ALICIA DANIEL

Sun streams under the evening clouds, lighting us up on Raven Ridge. We are glowing, and not from exertion. Eighteen Vermont Master Naturalists just spent five hours hiking a quarter of a mile with me. We smelled the sharp wintergreen scent of black birch sap, rubbed the sulfur yellow buds of a bitternut hickory and gazed at its canker-strewn branches, and we ate bright red American basswood buds (picture a mouse in a motorcycle helmet!) and felt the slippery mucilaginous goo in our mouths. It is Superbowl Sunday or, if you prefer, just another Sunday in the woods chilling with winter trees.

Creating the Vermont Master Naturalist Program is a dream come true. VMN is fertile ground for teaching the layer cake approach and, best of all, it allows me to work with UVM Field Naturalist and Ecological Planning graduates. FNEP alumni Sean Beckett, Sophie Mazowita, and Monica Przyperhart head VMN Chapters in Montpelier, Cambridge and Middlebury areas. Alumni also lead field days on natural communities, pollinators, and winter tracking and star in VMN films about wildlife habitat and vernal pools.

Nationally, most Master Naturalist programs focus on plants and animals – the charismatic living pieces of the landscape. VMN diverges by building a framework from the ground up, giving natural communities a solid geologic foundation. Besides its holistic approach, VMN is unique in scale. Other master naturalist programs are regional, state-wide or, in one case, national. The Vermont Master Naturalist program is by nature local.

It is as if the question of VMN's scale was decided by men sitting around an oak table in Massachusetts 250 years ago, gridding off six mile by six mile squares on a Vermont map. Those squares became Vermont towns. The founder's experiences with towns in southern New England taught them that six miles by six miles was a magic number. That distance allowed farmers (and eight out of ten Vermont settlers *would* be farmers) to travel from anywhere in the town by horse or by foot to the center village to conduct their business and home again in time to milk the cows. Center villages by charter had a church (or two or three), a green for military drills, a post office, a store and often later additions like a pound for loose pigs. Vermonters of European descent embraced their towns and have hung on tightly ever since.

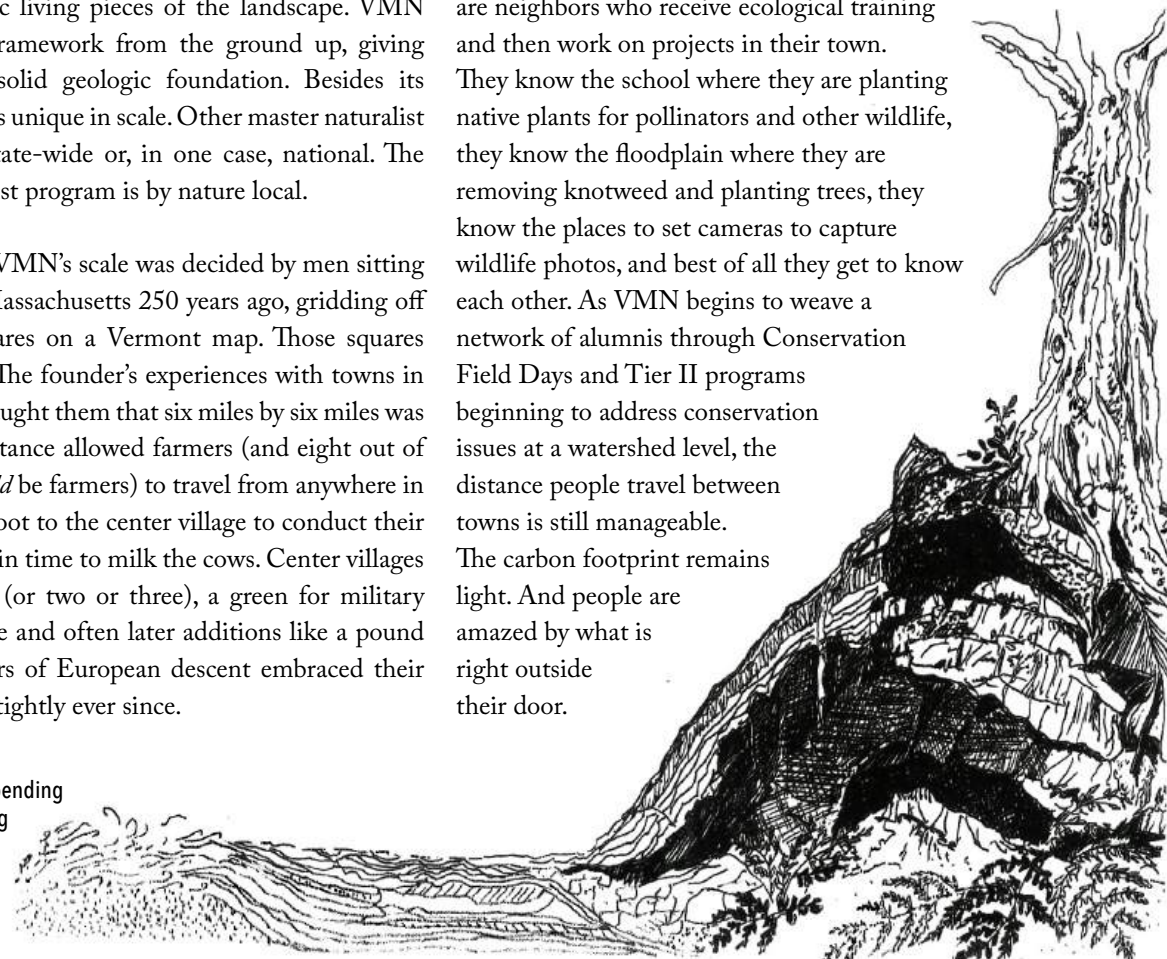
Alicia Daniel (Cohort E) loves spending her time training and mentoring naturalists through the UVM Field Naturalist Program and the Vermont Master Naturalist Program.

It turns out that telling the story of Vermont in a six mile by six mile square area is a piece of cake. All you need are bedrock outcrops, gravel and/or clay pits, stone walls, cellar holes, barns, natural communities and wildlife to track in winter. Almost all Vermont towns have these features – if you know where to look. And it is fun to look. It's a game of "let's find your special places," whether it's a glacial spillway over a mountain pass or a hidden glade of lady slippers right in the middle of town.

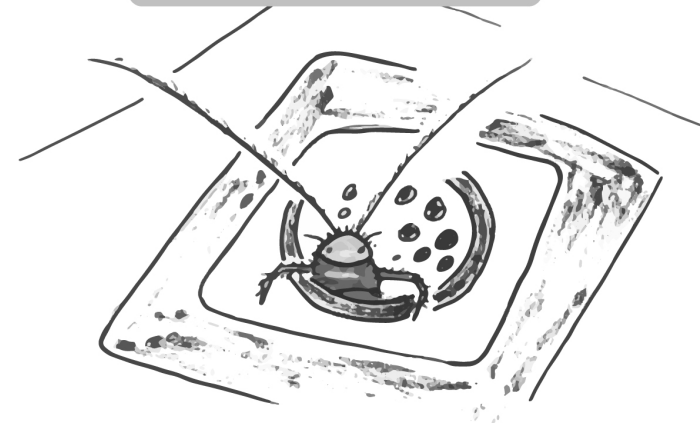
In addition, decisions about school budgets, local taxes, and conservation issues such as managing a town forest, delineating wildlife corridors, or restoring riparian buffers are decided at a town level in Vermont. These decisions are often made by volunteers. It's a lot to ask of them. Working with Vermont Fish and Wildlife's Community Wildlife Program, in collaboration with FNEP alumni Jon Kart, Jens Hawkins-Hilke and Dave Moroney, VMN helps provide ecological training and technical support to these individuals.

Two hundred and fifty years later, the town scale is still a human scale. Vermont Master Naturalists are neighbors who receive ecological training and then work on projects in their town. They know the school where they are planting native plants for pollinators and other wildlife, they know the floodplain where they are removing knotweed and planting trees, they know the places to set cameras to capture wildlife photos, and best of all they get to know each other. As VMN begins to weave a network of alumnis through Conservation Field Days and Tier II programs beginning to address conservation issues at a watershed level, the distance people travel between towns is still manageable. The carbon footprint remains light. And people are amazed by what is right outside their door.

Artwork: Nancy Stone

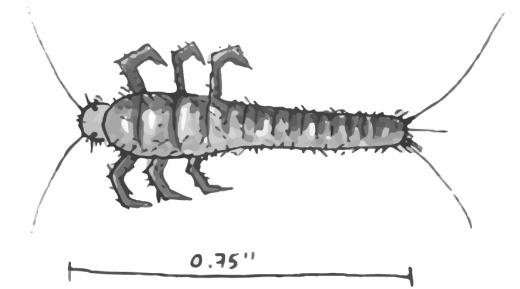


ALL THAT GLITTERS
BY CATHERINE WESSEL & LEE TOOMEY

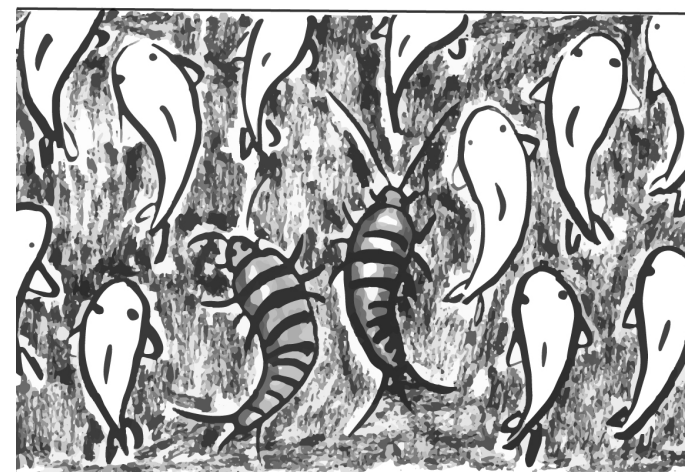


WHEN THE NIGHT FALLS, THE SHY SILVERFISH EMERGES FROM THE SHOWER DRAIN.

LEPISMA SACCHARINUM



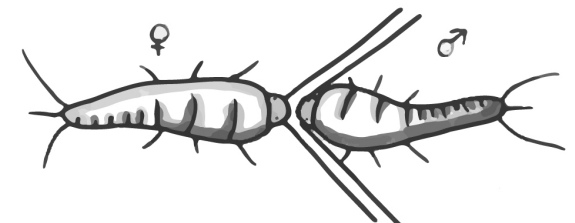
WITH SIX HANDS FOR HOLDING AND A SVELTE AND SHINY FORM, HE IS A CREATURE MADE FOR LOVE.



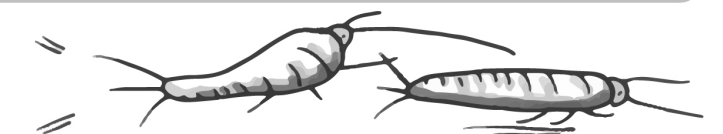
THOUGH THERE ARE PLENTY OF FISH IN THE SEA, THIS TERRESTRIAL INSECT MUST FIND HIS MATE IN THE DARK AND DAMP CORNERS OF YOUR HOME.

WHEN HE FINDS THE ONE, HE BEGINS THE 30 MINUTE COURTSHIP RITUAL...

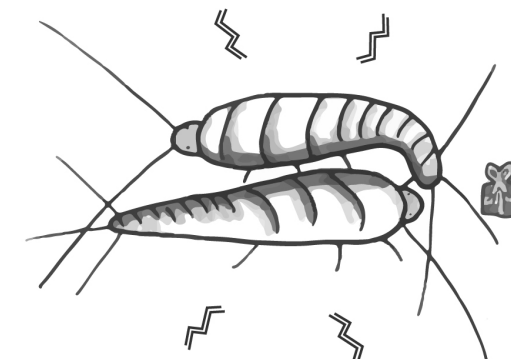
FIRST, THEY TOUCH VIBRATING ANTENNAE...



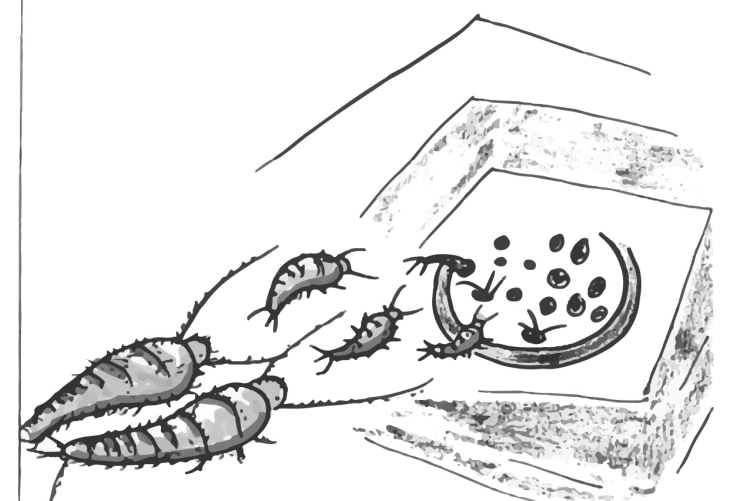
SECOND, A CHASE! HE DARTS AWAY AND SHE TRIES TO CATCH HIM...



THEN THEY VIBRATE SIDE-BY-SIDE, UNTIL IT IS TIME FOR HIM TO HAND OVER THE SPERM PACKET AND FOR THEM TO PART WAYS...



RETREATING TO THEIR DRAINS UNTIL LOVE IS IN THE AIR ONCE AGAIN.



Lee Toomey and Catherine Wessel just graduated from the Field Naturalist Program in Cohort AM.

NOTES FROM THE FIELD

COHORT AM ('24): THE SPOTTIES



WILL DURKIN

Will's project took him to his home state – even home watershed – of Maine, where he worked with a partnership of five regional land trusts to assess forest climate vulnerability. The partnership, spanning western Maine and eastern New Hampshire, is interested in understanding how climate change will alter the region's forest dynamics and how to best adapt their management practices to anticipated impacts.

Will spent the 2023 field season swatting mosquitos, eating blueberries, and trying to not let the birds distract him as he established sixteen 1.5-acre sampling plots where he measured, identified, and mapped the location of over 5,600 stems and collected regeneration data. He then incorporated all his data into a forestry model, *HeteroFor*, which can simulate forest growth and dynamics for the next 77 years under different climatic and silvicultural management scenarios. Will hopes his results will help guide landowners in implementing effective climate-adaptive forest management strategies.



MICHELLE GILES

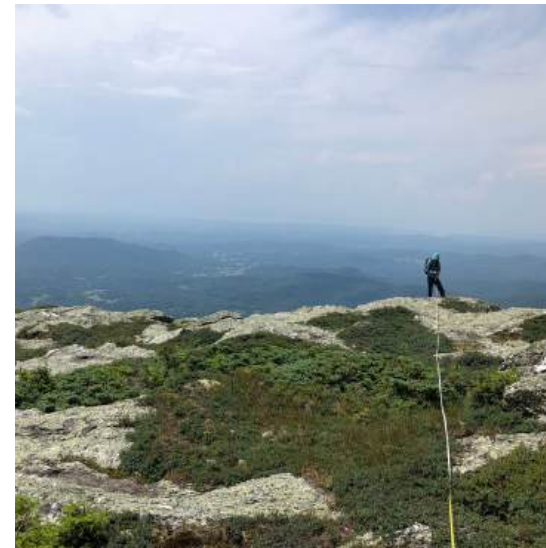
Urban forests are special places, often overlooked when it comes to long-term ecological monitoring. Michelle Giles established 41 Continuous Forest Inventory plots in UVM's own Centennial Woods Natural Area within the cities of Burlington and South Burlington. She collected data on the size, species, and canopy of over 1,700 trees in the woods, stopping to appreciate tree frogs and chipmunks whenever possible. With that data, she generated an informed management plan for the 147-acre urban forest.

She also spearheaded an investigation into making Centennial Woods accessible to students and visitors who use mobility aids such as wheelchairs or walkers. She completed a trail assessment, consulted with trail builders, talked with stakeholders and neighbors, and presented to various student organizations to spread the word and get feedback. Her efforts culminated in a proposal for funding the design of an ADA-accessible trail.



LEE TOOMEY

The Hohe Garbe spans 420 hectares along the former East-West German border in northern Saxony-Anhalt. The area hosts one of the largest floodplain forests in the UNESCO Biosphere Reserve Elbe River Landscape and forms part of the German Green Belt, an 870-mile nature reserve tracing the historic wall's path. However, the forest's connection with natural flooding was severed by an obsolete agricultural dike. In 2019, restoration efforts began to revive this connection, involving the opening of the dike and excavation of new flood channels. During the 2023 field season, Lee conducted vegetation surveys to assess the impact of these restoration measures on the landscape. Sponsored by BUND, Friends of the Earth, Toomey used data and spatial analysis to quantify changes in vegetation composition, providing valuable insights for future management practices aimed at preserving floodplain functionality. This study underscores the importance of international collaboration in conservation efforts, particularly as nations increasingly turn to nature-based solutions to address climate change.



CATHERINE WESSEL

Mount Mansfield's ridgeline is the largest alpine area in Vermont and home to many plants that are otherwise uncommon or rare in the state. The last study of community plant composition here was completed in the early 1990s, and in the 30 years since, the number of days of snow cover have dropped and minimum temperatures have climbed. To see how these unique natural communities are responding and to understand species presence, abundance, and distribution, Catherine resurveyed four permanent summit plots and established two more. Within randomized quadrats she collected data on environmental variables and cover percentages of plants and lichens. Sponsored by the Green Mountain Club, which stewards the Long Trail, and by UVM, which counts the ridgeline as one of the university's Natural Areas, she had the great privilege of spending her time among the many resilient species that endure the rain and wind of the ridgeline for far longer than a field season.



DAVE MORONEY

Dave conducted an ecological assessment of Adams Camp, a parcel owned by the Trapp Family Lodge in Stowe, VT, on behalf of Stowe Land Trust, with a focus on balancing recreational trail development with protection of wildlife habitat.

After a summer of bird counts, camera trapping, and vegetation surveys, Dave changed hats and acted as a facilitator throughout the process of updating the Adams Camp Recreation Management Plan. He interviewed key stakeholders, surveyed the community, and organized a series of meetings – through which the stakeholders agreed to adopt several recommendations from his ecological assessment, including the designation of a formal trail-free area in the center of the parcel. Dave's project concluded with a GIS-based inventory and analysis of the complete trail network in Stowe to assist Stowe Land Trust with future conservation decisions.



EVAN HORNE

Mass Audubon, New England's largest nature-based conservation organization, initiated a project in 2015 to enroll roughly 10,000 forested acres in the California cap-and-trade program. Enrolling in the program committed Mass Audubon to maintaining the carbon in these forests for at least 100 years and establishing intensive long-term monitoring to ensure these forests continue to store and sequester carbon. Evan leveraged the existing plot network to assess other ecosystem variables, quantifying forest resilience and vulnerability. Adapting methods the National Park Service and other agencies use to inventory and monitor their forests, he identified patterns of regeneration failure and compositional mismatch that could lead to a shift in canopy composition and structure. He used mixed models combining anthropogenic stressors, climate change, forest structure, and other variables to identify possible drivers of regeneration failure. He found that regeneration debt was significantly associated with herbivory pressure from white-tailed deer, underlining the need for active deer management across the state.



Image: Veronica Magner

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 and in our communities. We are now accepting pre-proposals for Field Naturalist partnerships during the 2025 field season.

Whether your needs involve fire ecology or citizen engagement, natural community mapping or landscape restoration, pre-proposals are 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, 2024.

Winning proposals call for a \$6,500 partner contribution to support students with a Field Naturalist Fellowship during their time in the program. Your partnership includes:

- More than a year of collaboration, beginning as soon as early 2025
- Literature and other academic research to support your project
- Field work extending from early spring through fall of 2025

Continued collaboration culminating in a draft by December and a final report by spring of 2026. Questions? Contact Dr. Walter Poleman by email (walter.poleman@uvm.edu) or at (802) 318-8441.



The FNEP Alumni Association helps build the relationships, skills, and ideas necessary for tackling the big environmental issues of our time. We connect students and alumni with professional opportunities and match partners with FN expertise. First and foremost, we support the rigorous, relevant training of Field Naturalists at UVM. Here's how to get involved:

BECOME A MEMBER: Membership dues enable us to host gatherings, support students, provide alumni grants, and more. Members gain access to our full alumni database.

SUPPORT OUR STUDENTS: Donations to the Lillian "Porky" Reade Fund exclusively support current students with whatever financial barriers stand in the way of their academic success.

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.

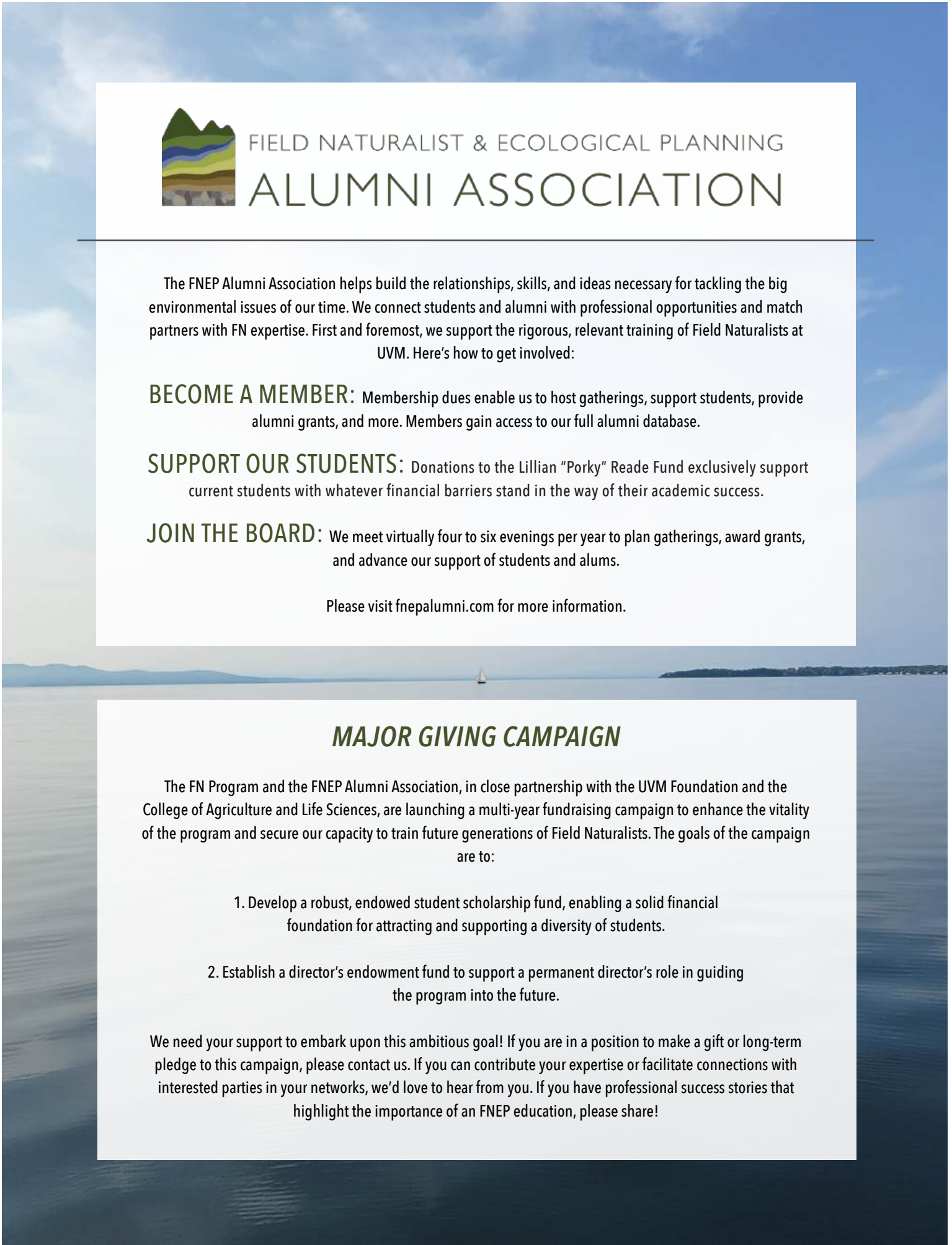
MAJOR GIVING CAMPAIGN

The FN Program and the FNEP Alumni Association, in close partnership with the UVM Foundation and the College of Agriculture and Life Sciences, are launching a multi-year fundraising campaign to enhance the vitality of the program and secure our capacity to train future generations of Field Naturalists. The goals of the campaign are to:

1. Develop a robust, endowed student scholarship fund, enabling a solid financial foundation for attracting and supporting a diversity of students.
2. Establish a director's endowment fund to support a permanent director's role in guiding the program into the future.

We need your support to embark upon this ambitious goal! If you are in a position to make a gift or long-term pledge to this campaign, please contact us. If you can contribute your expertise or facilitate connections with interested parties in your networks, we'd love to hear from you. If you have professional success stories that highlight the importance of an FNEP education, please share!

Image: Steve Root



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