The Butterfly Effect

Harnessing the spirit of residents, schools, organizations, places of worship, and businesses to create a greener community.

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Cover: The mourning cloak butterfly, which overwinters in its winged adult form, emerges in very early spring. It can be startling to see this butterfly fluttering about on a sunny early spring day when snow still remains on the ground and much life still lies dormant. The mourning cloak finds early season sustenance in tree sap, mud, even bird droppings and dung. A surprisingly long-lived butterfly (10-12 months), the mourning cloak lays its eggs on a variety of host trees such as elm, willow, birch, aspen, and cottonwood. **Left, top:** The color and pattern of the mourning cloak caterpillar reflect Mother Nature's artistic perfection. **Left, bottom:** A mourning cloak chrysalis. Leave the leaves. Because the "leaf" may actually be a moth or butterfly. **Photo credits:** Marcie O'Connor, Prairie Haven.

Life Underfoot in the Violet Patch

The Intertwined Relationship between the Common Violet and the Great Spangled Fritillary

A native plant gardener soon realizes there is infinitely more going on in their habitat plot, no matter how small, than readily meets the eye. Tuning into and connecting with garden life by noticing the variety of species, their relationships and habits at different times of day and season, we find ourselves more understanding of the interconnectedness of it all. If we pause to consider the life happening even in the common blue violet (*Viola sororia*) patch, we may be drawn to looking more closely, treading more softly, and gardening more carefully.

The relationship between violet and fritillary life cycles is but one case of what is not often readily noticed by the unpracticed eye in the native habitat garden. Taking the time to understand floral/faunal connectedness in nature has a double-fold benefit. First, we are more likely to witness more of what's unfolding in a given habitat and second, by practicing awareness, we play a vital role in allowing natural space to be one where its inhabitants can survive and thrive.

I have been aware for years that the violet plant family (*Violaceae*) is the larval host plant of greater fritillary (genus *Speyeria*) butterflies. This awareness gave the "yard violets"—as the common blue are often called—and Canadian violets in my yard a pardon to meander freely. However, other than spotting fritillary butterflies nectaring on summer blooms, I had never seen evidence of the fritillary's other life stages in my lush violet grounds.

Curious, I recently delved into the life cycle of the great spangled fritillary (*Speyeria cybele* species), the fritillary seen most often in the Twin Cities area where I live. All lepidoptera (moths and butterflies) go through the process of metamorphosis that begins with an egg being laid, and then moves through the larva (caterpillar), pupa (cocoon or chrysalis), and adult (winged) phases. There are multiple variations in the way these stages manifest in lepidoptera, influenced by time of year, type of host plant, and the life cycles of both the insect and the plant. Such is the diversity of life: Multiple species are somehow able to live within their own niche, sharing an environment without getting in each other's way.

The larval stage requires specific plants that the lepidoptera species has evolved to feed upon: the species' host plant(s). Some lepidoptera are specialists, having only one host plant species they can feed upon, such as the well-known exclusive association of the monarch butterfly and milkweed. Others are generalists, having more plant species as a selection. The great spangled fritillary (as are all greater fritillaries) is a specialist reliant solely on violets to nourish its young.[1]

Left: If we pause to consider the life happening even in the common blue violet (*Viola sororia*) patch, we may be drawn to looking more closely, treading more softly, and gardening more carefully. **Photo credit:** Vicki Bonk.

[1] The fritillary family is comprised of the greater fritillaries (genus *Speyeria*) and the lesser fritillaries (genus *Bolloria*). Butterflies in the *Speyeria* genus cannot survive without a violet host plant. Butterflies in the *Bolloria* genus use violets as a host plant, although the native passionflower is also used as a host for several lesser fritillary species.

Lepidoptera life cycles have evolved over thousands of years in tandem with the life cycle of its host plant(s), so there is critical "matching up" that must take place. Looking closely at the greater fritillary, we can start by examining its fascinating life cycle in early summer. Males emerge first from their chrysalides, usually a number of days before the females. When the females emerge later, the mating begins. As is true of all the greater fritillaries, the great spangled are single brooded (one generation per year). After mating, the male's life soon ends, while the females live on in a state of reproductive diapause.[2] During July and August, the females are rarely seen and live in a somewhat dormant state, perhaps hidden in a woodland. It's not until late summer that they become more active and visible. During this time, females deposit their creamy white eggs singly, near or on violets. When the tiny, black fuzz-ball caterpillars emerge, they eat part of their eggshell for sustenance. However, they do not eat any of their violet host plant at this time. Instead, the miniscule first instar caterpillar overwinters among the insulation of leaf litter.[3]

The nearly invisible fritillary caterpillars overwinter near or on violets. So note well: Late summer and early autumn are not the time to be thinning violets. Rather, a good time to thin spreading violets is in July and early August when the host plants aren't occupied by eggs or caterpillars. Later in the season, fallen leaves will blanket these violets, providing shelter. Thus, we see a case for leaving the leaves alone. Leaves and duff offer necessary life cycle habitat.

With Mother Nature´s amazing co-evolutionary timing (that is, timing that has not been disturbed by the mismatches caused by climate change), the itzy-bitzy overwintering caterpillar becomes active in spring, usually May, right when violets begin to emerge. At this time, the larvae begin to ravenously munch on the violets' delectable new growth. The great spangled fritillary life cycle is synchronized with the violet's growth cycle in order to give these caterpillars an abundant supply of food. Again, gardeners are cautioned to let the leaf litter be for a myriad of ecological reasons. The great spangled fritillary is highly secretive and its spring survival relies heavily on fallen leaf cover. To avoid predators, larvae hide among the leaves during the day and come out at night to dine on the violets. No wonder we unaware humans rarely see them! Ground-feeding birds and spiders looking for a meal are among the most likely to detect these larvae.

Right (clockwise from top left): Around late August, the cycle begins with a single egg oviposited on a violet leaf; The pearly egg hatches within a few weeks; The first tiny instar caterpillar overwinters in leaf duff, then emerges in May (final instar pictured here). The great spangled fritillary goes through several instar phases until its final mature phase; The camouflage of the tiny chrysalis protects it as it pupates for a few weeks in June. **Photo credits:** Sara Bright and alabama.butterflyatlas.usf.edu.

[2] Diapause in lepidoptera is a state of paused or suspended reproduction in which females do not mate or reproduce.

[3] Instar stages are the developmental stages between insect molting in which the exoskeleton is shed.

Left undisturbed and uneaten, the caterpillar completes its instar stages sometime in June and pupates into a well-camouflaged and concealed chrysalis—suspended head downward by silken threads attached to a log, rock, bark or leaf. A few weeks later, the butterfly ecloses, and we've now come full circle with the great spangled fritillary life cycle.[4] At this point, the native plant gardener can sustain the newly emerged butterfly by extending a floral welcome. Invite the adult butterflies in your landscape to stick around by providing the fritillary's preferred native nectar plants: milkweeds, Joe Pyes, native thistles, coneflowers, wild bergamot, and more. Consider the "floral refreshments" of late summer bloomers so that female fritillaries can then notice that your garden also includes its necessary host plant, the violet. The more violets your garden offers, the more visible and viable it becomes as a food source for next season's very hungry caterpillars.

Plentiful violets are essential for fritillaries, but their ecological usefulness reaches further. As a part of the circle of life, fritillary larvae are a food source for birds and other predators. And, native bee species such as mining bees (*Andrena*), mason bees (*Hoplitis*), bumble bees (*Bombus*), and sweat bees (*Halictus*) are all attracted to violets. Syrphid flies eat violet pollen, and skipper butterflies are attracted to the nectar. Some birds and small mammals find the seeds delectable. Ants consider the seeds an important food source, unintentionally farm them, leading to more violets! This spring-blooming ground cover has wonderful "bee lawn" characteristics: the pollen and nectar food source of a native plant, low growing, mowable, foot traffic tolerant, resilient, and perennial.

With their proliferation methods, violets can become too much of a good thing. There are ways to work alongside them. Edit violets only in July and early August to avoid editing the fritillaries. Keep violets working for wildlife (and you) in a number of ways. Allow them to be massed as a groundcover (that's best for the fritillaries, too). Violets are manageable as a garden border, and as a pollinator lawn alternative when combined with other native plants such as self-heal and wild strawberries. Violets are a terrific living plant mulch/cover under shrubs. Violets can be brought into check by having them share space with other "exuberant" plants such as ostrich fern. Violets also grow well underneath many trees, affording a soft landing environment for a variety of beneficial insect larvae, as well as providing better soil moisture retention.

Violets have a niche in the homegrown habitat garden. Diminishing wild areas make "bringing violets home" vital. Fritillary butterflies, who need violets to exist, have helped elevate violets from its misunderstood status as disrespected "yard violet" to an important host plant, reliable nectar source, and a key ingredient in an alternative lawn. Understanding the ecological value of all native plants and their faunal relationships gives us inspiration and knowledge to act as engaged stewards. Even in one little patch at a time.

—*By Vicki Bonk*

Left: The great spangled fritillary butterfly emerges in mid-summer. Pictured here on common milkweed. **Photo credit:** Vicki Bonk. **Next spread:** The regal fritillary needs large swaths of prairie violet to survive. A project at Three Rivers Park outside of Minneapolis, Minnesota, has reintroduced this species (listed as both a Species of Greatest Conservation Need and a Species of Special Concern by the Minnesota Department of Natural Resources) to the park with good success. The regal fritillary is pictured here on butterfly milkweed. **Photo credit:** Travis Bonovsky.

[4]An insect ecloses when it emerges as an adult from a cocoon or chysalis, or emerges as a first instar from an egg.

The Great Egret

Sun shining down upon the nearly five-foot wingspan of the great egret illuminates the pure white feathers of this bird. Because its stunning plumes were used as decoration in the hat making trade, the great egret was almost hunted to extinction in the late nineteenth century. The near extinction of this and other wading water birds set the bird conservation movement in motion, leading to the establishment of Audubon chapters across the country.

Wildlife photographer Travis Bonovsky explains how he captured this image. "This past summer I spent more time visiting a natural area close to home. The area doesn't really have an official name to my knowledge, but consists of two large 'retention ponds' just south of a golf course. The area was beautifully restored with native plants, shrubs, and trees some years ago and is now attracting a nice variety of urban wildlife including birds, insects, and more. In late July, this beautiful great egret took flight from the water and circled just above me!"

–Nature photographer, Travis Bonovsky

Stories of Making Change

People Doing Good Things in the Place Where They Are

Telling the stories of individuals dedicated to making environmentally impactful change in their communities is an important mission of Neighborhood Greening. Following are the stories of individuals who have "claimed dirt" as well as pushed for change in their communities in order to grow "clean food" and create ecologically functional habitat in places where it did not previously exist. We hope these stories inspire you to scan your own communities to make claims of your own. The cumulative impact of individual actions is how meaningful change happens—also known as the butterfly effect and, not coincidentally, the name of this publication. As our tagline states: Harnessing the spirit of residents, schools, places of worship, organizations, and businesses to create a greener community. This special feature showcases some of that inspiring spirit.

The Overlooked Space Between Street and Sidewalk:

How a Smart Urban Garden Design Can Create Community for People and Insects

The boulevard garden outside of the Birchwood Café in Minneapolis, owned by longtime restaurateur Tracy Singleton, is an important community amenity for passersby, customers, and pollinators. This seemingly effortless lush planting was created by Kim Knudsen, director of horticultural services at Phillips Gardens. Often referred to as "hell strips," the terrain between a road and a sidewalk can be a tough place for plants to survive. These strips are challenged by heat that radiates from paved surfaces, poor and compacted soil, roadside salt, and the general travails of foot traffic in an urban area, as well as pet "visitors."

With her 35 years of urban horticultural experience and design, Kim was ideally qualified to create this hugely popular streetside planting. Given the high volume of both pedestrians and restaurant patrons who experience this special garden, Kim wanted to create a bit of an "entertainment factor" with this particular project. To bring in a pleasing balance of color and beauty as well as sustenance for pollinators, her design includes an eclectic mix of regionally native vegetation, some of her favorite reliably hardy annuals, a range of edible vegetation, and nativars. Says Kim, "As you can see, I like to mix it up! I am mostly after beauty, butterflies, and hummingbirds for people to enjoy while sitting at the tables." The garden is so appreciated that she finds herself fielding numerous questions whenever she periodically checks in on her creation throughout the season. Hopefully, this wondrous planting has inspired others to "claim" the boulevard in front of their own homes.

Some of the vegetation in the Birchwood Café boulevard garden:
Culver's root
Pale purple coneflower
Sunflower species
Dense blazing star
Butterfly milkweed
Anise hyssop
Purple prairie clover
Prairie smoke
Little bluestem

Annual non-native vegetation that also attracts pollinators:
Anise-scented sage
Nicotiana species
Zinnias
Purpletop vervain

Plus some edible vegetation such as:
Kale
Nasturtium
Herbs
Calendula

Urban Agriculture

Market Gardening Comes to Town

Local food production is one of the key components of a climate crisis solution. The spread of the urban agriculture phenomenon across the U.S. is encouraging in this regard. Many cities have embraced the concept by allowing and encouraging the farming of vacant lots. But what does urban agriculture look like in U.S. suburbs where vacant lots are not an issue?

In 2021, Inver Grove Heights became the second suburb in Minnesota to "legalize" urban agriculture. It is called market gardening here and it takes a slightly different form than it does in big cities. As one planning commissioner put it, "It's like a lemonade stand for vegetables in your driveway."

Most suburbs allow gardening, of course. But almost all suburbs disallow the selling of the produce from your residence. I grow mushrooms in my shady yard. In August of 2020 I approached the city planning commission for a permit or variance to sell the mushrooms. It was then that I learned the zoning ordinances prohibited such commercial activity in residential zones. Thus began the months-long process of petitioning for a zoning ordinance change.

I believe there were two keys to the success of the Inver Grove Heights change. One: A citizen did the heavy lifting. I researched the ordinances of several other cities and drafted a proposed Inver Grove ordinance. This meant that city staff, commissioners, and council members could simply edit the draft instead of spending hours doing the research and drafting themselves. And two: The planning commission sponsored a survey that showed 79 percent of respondents were in favor of market gardening. It's hard for officials to look past such overwhelming support.

I encourage other suburban dwellers to pursue such a zoning change. There are at least two model ordinances to follow now in Minnesota. The ordinance I helped developed can be found in my city's ordinance under this heading: 10-15-33: COMMUNITY GARDENS, MARKET GARDENS, AND PERSONAL GARDENS. Momentum is building. With a little hard work and a lot of patience, your suburb could be next!

—*Story by Dawn Gaetke*

Right: "Market garden" chestnut mushrooms growing in Dawn Gaetke's suburban home garden.

Schoolyards: A Vast Resource

Growing Fruits and Vegetables, and Learning about Food at School

One evening I watched a documentary on Netflix called "Fed Up" and that was all it took to get the wheels spinning in my head about the foods we feed our children in school. I felt overwhelmed about the idea of battling the processed food industry for my own young children and I needed something I could *do*, because I couldn't just sit back and accept the status quo. Knowing how closely nutrition and health are connected, I came up with the idea of starting an edible school garden in the elementary school that my children attended. I gathered encouragement and idea clarity from some buddies and drafted up a pitch for the school principal. My idea was to start small, with six raised beds and a small pumpkin patch.

I focused on goals that I hoped to achieve through starting the garden:

1. Promote wellness by encouraging healthy eating habits
2. Increase the connection between our children and whole, fresh foods
3. Foster a sense of environmental stewardship in the students

Luckily, the school principal saw both the value and my passion for this project. He told me to find a team of people to help me and to find some money to make it happen. Um, okay. Well, determination cannot be underestimated. I presented my idea at a school PTA meeting, found some like-minded parents who were concerned about their children's nutrition, and networked with some of my friends to join me. I asked our PTA for money, had a friend host a large Norwex party and donate the profits, and made an Amazon wish list that was emailed out to the school for trellises, garden gloves, and watering cans.

Building the garden was a school community event, with parents and children helping to assemble the raised beds, dig out pathways, and put in the fence. And there it was! The vision had become a reality; it was so beautiful and authentic and collaborative.

The Mendota Garden is in its sixth year now and going strong. Through trial and learning, the group of volunteer parents has now settled in on set activities for each grade level to be involved in the garden from planting through to harvest, with an opportunity to see the cycle all the way through. Kindergarteners plant lettuce and radish seeds and then harvest what they grew and celebrate with a salad party. Many parents have reported that their five-year-olds request radishes from the grocery store after this experience! Other activities include making Stone Soup with a connection to the book, learning about the seed cycle, growing GIANT cabbages, honey taste testing with a focus on the importance of pollinators, pumpkin picking in the fall, and a school-wide farmer's market.

Organization and flexibility have been key to the success and sustainability of the garden. Parents want to help because the activities are fun, meaningful, and often involve spending 45 minutes outdoors in the sunshine in the middle of a work day! And the students, they truly flourish when given the opportunity to dig in the soil and nurture a plant that can one day nurture them in return.

—*Story by Kirsten Ramirez*

The Suburban Lawn

Shifting the Paradigm

I live in a lovely but turf-dominant Twin Cities suburb in Minnesota. After earning my certification as a Minnesota Master Naturalist and studying the work of noted ecologist Douglas Tallamy, I began to understand the critical importance of transitioning my corner of the world to a more natural habitat, primarily for the sake of native birds and other pollinators, but also to improve water, soil, and air quality.

I live in a neighborhood with fairly strict guidelines so it was important to consider the cultural ramifications of such a transition and follow the daunting but necessary process of receiving approval from my Homeowners' Association (HOA). This involved putting together a well-organized presentation packet that included visuals of the proposed new yard, a list of plants, and a written description of the project—which was designed and ultimately installed by the very talented native landscape designer Douglas Owens-Pike. It helped to provide a rationale for why we should begin implementing what is described in Tallamy's, *Nature's Best Hope*, as a community network of landscapes planted with native vegetation.

Despite the reasoning, I knew it would be a tough sell. The vision for my property might cause concern among neighbors who relate well-groomed yards to Midwestern virtue. I was aware the HOA board is required to approve projects as they relate to covenants that were structured decades ago. The committee needed to weigh each new request against ones they'd denied in the past (butterfly gardens and vegetable gardens in front yards, for example) and show concern for the point of view of all who live in the neighborhood. In anticipation of possible objections, I made sure that the shift from mowed turf to multi-level plantings in my yard would include stone edges so neighbors could visualize the intention of the new designs. It was important not to let the front yard grow wild and out of control.

The first steps in this plan would not be much of a challenge since a pocket pollinator garden that replaced a dying linden tree simply added color. The biggest changes would come in the third year when I replaced my conventional mowed Kentucky bluegrass lawn with Pennsylvania sedge, a flowing "lawn" that is about 6-8" high, and converted it using mechanical rather than chemical means. I intended to add a small vegetable garden to the front yard, since it is the only sunny spot on my property. The original plan to surround the garden with a picket fence was denied by the HOA board, since fences are not allowed in our front yards. However, the adaptation of a stone retaining wall turned out to be an even better-looking solution.

The board struggled with whether to say yes or no to my novel request. They wanted to approve it but were unsure how others in the neighborhood would respond. In the end, I was relieved that they gave provisional approval.

The yard is now starting its third full year of growth. It was not surprising that some neighbors have contacted our neighborhood association to ask questions, such as, "will the sprouting sedges fill in eventually?" (The answer is yes.) Or to complain that there may be weeds growing through the mulch. Regardless, most passersby—especially during the pandemic—have been inspired by this transformation. The yard, in its new state, allows me to tell stories to people of all ages about how valuable it is to have the plants do the work of filtering water that makes its way to the rich fen in the nature preserve across the street. I share that my yard no longer needs fertilizer and pesticides and requires far less water and time to keep in shape.

My property in now listed as a National Wildlife Federation-Certified Wildlife Habitat. The colors of the garden change but provide continuous blooms from May through October. The profusion of season-long color inspires people to keep stopping by to ask about the latest blossoms. Meanwhile, I have kept an eye on edges and weeds to demonstrate careful tending. And I have likewise learned that it is okay to introduce select ornamental plants here and there to provide a slightly more horticultural sensibility for those who respond less to blousy native plants and more to familiar cultivated species.

This work has been very fulfilling from an environmental conservation perspective and has propelled me to become a more active advocate with state and federal elected officials. I really can "walk the talk" when it comes to asking for their legislative support. It has also shown me what a great tool a native plant garden and yard can be in connecting with others—even if we are new to each other or align with divergent beliefs. Nature is a powerful force for connecting humans of all ages and backgrounds.

This gardening experience has empowered me to join the board of Monarch Joint Venture, as well as lead the Conservation Committee of the Saint Paul Garden Club (an affiliate of The Garden Club of America). The experience has also inspired my personal development as a botanical watercolor artist. What a rich and empowering platform for cultural change it has become.

—*Story by Dana Boyle*

Left: Dana Boyle's first growing season. The best is yet to come.

Mission to the Earth

Creating Biodiversity at One's Place of Worship

In the spring of 2020, we were in the first stages of the pandemic and religious services at my church had been suspended. Entry to the church was limited, making any effort to do interior maintenance impossible. One day I received an email from the church asking for volunteers to assist with planting two rain gardens. At the time, I did not know what a rain garden was, but since I often volunteered for projects at the church, I signed up. A local environmental group brought in enough volunteers to do the ground prep and plantings, but there was a need to water the new plantings to assure their survival the first year. In spite of near-record heat that summer, a team of us from the church created a schedule for watering and the gardens not only survived, they thrived.

During that summer, I had a meeting with two of the environmental community volunteers and we turned our attention to a property line we shared with a condominium development. We guessed that the property line had once been demarcated by an old farm hedgerow based on the vegetation that was growing in this particular area. A broken-down fence divided the properties and many non-native trees and shrubs—including buckthorn—had sprouted, grown, and in some cases, had lived out their lives unbothered by the church members or the condominium association next door. But within the invasive tangle were some unexpected surprises: native Solomon's seal, a few black walnut trees, and black cherry. As we did our initial walk-through of this area, I emerged with hundreds of stickers on my clothing!

Under the guidance of our enviro-volunteers, we gathered other volunteers that included a boy scout seeking a project to achieve an award, a 4-H group that met at our church, our church youth group, and several other church member volunteers. Collectively, we set about renaturing the property. First, we did general weed control using a weed whip to allow entry into the area under renovation. We then used chain saws and hand saws to remove diseased native trees, as well as the vast majority of the non-native brush. We hired a tree service to remove two large non-native trees. We then gathered cardboard boxes, flattened them, and laid them as a weed barrier.

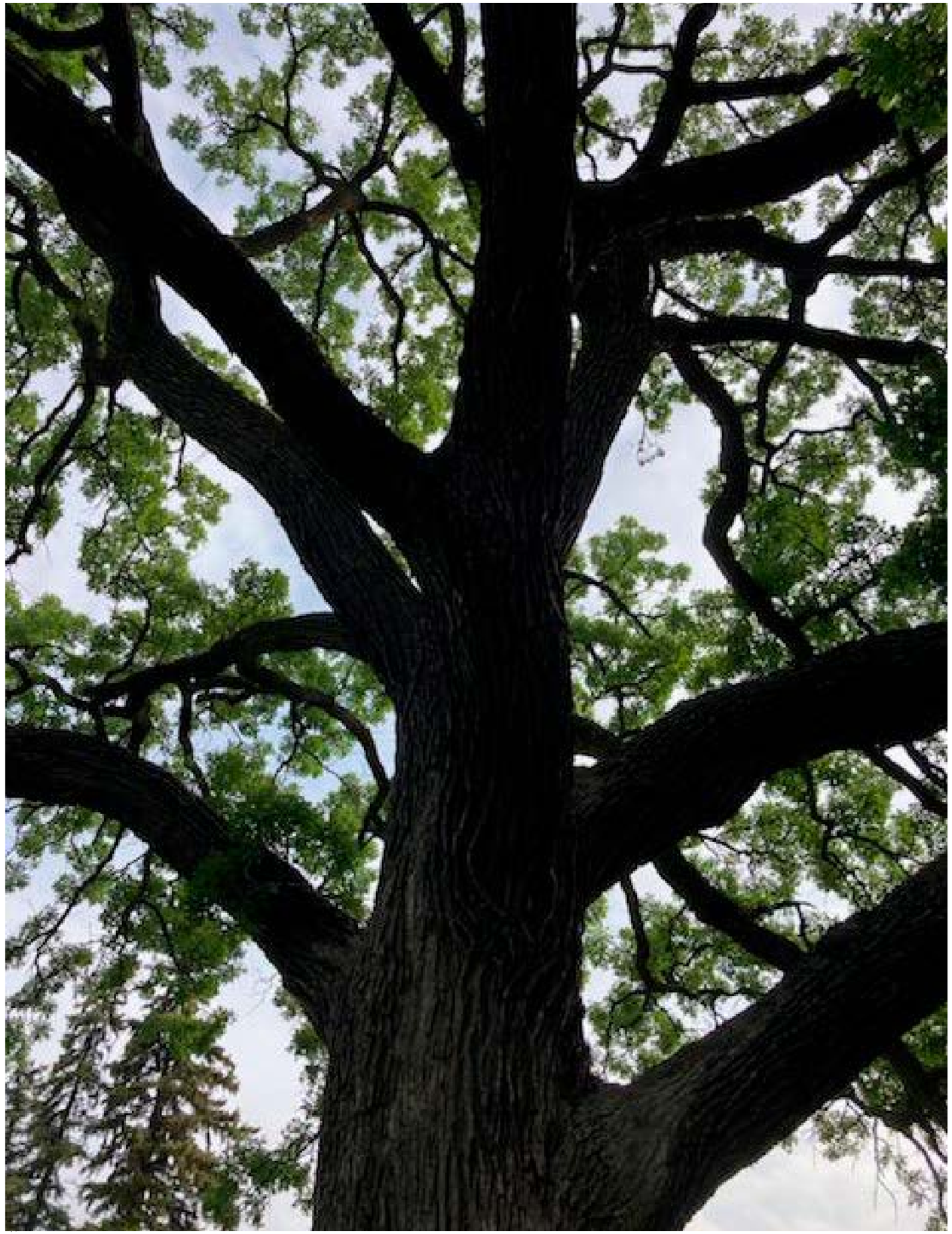
Left: One of two raingardens on the church property. The expansive property is slowly being planted out with regionally native trees.

In all, we laid down cardboard and mulched an area that averaged 15 feet in width and about 300 feet in length. We then planted native tree saplings and shrubs in that area. Additionally, we planted a dozen native trees on other parts of the property. The city, at our suggestion, removed a diseased tree from the right-of-way and replaced it with four native trees. Along with those efforts, another group of church volunteers repaired our sprinkler system so that now we have water to support the new plantings.

In our church denomination, one of our more recent initiatives has been to focus on our "mission to the earth"; groups have formed within some congregations that are called Earth Keepers. Within Christian theology there is much to support this type of mission even though, in our case, we had neglected our own property. I have been thankful to our community environmental volunteers who have inspired us to take a look at how we manage our property. In turn, I too am inspired to assist our condominium neighbors to restore their property to more reflect its natural glory and to provide a home for native birds and other animals. I believe there are many places of worship and other non-profit entities that have ignored the potential to renature their properties. Hopefully, the experience that we have had is one that other churches, condo associations, and non-profits may find inspiring.

—Story by John Grinager

Right (clockwise from top): This curb-cut raingarden was installed during city road reconstruction. The catch basin infiltrates stormwater runoff. Church volunteers clean out accumulated debris from the basin several times a season, bag it, and throw it in landfill trash. The city installs these important green infrastructure raingardens, at no cost to the property owner, during road reconstruction projects. In exchange, property owners must commit to stewarding and maintaining these beautiful gardens; A young volunteer helps at the rain garden; Buckthorn removal begins!



Trees Are Our Future

What We Can Do to Enhance Forest Communities

We might be fooled while meandering in a forest of old-growth trees that has been protected from the direct human exploitation of logging, farming, commerce, or housing. These forests still stand tall with wide canopies that embrace the surrounding environment, cool the summer air, and add humidity from water pumped out of the soil. These rare mature forested areas nurture habitat for insect and bird species that forage on foliage, flowers, fruits, and nuts. Among the branches, these giants cradle avian nests for the next generation. But these aged forests are besieged by an onslaught of threats ranging from climate disruption to species of invasive plants and insects to introduced diseases. Despite these daunting challenges, the good news is that we can learn from past mistakes. Each of us can contribute to help improve the resilience of these remaining forest communities, as well as learn about how to create tree resiliency in our own yards and communities.

Paradise Lost

Europeans arrived in North America some four hundred years ago. They found forests that had been carefully managed by local tribes of American Indians who harvested nuts and berries. Streams ran free and clear. A broad mix of wildlife thrived on the foods from the giant canopy trees overhead as well as shrubs and ground cover plants below. Balance and diversity prevailed.

Today, researchers point to shocking declines in the number and diversity of both birds and insects nurtured in these formerly robust and plentiful forest communities. Close to three billion fewer birds are found in North America today than 50 years ago—a loss of over one quarter of former abundance. And scientists studying arthropods (a broad class of invertebrates that includes insects) warn of a catastrophe unfolding.[1]

Staggering invertebrate losses are likely a result of incessant habitat destruction from intensive modern agricultural practices. Larger monoculture fields have erased the wildlife diversity that had once been supported by forests, and then, after the forests were removed, the habitat hedgerows that grew in smaller fields. Native plants within remaining narrow hedgerow bands are among some of the only habitat available for now-threatened farmland birds and insects. Without hedgerows, essential insects and other wildlife become more vulnerable to impacts of more intensive pesticide applications, urbanization, industrialization, introduced species, and climate change.

A shocking loss of diversity has been documented for animals as well. In the past 40 years, wildlife abundance across our planet has been cut by more than half. Further decimation of animal populations will yield "cascading catastrophic effects" on ecosystems, hastening the annihilation of nature. The window is closing to rebuild the habitat necessary to sustain these animals.

Forest Communities: Threatened by Earthworms, Climate Change, and Invasive Species

Forest ecosystems are disrupted by the trifecta of earthworms, climate change, and invasive species, which in tandem, trigger a cascade of catastrophic effects.

All photos in this article credited to Douglas Owens-Pike unless otherwise noted.

[1] Rodolfo Dirzo, a Stanford University ecologist, has developed a global index for invertebrate abundance. His index reveals a 45 percent decrease of invertebrate populations during the past 40 years. Insects most severely impacted include: bees, butterflies, moths, beetles, dragonflies, and damselflies.

Earthworms

The northern tier of North American forests, covered with ice during the last glacial advance, evolved without earthworms. Following colonization by Europeans, we now have worms introduced from both Europe and Asia. These introduced earthworms disrupt the nutrient balance of forest ecosystems. Across vast areas of our northern forests, massive numbers of earthworms cause an accelerating set of failures. Local native plants evolved to require only a slow release of the primary nutrients used to build plant cells (nitrogen, potassium, and phosphorus). Non-native earthworms disrupt this slow natural process by grinding up fallen leaves and transporting nutrients deeper into the soil than many native roots can easily access.

The loss of nutrients is compounded by the depletion of deep forest litter of fallen leaves, which formerly served to cushion soil from the impact and compaction of raindrops. Without deep leaf litter, bare soil is exposed and critically needed essential nutrients are washed away in heavy rains. This erosion reduces the abundance of ground cover plants. A vast array of insects formerly thrived in that deep leaf litter. Those critters were the base of the food chain for songbirds, essential in nourishing their next generation. Where there had been a thriving community full of diverse life, color, song, and all the associated activity, we are now left with a greatly diminished ecosystem.

The old trees are still standing but slowly declining. With time, they will be replaced by early colonizing species such as box elder and savanna-edge small trees. None will have the longevity of the former overstory.

Climate Change

Trending weather records reveal differences from averages of the previous century. These differences include longer periods of drought followed by heavier rainfall events, both in volume of rain and severity of winds. Warmer air can hold more water. When it is finally released, more rain falls in shorter intervals. Other observations include growing seasons extended by weeks in both spring and fall, less lake ice (thinner and over a shorter season), more freezing rain that would have fallen as snow in the past, and warming summer nights. These changes have been consistent across the Upper Midwest, extending to the East Coast and up into southern Canada. Moving further north, temperature increases will become even more exaggerated from historic averages.

This climate change exacerbates the soil stripping that results from introduced earthworms. Erosion takes nutrients away from trees where there are heavy infestations of introduced earthworms. These displaced nutrients flow into local water bodies, feeding harmful algal blooms. This process contributes to degraded downstream water quality; people and animals get sick and can die from drinking this now polluted water. These algae ultimately expand the dead zone in the Gulf of Mexico. Algal blooms, fed by this flush of nutrients from our impoverished forests, destroy the formerly rich seafood production of shrimp and other fish.

Invasive Species

The forest floor is also impacted by widely spreading monocultures of invasive species such as garlic mustard and buckthorn introduced from Europe. Both of these species exude chemicals that inhibit the growth of

Top right: The deep layer of well-drained sandy gravel soil topped by fallen leaves in this stand of mixed red and white oak was deposited as the last ice sheet retreated 10,000 years ago. Before European settlement, this forest would have had frequent ground fires that would have kept the forest more open. Mature oaks are resistant to fires that do not reach into their canopy. **Bottom right:** This stand of black oak is threatened by faster growing red maple that will overtop and shade out the oaks. It is unlikely the red maple would be able to persist on this hot, dry, south-facing slope as climate continues to warm, so they will be removed.

the formerly diverse mix of native ground covers. The dominant, tallest trees of our forests have also been decimated by the introduction of diseases including chestnut blight, Dutch elm disease, and more recently, emerald ash borer.[2] Compounding these stressors, exploding numbers of deer consume enough foliage to drastically reduce survival of any remaining tree seedlings.

Research suggests it will be difficult for many of the remaining overstory species to survive our changing climate conditions. Instead of cool, enclosed, dense, "Big Woods" forests that covered large areas of the eastern half of North America, we will be left with hotter, open savannas dominated by oaks, with grass species covering the soil between less diverse, scattered trees. These changes will further reduce the diversity of ground-level spring flowers, reducing the number and diversity of insects and birds that depend on the former cooler growing conditions.

The Beginning of Assisted Migration

What options do we have to reduce these trends? Resilient forests of the future will require human intervention, because our climate is changing faster than local trees can adapt, evolve, or move in order to persist. Worldwide efforts are underway to plant trees that are more likely to survive the combined challenges of climate change and introduced competitors (both insects and plants), as well as diseases from other continents. In the Midwestern region where I live, lists of recommended trees of the future typically include our northern tier of resilient native oaks and hickories along with some southern oak and hickory species that could be introduced farther north. Several tree genera new to our northern tier of states and Canada include tulip tree, sycamore, and sweet gum.

One program in Minnesota encourages farmers and anyone interested to collect seed from native trees in central and southern regions of the state. Those seeds will then be dispersed into the best new suitable habitats on the north shore of Lake Superior. The overriding concept is to diversify the climate tolerance of the species currently found in those same habitats. Ideally, this will help ensure some forest cover for generations to come. Without our intervention, forests will be decimated.

Restoration of Habitat

This new idea—that human intervention is not only acceptable but necessary—has its skeptics.[3] For decades, the emphasis in restoration ecology has been to use local ecotype vegetation. Yet, we all seek forests that are better able to handle climate changes already underway. Ideally, steps already taken move us toward building habitat for the greatest diversity of fauna to survive. Experiments are underway across the globe that seek to discern best practices. At Acadia National Park, for example, species survival of introduced trees from further south is currently being tested. (Researchers will remove any introduced species after the trial period.)

Depending on which land agency or preservation organization is responsible for managing a tract of land, we can envision different criteria for what level of intervention would be ideal. As there is a great deal of uncertainty about what the new climate will be in any one area, it seems best to attempt a variety of techniques that aim to preserve or enhance both diversity and resilience. Large urban centers, for example,

[2] The fate of our country's native ash trees, due to the movement of the destructive emerald ash borer through our natural and built landscapes, could very well mirror that of our once robust forests of native elms and chestnuts. The loss of Northern and floodplain forests that are dominated by ash will permanently alter the natural ecosystems and food webs that depend on ash.

[3] Many of these worldwide efforts are controversial. When done well, restorations that plant the "right tree in the right place" restore biodiversity and infuse local economies. When the wrong trees are planted in the wrong place, tree planting initiatives can actually "reduce biodiversity, speeding extinctions and making ecosystems far less resilient."

should take a more radical approach toward what should be introduced that might thrive, (without becoming invasive pests) given changing climate parameters. Larger tracts of parks or designated wilderness could rely on a more conservative set of guidelines that allow more limited intervention. In these larger tracts, we could introduce ecotypes from further south but no new species.

Trees for Our Future

My own career has primarily focused on the restoration of native habitat within a metropolitan core. I've worked with businesses and homeowners, often to transform the urban-standard lawn with extremely limited diversity, to forest edge communities that team with life. These transformed spaces promptly create healthier habitat—from the soil (built from the slow decomposition of leaf litter) on up into the top of the canopy. These restored habitats all sustain a vastly wider variety of insects and birds than more traditional urban or suburban landscapes.

While my decades-long career in ecological "urbanscaping" was extremely satisfying, I became interested in creating a "living laboratory" to test theories about tree resilience in a changing climate. So, ten years ago, I purchased 80 acres of forested and neglected farmland in northwestern Wisconsin in order to observe the resiliency of various regionally non-native tree species as well as various native ecotypes from more southerly regions. My goal is to offer a prototype of how other land owners could manage their land for what the future climate will require.

One of my approaches to pursuing assisted migration has been to purchase seedlings of two oak species (*Quercus macrocarpa* and *Q. velutina)* through the Illinois Department of Natural Resources. While these two oak species are both native in my home forest, the purchased seedlings evolved in forest communities 400 miles south of my home. Adding that southern genetic diversity is expected to improve the survival of local individual trees of the same species, since the introduced seedlings are already adapted to a warmer climate that is moving north.

Additionally, I'm introducing new species that are not indigenous to my region. One of these is bald cypress. This tree is similar to locally native tamarack (which is predicted to struggle in the future) in that both are deciduous conifers, having needles that turn golden yellow in the fall. Their branches are bare all winter. Come spring, delicate new needles emerge. Both of these conifers can tolerate water-logged soil, conditions that few other trees can survive. But despite tolerating wet soil, bald cypress do not require so much water to survive. These introduced trees will survive when planted on moderately moist upland soils and will improve the diversity of my forest community.

My current woodland is composed of red maple that are beginning to overtop and outcompete the older white oak. The faster growing red maple are blocking more and more light from the slower growing oaks. Unlike the oaks, red maple prefer cooler growing seasons and are not expected to survive our new climate. Rather than allowing maple to snuff out oaks now, only to watch the maple die in the future, my plan is to girdle the maple, giving the oaks a better chance to survive in the interim. Killing the maple is easily accomplished by removing the bark from all around the base of each trunk, then allowing them to stand dead for a season. At first, these dead snags provide habitat for insects that are food for our native woodpeckers. Ultimately, they will be harvested, becoming a source of winter heat in my wood stove.

Photo credit (bottom left): Jeff Zechlin.

My efforts will not eliminate the currently widely successful maple in my region. Thus, its important values will not be lost. Red maple are a host plant for many insects, such as the rosy maple moth, and it's a high-nutrition, early-season source of pollen. Sugar maple are a key source of income for many farmers who supplement their income by tapping trees in late winter to harvest its sap. The best approach to this manipulation is to keep some woodlands dominated by maple and others managed to ensure oak species' health and survival.

Although we will quickly provide new habitat for current wildlife—it will require time before we can draw solid conclusions from my efforts toward optimizing my 80 acres for future tree resiliency—I am nonetheless deeply drawn to this work. My concern for the future of this precious planet compels me to keep experimenting, learning, taking notes, and sharing knowledge. On occasion, I host tours of this property and enjoy sharing this journey with others.

What You Can Do

Anyone with land surrounding their home can contribute to improving the health of our future forests by adding to the diversity of local tree species. There are now several programs in our northern tier of states that are coordinating efforts to offer seeds or seedlings of trees from the same species that evolved in similar habitats found 200 to 300 miles south of one's region. Get in touch with your local Department of Natural Resources to learn how to get involved. We can also build on what we have lost by planting newly developed tree varieties such as American chestnut and American elm that are resistant to devastating chestnut blight or Dutch elm disease.[3] Additionally, consider adding to the native species mix already on your property by including some of the trees (from the list of trees at the end of this article) that are predicted to survive the disruption of climate change. And if your forest or home landscape is already degraded by introduced invasive species, work to get them under control and replace those competitors with recommended trees.

Reconsider Your Home Landscape

Consider yourself a force for change, leaving a healthier planet for the insects and birds that survive on the trees you plant. Your nurturing will benefit pollinators as well as the plants, fruits, and vegetables their labors make possible. Know that future generations, fortunate enough to benefit from your stewardship, will enjoy a more balanced ecosystem that will help improve Earth's biosphere.

An initial step is to reconsider the traditional turf grass lawn. Instead of a manicured lawn growing under mature trees, restore a mix of the native spring ephemerals and other native ground cover perennials that evolved in your region. This ground layer of diversity would have likely been present before your home displaced a rich forest community and turned it into a monoculture of introduced lawn grasses. Adding this layer of native diversity under your trees will improve your trees' likelihood of long-term survival. (Note: If you are not able to control your local deer population, it is essential to protect these new plantings from their grazing and browsing.)

Most urban lots will have space to plant one or two trees, especially if you recently removed a diseased or dying tree. The best choice for replacement can come from your "neighborhood forest." As you walk around your community, note which tree species are present as well as missing from the recommended list (see list at end of this article). Your survey can reveal what will yield the most benefits in regard to adding to species diversity in your local community.

Previous spread: Bur oak has some of the best qualities to persist in our new climate. This individual is several hundred years old, growing in a former savanna edge of a prairie in central Minnesota. During its lifespan, this tree has withstood severe drought and ground fire, and has excellent resistance to oak wilt that can devastate stands of red oak. Individuals have been found that are over 400 years old. **Above:** Douglas Owens-Pike in his nursery of approximately five-year-old black oaks, planted in spring of 2020. **Photo credit:** Joan Feldman Plumb.

We are in the midst of an abrupt climate shift so a mix of both historically local native trees as well as some of the suggested introductions is ideal. We should plant trees that will survive for the next several hundred years, and many human generations. But your local urbanscape should also include key vegetation (think willows, maples, cherries, and oaks) that supports current native pollinators and other insects as well as those invertebrates that are shifting north as climate changes.

Beyond your own yard, contact your community forester to inquire about their plans for invasive and diseased tree removal. Ask what species will be planted to fill those openings. Share the attached list of those expected to be the best candidates for survival. Urban plantings should include as much diversity as possible, not relying on a few old standards that have worked for your city in the past.

Planting for Longevity

Despite a wealth of evidence that instructs on the best tree growing techniques, far too many tree saplings are still poorly managed in the nursery setting. Those poor specimens are then planted far below the best depth in landscape soil where they eventually die from stem-girdling roots. Learn to spot these problems by studying how trees appear in a natural forest. Observe how sweeping flares flow down and away from the trunk before meeting the soil surface. Trees should not have sheer vertical sides at ground level as they mature. Stem-girdling roots prevent the desired flares.

Beyond species selection, for your tree to survive, it must be planted at the proper depth (the first major root should be close to the soil surface) and watered correctly (a deep soaking, once a week, in a wide circle is ideal). As the tree grows, frequent pruning, with small cuts, will ensure a single leader. Proper pruning removes multiple stems that are easily damaged in strong winds. Click here for a great tree planting tutorial.

Your tree choices will make a difference for the health of our planet. Starting in your own yard or neighborhood, and then by radiating out into the larger community, you will serve as a source of both inspiration and knowledge, offering friendly guidance to help your neighbors (as well as your local municipality) make better choices in this time of climate upheaval and uncertainty.

Trees Recommended for Planting in the Upper Midwest and Southern Canada in the Face of Climate Disruption (that could be enhanced with ecotypes from habitat 200-300 miles south):

American basswood, *Tilia americana*
American elm, *Ulmus americana* 'Valley Forge'
Bur oak, *Quercus macrocarpa*
Black oak, *Quercus velutina*
Red oak, *Quercus rubra*
White oak, *Quercus alba*
Hackberry, *Celtis occidentalis*
Shagbark hickory, *Carya ovata*
Bitternut hickory, *Carya cordiformis*
Silver maple, *Acer saccharinum*
Ironwood, *Ostrya virginiana*
Honeylocust (native with thorns), *Gleditsia tricanthos*
Black walnut, *Juglans nigra*
Witchhazel, *Hamamelis virginana*
Eastern red cedar, *Juniperus virginana*
Black Hills white spruce, *Picea glauca* 'Densata'
White pine, *Pinus strobus*

Introduced species that are now found further south or in other parts of the world that may have a better chance of thriving further north in the Midwest and southern Canada due to a changing climate:[4]

American sweetgum, *Liquidambar styraciflua*
Blackgum, *Nyssa sylvatica*
Winged elm, *Ulmus alata*
Ohio buckeye, *Aesculus glabra*
Catalpa, *Catalpa speciosa*
Mockernut hickory, *Carya tomentosa*
Pignut hickory, *Carya glabra*
Shellbark hickory, *Carya laciniosa*
European beech, *Fagus sylvatica*
Ponderosa pine, *Pinus ponderosa*
Laurel oak, *Quercus laurifolia*
Scarlet oak, *Quercus coccinea*
Southern pin oak, *Quercus palustris*
Sassafras, *Sassafras albidum*
Scarlet oak, *Quercus muehlenbergii*
Pecan, *Carya illinoinensis*
Sycamore, *Platanus occidentalis*
Tulip tree (yellow poplar), *Liriodendron tulipifera*
Bald cypress, *Taxodium distichum*
Redbud 'Columbia', *Cercis canadensis*

—By Douglas Owens-Pike

Left: Hemlocks are not expected to survive climate disruption. This several-hundred-year-old specimen is growing in the uniquely cool habitat within a few miles of the south shore of Lake Superior. White pine is expected to persist, despite our changing climate, with longevity of up to 450 years.

[4] Some resources for climate change trees for New England:

- USDA McIntire-Stennis Program; 61,784; 2018-2021. "Recent Changes and Future Trajectories of an Ecosystem at the Crossroads: Implications for Planning, Management, and Conservation of Long Island Pine" Barrens. M. Dovciak (PI), T. Green, K. Schwager and, Wason JW.
- Bevilacqua E, Dovciak M (2017) Climates on the move: Implications of climate warming for species distributions in mountains of the northeastern United States. *Agricultural and Forest Meteorology*, 246: 272–280.
- Climate Change Response Framework

About This Journal

In mathematical chaos theory, the butterfly effect is the concept that a ***very small difference in the initial state of a physical system can make a significant difference to that state at some later time.*** What can this theory offer to the communities in which we live? We think it offers a lot. The cumulative effort of individual actions can positively impact the local ecosystems that comprise our lakes, streams, wetlands, yards, gardens, recreational areas, open spaces, roadsides, schools, and places of worship, and much more.

Neighborhood Greening, a non-profit organization dedicated to environmental education and stewardship, publishes *The Butterfly Effect* twice per year. In the journal, we celebrate community successes, examine small but impactful changes we can make to become better stewards of our local ecosystems, and tell the stories of those who are striving to green their neighborhoods. By harnessing the spirit of community, we believe focused efforts will make our neighborhoods better places to live for both humans and wildlife. There is much we can do together to positively impact our shared environment. House by house. Block by block. Neighborhood by neighborhood.

We hope you enjoyed *The Butterfly Effect* and that you look forward to receiving this free publication in your inbox twice per year. If you haven't already done so, you can sign up by clicking here. Be sure to connect with Neighborhood Greening on Facebook and Instagram to keep learning how to help green your neighborhood throughout the year.

Do you have a story or idea to share about how you or someone you know is making your neighborhood greener, more environmentally sustainable, or wildlife friendly? Please send your ideas to Green@neighborhoodgreening.org. Want ideas to green your neighborhood year round? Be sure to check out "42 Ways to Green Your Neighborhood" on Neighborhood Greening's website.

Please consider making a small donation to Neighborhood Greening to help harness the cumulative environmental impact of indivdual actions.

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