Great Barrington Pollinator Action Plan

Connecting Habitat & Community

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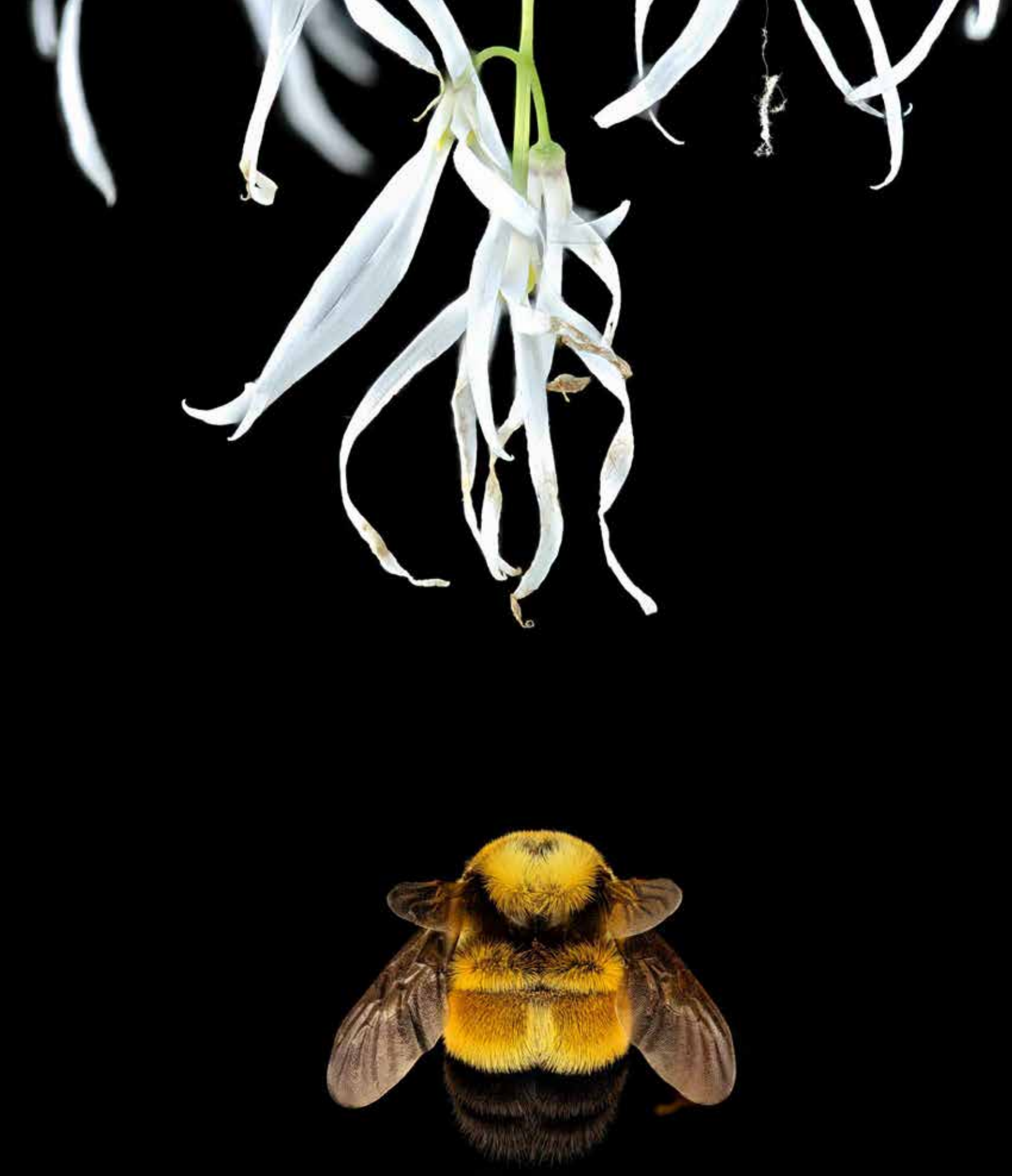


Virginia Fringetree, Chionanthus virginicus *(top) and the endangered rusty-patched bumble bee,* Bombus affinis *(bottom). Photographs courtesy Helen Lowe Metzman and USGS Bee Inventory and Monitoring Lab.*

Executive Summary: Life as We Know It

Our responsibility is to species, not to specimens; to communities, not to individuals.

—Sara Stein, *Noah's Garden*

There is a worldwide phenomenon taking place, and it affects every element of life as we know it. Globally, across the United States, and throughout Massachusetts, pollinator species are in decline. The exact causes of the decline of each of the tens of thousands of species may still be indefinite, yet much is already understood: without pollinators, human life and all terrestrial ecosystems on earth would not survive. Pollination is not just fascinating natural history: it is an essential ecological function (U.S. Forest Service).

According to the National Academy of Sciences, close to three quarters of the flowering plants on earth rely on pollinators in order to reproduce. From these plants comes one-third of humankind's food, and even greater proportions of food for wildlife. Citizens in Great Barrington, Massachusetts, are well aware of the risks associated with pollinator collapse. Since 2016, they've been working actively in the public realm to secure local legislation to protect and expand pollinator habitat in their town.

This Pollinator Action Plan, produced in collaboration with the Town of Great Barrington Department of Public Works, The Great Barrington Agricultural Commission, the Conway School, and key stakeholders across the region, proposes an interconnected pollinator habitat network through Great Barrington, with scalable models applicable to other towns and properties with different uses, to guarantee a healthy pollinator population in Great Barrington and across the Berkshire region.

Great Barrington has a lot to offer pollinators: traversed by three rivers, it is situated in one of the most ecologically diverse regions in Massachusetts and southern New England. Over one-third of the town's 46 square miles is protected land, and municipal lands comprise nearly 336 acres. These municipal properties include forests, parks, town buildings and their grounds, cemeteries, the Lake Mansfield Recreation Area, and the McAllister Wildlife Refuge. About 6,000 acres is currently or was historically farmed, and large portions of former farmland remain undeveloped today. All the necessary natural habitats exist to foster a thriving pollinator community.

Threats are also present: among them, the potential for continued expansion of human development into the intact natural spaces that pollinators need. Pesticide use, particularly in large scale agriculture, is decimating pollinator communities. Global climate change has shown to disrupt natural cycles including the synchronization between bloom time and bee emergence (Yale E360).

This document maps the pollinator habitat potential for Great Barrington's diverse municipal properties, the 91 miles of local roads the Department of Public Works maintains, the nearly 4,000 acres of active farmland in the town, residential properties, schools, golf courses, streetscapes, and parking lots, and the potential for establishing green roofs in the urban town center. These recommendations can be found in the **Opportunities** chapter.

Along with the benefits of supporting pollinator survival, Pollinator Action Plan recommendations offer additional advantage to the Town of Great Barrington, its Department of Public Works, and local farmers and gardeners. Such improvements can also provide favorable outcomes for the school district, local residents, institutions, businesses, and Massachusetts Department of Transportation. For example, besides providing more forage and habitat for pollinators, the benefits of modifying mowing frequency include reduced costs, better air quality, lower noise levels, more water conservation, improved infiltration, and healthier environment for people and pets. Other measures such as pollinator strips and forage cover crops can help farms stabilize slopes, filter stormwater runoff, improve erosion control, discourage weeds, and sequester carbon.

The Great Barrington Pollinator Action Plan is an educational toolkit that could be picked up by anyone in the northeast region of the United States, and likely provide enough information to identify and prioritize sites, and implement pollinator habitat in those areas. Anyone with access to a piece of land or sidewalk strip can use this plan. Through a collaborative effort, reaching across experiences, social strata, and ecosystems, the citizens of Great Barrington can build a thriving, lively, pollinator-friendly community—and inspire other communities to do so, too.

Introduction: Building a Local Movement

The Town of Great Barrington has a long history of political expression: in 1774, 1,500 men in Great Barrington shut down the Berkshire County Court in response to British oppression (Wikipedia, Great Barrington). Today, the town has a reputation for being politically progressive, environmentally conscious, and culturally diverse.

On May 9, 2016, Great Barrington became the first municipality in New England to pass a Pollinator-Friendly Community Resolution. The resolution recognizes pollinators as essential to a healthy ecosystem and local food system, and correlates their decline directly with widespread insecticide use. In many ways, this was following in the footsteps of the federal government, whose *National Strategy to Protect Pollinators and Their Habitat* was released one year prior, focusing on not only insecticides, but also industrial monocultures, habitat destruction, extreme weather, and disease as contributing factors to the decline of pollinator populations.

Great Barrington is a land rich in biodiversity: the town hosts 45 Massachusetts Species of Conservation Concern, and over 17,000 acres are classified as "Critical Natural Landscape" by the Massachusetts Natural Heritage & Endangered Species Program. Settled in the fertile Housatonic River Valley, Great Barrington has a long history of agriculture, dating at least as far back as the Mahican Native Americans (NHSEP, 2011a). Today, locally grown crops such as apples, berries, squash, and nightshades all depend upon pollination. Well aware of the global pollinator crisis unfolding, the citizens of Great Barrington decided to take action.

Great Barrington's resolution encourages the adoption of policies that minimize the sale and use of insecticides in the town, and "urges all Great Barrington property owners, residents, businesses, institutions and neighborhoods" to adopt the following practices:

- Commit to avoid using insecticides
- Avoid planting flowering plants treated with systemic insecticides
- Plant more pollinator-supporting forage on their property

In response to the unanimous support for the Pollinator-Friendly Community Resolution on behalf of the town Selectboard and Agricultural Commission, the Department of Public Works (DPW) hired a Conway School team of students to devise a town-wide pollinator plan, with the Agricultural Commission acting in an advisory capacity. The goals for the plan included the following:

VISIBILITY

- Identify centrally located demonstration sites for pollinator habitat
- Provide public education and outreach components to the plan

SCALABILITY

- Design replicable pollinator habitat models
- Identify potential pollinator habitat corridors
- Address regional food security through pollinator habitat

MANAGEABILITY

- Recommend low maintenance plantings that are easy to establish
- Consider low cost and low water requirements
- Focus on native species of plants

The Town of Great Barrington intends to use predominantly town-owned and managed sites to enhance and broaden pollinator activity. The Town wants to leverage highly-trafficked downtown sites to springboard a local pollinator movement, by educating the public with demonstration gardens, interpretive signs, and educational materials available on the town website and at town libraries, including this plan. These town properties can thus serve as models for other properties at a variety of scales, and with a variety of land uses. This plan looks to foster native plant communities that are financially feasible and easy to maintain.

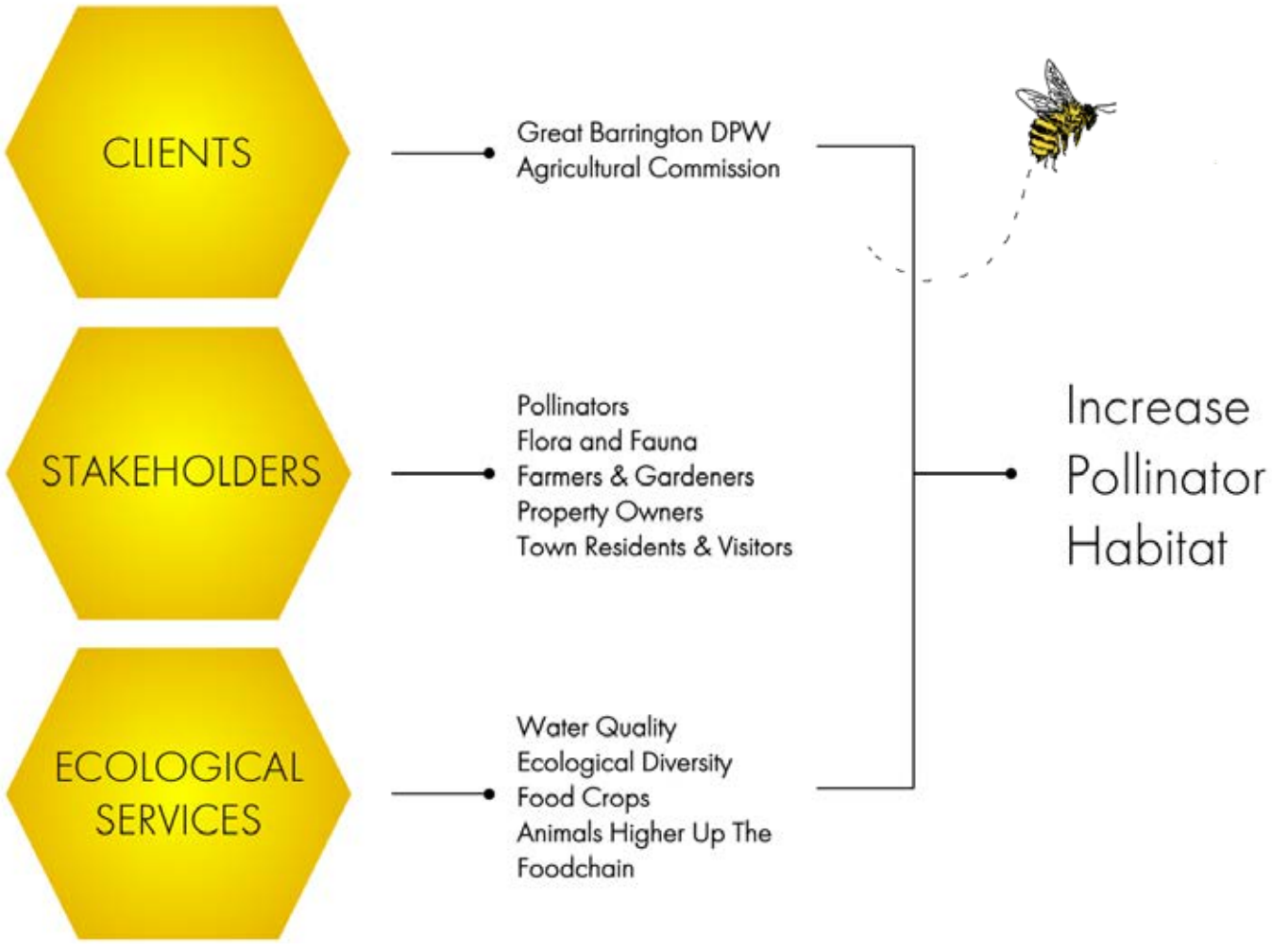
Through alliances with area residents and property owners, farmers, gardeners, local businesses, schools, and community organizations, the Town of Great Barrington

hopes to establish a network of pollinator habitat corridors that span across the town and reverberate farther, into other communities in the region. One major concern is translating pollinator habitat to landscapes with different uses, which this plan endeavors to address through a **Toolkit** section which includes informative literature, "how-to" guides, and planting diagrams for a wide range of site conditions and parcel sizes.

By following the recommendations in this report, Town agencies in charge of public land and roadside maintenance, conservation authorities, farmers, private landowners, businesses, and schools—in Great Barrington as well as in other municipalities—will have the tools they need to:

- Establish and maintain successful pollinator habitat
- Protect existing pollinator habitat
- Improve water quality
- Promote ecological diversity
- Support local food security
- Benefit wildlife animals higher up the food chain

In the following chapters, this plan will discuss the challenges and opportunities for pollinators in Great Barrington, analyze the environmental conditions and geographic distribution of potential habitat sites, zoom in on a few of these sites in detail, and present case studies and key findings for building a robust, successful local movement for pollinator habitat connectivity.

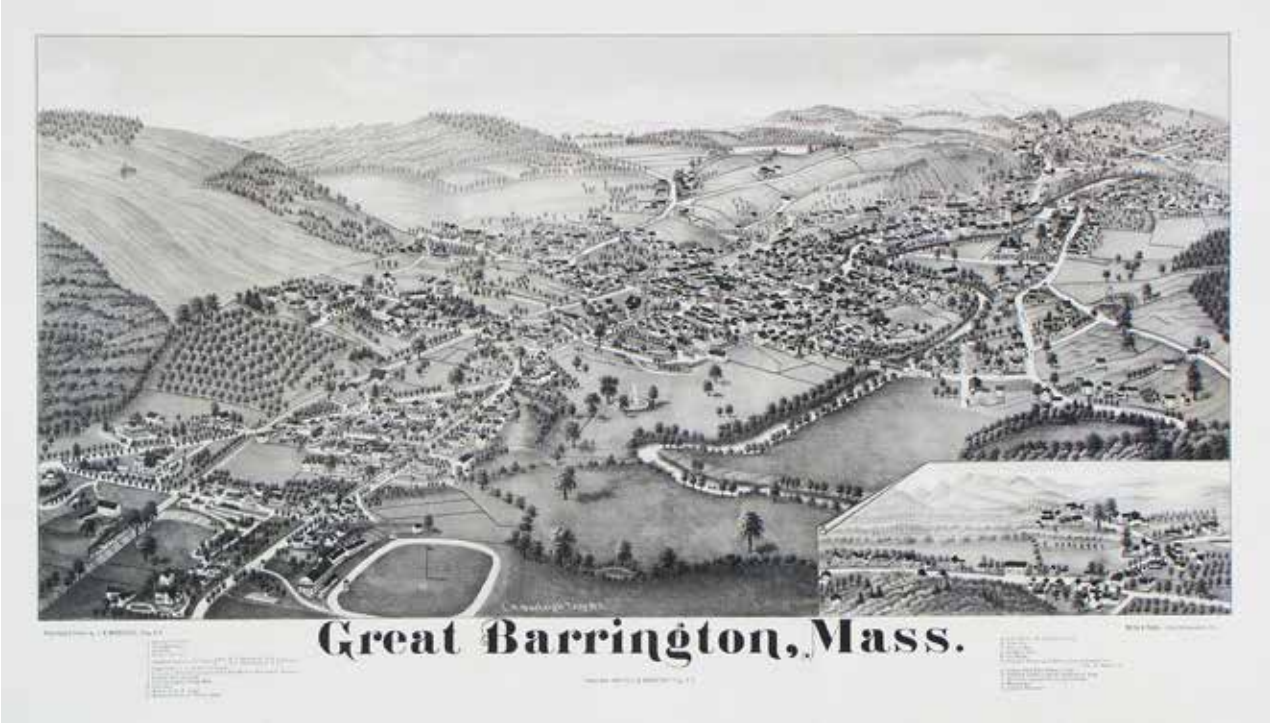


History & Context

Then

Great Barrington sits on the old Native American trail that connected Albany to Boston. It was known as mahaiwe, or "the place downstream," by the Mahican tribe. Throughout its history, most of Great Barrington's development has paralleled the Housatonic River. The nutrient-rich lands along the river's banks attracted the Mahicans, and, eventually, European settlers. In the 1800s, human land use extended outward from the river in the form of agriculture and people began to harness the energy of the river to power grist and saw mills. During the Industrial Revolution, the Housatonic became a "working" river spoiled by dioxins, raw sewage, PCBs, and everyday household waste. Great Barrington is the birthplace of African-American civil rights activist W.E.B. DuBois, who stated in 1960, "...the town had made a sewer of the beautiful Housatonic River, instead of the park it might have been" (Cupo et al, 7).

With the arrival of the railroad in the late 19th century, Great Barrington became a Gilded Age resort community for those seeking relief from the heat and pollution of nearby cities. Wealthy families built grand homes called Berkshire Cottages here, as others would in nearby Lenox and Stockbridge (Wikipedia, Great Barrington).



Now

Today, Great Barrington is a regional destination, with world-class arts and cultural programming, including the annual Berkshire International Film Festival. A formerly manufacturing-based economy is now service-oriented, with a vibrant urban downtown. It's a big "small town": at just under 46 square miles, the town has a population of 7,100 people, 86 percent of whom are full-time residents (Master Plan 2013). In 2012, Smithsonian magazine named Great Barrington one of the twenty best small towns in America.

Restaurants, performance venues, trails, and outdoor recreational activities attract visitors throughout the year. The Appalachian Trail passes through the southeast corner of Great Barrington, and there are numerous lakes and ponds which are open to the public.

A history of community support and regional self-reliance exists in Great Barrington. This is perhaps most evident in the BerkShare, a local currency that gained momentum in the 1990s and formally entered circulation in 2006 in order to encourage money to remain within the local economy.

In 2016, the Main Street Reconstruction Project improved sidewalks, sewers, and utilities, and removed nearly all the mature trees that lined Main Street. These were replaced with young trees of varying sizes and growth habits, and several of the sidewalk strips these new trees are planted in have been "adopted" by local businesses with the intention of planting them each spring. Nearly two years later, many of these sidewalk strips still remain unplanted beneath the young trees.

Given the historical significance of Great Barrington, and the widespread impact its social movements and cultural programming has had across the region, the establishment of a pollinator corridor through the Town will likely have a profound impact on the wider community. Hopefully, Great Barrington's example will serve as a model to be replicated by other municipalities.

Mason bee, Osmia calla *(top) and hairy skullcap,* Scutellaria elliptica *(bottom). Photographs courtesy Anders Croft and Helen Lowe Metzman.*

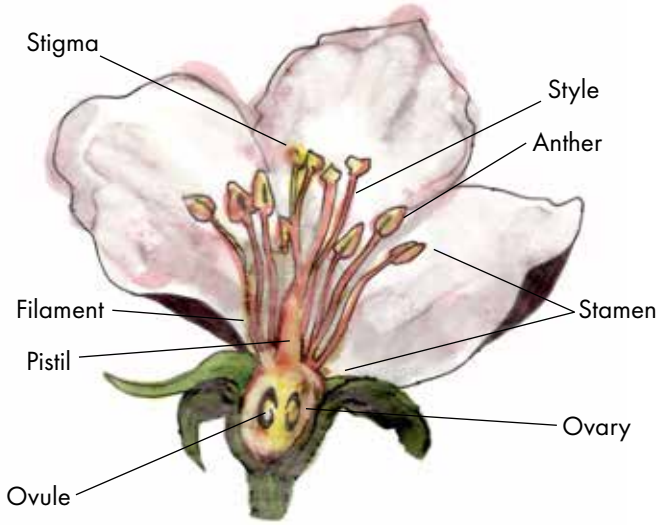
Why Pollinators?

Pollinators are animals that fertilize plants, resulting in the production of seeds and fruit. In the northeast United States, pollinators include bees, butterflies, moths, beetles, flies, ants, and birds. These small creatures are vital to the ecosystems that humans rely upon for sustenance. In Massachusetts, bees alone pollinate 45% of the food crops grown (Massachusetts Pollinator Plan).

Bees are widely considered the most important group of pollinators: with the exception of a few species of wasps, only bees deliberately gather pollen to bring back to their nests for their offspring. Bees also exhibit flower constancy, meaning that they repeatedly visit one particular plant species on any given foraging trip. This is significant because pollen is wasted if it is delivered to the wrong species of flower. On a single foraging trip, a female bee may visit hundreds of flowers, transferring pollen the entire way. By contrast, butterflies, moths, flies, wasps, and beetles visit flowers to feed on nectar (or to feed on the flower itself, in the case of some beetles) and not to collect pollen. They therefore come in contact less frequently with the flower's anthers than bees do (Mader et al., 22).

What is Pollination?

Pollination is the act of transferring pollen grains from the male anther of a flower to the female stigma. Successful pollination allows plants to produce seeds. Flowers are the tools that plants use to make their seeds. The basic parts of the flower are shown in the diagram



Native Bees

Of the 4,000 native bee species in the United States, Massachusetts is home to 386. Even in today's vastly altered landscape, native bees still do the majority of pollination (Moisset and Buchmann, 1). Native bees are two to three times better pollinators than honeybees, according to Cornell University entomology professor Bryan Danforth. "Honeybees are more interested in the nectar. They don't really want the pollen if they can avoid it... wild, native bees are mostly pollen collectors. They are collecting the pollen to take back to their nests" (Gashler).

In a study of 41 different crop systems worldwide, honeybees only increased yield in 14 percent of the crops. Who did all the pollination? Native bees and other insects. For watermelons, native bees do 90 percent of the pollination. For blueberries, native bee pollination creates twice as much fruit as honey bees (Pearson). For example, the southeastern blueberry bee, *Habropoda laboriosa*, is capable of visiting as many as 50,000 blueberry flowers in her short life, and pollinating enough of them to produce more than 6,000 blueberries. At market those 6,000 blueberries are worth approximately $60.

Each flowering plant species usually has a small guild of bees or other pollinators which coevolved with them to ensure their pollination. Squash bees (*Peponapis and Xenoglossa*), for example, pollinate flowers of squash, pumpkins, melons, and other cucurbits. The world as we know it would not exist if there were no bees to pollinate the earth's 250,000 flowering plants—in fact, if not for bees, all flowers would be green.

Managed Bees vs. Wild Bees

The Varroa mite *(Varroa destructor)* is the number one enemy of beekeepers. This parasite is present in all honey bee colonies throughout the U.S. and in most of the world. Fortunately for native bees, the Varroa mite does not affect them; there are, however, numerous other invasive pathogens and pests which are spreading to native bee populations. Many diseases which affect native bumble bees, for example, came with the import of commercial hives of the non-native Buff-tailed bumble bee, *Bombus terrestris*.

What are a Bee's Needs?

Bees require more than pollen and nectar: like birds, they need to collect nest-building materials and find suitable habitats in which to forage and live.

Habitat connectivity is key: most native bees range between 200 and 500 feet. Adjoining riparian forest and meadow communities provides extensive forage and nesting opportunities for native pollinators such as ground nesting mining bees (*genus Andrena*), wood nesting Mason bees (*Osmia spp.*), and monarch butterflies.

If you meet the forage, shelter, and overwintering needs of a diverse community of native bees, you will create habitat for other pollinators as well (Mader et al., xi).

Bees can be categorized in several ways: whether they are solitary or social, whether they nest in the ground or in a cavity, whether they build and provision their own nests or parasitize the nests of others (cuckoo bees), and by their foraging habits. While the majority of bees are generalists, meaning they gather nectar and pollen from a wide range of flower types and species, a good proportion of them are specialists, and visit a single plant family or genus for all their pollen needs. Of the roughly 4,000 native bee species in the United States, over 90 percent lead solitary rather than social lives, meaning each female constructs and provisions her own nest without any help (Mader et al.).

Different bees have different habitat needs. Let's look at some examples.

Wood-Nesting Bees

Nearly 30 percent of Massachusetts solitary bee species are wood nesters that build their nests inside hollow tunnels. These tunnels may occur in the soft pithy centers of some twigs (e.g. box elder, elderberry, or various cane berries); they may be left behind by wood-boring beetle larvae or, in the case of carpenter bees, may be excavated by the bees themselves. Another small but important set of bee species – at least one of which has been documented as an important pollinator of watermelon – tunnel into soft, above-ground rotting logs and stumps. Leave standing dead wood whenever possible.

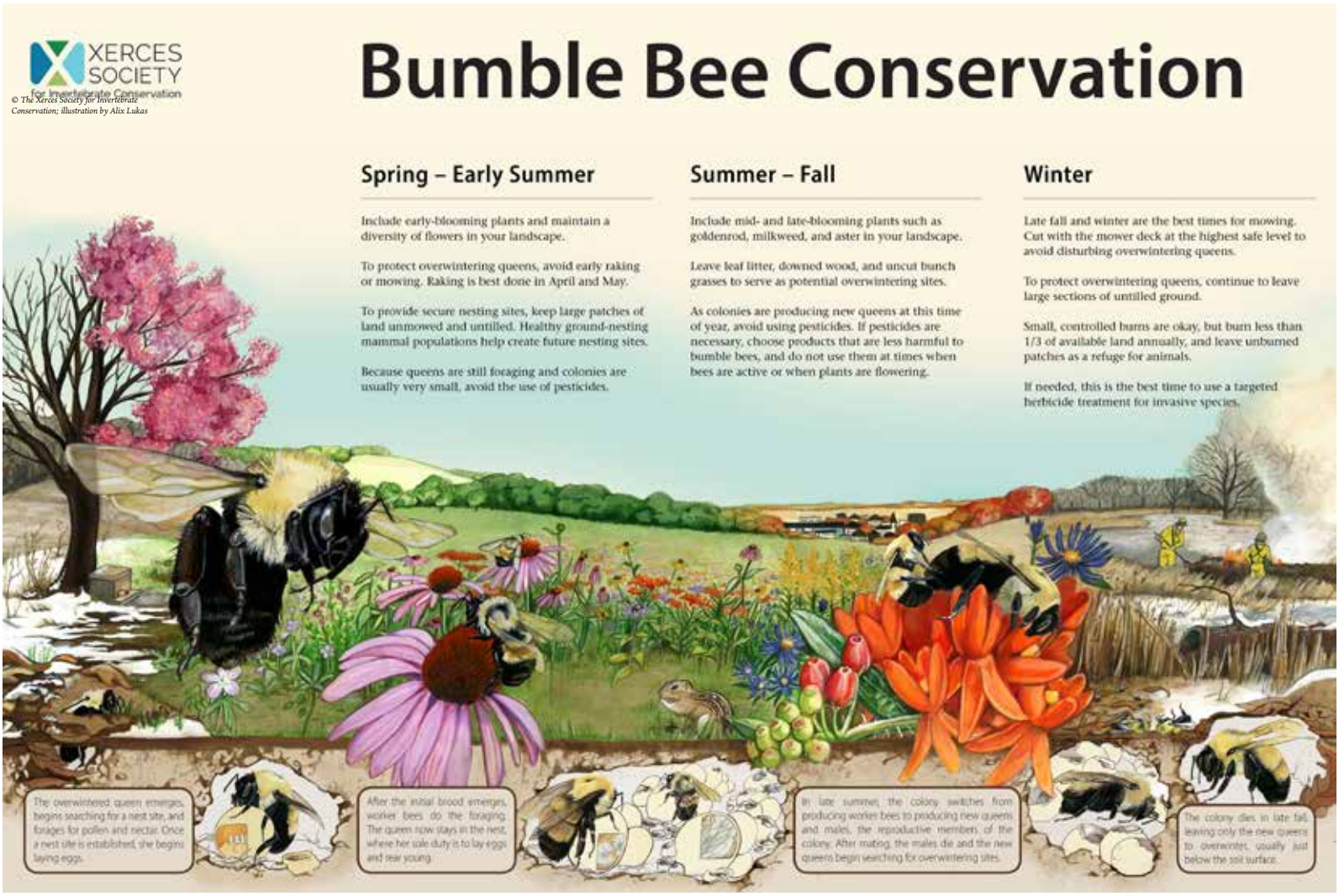
Ground-Nesting Bees

Nearly 70 percent of Massachusetts solitary bee species excavate their nests underground. These ground nesting native bees all burrow narrow tunnels down to small chambers (the brood cells) six to 36-plus inches under the surface. Inside these brood cells, next year's bees develop. In order to build these nests, bees need direct access to the soil surface, often on sloped or well-drained sites.

Social Bumble Bees

There are 18 bumble bee species (*genus Bombus*) native to Massachusetts; 15 are thought to be present, and the other three species extirpated. The only wild social bees, bumble bees are considered the most effective crop pollinators. They are generalists, and are often the first bees active in spring and the last bees active in the fall. Early-blooming plants such as willows and spring ephemerals, and late-blooming plants like goldenrod are important to their survival. Their ability to regulate their body temperature by shivering or basking in the sun makes them important pollinators of spring-blooming wildflowers and fruit crops. Another feature that makes bumble bees important pollinators is their ability to buzz-pollinate (also called sonicate) flowers by disengaging their wings from their flight muscles, and using those muscles to shake their entire body at a frequency close to the middle C musical note! This vibration significantly increases the release of pollen from some flowers, including tomatoes, peppers, blueberries, and cranberries (Mader et al., 45).

They construct nests in small cavities, often in old rodent burrows, either underground or beneath fallen plant matter, or occasionally above ground in abandoned hay bales or birds' nests. These adaptable bees will also nest in the walls of buildings, in used birdhouses, old rock walls, and even inside discarded mattresses and junked car seats (Mader et al., 41). Queen bumble bees start new nests each spring, and by mid-summer their colonies can have dozens or hundreds of workers, all visiting nearby flowers. Creating bumble bee nest sites can support crops that flower during summer months.



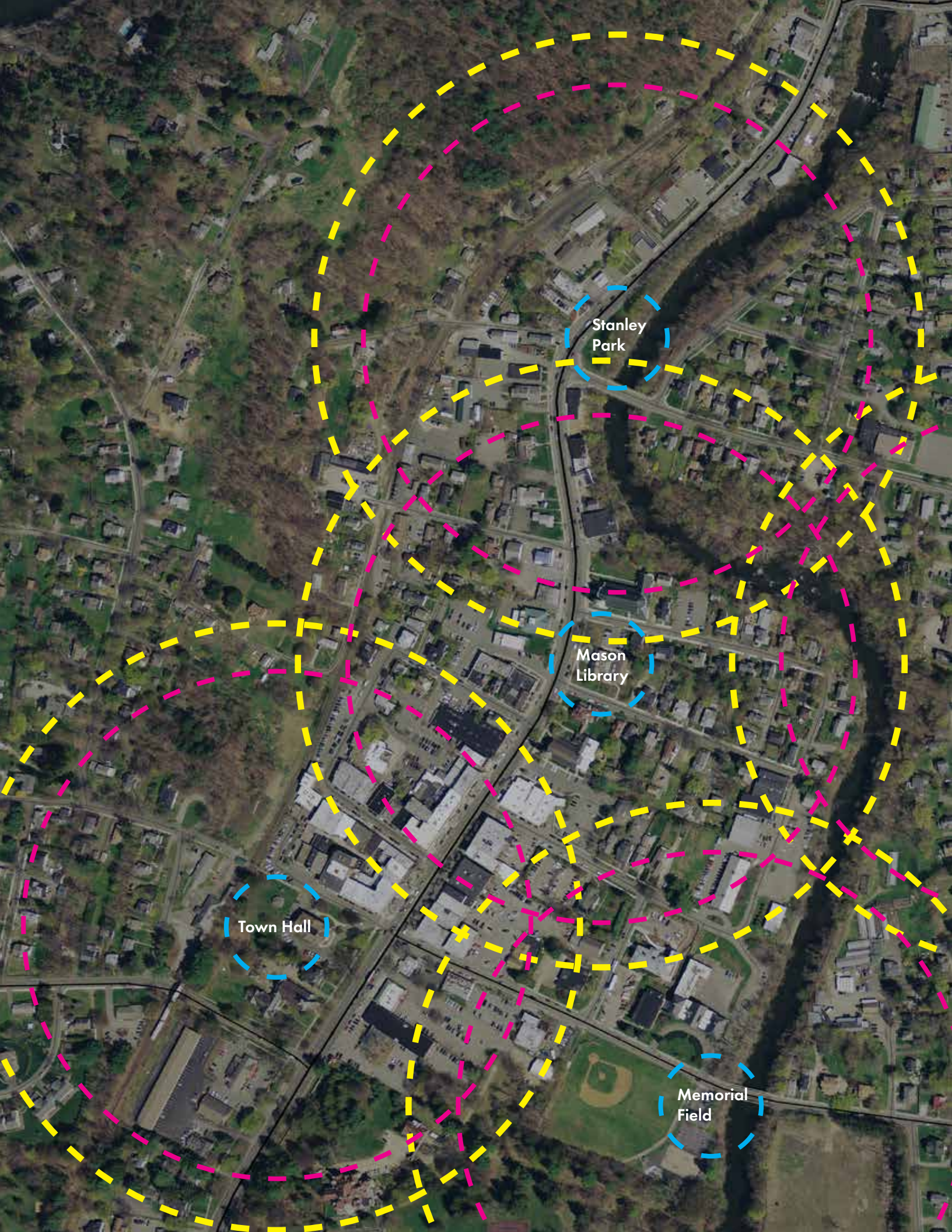
What About Honey Bees?

The main advantage of honey bees (*Apis mellifera* being the most common species) as crop pollinators is that they can be supplied in large numbers and are readily transportable. But how do they compare at the actual job of pollination?

Before European settlers arrived, there were no honey bees in North America. The honey bee still does not know how to pollinate tomato or eggplant, and native bees are vastly more effective at pollinating other native plants such as pumpkins, cherries, blueberries, and cranberries. Most native bee species forage for longer periods of time — earlier or later in the day — than honey bees. Native bees will also visit flowers in wet or cold conditions, when honey bees remain in the hive.

In a study in Utah, when blue orchard bees (*Osmia lignaria*) were used to pollinate cherry orchards, average fruit production was more than double that of when honey bees were used. Why were the blue orchard bees more efficient? They have a shorter foraging range, meaning they rarely left the orchard; they make contact with anther and stigma on almost every visit; and they are active at light levels and temperatures too low for honey bees. Over five days, the blue orchard bees spent 33 hours foraging, compared to 15 hours by honey bees (Mader et al., 22).

The recommendations outlined in this report — to increase pollinator habitat, improve flower sources, and protect pollinators from pesticides — also support habitat for colonies of honey bees.


Stanley
Park
Mason
Library
Town Hall
Memorial
Field

How Far Bees Travel

How far a bee can fly depends on its size. A large bee can forage farther than a small one.

Size	Example	Average Distance	Max. Distance
Small	Sweat bee	300 ft.	600-900 ft.
Medium	Mason bee	1500 ft.	0.5 miles
Medium	Honey bee	4 miles	Up to 7 miles
Large	Bumble bee	900-1800 ft.	0.5-1.7 miles

When foraging for food, most bees search for two things: nectar for energy, and pollen to feed their brood. Some bees also collect special oils from flowers to use as both an adult and larval food source.

The range of flowers from which bees can gather nectar depends upon the length of the bees' tongues. Short-tongued bees can drink only from open flowers such as asters and daisies; long-tongued bees can reach nectar offered by deep or complex flowers such as lobelia and lupines.

Some bees will also forage for nest-building materials. For example, Mason bees search for areas of damp clay soil from which they gather balls of mud to bring back to their tunnel nests. Leafcutter bees search for leaves (and sometimes flower petals) from which to cut pieces to wallpaper their brood cells.

Bumble bee

Mason bee

Sweat bee

360 ft.

The endangered Karner Blue butterfly (Lycaeides melissa samuelis) *was previously found in Massachusetts, but is now extirpated. Photographs courtesy USGS Bee Inventory and Monitoring Lab.*

Butterflies and moths belong to the same insect order, Lepidoptera. *In general, butterflies are brightly colored and fly by day, and moths are colored in muted grays and browns and fly by night. There are numerous exceptions, however: Skipper butterflies (of which Great Barrington's threatened Dion Skipper* [Euphyes dion]*, is one example) are small, brown, and mothlike; moths such as the foresters, ctenuchas, and tigers are day-flying and colorful.*

Both butterflies and moths begin life as eggs laid on or near the species' particular host plant. Each hatches as a tiny, soft-bodied caterpillar, eating and growing until it transforms into a pupa or chrysalis, the mummy-like quiescent stage between larva and adult. Many moths also spin a cocoon from their silk glands to surround the chrysalis to provide an additional layer of protection.

Butterflies

Although butterflies are not the most important pollinators of plants, they are among the most conspicuous. Pollinator gardening began as an attempt to lure them into yards, to delight young and old people alike.

Like most wasps and flies, butterflies consume nectar only as adults, to fuel their own flight. They do not actively gather pollen, nor do they provision nests for their young. Instead, most butterflies lay their eggs on just a few closely related types of plants. After hatching, the caterpillars eat only the leaves or flowers of those plants. Butterflies lack the branched pollen-trapping hairs found on bees. Nonetheless, through the occasional accidental dusting of pollen, they do contribute to plant reproduction.

Like most insects, butterflies need warm temperatures and sunshine in order to fly. They are consequently often found flying in open areas or those with good southern exposure. They also prefer areas sheltered from prevailing winds, as they are weaker flyers than many other insects. Monarch butterflies, however, may fly long distances by soaring on wind currents; other butterflies, like skippers, are not strong flyers.

Monarchs (*Danaus plexippus*) are members of the Milkweed Butterfly subfamily (*Danainae*), which includes numerous other species. *Danainae* use milkweeds as their sole host plants, meaning that milkweed is the only plant that monarch caterpillars feed on.

Monarchs are the only butterflies in the world that regularly migrate thousands of miles to overwinter (from the northeast United States and southern Canada to central Mexico and the California coast). Poisons derived from their milkweed hosts make monarchs unpalatable for birds, a condition which is advertised by their bright orange and black design (Mader et al., 56-61).

Moths

There are more than 10,000 moth species in North America, compared to about 800 butterfly species (Mader et al., 22). Many moths are very important specialist pollinators for the plants they assist in reproduction, and/or vital food for other wildlife such as songbirds.

As caterpillars, moths feed on a slightly wider range of food sources than butterflies do. Less than 1 percent of moth species eat fabric made from natural fibers such as wool or silk. Since most bees, wasps, flies, and butterflies are inactive at night, moths are the most important group of pollinators for night-blooming plants.

Like butterflies, moths do not actively gather pollen, but while they are foraging for nectar, pollen grains become stuck to a moth's body or tongue and are accidentally spread among flowers. For some specialized plants, moth pollination is essential.

Protecting Butterflies and Moths

Butterflies are threatened by habitat loss and fragmentation due to urbanization and the intensification of agriculture, the widespread use of pesticides, and the introduction of invasive species that out compete native host plants. NatureServe, the nonprofit network of natural heritage programs, estimates that 17% of U.S. butterflies are vulnerable, imperiled, or critically imperiled (Mader et al., 58). The Monarch butterfly faced an 81% population decline in North America between 1993 and 2014 (Thogmartin et al.). In Great Barrington, there are three species of butterflies and moths which are of Conservation Concern in Massachusetts: the Ostrich Fern Borer Moth (*Papaipema sp. Pterisii)*, the Gold-spotted Ghost Moth (*Sthenopis auratus*), and the Dion Skipper *(Euphyes dion)* (NHESP 2011a).

4,500,000 Honey Bee Colonies (1980)

3,250,000 Honey Bee Colonies (1990)

Pollinators in Peril

Colony Collapse Disorder doesn't just affect honey bees. Pollinators worldwide are in decline due to:

Pesticides

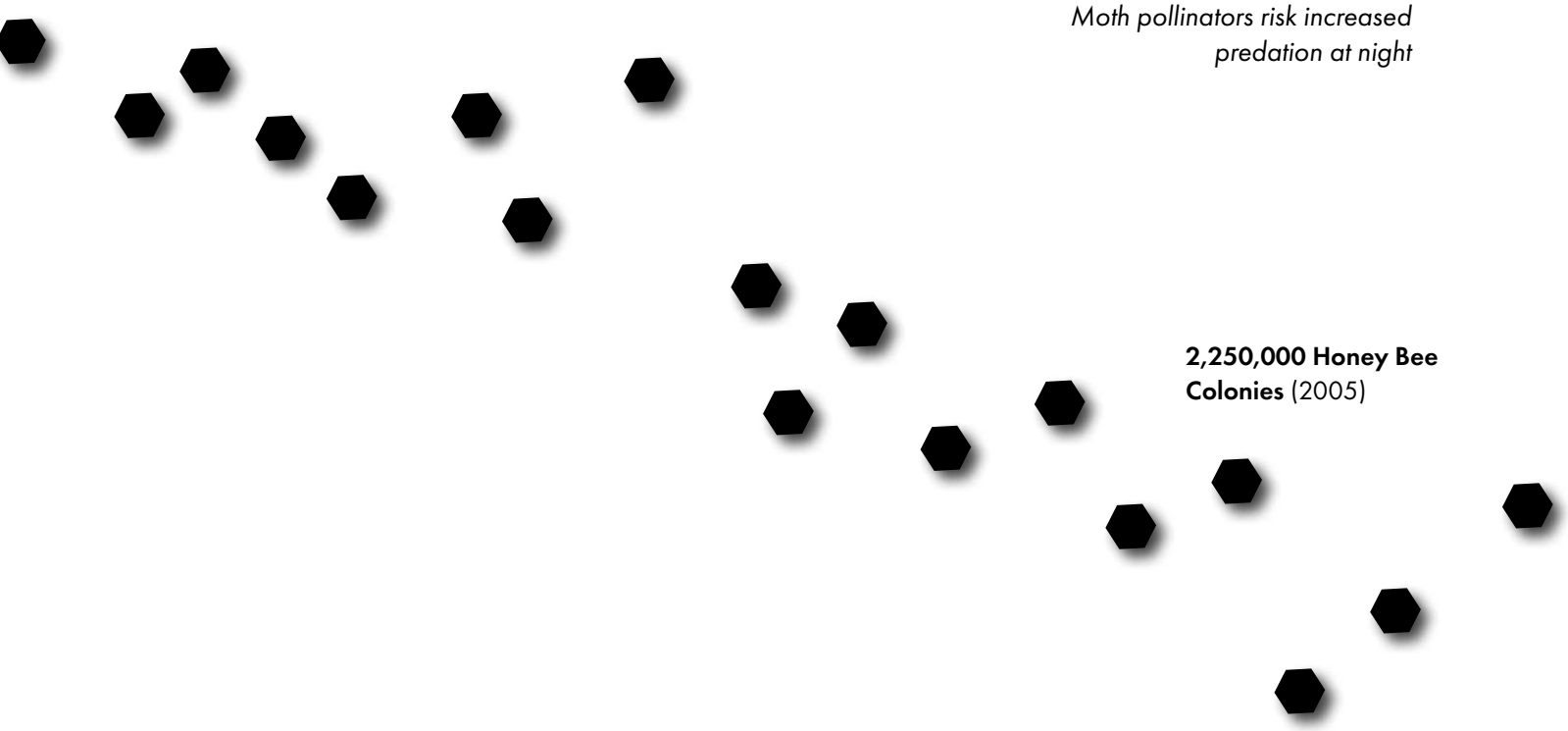
Habitat Loss, Degradation, and Fragmentation
23% of native plant species in decline due to their specialist pollinators declining

Climate Change
Disrupts synchronization between bloom time and bee emergence; flowering plants migrating north or to higher elevation may not move in sync with their pollinators

Air Pollution
Bees and other pollinators rely on scent trails to find flowers; river valleys tend to have high levels of air pollution during warmer months

Introduced Parasitoids and Pathogens

Light Pollution
Moth pollinators risk increased predation at night



2,250,000 Honey Bee Colonies (2005)

Honey bee statistics for continental United States (USDA).

Pollinator Decline

Pollinator decline is an area of controversy and concern, with a growing consensus that a combination of multiple stressors, rather than a single cause, has lead to population declines.

Pesticides, particularly neonicotinoids, are one of the most controversial contributors to decline. The concern with pesticides and herbicides is twofold: 1) the direct health implications of pesticides on pollinators and 2) the use of herbicides in cropping systems, which reduces plant diversity and the variety of flowering plants in the area. Neonicotinoid insecticides travel systematically throughout plants, including to pollen and nectar, increasing the likelihood of pollinator contact. Neonicotinoids are used widely on farms, as well as around our homes, schools, and landscapes. Extremely concerning is the prolific inclusion of them in home garden products. Nurseries often treat their plants with neonicotinoids. Nearly 100 percent of all conventional corn and 60 percent of all soybeans planted in the U.S. are currently coated with neonicotinoids (Xerces). When seeds are treated with neonicotinoids, the chemicals work their way into the pollen and nectar of the plants. **Neonicotinoids are about 6,000 times more toxic to bees than DDT** (Environment Massachusetts).

Loss of suitable habitats also contributes to the decline of pollinator populations. Urbanization and land conversion remove and fragment habitat. A combination of different kinds of habitats is needed for food, nesting and mating areas, and migration. Human development has also led to the disruption of some migratory pathways.

Transportation of bees and an increase of commercial bee colony trade have contributed to the spread of parasites and diseases outside of the normal range. The spread of parasites and pathogens is problematic because the new host species often lacks resistance, increasing the likelihood of death.

The impact of current and future climate change on pollinators is not yet well understood. Historically, changes in climate have caused the native ranges of plants and animals to shift to where conditions are more favorable. Many plants and pollinators have evolved a mutualistic dependency, so with potential range shifts there is concern that plant and pollinators will shift in different directions, or at different rates. Range shifts due to climate change have already been observed with some butterflies. Another concern is the alteration of bloom time and pollinator emergence. Climate change has the potential to lead to earlier, warmer temperatures in the spring, which could disrupt the synchronization of flower development and pollinator emergence, and also cause flower and bud damage due to the increased frequency of late frost events.

Pesticide Regulation

As of the printing of this report, the State of Massachusetts is considering legislation to protect pollinators from certain classes of pesticides, including neonicotinoids. Bill H. 4041 "An Act To Protect Massachusetts Pollinators":

- Requires that neonicotinoids be applied only by licensed or certified applicators
- Limits application during the blooming season to agricultural and horticultural uses only
- Requires applicators to give adjacent property owners notice of risks associated with neonicotinoids to pollinators, and offer applicators alternative products to use
- Requires that seeds, plants, or other materials treated with neonicotinoids be labeled at point of sale
- States that neonicotinoid training will be integrated into the existing pesticide applicator licensing process
- Establishes a special commission to investigate pollinator health, including farmers, beekeepers, environmental advocates, and scientists

Neonicotinoid Movement in the Environment

Neonicotinoids are being found throughout the landscape in areas where they were not applied. This figure illustrates some of the main pathways for neonicotinoid movement in the environment and also shows how this movement could expose beneficial insects.

XERCES SOCIETY for Invertebrate Conservation

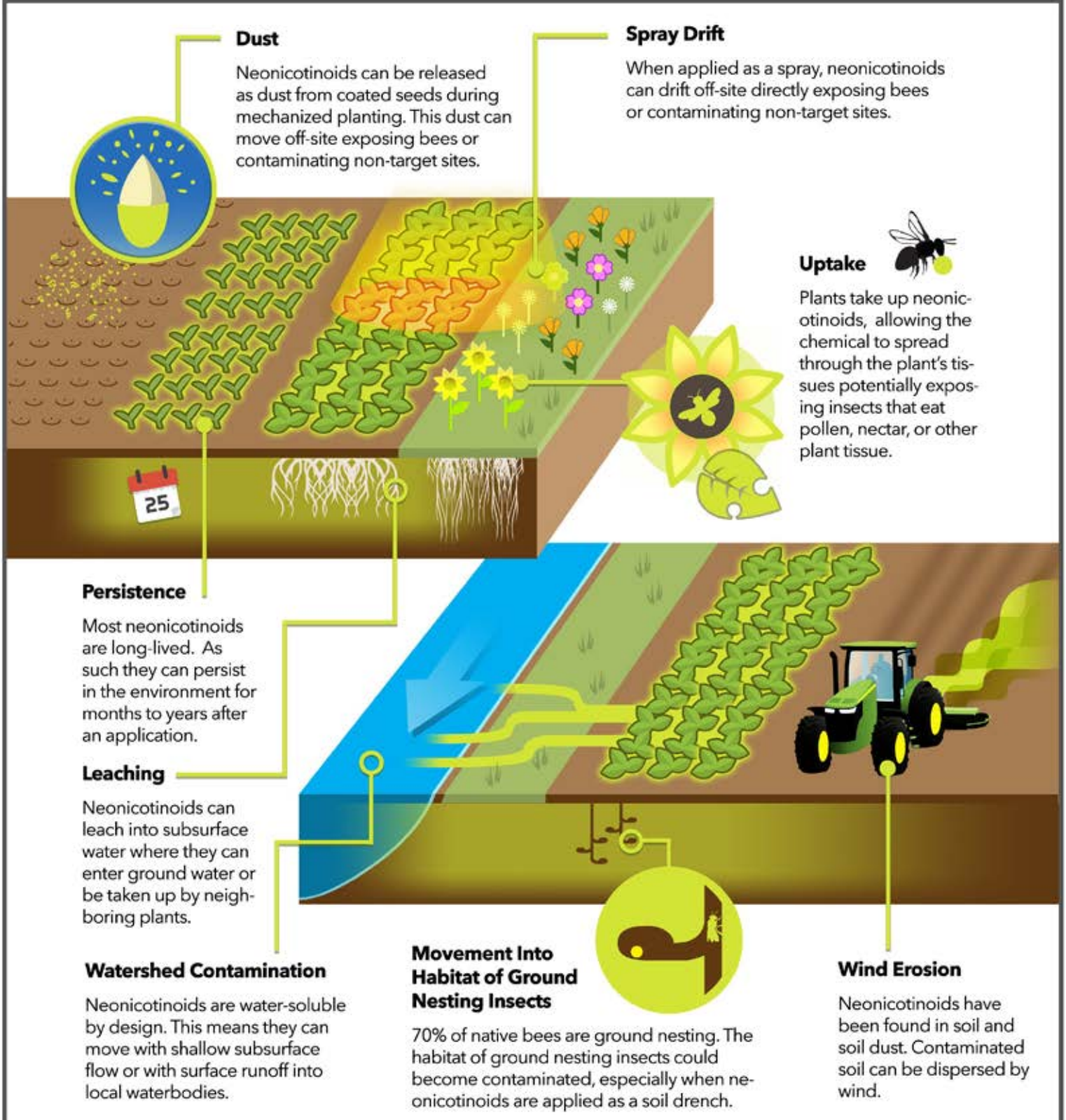


Illustration by the Xerces Society / Justin Wheeler from the report *How Neonicotinoids Can Kill Bees*

xerces.org/pesticides

Other Significant Pollinators

Monarch Butterfly

Spread pollen farther than bees.

Adult monarchs are generalists; their caterpillars feed only on milkweed.

81% population decline globally.

Ruby-Throated Hummingbird

As adept a pollinator as honey bees.

Uses trees, shrubs, and vines for shelter; red, tubular flowers for forage.

Not threatened.

Dion Skipper Butterfly

Spread pollen farther than bees.

Occupy sedge wetlands, riparian marshes, wet meadows, and shrub swamps.

NHESP Threatened Species in MA. **Great Barrington is 1 of 11 towns in MA that host it.**

Ostrich Fern Borer Moth

Pollinate night-blooming plants.

Occupy mature floodplain forest and wooded swamps.

NHESP Species of Special Concern in MA. **Great Barrington is 1 of 6 towns in MA that host it.**

Ruby-Throated Hummingbird

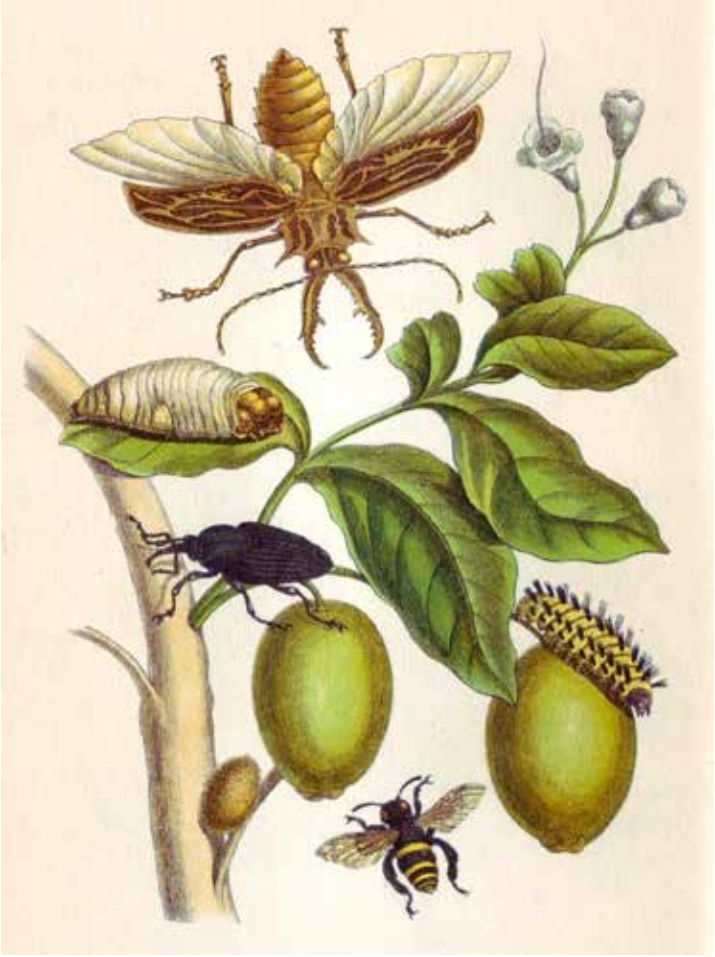
Archilochus colubris

In the eastern United States, there is only one kind of hummingbird, the Ruby-throated hummingbird. Its efficiency as a pollinator is comparable to that of a honey bee.

Ruby-throats play an important role in the food web, pollinating a variety of flowering plants. Scientists believe that as many as 19 species of plants found in the eastern United States have co-evolved with ruby-throats, noting the relationships between the tubular shape of certain flowers and the length and shape of a hummingbird's bill. The ruby-throat laps up nectar by flicking its long, forked tongue deep within a flower at rates up to ten times per second. It forages while hovering airborne, inadvertently collecting pollen on its feathers and bill before darting off to its next meal.

Ruby-throats are birds of the forest edge; the female typically builds her nest near an open area on a downward-angled branch, sometimes overhanging water. They are far more common in hardwood than in coniferous forests, and are found from sea level to at least 6,000 feet in elevation. Nests have been reported in deciduous and evergreen trees at heights from eye level to 60 feet above ground. Fortunately, the ruby-throated hummingbird is abundant throughout its range and it has a total estimated population of over 7 million individuals (Mader et al, 22).

Pollinating wasps have very similar life cycles to bees and share similar habitat needs; conservation measures for bees will assist them, too. Flies and beetles are significant pollinators as well, but while scientists know about their role in pollination, there are no well-established conservation techniques for them (Mader et al., xi).



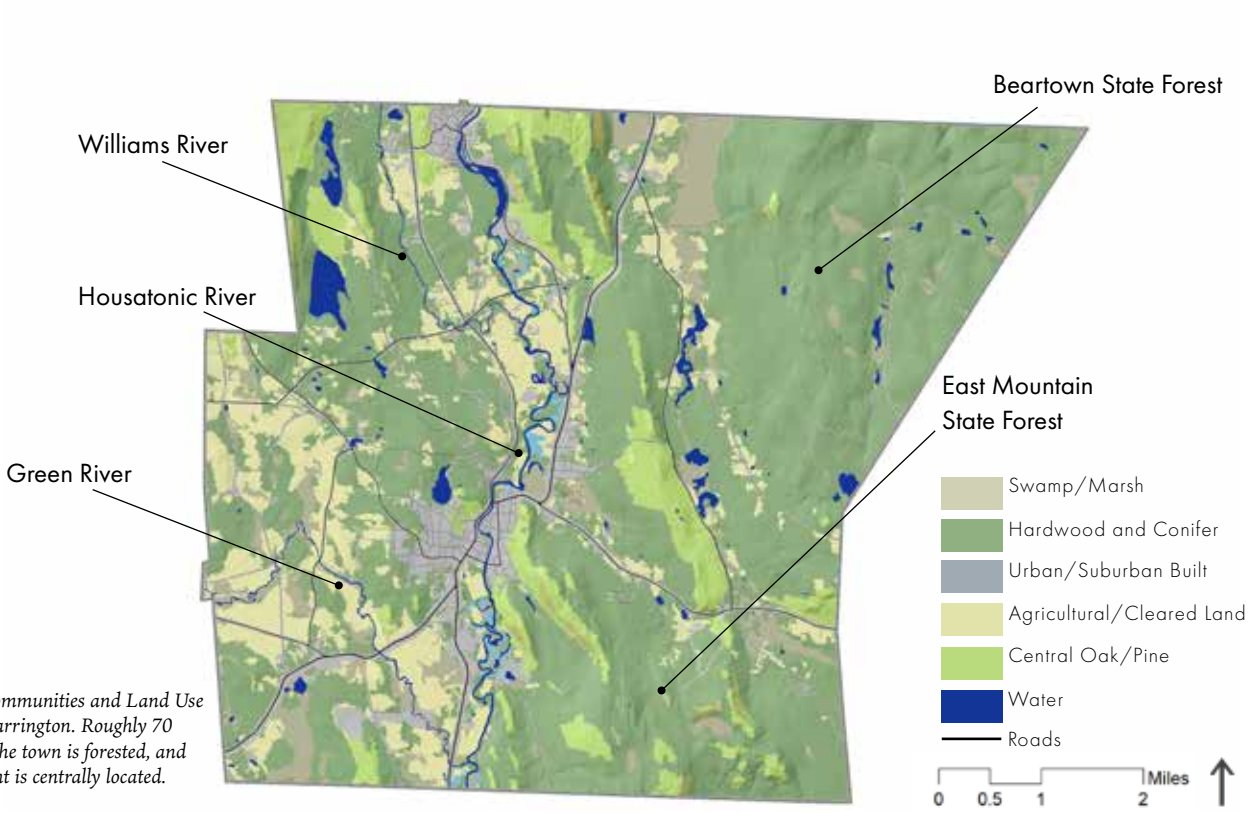
Painting by Maria Sibylla Merian (1647-1717)

What About Wasps, Flies, and Beetles?

Beetles represent the greatest diversity of pollinators, with nearly 30,000 species in North America alone. Fossil records suggest that beetles and flies were probably the first insect pollinators during the late Jurassic era around 150 million years ago. Bees, by comparison, appeared in the fossil record about 100 million years ago. Beetles remain important pollinators for flowers that still display ancient characteristics, such as magnolias and water lilies (Mader et al).

Flies are another large group of lesser acknowledged pollinators. Pollination by flies is second to bee pollination in increasing flower diversity throughout evolution. Flies are generally attracted to foul-smelling pale, dull purple to brown flowers. Some common flowers that use foul smells to attract flies and insects for pollination include Jack-in-the-pulpit *(Arisaema triphyllum)*, Paw-paw *(Asimina)*, and Red trillium *(Trillium erectum)*.

Environmental Conditions



Natural Communities and Land Use in Great Barrington. Roughly 70 percent of the town is forested, and development is centrally located.

Natural Communities

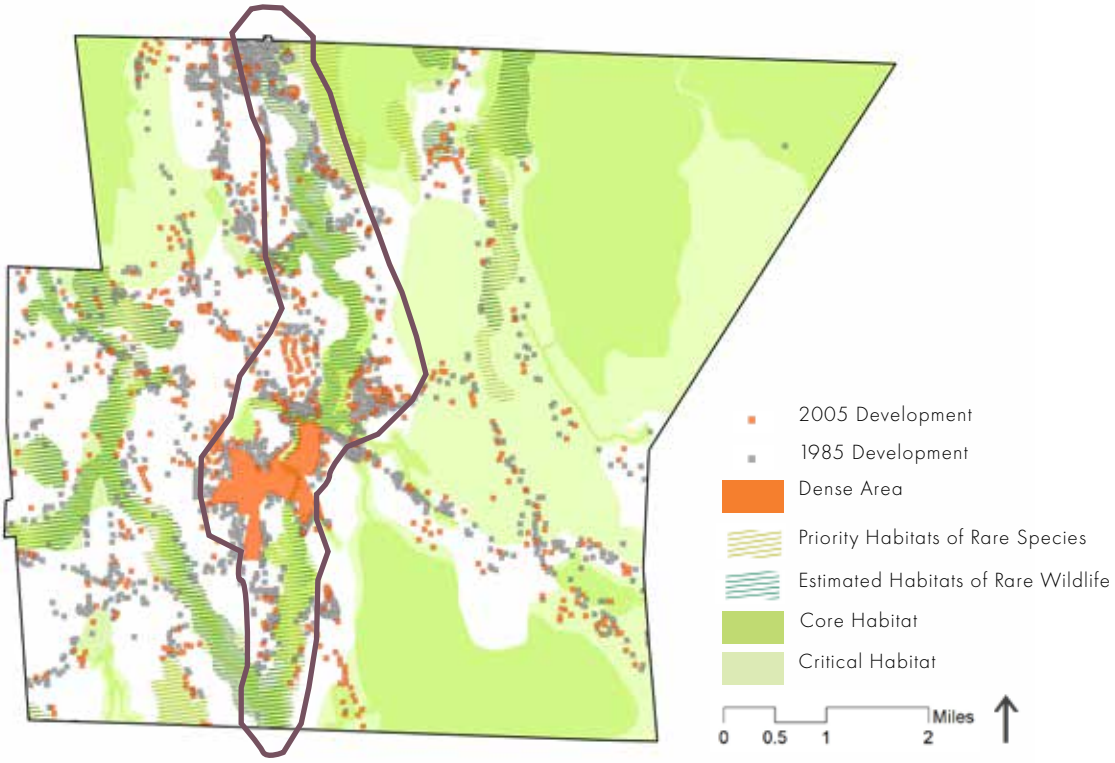
Analyzing the geographic features, ecological conditions, and economic and cultural practices that prevail in Great Barrington, along with current and projected effects of climate change, reveals the threats faced by pollinators and opportunities to support them.

Great Barrington is located in south-central Berkshire County, in the heart of Massachusetts' Housatonic River valley. The river enters town from the north, between Ball and Monument Mountains, winding south through farmland, the village of Housatonic and the downtown center of Great Barrington in the lowlands. The river carves a sinuous path, with flooding and ebbing over time having formed looping oxbows along its floodplain. Smaller tributaries to the Housatonic pass through the valleys of western Great Barrington, among them, the Williams River and Green River, running north to south and west to south, respectively. Lakes and ponds are relatively abundant. The limestone-rich bedrock, a stark contrast to the typically acidic bedrock found throughout Massachusetts, creates alkaline lakes and streams, as well as calcareous fens (rare and distinctive wetlands characterized by a substrate of non-acidic peat). These conditions host an abundance of rare and endangered species present in Great Barrington (NHESP, 2011a).

The landscape of eastern Great Barrington is mountainous, heavily wooded, and predominantly under protection, with Beartown State Forest, East Mountain State Forest, and the Appalachian Trail Corridor all rising from the central river valley. Of the town's total area of 29,292 acres (45.8 square miles), nearly 70 percent is forested, with predominantly evergreen, transition, and northern hardwoods (NHESP, 2011a).

Natural habitat is most fragmented in the center of town, along the Housatonic River. Here lie most of Great Barrington's impervious surfaces and developed lands, covering 9 percent of the town's total area. Agricultural lands, 13 percent of the total area, also contribute significantly to fragmentation, and lie primarily along the lower reaches of the Green River, in the southwest portion of town. Interstate Route 7 parallels the Housatonic; other routes including 41 and 183 criss-cross the east and west portions of town.

Habitat & Development



Development Trends in Great Barrington have largely followed the river valleys—areas with the greatest biodiversity and ecological significance.

In the river valley lowlands of Great Barrington, soils are generally floodplain alluvium or sand and gravel. In the highland areas which dominate the rest of town, soils are predominantly glacial till or bedrock. The valley floor in Great Barrington holds not only fertile farmland, but also long stretches of floodplains along the Housatonic and its tributaries. These floodplains host a great diversity of wetlands, natural communities, and uncommon plants and animals, and are part of the Western New England Marble Valleys ecological region. This is one of the most distinct and biologically rich ecoregions in Massachusetts and all of New England (NHESP, 2012). The valleys support an impressively high percentage of MA state-listed species and natural communities, including the pollinators dion skipper butterfly and ostrich fern borer moth, and plants such as downy arrowwood (*Viburnum rafinesquianum*) and hairy wild rye (*Elymus villosus*). Much of this area is designated by MassWildlife's Natural Heritage & Endangered Species Program (NHESP) as Priority Habitat of Rare Species and Estimated Habitat of Rare Wildlife (NHESP, 2011). Protection of this habitat is critical to conservation of the river ecosystem, but as most of it is on privately owned land, stewardship by private landowners and farmers is critical to its continued survival (NHESP, 2011). The population of Great Barrington was 7,104 according to the census of 2010, nearly a ten percent decrease from 1990. According to the Town Master Plan, little or no population growth is projected over the next decade. While development trends up to the mid-1980s followed historical development along the Housatonic River and its tributaries, areas of significant biodiversity, including the habitats of many rare and threatened species, new development in the past three decades has occurred largely outside of those fragile ecosystems (see above). Although the Master Plan (2013) calls for all new development to be infill, the building patterns of the past three decades indicate continued penetration into undeveloped areas.

Protecting Biodiversity

MassWildlife's Natural Heritage & Endangered Species Program (NHESP) is responsible for protecting the state's wide range of native biological diversity. **NHESP Priority Habitat** is based on the known habitat for all state-listed rare species, both plants and animals, and is codified under the Massachusetts Endangered Species Act (MESA). **NHESP Estimated Habitats**, a sub-set of the Priority Habitats, are based on the habitat of state-listed rare wetlands wildlife and codified under the Wetlands Protection Act (WPA), which does not protect plants, and the Massachusetts Endangered Species Act.

The NHESP used 22 years of natural history data to create **BioMap2,** identifying lands that are crucial for preserving the state's extensive biodiversity. BioMap2 identifies core habitats and supporting natural landscapes to guide conservation in Massachusetts. BioMap2 also includes the habitats for species of conservation concern identified in the State of Massachusetts Wildlife Action Plan.

BioMap2 Core Habitat includes:

Habitats for rare, vulnerable, or uncommon mammal, bird, reptile, amphibian, fish, invertebrate, and plant species

Priority Natural Communities

High quality wetland, vernal pool, aquatic, and coastal habitats

Intact forest ecosystems

BioMap2 Critical Natural Landscape includes:

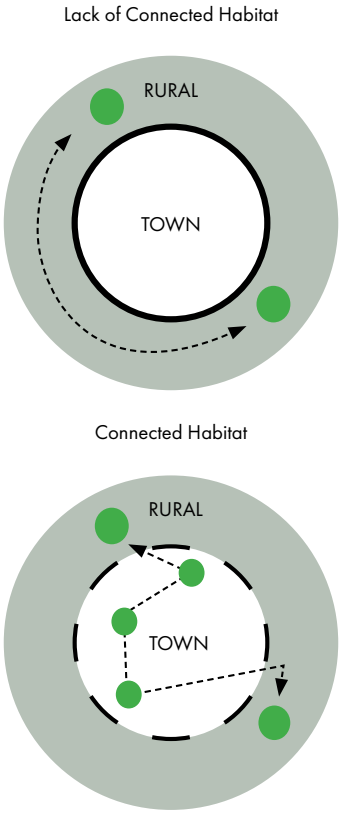
The largest Landscape Blocks in each of eight ecoregions in the state

Adjacent uplands that buffer wetland, aquatic, and coastal habitats

(NHESP, 2012)

While 36 percent of Great Barrington's total land area (10,511 acres) is open space protected in perpetuity, most conservation land lies high in the Berkshire Hills ecoregion, in the south and east portions of town. These highland areas are less diverse than the valleys, but their forests still support a distinctive suite of species and natural communities, including vernal pools that provide breeding habitat for state-listed amphibians like the Jefferson salamander (*Ambystoma jeffersonianum*). BioMap2 Core Habitat and Critical Natural Landscape blocks are present throughout both valley and highland ecoregions. Of the total land area in Great Barrington, 11,174 acres, or 38 percent, is BioMap2 Core Habitat, and over 56 percent of that land is protected; 17,057 acres, or 58 percent, is BioMap2 Critical Natural Landscape, and nearly 50 percent of that land is protected (NHESP, 2012).

Clearly, there are many benefits to living in a region of such ecological and biological diversity, for humans and wildlife. The fact that over 50 percent of Great Barrington's critical natural habitat is protected is a testament to the conservation ethics of the community. By establishing pollinator habitat in the urban center of town, plant and animal species can communicate across a fragmented center, strengthening ecological ties throughout.



Establishing pollinator habitat in the town center of Great Barrington creates opportunities for connectivity between fragmented natural communities found in rural outlying areas.

Roads

One of the biggest threats facing pollinators today is the destruction and fragmentation of habitat. Roads have historically followed the river valleys in Great Barrington, contributing to the disintegration of once intact ecosystems.

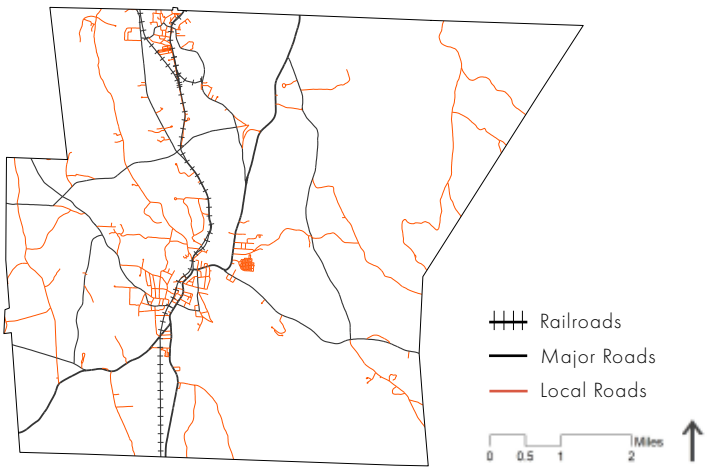
Running north-south from the Canadian border in northern Vermont nearly to the Long Island Sound in southern Connecticut, Route 7 connects Great Barrington to the greater part of western New England, making many regional cultural and economic connections possible today. The highway runs through the center of town, becoming Main Street. Its path parallels the Housatonic River, vehicles zipping past one of the most ecologically sensitive areas in the state.

Another rural highway, Route 41, also runs north-south through the downtown corridor, following the Williams River, a tributary to the Housatonic. Minor state roads, including Routes 183 and 71, extend to the north, southwest and southeast from downtown, carving through the town's rural, residential, and agricultural areas. As roads have paved the way through tracts of forest, the town has expanded along these arteries, fragmenting natural communities. All these major state and minor town road systems, adding up to 42 total miles in length, are maintained by the Massachusetts Department of Transportation (MassDOT).

The 91 total miles of local roads in Great Barrington are concentrated densely around the downtown center, and spread into nearly every direction. These roads are denser in the western part of town, as there are fewer roads in the largely protected, forested eastern region. The Great Barrington Department of Public Works (DPW) maintains the local road system, and many of these local roads border residential property. They also extend through rural and agricultural areas.

Roads not only fragment habitat, but also transport pollutants, alter soil fertility, affect water hydrology, and increase sedimentation through the production and conveyance of runoff. In the northeast, roads contribute significantly to the pollution and salinization of waterways, due in large part to the use of chemically-based road deicers in winter months.

The Housatonic Railroad runs north-south through the center of town, along the Housatonic River. Railroad corridors have contaminated soils from chemically



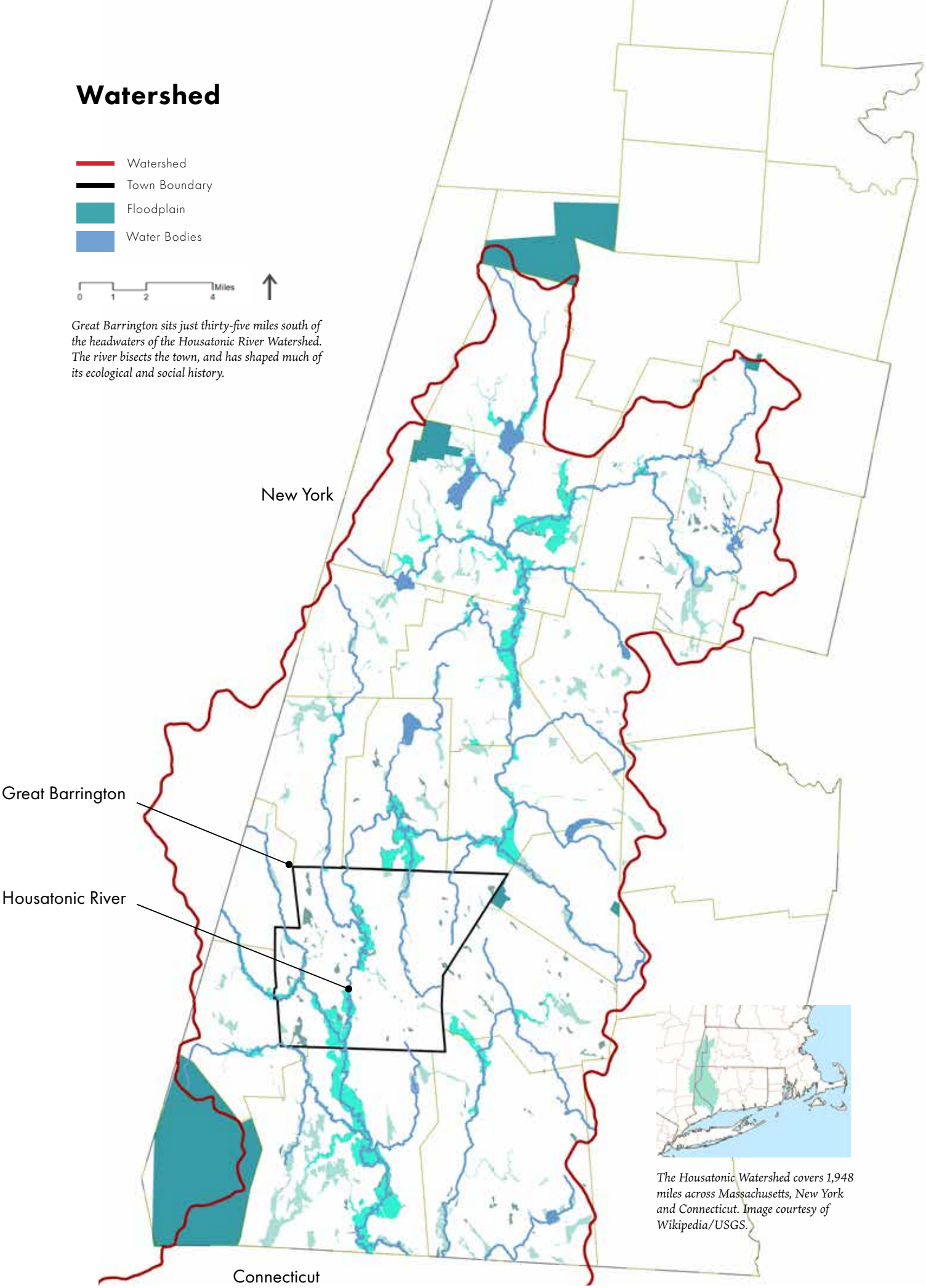
Road and railway systems have largely followed the river valleys in Great Barrington, contributing to the fragmentation and contamination of suitable pollinator habitat—but also providing opportunities for reconnection today.

treated railroad ties and the prevalence of herbicide application along railroad lines, to control invasive plants. As a result, railroad corridors may lack native blooming plants, or contain contaminated flowering plants, thus reducing or envenoming forage for pollinators. The railroad lines abut a few town-owned sites, including Town Hall.

While roads and railroad lines clearly fragment—and potentially contaminate—suitable foraging and nesting sources for pollinators, the linear form of these transportation corridors could potentially create opportunities for reconnecting habitat across a fragmented downtown area. In order to do so safely and successfully, this may require:

- Refraining from the use of pesticides along roads and railroad lines
- Increasing flowering native vegetation along these corridors
- Shifting maintenance practices, such as mowing, to better support pollinators throughout their life cycle (refer to the **Roadside Management** section in the **Opportunities** chapter for detailed maintenance suggestions).

Watershed



Great Barrington sits just thirty-five miles south of the headwaters of the Housatonic River Watershed. The river bisects the town, and has shaped much of its ecological and social history.

The Housatonic Watershed covers 1,948 miles across Massachusetts, New York and Connecticut. Image courtesy of Wikipedia/USGS.

The Housatonic River has been linked to the development of Great Barrington since Native Americans fished its waters and settled its fertile floodplains in order to farm them. The river's name is derived from the Mahican phrase usi-a-di-en-uk, translated as "river of the mountain place". It flows north to south/southeast through a valley between the Taconic Mountain Range of eastern New York and the Berkshire Hills of western Massachusetts. Its headwaters begin in the Berkshire Mountains near the city of Pittsfield. It's watershed drains about 1,950 square miles in New York, Massachusetts, and Connecticut before emptying into the Long Island Sound. Its major tributaries in Massachusetts include the Williams River, the Green River, and Konkapot River, all of which pass through Great Barrington (NHESP, 2011a).

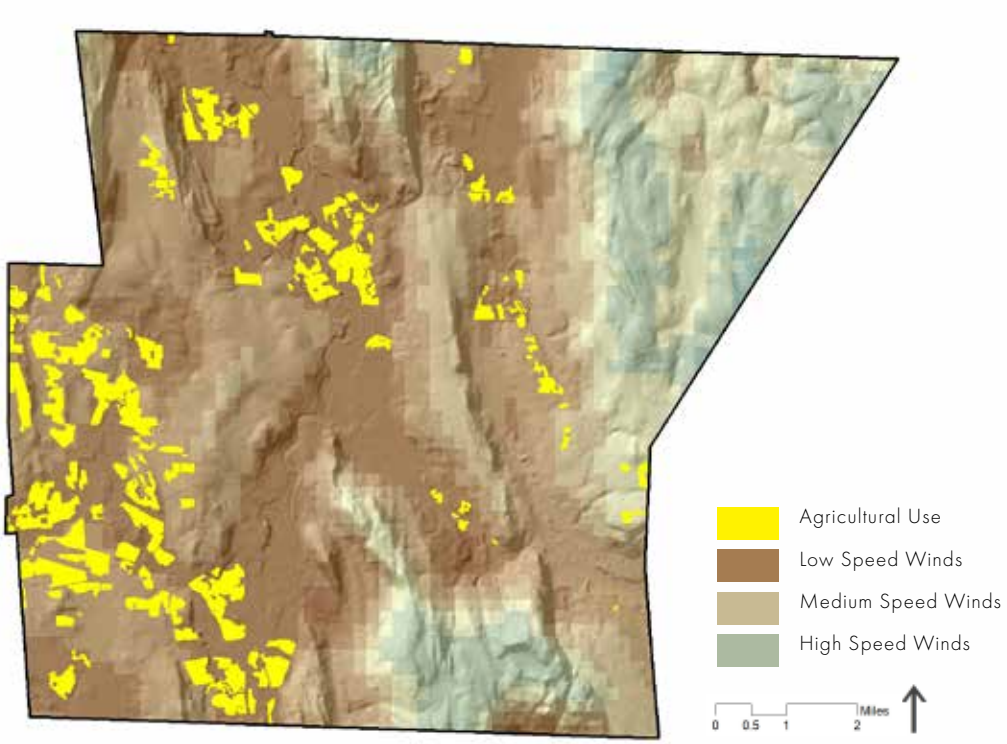
The Housatonic River watershed is one of the most biodiverse areas in the state, with calcareous wetlands in a high-terraced floodplain forest (NHESP, 2011b). The river supports a range of biological communities with a high concentration of Massachusetts state-listed plant and animal species (NHESP, 2012). The Housatonic's riparian area in Great Barrington contains prime agricultural land, and most is privately owned. A lack of buffers along most agricultural fields means that pesticide runoff enters the water untreated.

The Housatonic River has a long history of pollution from its industrial past. In addition to the cleanup of PCB contamination, other conservation priorities for the Housatonic watershed include lake and pond eutrophication reduction, invasive plant and animal management, and environmental education and natural resources stewardship. One example of such efforts is the River Walk, a public greenway trail along the Housatonic in downtown Great Barrington. The Great Barrington Land Conservancy manages the River Walk trail, and has spent more than three decades stewarding the natural plant and animal communities of the riverside and increasing pollinator habitat, specifically for Monarch Butterflies. A planned extension of the River Walk trail going south is currently in development by the Town, with an eye toward pollinator habitat restoration as a focal point of the project.

Refer to the **Trails** section of the **Opportunities** chapter for a more detailed description, as well as images.

Proposed River Walk extension area.

Agriculture & Wind



Wind in Great Barrington primarily blows from northwest to southeast, which may disperse pesticides into neighboring properties and impact pollinator habitat.

Pesticide and herbicide use have become common practice in large-scale agriculture in order to boost crop yields. Although wind often functions as a pollinator, it can also greatly degrade pollinator habitat, as the pesticide use common in commercial agriculture is often carried by wind when applied as a spray. This is referred to as pesticide drift. Wind can drastically change the effect of pesticide and herbicide use: when wind speed is doubled, there is nearly a 70 percent increase in drift downwind from a chemical sprayer (Montana State University).

Wind patterns in Great Barrington may exacerbate pesticide drift, as average wind patterns for the area blow from the northwest to the southeast, potentially contaminating crops to the southeast of higher winds. Wind can also erode exposed farm soil, dispersing contaminated soil dust far from its source. This is one reason why cover cropping is so important. The use of flowering cover crops, such as buckwheat, on farms that don't use pesticides also provides important pollinator habitat, as well as benefiting soil fertility by fixing nitrogen.

Refer to the **Agriculture** section of the **Opportunities** chapter for more information on pollinator habitat on farms and cover cropping.

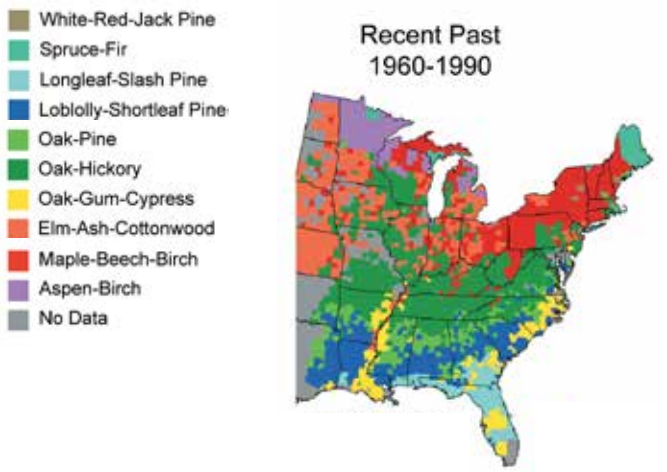
Anemophily is the process by which wind blows pollen from the anthers of one plant to the stigmas of another. In Massachusetts, many hardwoods, conifers, and grasses rely upon wind-mediated pollination. Pollen from anemophilous plants tends to be smaller and lighter than pollen from plants that are entomophilous (pollinated by insects), with very low nutritional value. However, insects gather pollen from anemophilous flowers at times when higher-protein pollens are scarce, such as in early spring. Anemophilous pollens may also be inadvertently captured by the electrostatic field of bees. Some flowers that are generally anemophilous are observed to be actively worked by bees, for example, with solitary bees often visiting grass flowers, and honeybees and bumblebees frequently gathering pollen from corn tassels, as well as from other grains. Anemophilous trees tend to produce significantly more pollen, as their reproduction is more dependent on chance.

Climate Change

Signs of our rapidly changing climate become more obvious each year. The Union of Concerned Scientists reports that if global warming emissions continue to grow unabated, the northeast can expect dramatic temperature increases and other climate changes within our lifetime. With a "business as usual" approach to climate change, the typical summer in Massachusetts may feel like the present-day summer in South Carolina before the end of this century. The choices we make today and in the coming years matter greatly, for the future of all life on earth.

The rising temperatures caused by climate change already influence plant and animal species migration. By revisiting records kept by Henry David Thoreau, scientists showed that plants of all kinds in Concord, Massachusetts, now flower about 18 days earlier than they did in the 1850s. As the planet warms, plants and pollinators alike may adjust to the changes in different ways, leading to mismatches between these symbiotic partners that have coevolved for millions of years. Climate change is being shown to disrupt the synchronization between flower bloom time and bee emergence, for example. This compounds many of the other challenges facing pollinators today (Welch, 2017).

In a study of bumble bees and the plants they visit in the Rocky Mountains, researchers found that the timing of both has shifted earlier, but not by the same amount. The shift in flowering has been greater than the shift in bumblebee timing, resulting in decreased synchrony. In Japan, biologists have followed a spring wildflower (*Corydalis ambigua*), and its bumblebee pollinators, and similarly found that the plants were more sensitive than the bumblebees to early onset of spring as the bloom time was abbreviated with higher temperatures. Reduced synchrony of bees and flowers resulted in lower availability of pollinators for the plants, and potentially also lower availability of food for the pollinators (Boyd, 2017).

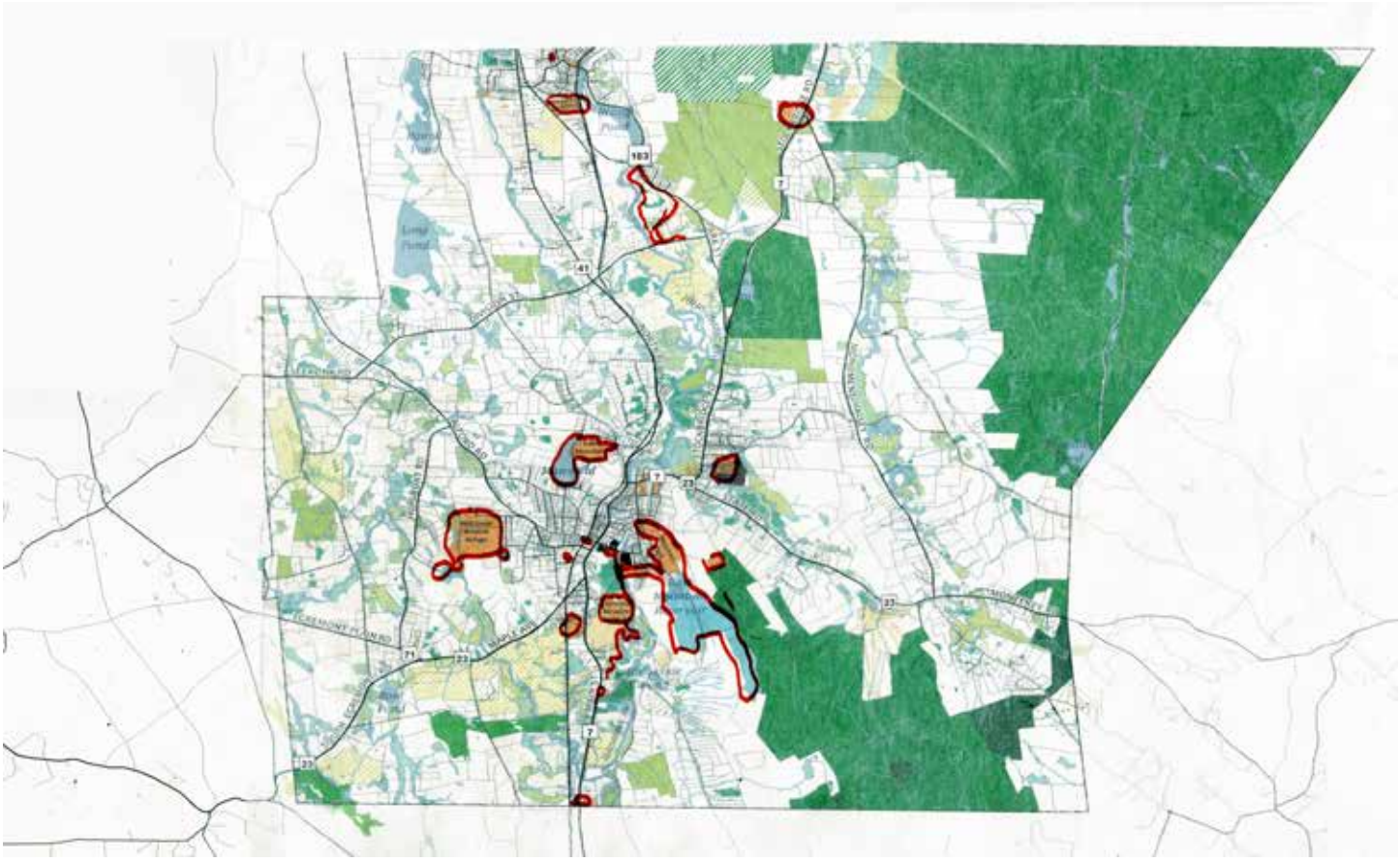


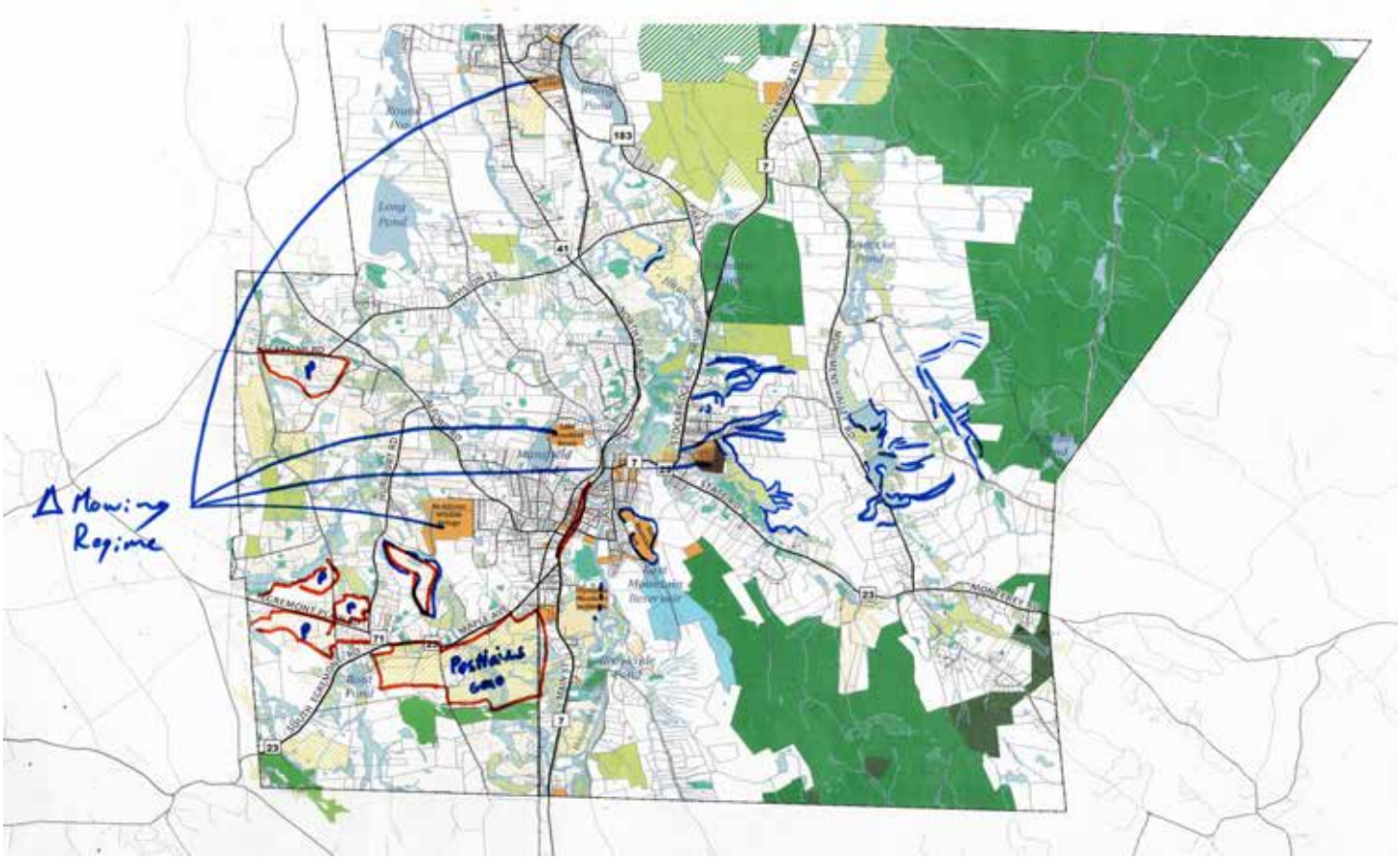
Projected forest composition map (right) courtesy of Team, National Assessment Synthesis. Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change. Cambridge, UK and New York, NY, 2001.

Projected Forest Composition Change for the Eastern United States

Light Pollution

Since most pollinators are inactive at night, moths are the most important group of pollinators for night-blooming plants. Nocturnal pollinators such as moths cannot see color in the dark, but use smells and moonlight as guides to pollen sources. Urban light pollution disrupts this process, by attracting moths to artificial lights at night, thereby making them vulnerable to predation. Most of Great Barrington's light pollution is emitted within the downtown center, close to the Housatonic River, important breeding and nesting grounds for moths such as the Ostrich Fern Borer (*Papaipema sp. Pterisii)*, a Species of Conservation Concern according to the BioMap2 report (NHESP 2012).




Δ Mowing Regime
Pesticide use

Local Views

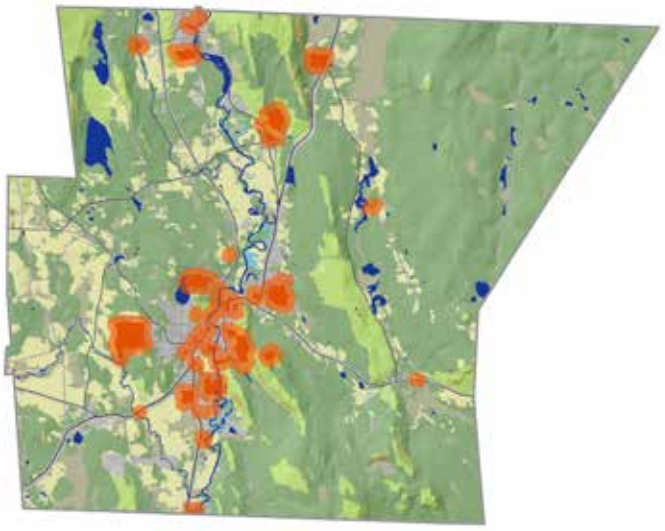
After analyzing the prevalent physical, environmental, and social conditions that shape the life of pollinators in Great Barrington, members of the community were called upon for their recommendations, moving the project forward enormously.

Two public meetings were held with key stakeholders in Great Barrington, including Parks Department Commissioners, Conservation Commission staff, the Town Manager, a DPW Superintendent, a Selectboard member, Agricultural Commission members, expert horticulturists, and residents from Great Barrington and neighboring towns. Their participation in a group mapping activity during the first meeting provided crucial feedback and informed recommendations and next steps. Their main suggestions for creating a pollinator network through Great Barrington were to:

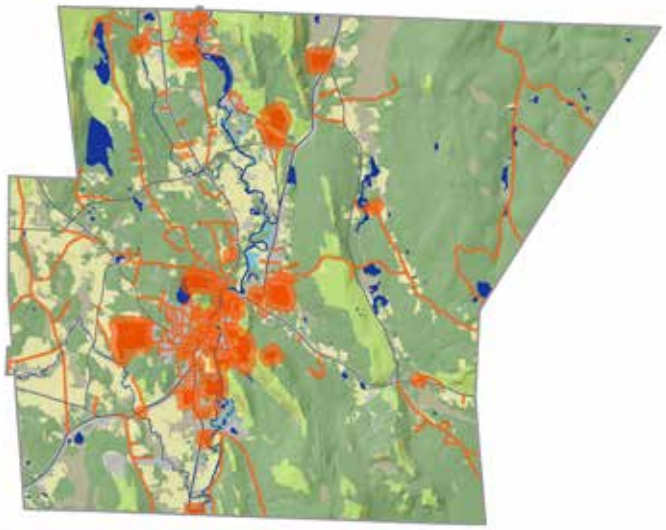
- **Prioritize municipal properties** to establish contiguous demonstration sites of pollinator habitat in the center of town.
- **Change mowing strategies** at all scales, based on zones of use: roadside edges, residential properties, farm riparian edges and boundaries, cemeteries and open spaces.
- **Educate the public and town employees** and provide a rationale for the value of changing mowing practices and establishing pollinator habitat.
- **Build on existing natural resources** within the town, including protected open spaces, and leverage supportive partners already in place, to successfully implement the pollinator plan recommendations.

This valuable public feedback informed a process for implementation of pollinator habitat on varying site scales and for a wide-range of uses. In following this process, a town-wide pollinator network will connect the fragmented landscape of the downtown core with residential and agricultural properties just beyond. Prioritizing highly-visible town-owned properties creates an opportunity to engage and educate the public on the value of pollinators, thereby supporting the broader town goal of extending pollinator habitat throughout the region.

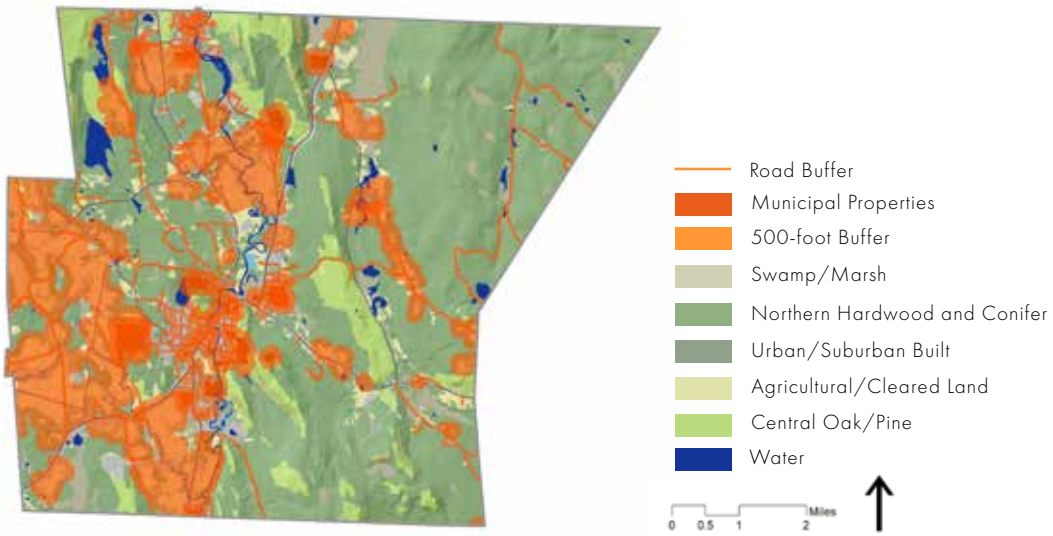
Stakeholders in Great Barrington engaged in a group mapping activity of the town, identifying potential areas for pollinator habitat (above and opposite page).



Municipal properties with a 500-foot buffer, the average distance a native bee ranges.



91 miles of local roads are appended to the municipal properties and associated 500-foot buffer.



With the 500-foot buffer also applied to agricultural land, the potential for pollinator habitat interconnectivity reaches throughout the town.

Opportunities in Great Barrington

Municipal Overview

Municipal properties provide tremendous opportunities to spatially connect and extend pollinator habitat in Great Barrington: they are centrally located, close together, and near important riparian, forest, field, and wetland habitat. These properties are under the Town's jurisdiction, both for planting and for maintenance. Municipal properties are also highly visible to the public, as most of them are right along Main Street/Route 7, or Route 41.

All of Great Barrington's goals for pollinator habitat can be achieved here: **visibility, scalability, and manageability.** In addition, municipal properties represent a wide range of ecosystems and land use types, from urban parks and sidewalk strips to riverbanks, meadows, recreational forests, ponds, and cemeteries.

Because municipal properties are so diverse physically, their planting design and management regimes can serve as replicable models for a wide range of properties in other parts of town as well as in other towns across the region. That might look like a compact, highly managed bed of native plants; a broad, urban garden; planted meadows; naturally-occurring meadows under pollinator-friendly management; or forest edges, planted with a pollinator-friendly canopy and understory, with an eye for early and late seasonal extension of flowering species.

As previously mentioned, one of the most pervasive challenges facing pollinators, worldwide as well as locally, is the loss and fragmentation of suitable habitat. This can be addressed in Great Barrington by forming a pollinator corridor through the center of town (see opposite), **bridging important natural communities** to the east and west sides of the Housatonic River. With nearly 40 percent of the land in Great Barrington under protection from development, and nearly 70 percent under forest cover, establishing pollinator habitat on municipal properties in the town center links intact habitat with the residential properties, farmland and fields that exist just outside the town center, as well as the valuable wetlands and riparian areas which are in the midst of downtown. Multiple opportunities for pollinator **habitat connectivity** are thus created where few, if any, previously existed.

To visualize the impact that municipal properties can have, a 500-foot buffer was applied to all Town-owned properties in Great Barrington (see maps on opposite page). Native bees are the most effective pollinators, as well as among those in greatest decline, and their average foraging range is 200 to 500 feet. Bumble bees, widely considered the greatest pollinators of all, fly an average of 1800 feet. A 500-foot buffer represents a conservative estimate of how far bees could sustainably travel in order to find suitable forage and nesting material. By placing a 500-foot buffer around each municipal property, the overlapping buffers create an interconnected pollinator habitat corridor. This provides a bridge between intact habitat on east and west sides of town, and promotes forest and field edges as opportunities. Riparian and wetland connections are also created, as many municipal properties are right along the Housatonic River.

In the eyes of pollinators, the greatest value of municipal properties might be their proximity to preserved mountains of intact forest to the east and expanses of agricultural and cleared land to the west. As you will see in the following chapter, by drawing upon these varied ecosystems and land use types through the incorporation of pollinator habitat on local roads, farms, and residential properties, Great Barrington has the potential to become an **interconnected, diverse matrix of pollinator life**, providing nesting and foraging opportunities to a wide range of native species.

Public Buildings

Town Hall

On the corner of Main Street and Castle Street, right in the heart of Great Barrington, Town Hall is a highly visible property that sits near popular downtown destinations. It acts as an anchor site, with its proximity to the Mason Library two blocks north, the Berkshire Co-op one block east, and the Housatonic River Walk less than a five minute walk away. Most municipal properties in the downtown center are within a mile or less.

Town Hall's formal exterior is framed by two stone benches in front of a monument, a symmetrical layout which could showcase a sample pollinator garden nicely, and give those passing by a reason to stop and sit.

Every summer, a weekly concert series is held in the gazebo behind Town Hall, and there is ample lawn as well as a playground for children to play. Due to its proximity to the Housatonic Railroad, however, a vegetative buffer is recommended behind Town Hall in order to assist in the buffering and slowing of herbicide drift.

Proposed areas for pollinator habitat in blue in the plan on the facing page that could serve as demonstration gardens with interpretive signage to engage and educate the public would occupy approximately 30 percent of Town Hall's property, leaving only 10 percent to mow regularly.

A phased option for increasing pollinator habitat could be immediate planting in the lawns facing Main Street and Castle Street. A long-term goal for this highly visible is a larger demonstration pollinator habitat. This location would involve connecting the front and side lawn through the removal of the front drive and addition of walkways to allow for visitors to meander through or sit to experience the pollinator gardens. Parking could shift to the back and be replaced with porous pavement.

Libraries

Just two blocks north of Town Hall on Main Street, the Mason Library has the potential of serving as a town-wide hub for pollinator education. At both public meetings, the Mason Library was suggested as a place to host workshops; stock pollinator-related books and audiovisual materials; and, possibly, offer a native seed bank for exchange. There is also a second library in Great Barrington, the Ramsdell Library in the village of Housatonic, where additional workshops and materials could also be made available to the public.

As another highly visible site on Main Street and to further reinforce pollinator education, gardens could be phased in at the front lawn within the semi-circle walkway and the north side lawn.

Plants with a rich variety of structure, height, and color, with varied bloom times across the seasons, could occupy what is presently lawn outside Town Hall. This space might include walkways and educational signs to inform the public of the importance of pollinators.

Presently, most of the Town Hall's 1.89-acre property is mowed grass. These open green spaces could translate nicely to pollinator garden beds.

Key downtown sites marked by circles could contribute to a contiguous pollinator network.

Public Parks

The Town of Great Barrington owns 301 acres of green spaces. Pollinator habitat could be established on many of those sites over time.

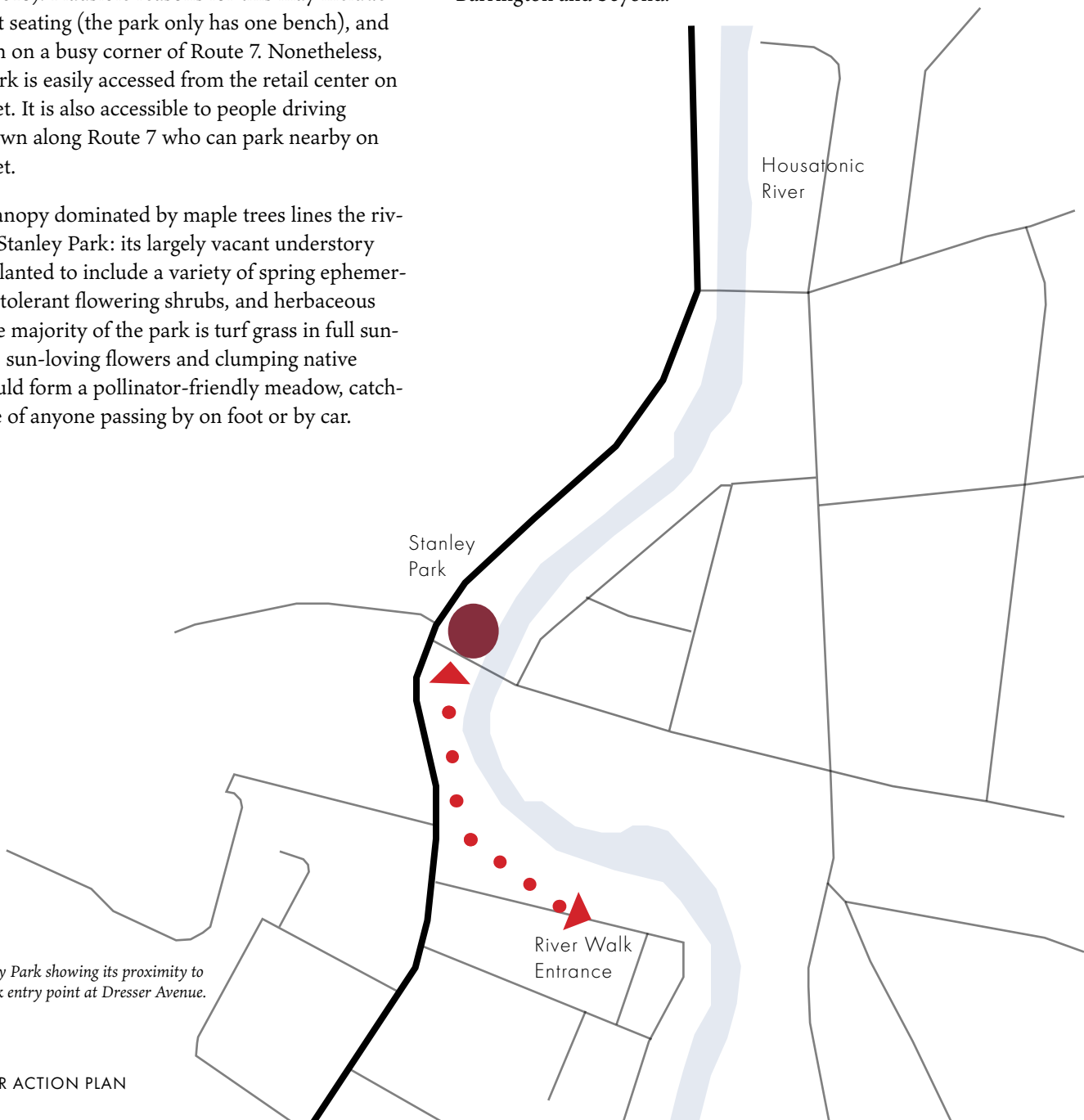
Stanley Park

In the heart of downtown Great Barrington, Stanley Park is a highly visible, triangular-shaped park with riverfront access and near River Walk access off Dresser Avenue, at the end of a vehicular and pedestrian bridge that crosses the Housatonic River. According to one town official, it is one of many town parks where "nobody ever goes" (Great Barrington Town Hall, second public meeting, March 1, 2018). Plausible reasons for this may include insufficient seating (the park only has one bench), and it's location on a busy corner of Route 7. Nonetheless, Stanley Park is easily accessed from the retail center on Main Street. It is also accessible to people driving through town along Route 7 who can park nearby on Main Street.

An edge canopy dominated by maple trees lines the riverbank of Stanley Park: its largely vacant understory could be planted to include a variety of spring ephemerals, shade-tolerant flowering shrubs, and herbaceous plants. The majority of the park is turf grass in full sunlight: here, sun-loving flowers and clumping native grasses could form a pollinator-friendly meadow, catching the eye of anyone passing by on foot or by car.

As the park is long and angular, it could easily support a winding path through the meadow with benches for seating. The path and benches could be shielded from the street by the structure of long grasses and native wildflowers. A turn in the path could lead to an opening in the riparian forest edge, offering a seated view of the river below.

At the northernmost part of Main Street, Stanley Park could anchor a pollinator pathway through downtown extending to the Town Hall and Mason Library at the opposite end of Main Street. It can also serve as a model for numerous other small urban parks in Great Barrington and beyond.



Map of Stanley Park showing its proximity to the River Walk entry point at Dresser Avenue.

Existing conditions of Stanley Park.

A photomontage of what the Park might look like after establishing a wildflower meadow and riparian forest understory with a meandering path.

Trails

Great Barrington contains over 48 acres of land with hiking trails or paths plus three river systems and dozens of lakes and ponds. The following typology could help to establish pollinator habitat on many of those sites, including the town-owned McAllister Wildlife Refuge and Lake Mansfield Forest.

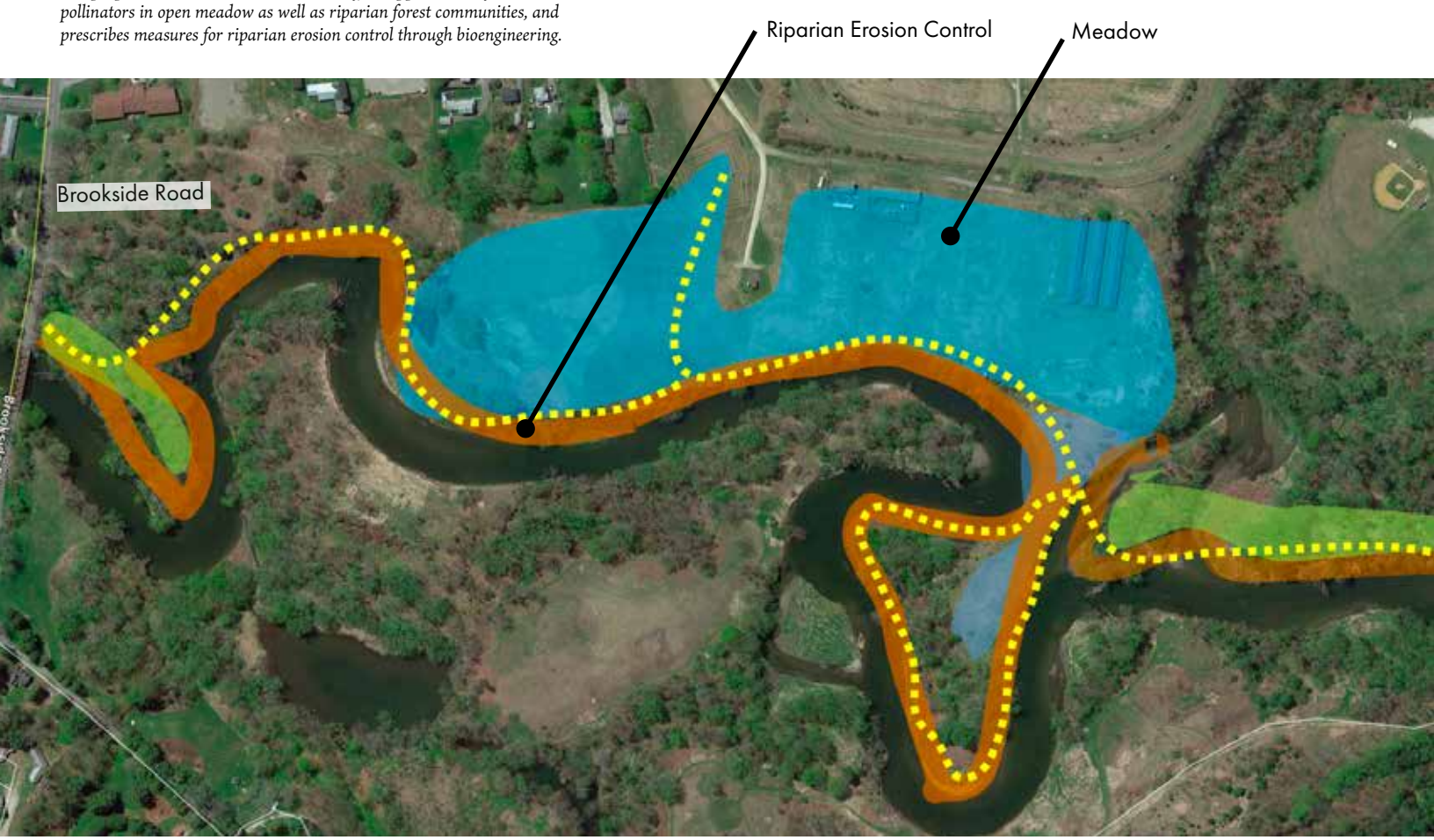
River Walk Extension

The proposed River Walk extension on the west side of the Housatonic River, a 1.5-mile corridor from Bridge Street to Brookside Road, provides an opportunity to diversify existing natural communities by incorporating more pollinator-supporting native plant species. An emphasis on milkweed and early & late blooming flowering species will extend the seasonal availability of pollen from early spring through late fall.

The area along the property extension is currently open meadow and riparian forest, with riverine sandbanks present in oxbows. The riverbank edges are steep and susceptible to erosion and occasional flooding. In 2011 and 2012, Hurricanes Irene and Sandy exceeded the 100-year flood mark and the river escaped its banks. There are public canoe launches near both Bridge Street and Brookside Road, and the original Housatonic River Walk ends just north of Bridge Street.

Great Barrington's residents have expressed an interest in continuing the River Walk trail and possibly including a bike path south of Bridge Street. For over three decades, volunteers and professionals have invested in bioengineering and ecological restoration along the original River Walk, including riverbank stabilization, planting and propagating native species indigenous to the area, and the management of invasive plants. Continuing the proposed River Walk extension would expand existing pollinator habitat, which includes already early-flowering maples, willows, and American hazelnut, many spring ephemerals, shade-tolerant native flowering plants, and

The proposed River Walk trail extension offers opportunities for pollinators in open meadow as well as riparian forest communities, and prescribes measures for riparian erosion control through bioengineering.

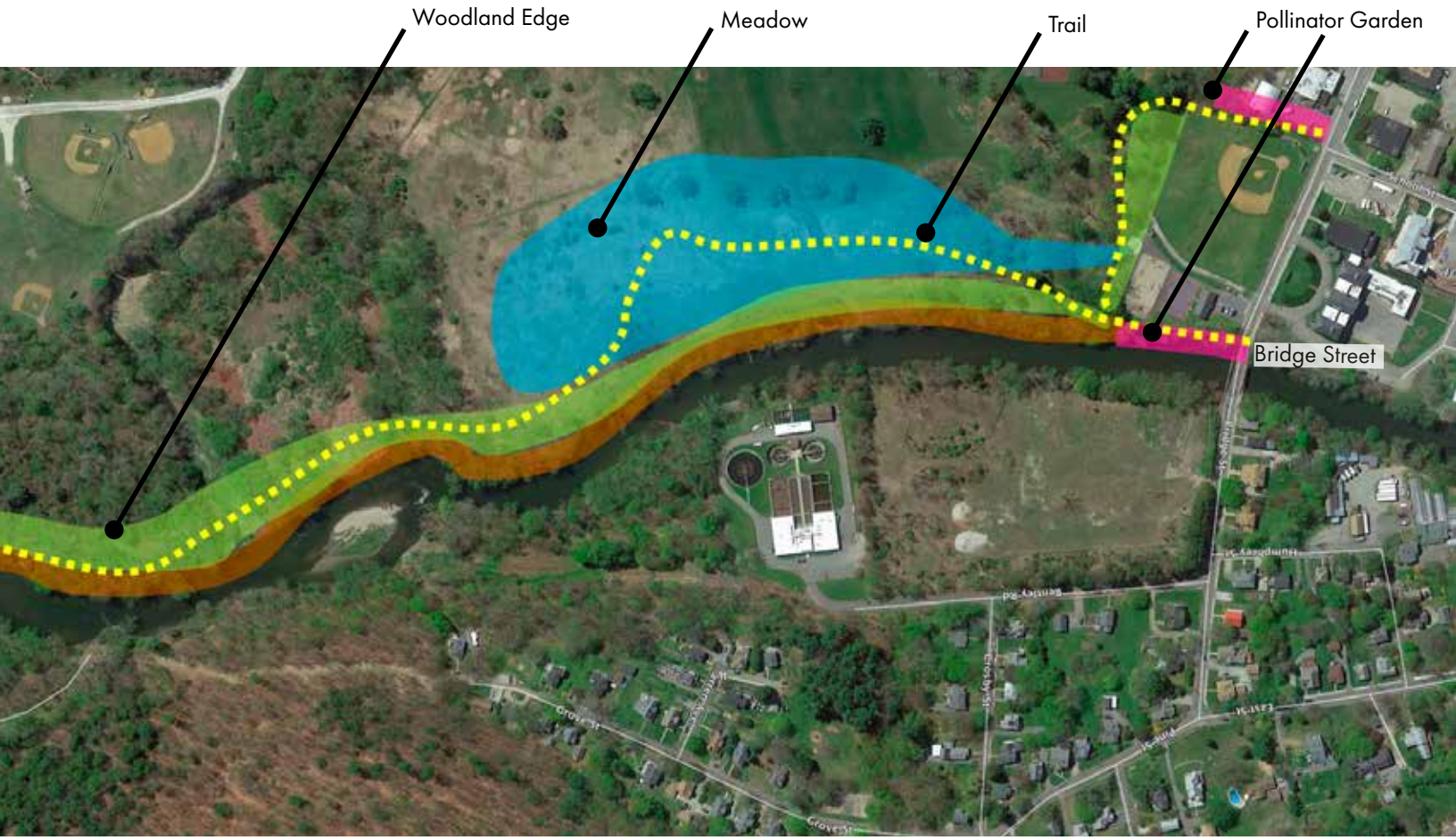


several species of milkweed. The trail receives over 5,000 visitors a year.

South of Bridge Street, at Memorial Field, the River Walk extension could include pollinator gardens and bioswales just off the road, between the Memorial Field parking lot/tennis courts and the river. Interpretive signs could welcome visitors to the trail, and inform them of the benefits of not only pollinator habitat, but also stormwater retention and filtering. People parking here can begin to enjoy the River Walk as soon as they exit the car. The path would then lead south, passing through a small forest edge before opening up again to a large meadow.

Early flowering trees and understory plants could enhance pollinator habitat in forested areas along the River Walk extension species might include striped maple (*Acer pensylvanicum*), red maple (*Acer rubrum*), and black willow (*Salix nigra*); butterfly and moth magnets like swamp white oak (*Quercus bicolor*) and pin oak (*Quercus palustris*); shade-tolerant understory plants such as spicebush (*Lindera benzoin*), winterberry (*Ilex verticillata*) and wild columbine (*Aquilegia canadensis*); and spring ephemerals like Jack-in-the-pulpit (*Arisaema triphyllum*) and bloodroot (*Sanguinaria canadensis*).

Within existing meadows and open spaces along the River Walk extension, many pollinator-friendly plant species are already present, including several varieties of goldenrod and milkweed. A reduced mowing regime—cutting meadows only once every year, or 2-3 years, in late winter—provides forage and nesting opportunities for overwintering pollinators, such as queen bumblebees. Native grass and flower mixes can also be seeded in existing meadows to further diversify the plant palette and attract a wider variety of pollinating species, as well as add more color and structural diversity for human enjoyment.

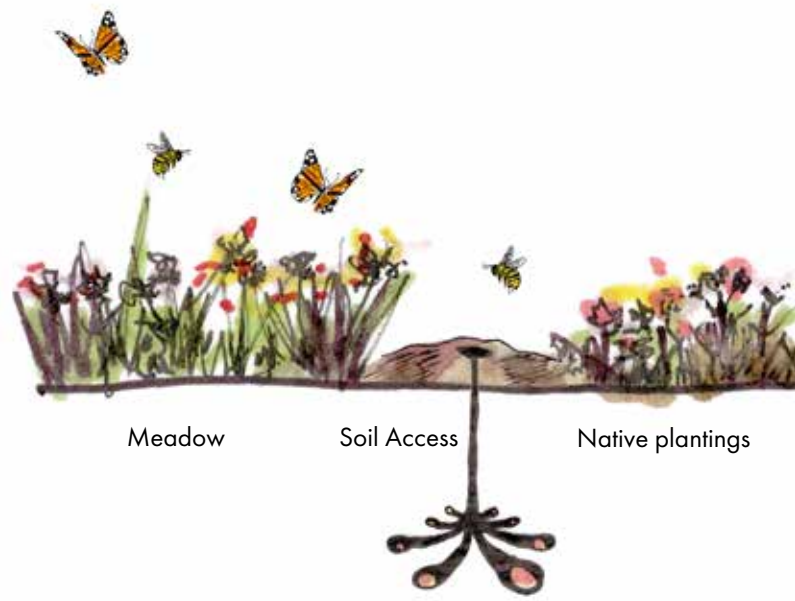


Mowing in the fall as opposed to the spring can be the difference between life and death for overwintering pollinators.

For riverbanks along the River Walk extension, deep-rooted native trees, shrubs, sedges and shade-tolerant perennial groundcovers could be planted to stabilize the riverbank, and further widen the pollinator palette. Throughout the River Walk extension, as in any new pollinator habitat, invasive species which may pose a threat to recently planted or seeded native, should be managed and removed, as required. The original Housatonic River Walk is a wonderful reference landscape, and its associated trail guide contains hundreds of plant entries.

Refer to the **Create a Meadow** section of the **Toolkit** for specific steps toward establishing and maintaining a pollinator meadow.

Refer to the **Plants for Pollinators** section of the **Toolkit** for a comprehensive list of recommended plant species for pollinators and the conditions they require.



A photomontage of what the River Walk Extension might look like after establishing a wildflower meadow. Adapted image from Larry Weiner Associates.

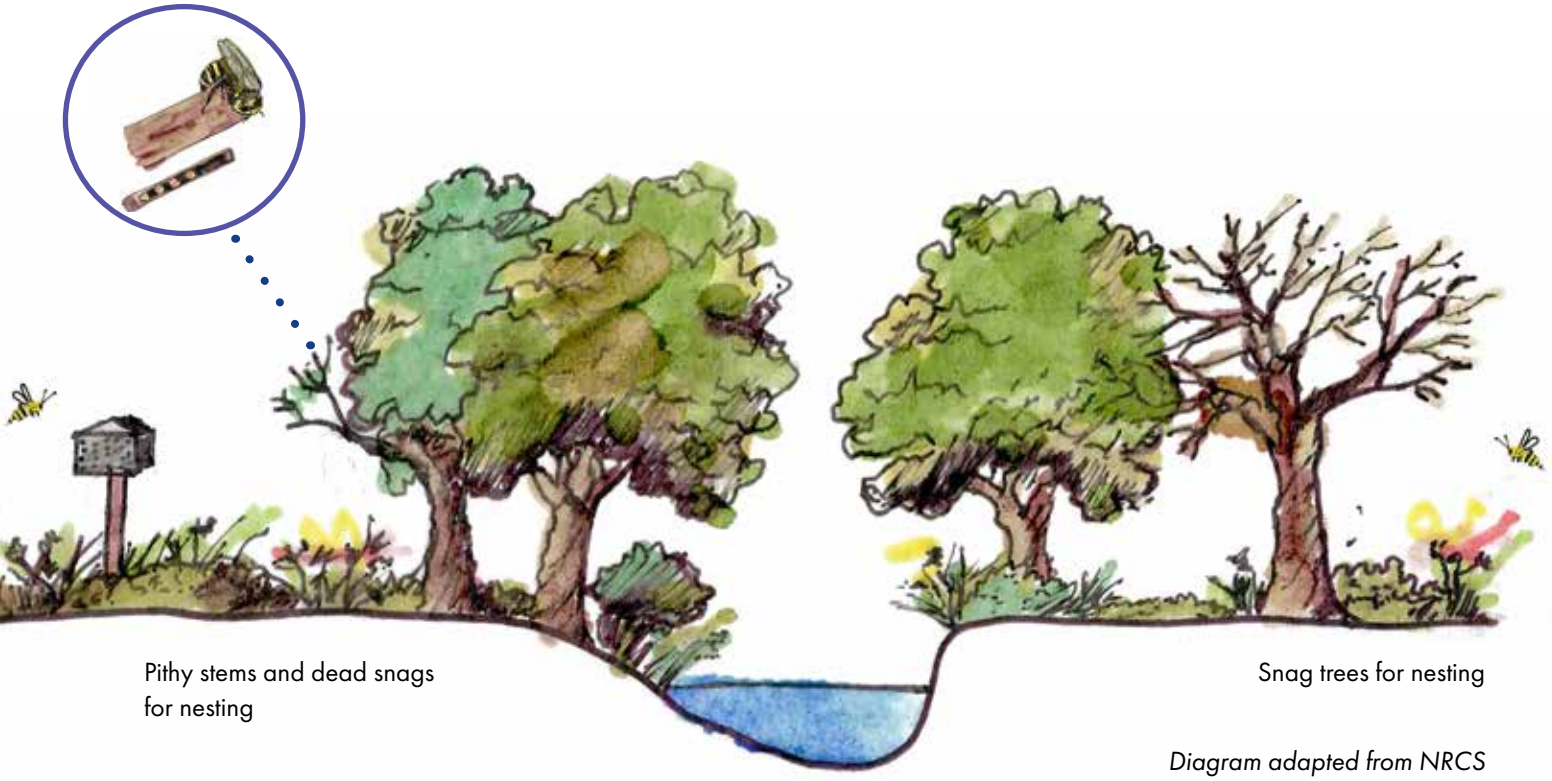


Diagram adapted from NRCS

Streetscapes & Parking Lots

With over 28 acres of parking lots in Great Barrington, and a recently completed reconstruction of Main Street featuring new sidewalks and sidewalk planting beds, there is potential for expanding pollinator habitat in the downtown, while simultaneously slowing runoff and stormwater before it reaches sensitive water bodies and ecosystems.

Great Barrington has over 1,100 acres of impervious surfaces, most of which are located in the downtown core. Although these surfaces—which include asphalt, concrete, and rooftops—fragment natural areas and help polluted runoff reach water bodies faster, they can also inspire unconventional approaches to expanding pollinator habitat. Fragmented environments serve as patchy yet vital resources, capable of supporting wild bee populations (Burr, et al).

According to the Town Master Plan, adequate parking has long been considered a problem in downtown Great Barrington. Available spaces are generally well used, with some events at the Mahaiwe Theater, a regional cultural attraction, drawing 700 guests. There are approximately 1,000 parking spaces downtown, 200 on-street and 800 off-street. Only 200 of the off-street spaces are public spaces, and the recent Main Street reconstruction reduced the number of on-street spaces by 20 (Master Plan, 2013). Great Barrington's parking is primarily behind buildings off Main Street, near the Housatonic River. Because many parking lots in town lack vegetated borders or medians, they contribute significantly to polluted runoff directly entering the Housatonic and other water bodies.

If the Town considers adding or renovating any parking spaces in the future, vegetated rainwater catchment systems such as bioretention basins could be included, in order to expand pollinator habitat as well as capture and filter stormwater and road runoff. This could also be the case with any new development in the urban center.

The new sidewalk planting beds on Main Street provide an opportunity to **further strengthen pollinator habitat connectivity downtown.** Currently, many business owners voluntarily tend to the planting beds outside their storefronts, but there are still some which remain unplanted beneath the tree.

Filling in new sidewalk planting beds with pollinator-friendly plants on Main Street could strengthen pollinator habitat connectivity downtown, linking municipal properties.

By providing planting diagrams and plant lists—which can be found in the **Toolkit** section of this report—and, possibly, starter material, the Town could engage more business owners in creating small-scale gardens outside their shops, increasing visibility of Great Barrington's pollinator habitat corridor. Signs could be posted in these sidewalk bed to increase public awareness and interest.

Parking lots in town could have bioretention basins to capture stormwater and pollutant runoff, and provide valuable pollinator habitat.

Berkshire Co-op Expansion

Another opportunity for connectivity and educational outreach along the trail could come from the expansion of the Berkshire Co-op market, neighboring Memorial Field to the west. Plans to significantly expand and renovate the existing Co-op market building include an expanded outdoor seating area, with ornamental gardens to provide shade and shield patrons from the parking lot. The new Berkshire Co-op could feature pollinator gardens and bioswales in this area, with a trail that heads east, along the treeline at the southern edge of Memorial Field, and connects to the River Walk extension trailhead at the Memorial Field parking lot.

Image courtesy of Benchmark Development/Berkshire Co-op.

Green Roofs

Well-designed green roofs can provide habitat compensation for rare and endangered species that are affected by land use changes. This has been established by numerous research programs, in cities such as Basel and London. Recently, Toronto adopted a bylaw that mandates green roof implementation on all new buildings. The height of green roofs may be a limiting factor for pollinators, however, as bees are less likely to visit taller structures. The City of Toronto found that green roofs implemented above the eighth story would not attract bees.

As a small town with structures that are predominantly four stories or less, Great Barrington certainly has the potential to implement green roofs that provide adequate pollinator habitat. An added benefit: green roofs raise pollinator habitat above street-level, which can help with the public's fear of bees.

Green roofs may also integrate elements of stormwater management, as they are the first step in retention and filtration of rainwater. This would not only reduce the amount of water that falls on the street, but also process it through vegetation before it reaches the Housatonic and other water bodies.

Roadside Management

With 91 miles of local roads under maintenance by Great Barrington's Department of Public Works, roadside edges provide an excellent opportunity for pollinator habitat connectivity throughout much of Great Barrington, with the added benefits of reduced mowing time, energy costs, and carbon emissions.

Roadsides can function as linear corridors of flowering vegetation, thus serving an important role in pollinator conservation. Typically, municipal road crews mow valuable blooming plants and apply pesticides to control invasive species. This reduces nectar and pollen food sources, and ultimately contributes to pollinator decline. Changing mowing practices is an important first step considering time and technique. By applying the following techniques, plants can reach a blooming stage and bloom longer, and larval host plants can remain intact. A regularly mowed narrow strip along the road (the "Clear Zone") will maintain visibility and evidence of care.

Three general techniques to support pollinators along roadsides are:

- Adjusting mowing schedules in specific zones to allow plants to flower
- Planting buffers containing a mixture of native flowering plants
- Avoiding pesticide and herbicide use whenever possible

There are many added benefits to managing roadsides for pollinators:

- **Lower Costs:** Less frequent mowing reduces labor and fuel costs, as well as carbon emissions. See Florida case study below.
- **Less Runoff:** Native plant root systems run deep, increasing water infiltration. This reduces runoff and the pollution it carries into our waterways.
- **Erosion Control and Invasive Species Reduction:** Once a diversity of native plants are established, they provide a stable groundcover, reducing erosion and controlling weeds.

Refer to the **Manage Roadsides for Pollinators** section of the **Toolkit** for more detailed instructions regarding how to establish pollinator habitat on roadsides in Great Barrington.

Mowing a 6-foot wide clear zone can provide roadside habitat without compromising driver safety. Photo courtesy of Jeff Norcini, OecoHort LLC.

Natural vegetation within a buffer zone. Photo courtesy of Ulster Wildlife.

Florida Roadways: The right-of-way of highway I-10 in Madison County, Florida was mowed up to seven times a growing season. In 2009, a pilot study on a one-mile segment of the highway was initiated, to look at the effects of a reduced mowing regime on plant composition, soil erosion, expenses, and highway operations. From 2009 to the project's completion in 2013, fence-to-fence mowing (treeline to treeline) was limited to once a growing season, in the fall. A 10 to 15-foot wide clear zone adjacent to the pavement continued to be mowed seven times each growing season. The vegetation was closely monitored over the years. Over time, more and more desirable plant species were found in the section of the right-of-way with the reduced mowing regime. Blooming wildflowers increased. Additionally, mowing costs were reduced by $1,000 per mile. The modified mowing regime did not increase soil erosion or have negative impacts on normal highway operations. (Hopwood, et al., 2015).

Agriculture

Approximately thirteen percent of the land in Great Barrington (3,800 acres) is devoted to agriculture. Establishing pollinator habitat on farmland presents a largely unexplored opportunity to increase soil health and nutrient content, improve water and air quality, and reduce pests. The following recommendations outline the many ways in which pollinator habitat can be applied to working agricultural lands.

Pollinator Meadows

Forty-five percent of crops in Massachusetts require bee-mediated pollination. This places significant value on pollinator habitat that is close to agricultural lands. Bees can increase crop yields if their habitat is prioritized near crops requiring pollination.

Pollinator meadows are large, contiguous bands of flowering perennials and annuals, selected to attract pollinators throughout the growing season. These meadows ideally cover 10 to 30 percent of the agricultural parcel (NRCS, 2018). This allows for adequate feeding, breeding, and nesting habitat. As most bees are ground-nesting, maintain existing bare ground where possible. Many woody stemmed plants, such as elderberry, raspberry and sumac, can be left for tunnel-nesting bees. For cavity nesters, leave rodent holes and plant native bunch grasses.

As pollinators are active at different times of the year, try to select a diversity of plants with different flower sizes, shapes, and colors, as well as varying plant heights and growth patterns, to establish the greatest numbers and diversity of pollinators. The planting scheme should include plants flowering from spring to fall.

Pollinator Strips

Pesticides are extremely toxic for pollinators. One alternative used to reduce cereal crop pests like the pervasive Japanese beetle (*Popillia japonica*) is to establish pollinator strips, which are rows of flowering plants. Recent studies indicate strong reductions in plant damage caused by cereal leaf beetles in fields with flower strips, compared to traditional fields. These experiments have indicated that densities of the harmful cereal-leaf beetle in adjacent fields of winter wheat were 40 to 53 percent lower than when no flower strips were sown at the field margin (Tschumi, 2015).

Ideally, pollinator strips would be approximately five feet wide and 300 feet apart. These wildflower bands support beneficial insects that compete with pests, build rich soil, and have been known to increase yields (Tschumi, 2015). Pollinator strips can be planted on contour to stabilize slopes and filter stormwater runoff.

Photo courtesy of Desmet Jan.

Forage Cover Crops

Similar to pollinator strips, forage cover crops provide many benefits to farms while encouraging pollinator habitat. Flowering cover crops enhance foraging habitat while increasing crop yields. Cover crops also improve erosion control, soil permeability, fix nitrogen, discourage weeds, sequester carbon, and harbor beneficial insects (Vaughan, 2015). Research has shown that flower density has a significant influence on the number of bees that are attracted to a particular cover crop, with the greatest bee visitation in those with the highest number of open blooms per zone (Ellis and Barbercheck, 2014). Greater plant diversity also supports more natural enemies which reduce unwanted pests. It is best practice to plant a multi-species cover crop, as related species will invite similar pests and pathogens.

Foraging habitat for pollinators is significantly reduced if cover crops are mowed or turned in while still flowering. It is imperative to wait until after peak bloom time to turn in a cover crop.

- If cover crops are turned in too early, pollinator mortality will increase, as their food source is removed
- Use delicate, less disruptive methods, such as tilling or low-mowing, in order to prevent the destruction of pollinator nests
- Ensure that conservation areas near cover crops stay undisturbed throughout the year, as this provides pollinator habitat following the termination of cover crops
- Leave cover crop die-back whenever possible, in order to provide nesting habitat
- Do not use pesticides or herbicides at any point in cover crop zones

Hedgerows

Throughout much of Great Barrington, agricultural parcels lack long, contiguous bands of natural vegetation. Hedgerows defined by Merriam-Webster as "a row of shrubs or trees enclosing or separating fields," can act as wildlife corridors, allowing dispersal between isolated habitats. These physical barriers also serve as windbreaks, and can impede pesticide drift. Bumble bees are known to use hedgerows to guide their foraging activity. Many farms have cut into existing hedgerows, impeding habitat networks for pollinators. To avoid ecological traps, farms that use pesticides should consist of vegetation less attractive to pollinators.

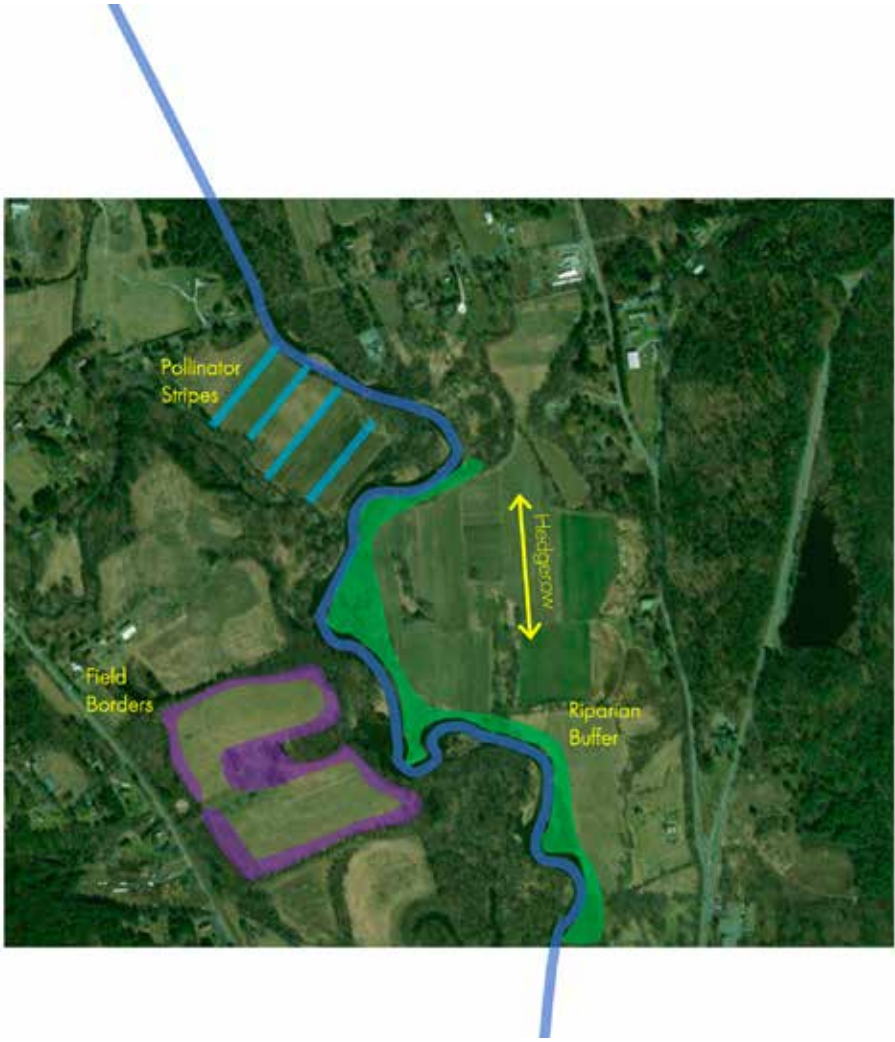
Riparian Buffers

Throughout Great Barrington, ecologically significant rivers and streams run right along agricultural areas, as most farms are located in their fertile floodplains. By establishing and maintaining vegetated riparian buffers along these waters, polluted runoff from farms can be filtered, erosion controlled, and pollinator habitat expanded. Riparian buffers can be strips of trees, shrubs and/or grasses; these planted buffers fill in barren gaps along water bodies and enhance existing natural buffers.

Healthy riparian buffers can withstand flooding, and provide the highest level of protection. Extending a minimum of 100 feet outward from a river or stream, a riparian buffer should ideally consist of three zones:

- Meadow
- Managed Forest
- Riparian Edge

The **meadow zone** consists of native grasses, wildflowers, or other herbaceous plants to reduce fast-moving water runoff and filter sediment. The area closest to human use will be the least accommodating for pollinator habitat. Ideally twenty-feet wide, the meadow zone is managed to encourage habitat for pollinators and ground-nesting bees. Once the meadow is established, mow in February or early March to minimally disturb nesting and cover habitat for pollinators and other animals.



The **managed forest zone** is planted with native, fast-growing, shade-tolerant tree or shrub species. Running between the meadow zone and riparian edge, the managed forest area needs to be twenty to sixty feet wide and will sustain occasional harvesting. This zone infiltrates stormwater into the soil and filters nutrients and other pollutants.

The **riparian edge** is planted with native species of water-tolerant trees and large shrubs with little or no harvesting. Immediately adjacent to the stream and river edge, this zone is at least fifteen feet wide. The vegetation stabilizes banks while filtering runoff into the water body. Trees shade the stream, which cools the water and provides better conditions for cold water-dependent fish species. Tunnel-nesting bees prefer dead standing wood, which is prevalent in floodplains.

What is an Ecological Trap?

According to Dr. Kimberly Stoner at the Connecticut Agricultural Experiment Station, "an ecological trap is a habitat that is attractive to an organism, but is detrimental to fitness. An attractive pollinator habitat [that is] contaminated with pesticides harmful to the pollinators is an ecological trap!" Another example of an ecological trap is the planting of tropical milkweeds in a temperate climate. Because the tropical varieties of milkweed don't die back in winter, as native milkweeds do, the plants may accumulate protozoan pathogens over time, risking death to the monarch caterpillars that feed on them exclusively.

Pollinators Bring Back Fertility

"Driving through the farm fields of Colusa County, in California's Central Valley, is a good way to dispel any sentimental image of farmland as lush, pastoral, and nature-rich. Massive monoculture acreages push right up against dusty roadsides, with virtually no wild plants in sight. The banks of irrigation ditches and road edges are sprayed constantly with herbicides and disliked until the dry soil takes on the consistency of powdered sugar—and pests are suppressed with mammoth boom sprayers and aerial crop dusters. The only nature that takes root in the midst of these farmlands tends to be the toughest weeds like mustard and yellow star thistle, and highly mobile cropland pests like starlings and ground squirrels.

Yet, in the midst of this unlikely backdrop one company is seeking to reverse the trend and bring a little bit of nature back to Colusa County. Working with Xerces staff, Muir Glen Organic Tomatoes has launched one of the largest native plant hedgerow projects in the area. This effort not only provides pollinator habitat adjacent to one of their processing facilities near the town of Williams, but also functions as a living demonstration site and outdoor teaching facility for Muir Glen's local network of organic tomato farmers. Established in 2012, the mile-long hedgerow has restored a formerly barren and compacted dirt roadside to create a vibrant, functional, and beautiful pollinator corridor.

The background behind this success is rooted in the particular value that native bees offer to agriculture. Recognizing how research now demonstrates a strong link between buzz pollination by bumble bees and increased tomato yields, Muir Glen worked with Xerces to design a complex, highly diverse hedgerow made up of dozens of species of native shrubs, bunch grasses, and wildflowers that would attract those and other native bees with both food sources and nesting habitat.

As a first step in this process, the project team worked to immediately stop erosion and soil loss at the site by terracing the roadside slope to establish a level planting area. The slope was further stabilized with straw erosion-control waddles, and the soil was amended with compost to add back organic matter and soil microorganisms.

Then, as a second step, the team hand-planted hundreds of the larger plants along the top of the slope, including elderberry, manzanita, deergrass, California lilac, coyotebrush, California buckthorn, showy milkweed, bladderpod, bush lupine, and many others. After planting, these transplants were initially supported with a single drip irrigation line and were heavily mulched with almond shells from local orchards. Because these native plants are highly drought-adapted, irrigation only needs to be maintained for the first two years of establishment before being removed in the third year.

Finally, supplementing the larger plants along the lower part of the slope, a diverse understory of native wild flowers, like California poppy, lacy phacelia, and Bolander's sunflower, was direct-seeded to further stabilize the soil and expand the plant diversity.

To ensure that the hedgerow is functioning as intended, Muir Glen and Xerces partnered with University of California–Davis scientists to monitor the abundance and diversity of bees using the new hedgerow and to compare those findings against the abundance and diversity of bees found in the field edge areas of other farmland nearby (where hedgerows were not present). Amazingly, after only the first year, the findings were dramatic—nearly twice as many bees were found at the Muir Glen hedgerow as were found on the edges of other nearby farm fields.

Supplementing these findings, additional research conducted by scientists at University of California– Berkeley now demonstrates that, in California's Central Valley, farmers can typically expect to see a return on investment within 10 years for the costs involved in planting a hedgerow (this time can be cut in half with USDA financial assistance through Farm Bill conservation programs). That return on investment comes in the form of enhanced crop pollination, and in reduced pest damage due to the increased numbers of beneficial insects that prey upon crop pests.

While financial returns and crop yields are a key part of the equation, Muir Glen's success story runs deeper. A once-dry, desolate landscape now stands as a green, life-filled example of what is possible. This is a significant step in a new farm paradigm that will be necessary for others to follow if wild pollinators are going to have a role in agriculture, both in Colusa County and beyond" (Xerces Society, 2015).

What You Can Do at Home

"Any person who has even a postage stamp yard can stop using pesticides, put in more native plants…and leave some wild areas for bees to nest in the ground. It is that easy to help make a difference." —Aimee Code, Pesticide Program Coordinator of the Xerces Society

There are approximately 3,000 residential properties in Great Barrington, covering 1,880 acres. Typically, in the United States, residential properties implement conventional landscaping practices, including fertilizer use and frequent mowing. By changing lawn management practices in residential areas to better support pollinators, fragmented habitat could be connected through a series of pollinator gardens and meadows, thereby bridging habitat on municipal properties in the urban town center with that of outlying farms, protected forest, and open space.

Frequent mowing of lawns reduces flower density, thus limiting food for pollinators. By decreasing mowing frequency, plants can grow and flower, providing increased foraging opportunities. Urban ecologists Susannah Lerman and Joan Milam at the University of Massachusetts Amherst performed an urban-suburban lawn study in Springfield, Massachusetts in 2014. They found that mowing at no lower than 3 inches, changing the mowing interval from once a week to every two weeks, and leaving lawns untreated with herbicides provided a diversity of "spontaneous" flowers, such as dandelions and clover, that offer nectar and pollen to bees and other pollinators. One of the main findings from Lerman and Milam, is that "when lawns are not intensively managed, lawn flowers can serve as wildlife habitat and contribute to networks of urban green spaces." (UMass Amherst Research Next). A federal study found that raising mowing height to at least 2.5 inches, mowing only every 2-3 weeks, and minimizing pesticide use can increase flower abundance by 70-300 percent (US Forest Service, 2015). Doing so also supports ground-nesting bees by reducing compaction.

Residential areas bridge the urban core and agricultural land.

After changing the mowing practices of Springfield homeowners, a UMass study documented 110 native bee species, 72 species of flowering plants, 2 new state records, and 6 new county records for bee sightings in the participant lawns (Lerman & Milam, 2014).

Here are a few steps homeowners can take to increase pollinator habitat:

- Develop a 3-week mowing rotation to ensure that lawn flowers persist throughout their growing season.
- Increase areas for flowering plants and dedicate less area to lawn grass. To add an element of formality, mow a six-foot-wide borders or paths at a minimum three-inch height, if not higher, around or through areas planted with flowers .
- Allow lawn "weeds" like clover and dandelions to grow. Research shows that lawn weeds are one of the largest and most important food resources for bees in urban areas.
- Use lawn alternatives. Native groundcovers, sedges, fescues, and low wildflowers can all replace or complement grass. Or, establish a meadow in place of lawn.
- Provide a variety of native flowering trees, shrubs, and wildflowers that bloom successively throughout the seasons. Many cultivars don't provide for the needs of pollinators: in some cases, they have lost the floral cues that attract pollinators to their flowers. Native plants can also require less care as they are adapted to local climates.

All of these options require fewer resources to manage effectively. Refer to the **Establish a Meadow** section of the **Toolkit** for instructions on how to start a meadow.

A six-foot wide mowed border frames and showcases a wildflower garden. Photo courtesy of Nick Mann, Habitat Aid.

Mowing lawn less frequently while maintaining a more frequently mowed path allows clover and dandelions to grow while keeping walking areas clear. Photo courtesy of Flickr user Dave Gunn.

This lawn uses Carex pensylvanica *sedge in place of turf lawn and does not require mowing. Photo courtesy of Jeff Epping, Olbrich Botanical Gardens.*

Seattle Pollinator Pathway

A project in Seattle, WA called Pollinator Pathway creates pollinator habitat connectivity through residential properties that are located between two disjointed public green spaces. The project includes collaboration from professionals with a range of experiences, providing resources at different scales. As part of the project, a design starter kit was developed, to help homeowners make their property more supportive of pollinators. Founder Sarah Bergmann worked directly with homeowners. The project is a collaborative effort that requires buy-in from homeowners in order to adhere to the project guidelines. Each of the 20 residential gardens are individually funded, researched, and designed. Unified, coherent gardens designed in partnership with the homeowner and the project's garden designer consider pollinator appeal, beautification, site conditions, ease in care and city requirements. Homeowners are responsible for maintaining maintain their gardens (Pollinator Pathway).

Pollinator-Based Learning

Pollinators can teach us a lot, as their lives and processes are inextricably tied to our food, our environment, and the greater part of life on Earth. There are many excellent precedents for pollinator-based school and community education.

School gardens provide an opportunity to integrate outdoor classrooms with pollinator habitat. A schoolyard pollinator garden connects students with the natural world, integrating subjects as diverse as math, science, art, health, and physical education. Gardens with edible plants offer students a direct connection with food sources, and help kids learn the valuable role that pollinators play in the growth of their food. Children can serve as "pollinator ambassadors" in their homes and communities, as their enthusiasm can influence families and friends to establish home pollinator gardens.

Some schools in Great Barrington may have existing garden programs, and Monument Mountain High School already has a horticulture program for students. If adding pollinator gardens is of interest to a school, and possibly, creating a pollinator-based lesson plan, the following resources may be of assistance. As school gardens require the commitment of many, available curricula and/or packaged kits can make the process easier to undertake.

- Pollinator Partnership provides a list of curriculum, education tools and helpful links, including a Bee Smart® School Garden Kit targeted to students in grades 3 to 6. Their Pollinator Gardening Curriculum is a PDF curriculum packet with lesson plans and activities for pollinator garden education.
- The U.S. Fish & Wildlife Service provides pollinator-related outreach and education materials as well as a schoolyard habitat guide.
- Pollinator LIVE offers links to a series of live interactive webcasts, satellite field trips, and web seminars about pollinators, gardening, and conservation. PollinatorLIVE provides lesson plans for PreK through grade 12.
- The Elkhart Education Foundation has a "Living Garden Project" and is an example of what an outdoor classroom might resemble in Great Barrington.
- Project Learning Tree is focused on environmental education, and has a Massachusetts chapter with courses available. Existing school pollinator gardens across the country are reference examples of different gardens at different scales.

To create a successful pollinator garden, it is helpful to:

- Forge partnerships with garden experts who can provide knowledge and resources to help implement a school garden program.
- Form a team that includes parent volunteers and participation from student or volunteer organizations dedicated to agricultural or environmental studies (such as Greenagers in Great Barrington). A supportive and involved school principal or head groundskeeper is key.
- Utilize the team, particularly the head groundskeeper and/or students, to decide where to place the garden. Choose a site with easy access from classrooms, in plain sight for public viewing, near a water source, and with full sun for a large part of the day.
- Pursue small grant opportunities and ask local nurseries to donate plants.

Photo courtesy of USDA.

Cemeteries

Image courtesy of Flickr user Adrian Tritschler.

The Cemetery Division of the Great Barrington Department of Public Works maintains approximately 140 acres of cemeteries, parks, and green spaces. According to one longtime groundskeeper who spoke at the first pollinator plan public meeting, "Town mows 180 hours a year...anything to reduce that would be great."

In Great Barrington, a lot of the cemeteries are predominantly unused open space, without graves. By implementing more pollinator-friendly mowing regimes, such as mowing only once a year, in late winter, and allowing borders, areas without graves, and forest edges to be seeded with native meadow mixes. Great Barrington's 140 acres of cemeteries, parks, and green spaces could make a significant contribution to town-wide pollinator habitat connectivity, significantly reduce the carbon emissions associated with mowing, and allow the Cemetery Division to free up more time for other activities, including the establishment and maintenance of pollinator habitat.

Other feedback shared at the first public meeting included the comment from one town official that the town has been contacted on several occasions regarding whether it offers any "Green Burial" sites. The Green Burial Massachusetts website defines a green burial as one in which the body is not embalmed; the burial container is made of biodegradable materials, or the body is wrapped in a shroud; there is no vault or cement grave liner – the container or body is placed directly on the soil; and a headstone, if used, is fieldstone or made from indigenous material. The Green Burial movement is part of a much larger societal trend, where people are wishing to remember their loved ones and to be remembered themselves, in the natural environments of forests and fields—in essence, to "return to nature."

Without toxic embalming chemicals leaching into the soil, green burials are clearly beneficial to wildlife as well. They may also provide better habitat than conventional cemeteries. As evidenced by the inquiries the town has already received, there is clearly an economic opportunity here as well: no green burial cemeteries exist in Berkshire County yet.

Refer to the **Establish a Meadow** section of the **Toolkit** for more detailed information on pollinator-friendly mowing regimes and meadow establishment.

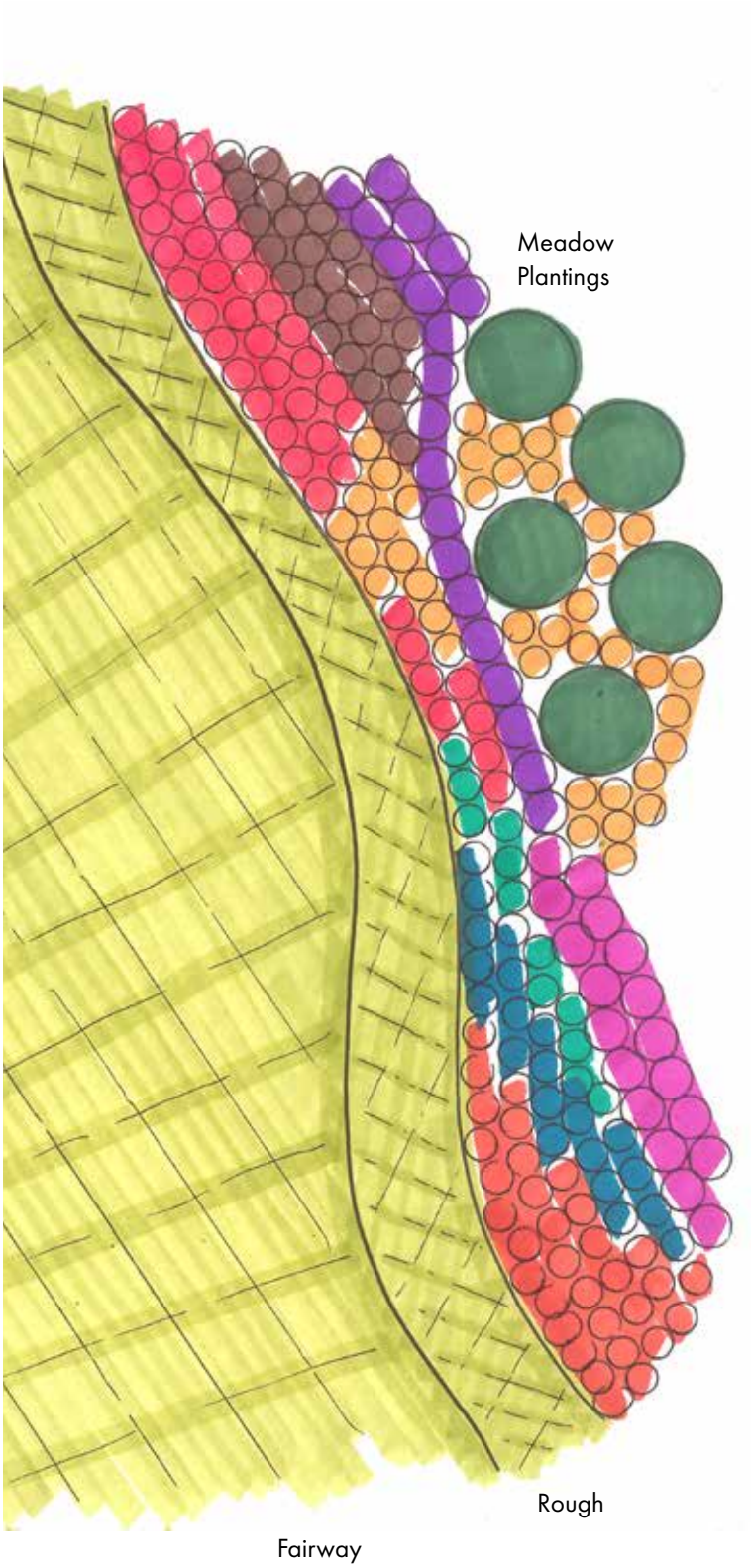
Rockville Links

"The Rockville Links Club is located in a densely populated suburbanized area of Long Island. As one of the few large green spaces in the area, the golf course provides habitat for a number of species of pollinators, as well as birds and other animals.

For the past four years, course superintendent Lucas Knutson has been identifying opportunities to enhance habitat on the golf course. He has taken advantage of opportunities to reconfigure, including opening up areas by removing trees damaged by Hurricane Sandy, and is incorporating native plants, establishing wildflower areas, installing bee hives, and adding nesting areas for birds, waterfowl, and bats.

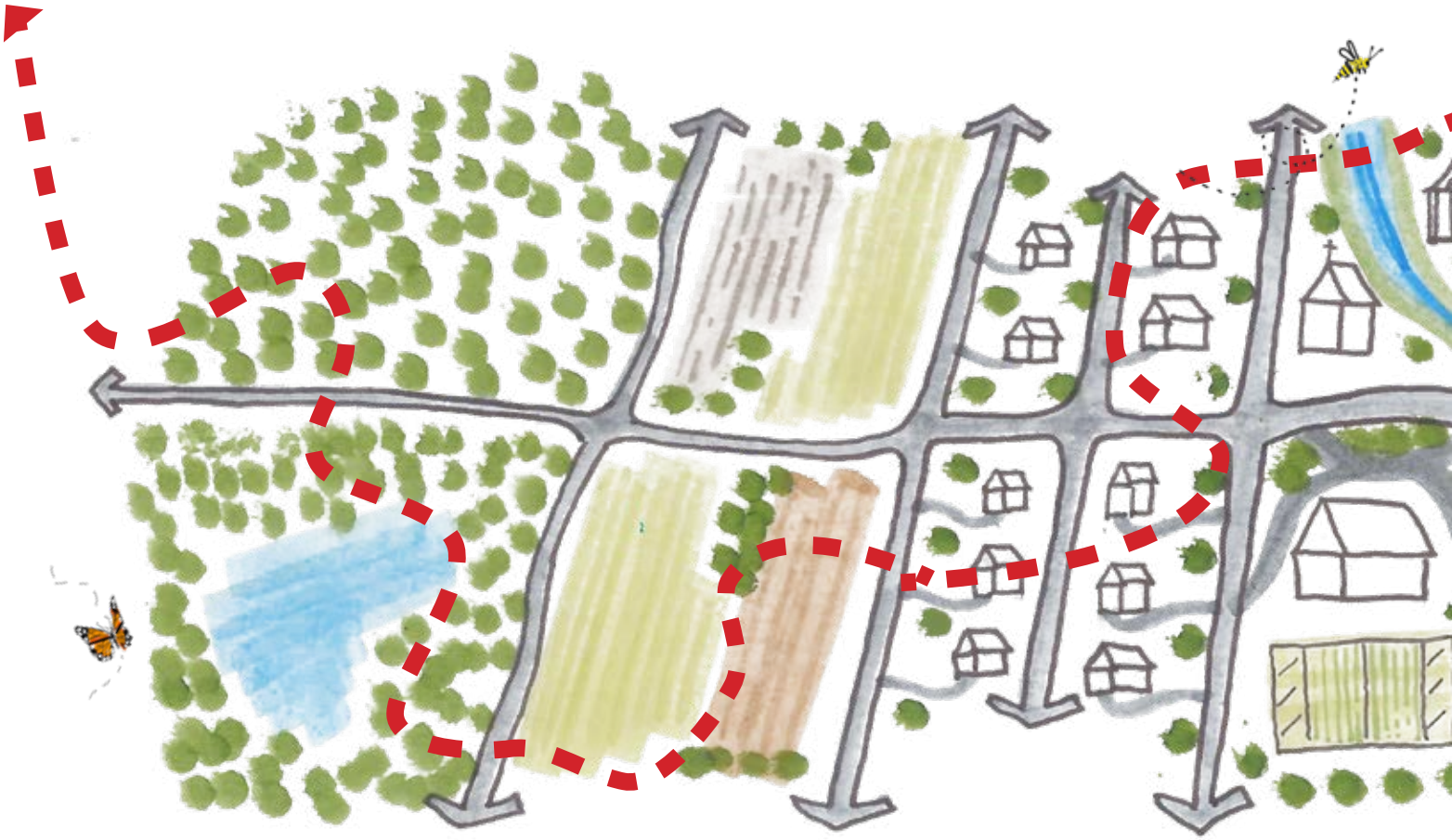
Beekeepers are responsible for installing and maintaining the hives, harvesting the honey, and overwintering the hives. In addition, the beekeeper conducted research on the pollen brought back to the hive by the bees. The results showed that two insecticides were present in small amounts on some of the pollen, but these were insecticides not used on the golf course. Additional research is planned to study and analyze the beeswax.

Golf course members have been supportive of the project. While some members initially raised concerns about the potential to be stung by the bees, Knutson has not heard of any instances where this has happened since the hives were installed. The bees typically fly out of the hives (with the "runways" positioned away from the area of play) and immediately increase altitude to 20 to 30 feet above the ground surface. Signs placed in the pollinator areas serve to let people know where the hives are to promote the project as environmentally beneficial." (Cornell University, 2016)



Meadow plantings along golf course edges will expand pollinator habitat and filter chemical runoff.

By establishing pollinator habitat in each of these land use zones, interconnections can be made throughout Great Barrington.

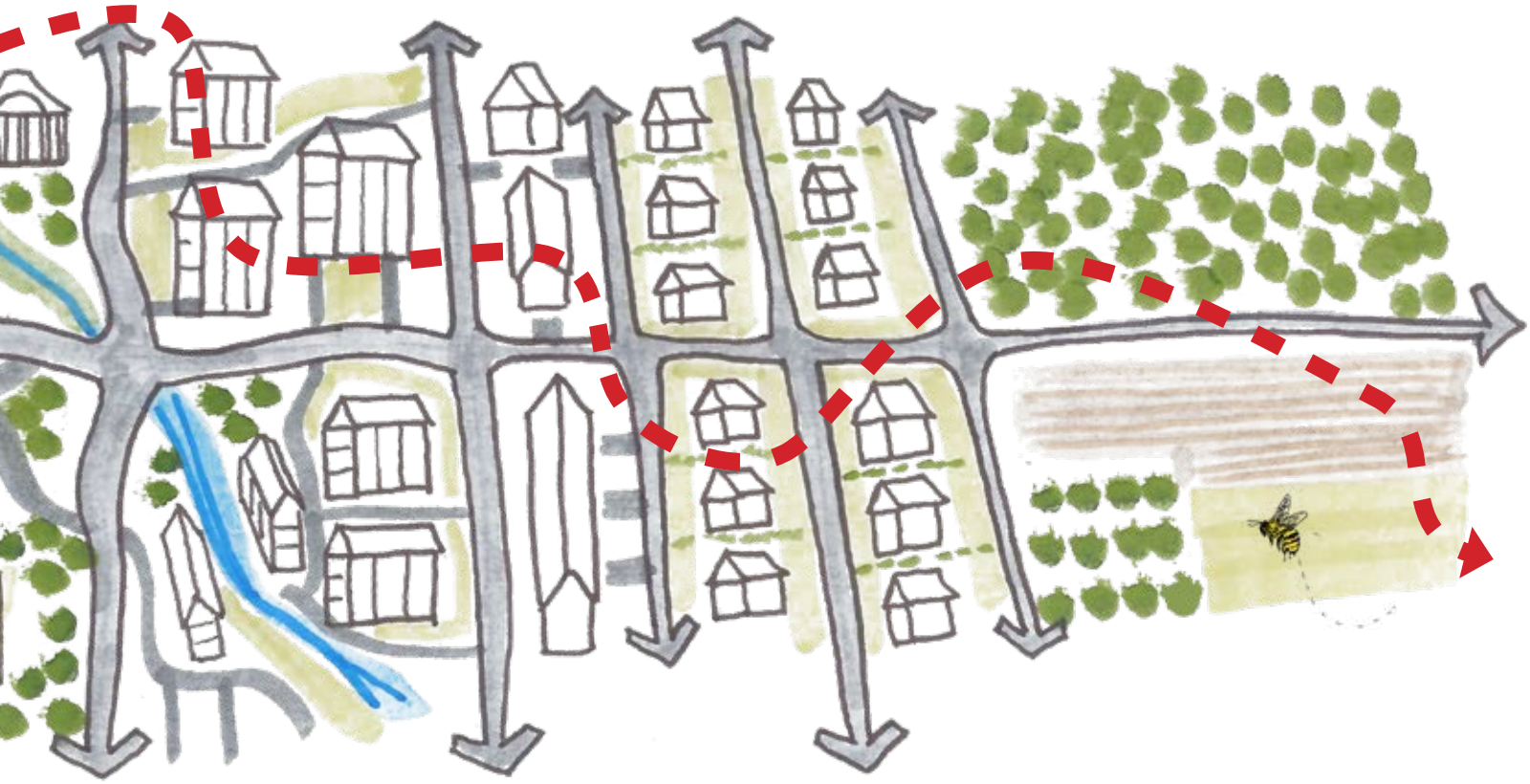


Protected Land

Agricultural

Residential

Considerations in Planning a Pollinator Network



Downtown Core

Commercial / Residential

Rural / Forested

There are numerous factors to take into consideration before selecting a site for pollinator habitat, and deciding which plants to establish, and by what method. The following pages present a process for making these decisions, listing relevant questions. As each site and situation are unique, different questions may arise which are not found here.

Once you understand the prevalent conditions which affect your site, you may turn to the **Toolkit** chapter, where more detailed planting diagrams, plant lists, and maintenance instructions are presented, to guide the process of creating a successful pollinator habitat network.

Property Selection

Prioritizing parcels for pollinator habitat in Great Barrington may be based on:

- **Property ownership** with town-owned parcels given the highest priority for faster implementation
- **Proximity** to other areas of potential pollinator habitat, to establish connectivity throughout town
- **Visibility** with centrally located sites being of highest priority, to inform and engage the public

Once a site is selected, the following considerations can help define what type of habitat may be most suitable.

EXISTING CONDITIONS

What are the physical and cultural characteristics of the site(s)?

PLANTING REQUIREMENTS

What is needed to establish the desired vegetation to enhance pollinator habitat?

MAINTENANCE REQUIREMENTS

What management criteria may be required following installation?

Existing Conditions are understood to be the ecological and cultural components that may influence a site. Assessing the following can help how alterations will be made and ensure that appropriate landscaping decisions are made, that the plants that are chosen are suitable for the unique conditions present, and that the kind of plant communities that are established will thrive.

- What habitat & vegetation currently exist, and what life do they support?
  What's doing well where? Are there any invasive plants present?
- Soil type, light conditions, and moisture levels.
  A soil sample will most likely need to be sent to a lab for analysis. Soil type, sun exposure to a site, and the water-holding capacity of the soil will determine which native plant species for pollinators will grow where.
- Parcel size and location.
  Knowing the scale of the site to be planted, and its proximity to disturbed areas or protected habitat, will also help guide the plant and natural community selection process. A wildflower meadow may not be possible in a sidewalk strip.
- Land use history.
  Is there a history of pesticide use, or environmental contamination on the site? Does anything show up in the lab soil test? Environmental remediation may be necessary, or A different site for Pollinator habitat.
- Current land use (and that of adjacent properties, if applicable).
  You may not want to put that delicate hummingbird garden along the boundary of a ball field.

Planting Requirements are guidelines to establish or enhance native vegetation for suitable pollinator habitat. This may be accomplished through multiple phases and at varying scales of parcel size, in order to meet both short and long term goals.

- What is needed to establish native vegetation to create or enhance pollinator habitat?
  Is there lawn or are there invasive plants to be removed? Are soil amendments required? Is direct seeding possible? Should plant plugs be used?
- If particular pollinators are desired, what are their host plants or desired forage plants?
- To attract pollinators, it is generally recommended to provide a variety of plant sizes, shapes and colors, and to include native clumping grasses, sedges, shrubs and trees.
- Increase floral abundance with varied bloom times, beginning early spring through late fall.
  At least three flowering plants in spring, three flowering plants in summer, and three flowering plants in fall.
- Plant large groups of a single species of plants together, rather than interspersed.
- Consider structural arrangements of plantings based on public use.
  Formal or wild? Lower growth close to sidewalks and foot paths?
- Use groundcovers instead of mulch.
  Ground nesting bees require bare, exposed pieces of ground to nest, preferably in sunny, well-drained sites. Establishing low-growing groundcovers early on will also make long term weeding less necessary.

Maintenance Requirements are steps to follow for successful establishment and long-term management.

- What kind of management is required following installation, and how often?
  Mowing/brush hogging, watering, weeding.
- Who will install it?
- Who will maintain it?
- Will staff education and training resources be provided?
- What is the short term and long term budget for maintenance?

The following **Toolkit** chapter includes planting diagrams, detailed maintenance instructions and lists of plants that benefit pollinators, for a variety of site conditions and uses.

Toolkit

The toolkit includes a set of planting design templates representing different site conditions, as well as "how to" instructions that describe best practices for and the nuts and bolts of establishing pollinator habitat. The instructions provide a starting point for landscape design and management.

The following toolkit diagrams include minimum suggested dimensions. When applied to real sites, different tools and sizes may be combined. Plant suggestions are provided in the **Plants for Pollinators** list.

Streetscapes & Parking Lots

A plant bed adjacent to a sidewalk or parking lot bed in full-sun can serve multiple ecological functions while enhancing pollinator habitat. Many plant beds are concentrated in the downtown core of Great Barrington, making them ideal for demonstration.

Herbaceous ground cover provides cover habitat and access to the ground while competing with invasive plants.

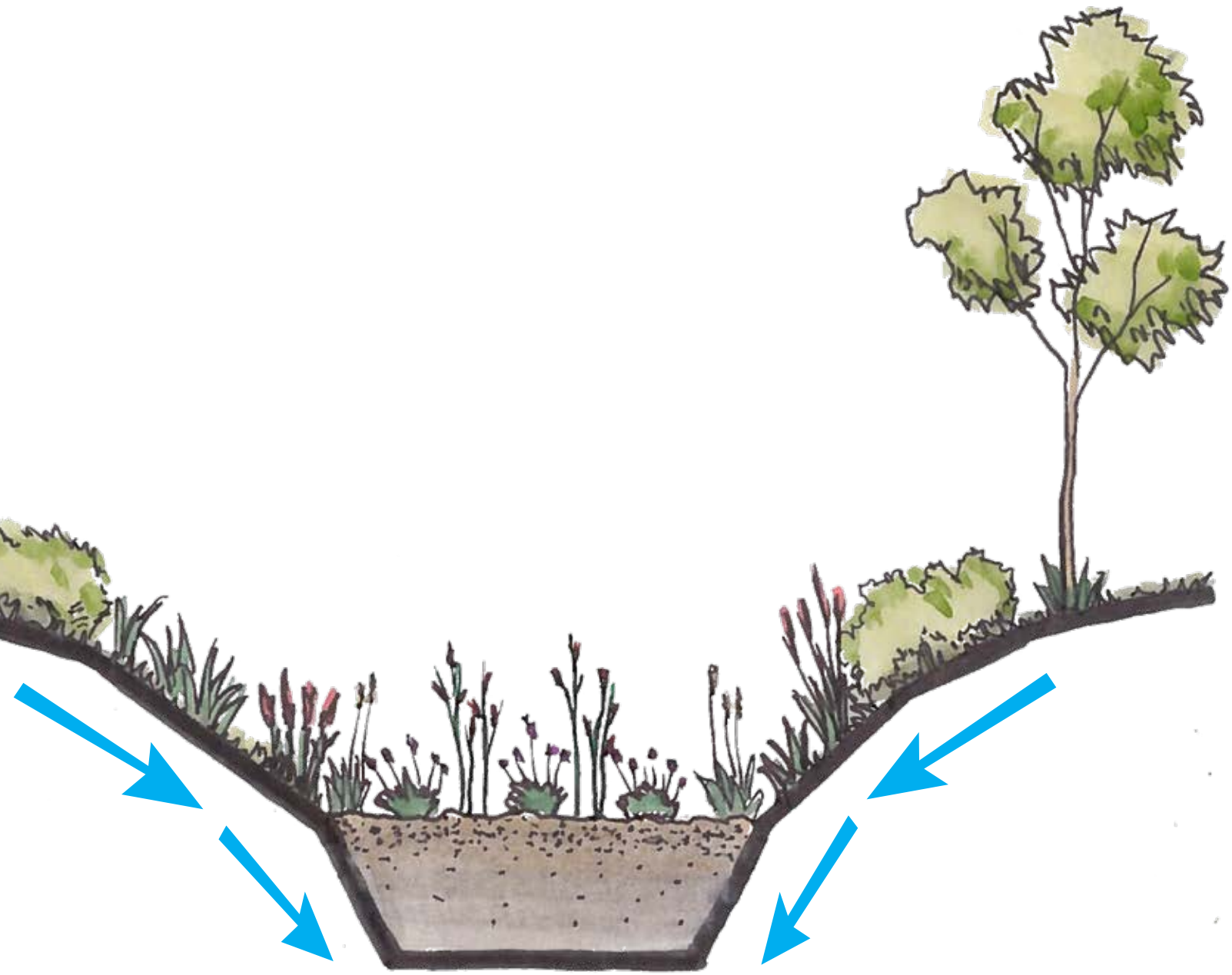
Trees sequester carbon, provide shade, and assist with stormwater infiltration.

Shrubs provide year-long habitat as dead stems are used for nesting.

- June Grass, *Koeleria macrantha*
- Nodding Onion, *Allium cernuum*
- Prairie Alumroot, *Heuchera richardsonii*
- Little Bluestem, *Schizachyrium scoparium*
- Butterfly Milkweed, *Asclepias tuberosa*
- Spotted Bee Balm, *Monarda punctata*
- Wild Petunia, *Ruelia humilis*
- Purple Prairie Clover, *Dalea purpurea*
- Prairie Smoke, *Geum triflorum*

Bioretention Basin

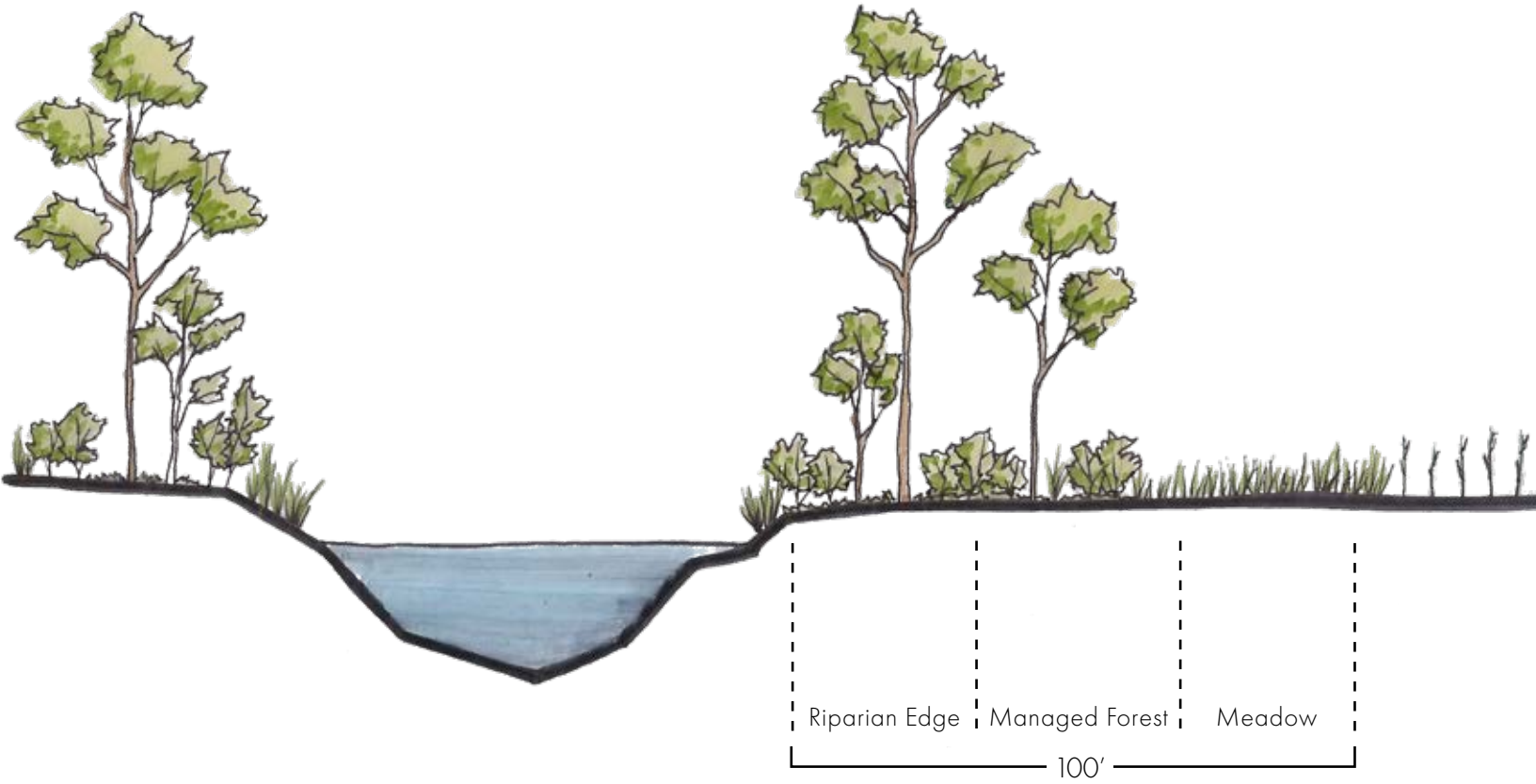
Bioretention systems are used to remove a wide range of pollutants from stormwater, including suspended solids, nutrients, metals, hydrocarbons, and bacteria from runoff.



Riparian Buffer

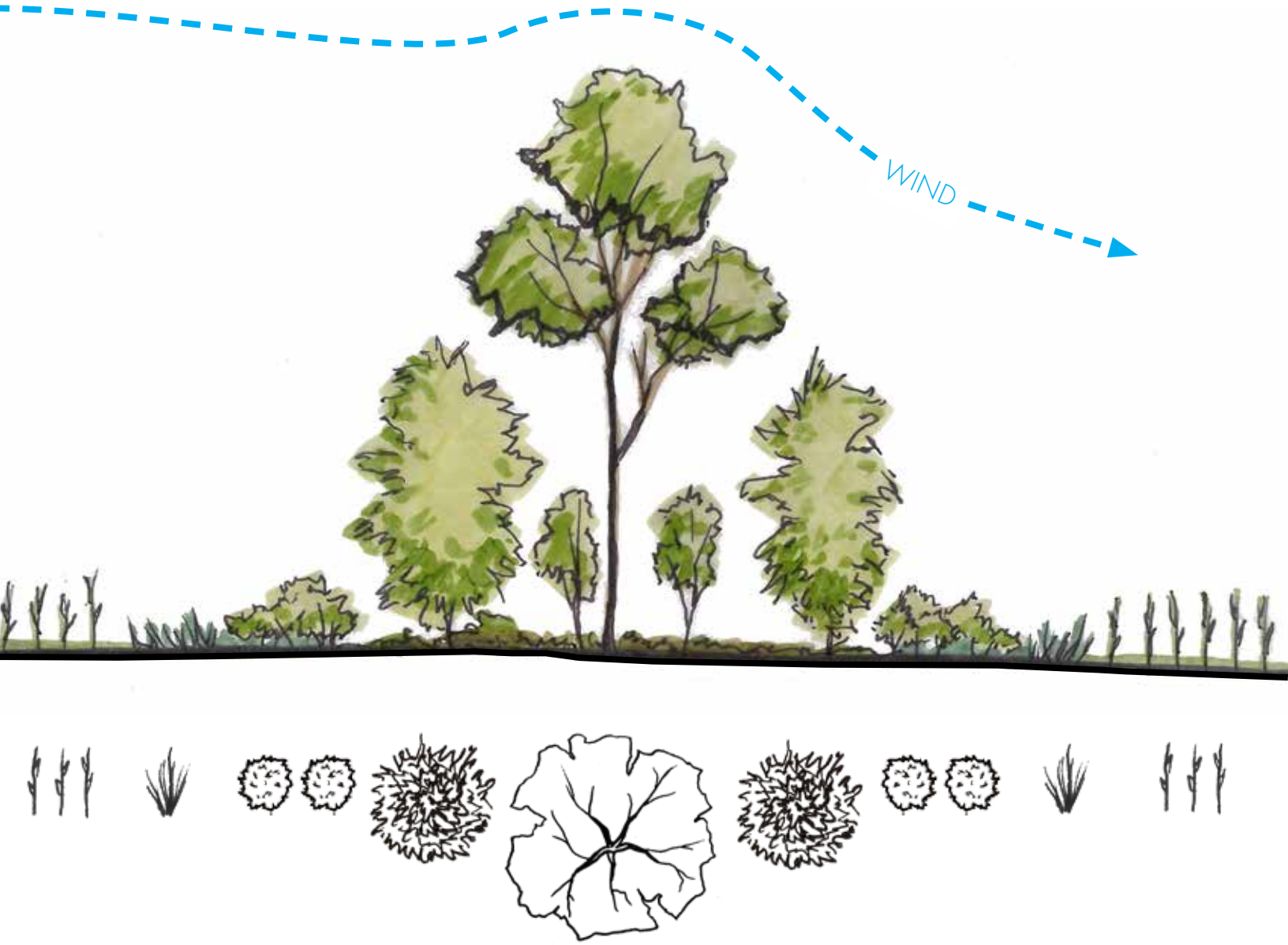
Parallel to streams and rivers, vegetated riparian buffers help filter pollutant runoff and control erosion while also providing pollinator habitat. Extending 100 feet outward from the water, a riparian buffer consists of three zones:

Meadow
Managed Forest
Riparian edge



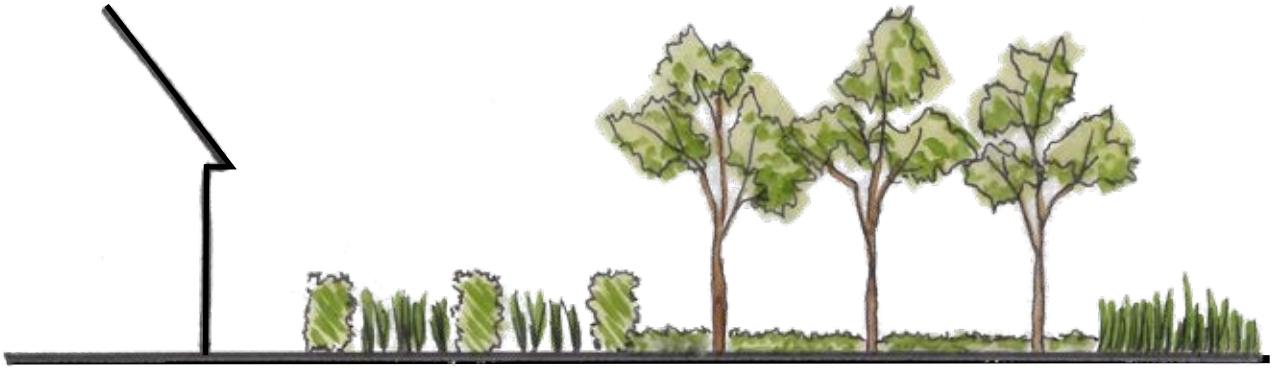
Agricultural Hedgerow

Pollinator hedgerows are diverse linear plantings of native flowering trees, shrubs, perennial wildflowers and grasses, designed to provide foraging and nesting habitat for pollinators.



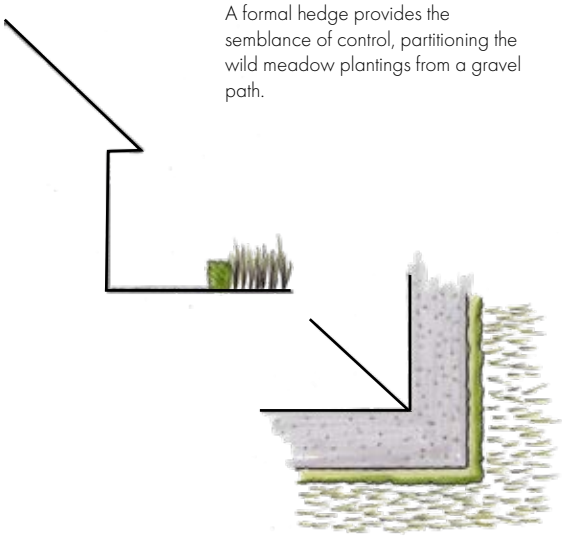
Wild & Neat

Pollinator gardens do not have to be scary and wild. They can provide many ecological services without ruffling too many feathers.

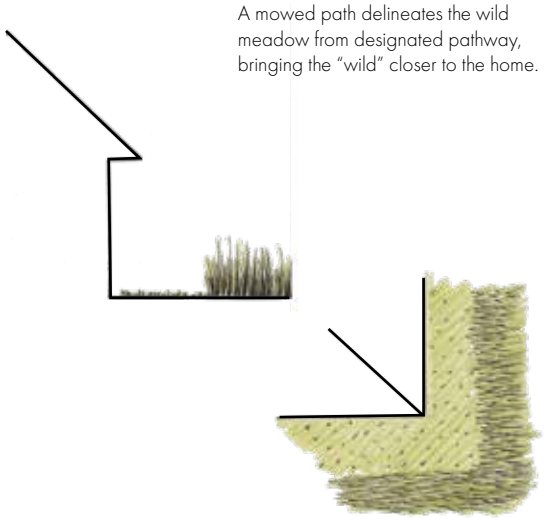


Formal residential gardens can benefit pollinators while providing the semblance of order

Wild plant beds are aesthetically unpleasant to many, but greatly enhance pollinator activity



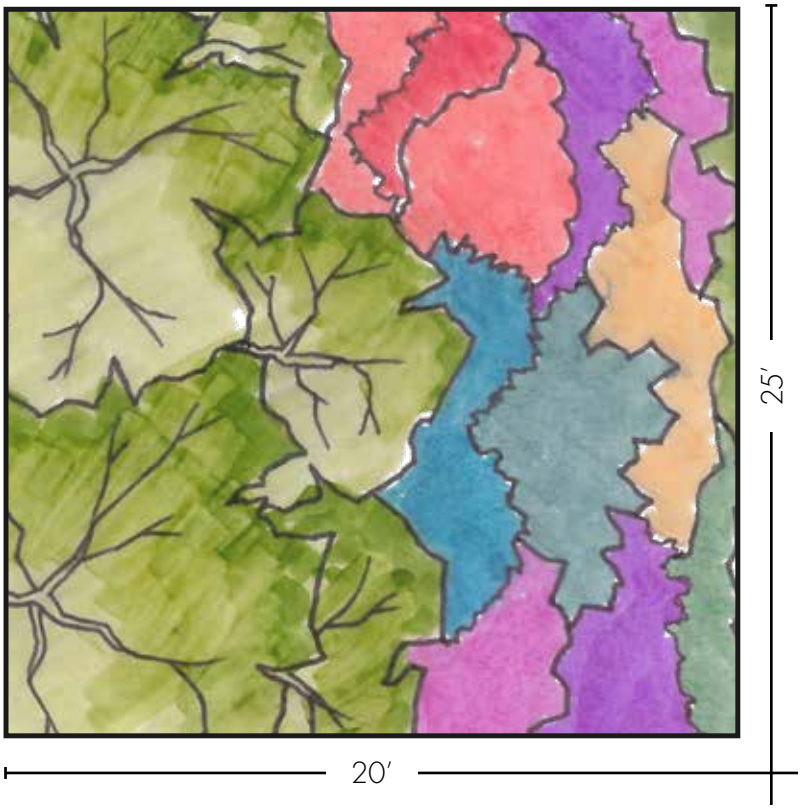
A formal hedge provides the semblance of control, partitioning the wild meadow plantings from a gravel path.



A mowed path delineates the wild meadow from designated pathway, bringing the "wild" closer to the home.

Woodland Edge

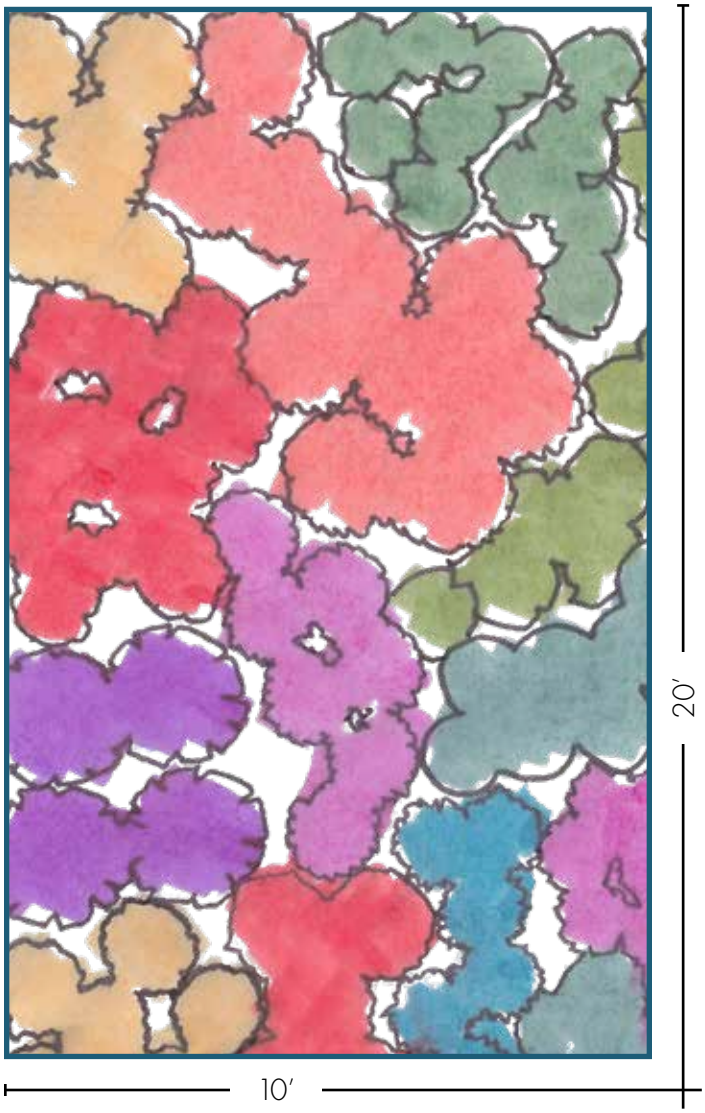
Plants can be added to diversify woodland edges in fields, parks, and residential properties.



- White Baneberry, *Actaea pachypoda*
- Wild Colombine, *Aguilegia canadensis*
- Golden Alexanders, *Zizia aurea*
- Large-Leaved Aster, *Geranium maculatum*
- Zigzag Goldenrod, *Solidago flexicaulis*
- Black-eyed Susan, *Rudbeckia hirta*
- Wild Bergamot, *Monarda fistulosa*
- Jacob's Ladder, *Polemonium reptans*
- Rough Blazingstar, *Liatris aspera*

Bumble Bee Garden

Plants that attract bumble bees could be integrated into any planting scheme.



- Purple Prairie Clover, *Dalea purpurea*
- Hoary vervain, *Verbena stricta*
- Culver's Root, *Veronicastrum virginicum*
- Pale Indian Plantain, *Arnoglossum atriplicifolium*
- Stiff Goldenrod, *Solidago rigida*
- Spotted Joe Pye Weed, *Eutrochium maculatum*
- Smooth Beard Tongue, *Penstemon digitalis*
- Fragrant Hyssop, *Agastache foeniculum*
- Ohio Spiderwort, *Tradescantia ohiensis*

Kit of Parts

As the diagrams below demonstrate, different toolkit parts can be combined and interchanged based on site conditions and preferences.


Woodland edge
Bumble bee garden with approximate 10' x 20' dimensions and a curved edge

Creating a Meadow

From Wildflower Meadows: Let's Get Real *by Larry Weaner and* Establishing Pollinator Meadows From Seed *by Eric Mader, Brianna Borders and Ashley Minnerath.*

"You don't plant a meadow; you set a series of natural events into motion and then guide their development."
—Larry Weaner (as paraphrased in *The Washington Post*)

To increase pollinator populations, the single most effective course of action is to establish a native wildflower meadow. This process consists of five steps:

1. Site analysis
2. Site preparation
3. Plant selection
4. Planting techniques
5. Ongoing management

1. Site Analysis

There are four main aspects to consider in analysis of a site. Item number one is light exposure. Full sun is a necessary requirement for a meadow planting. Insufficient sunlight will favor woody species over herbaceous wildflowers and grasses causing an increase in maintenance requirements.

Soil type will be your next consideration. It is imperative to understand and identify which soil you are working with (sand, loam, clay, etc.) in order to select plants that will adapt successfully to the site. If poor soils exist, a decision can be made to either amend the soil or narrow the plant list to those that will tolerate that specific condition. In some cases bad soil conditions, either poorly drained or very dry, can provide a competitive advantage to the meadow species. Fertilization should in most cases be avoided, as it will probably most likely favor the weeds more than the desirable species.

Grade and topography can affect a number of decisions. A north slope may not be favorable to meadow plants, as they will receive less direct sunlight. If the meadow is in a low lying area and remains wet during spring thaw and rains, plants adaptable to these conditions should be selected. Micro variations within the site can be noted and considered.

Analyzing existing growth on and adjacent to the site can yield extremely valuable information relating to which plants will grow well on the site which what specific weedy species are likely to be a problem. If a problematic weed or invasive plant is existing on or near the site, it is highly recommended to eradicate it beforehand in order to avoid future infestations. Sod removal is relatively easy if the existing vegetation is predominantly low-growing turf grasses. On small patches of land, solarizing the existing vegetation with clear UV-stabilized plastic is very effective.

2. Site Preparation

Much of the process is similar to turf grass seeding. Creating a finely graded seed bed, incorporating the seed into the soil, tamping or rolling for good seed to soil contact and mulching with salt marsh hay or a clean straw is necessary. Timing can be slightly different. Sowing in the fall is limited to late dormant seeding and the spring seeding period can extend into early summer. Late fall sowing is not recommended on sloped sites where erosion can be a problem.

Site preparation begins with the elimination of existing growth. The most common methods are several repeated applications of short lived herbicide, repeated tilling or a combination of the two. Horticultural vinegar (200 grade) is an ecological alternative to herbicides. Tilling will bring to the surface dormant weed seeds which must be allowed to germinate and then shallowly cultivated or sprayed with horticultural vinegar or herbicide before planting. A no-till seeding is possible if a shallow seed bed can be worked up among the dead plant material.

3. Plant Selection

Based on your analysis of the site, you can now select the plant species that will form your seed mix. To best support pollinators, there are several points to take into consideration.

Floral Diversity

Select a diversity of plants with different flower sizes, shapes, and colors, as well as varying plant heights and growth habitats, to support the greatest numbers and diversity of pollinators. At minimum, strive for three species to be blooming at any one time. If you would like to attract butterflies, including the larval host plants for the species that exist in your area is key (see **Plants for Pollinators** list).

Image courtesy USFWS Mountain-Prairie

In general, the plants that will afford the best long term results will invariably be those that are found in conditions similar to your site and are native to your particular region. As in most naturally occurring meadows and prairies, grasses should be a component of the plant mix, but for the benefit of pollinators, grasses and sedges should not comprise more than 25 percent of the mix by seed per square foot. Some grasses and sedges are larval host plants for butterflies, and provide nesting sites for some bumble bees and other insects. Only clump forming grasses should be used, including Little Bluestem *(Schizachyrium scoparium)*, Indian Grass *(Sorghastrum nutans)*, and Purple Lovegrass *(Eragrostis spectabilis)*. A nurse crop usually composed of fast germinating, clump forming grasses such as Canada Rye or Annual Rye should also be included to help secure the site from weed invasion and erosion during the first season.

Occupy Every Niche

An important concept to understand when combining plant species is the concept of niche. A study of a mature Midwestern prairie will reveal an incredibly dense tapestry where every possible space is occupied. If all of these elements are present the meadow will have a strong capability to resist weeds. There is no place left for them to grow.

You also need to fill the niches in time. Some plants are active in warm weather while some plants are most vigorous during the cool seasons, particularly spring. By including both types there will be no seasonal opening for weed invasion. Some plants establish a cover during the first year, some during the first few years and some long lived plants may not have a serious presence for many years. Purchase a seed mix that is not only appropriate for the geographic region of the site, also for the soil type.

4. Planting Techniques

For wildflowers, particularly perennial species in New England, early fall planting is often best. Many perennial plant seeds require exposure to cold temperatures and damp conditions before germination can occur. Winter precipitation also helps the seeds settle into the soil and will stimulate germination. Spring planting is possible, but typically favors grasses rather than the wildflowers that you want to dominate your pollinator habitat.

Due to the small size perennial flowers and some grasses, it will be necessary to mix the seed with an inert material like sawdust or sand before spreading. To achieve good seed to soil contact, the seed can be compacted into the ground with a standard lawn roller or the wheels of a tractor.

Meandering paths and secluded sitting areas can be seeded with low grasses and spring ephemeral flowers and occasionally mown during the season for easy access.

5. Ongoing Management

An understanding of "ecological succession" is important for the maintenance of a meadow. Ecological succession is the process by which a disturbed area progresses naturally from herbaceous meadow (first annuals, then perennials) to woody shrubs and pioneer trees and finally to a mature forest. In establishing a permanent meadow in the northeast, where woods naturally predominate, we are arresting the process of ecological development at the herbaceous perennial stage.

Although a meadow, once established, will require substantially less maintenance than a mowed lawn, the first one to two years will require guidance in order to achieve success. A maintenance plan should be in place before starting, to insure that this crucial portion of the project is not later neglected.

For the first year or two after planting, it will be necessary to carry out a weed control program. The methods that will be most appropriate will be determined by the size of the project, maintenance budget, method of installation and what weed species appear. As the process of ecological succession would suggest, the first year will bring a rapid cover of annual weeds while the perennial wildflowers and grasses are slowly developing underneath. This is to be expected, and if managed properly, is not a problem.

By mowing the meadow every 6 weeks to a height of 4-6 inches, you will not only prevent the annual weeds from seeding, but ensure that the young perennial plants growing below your mow height receive enough light for strong establishment. These perennials will emerge the following year far stronger than if they had been buried under 4 feet of annual foliage the first year. This is why the inclusion of annual wildflowers in your seed mix can be detrimental to the long term health of the planting.

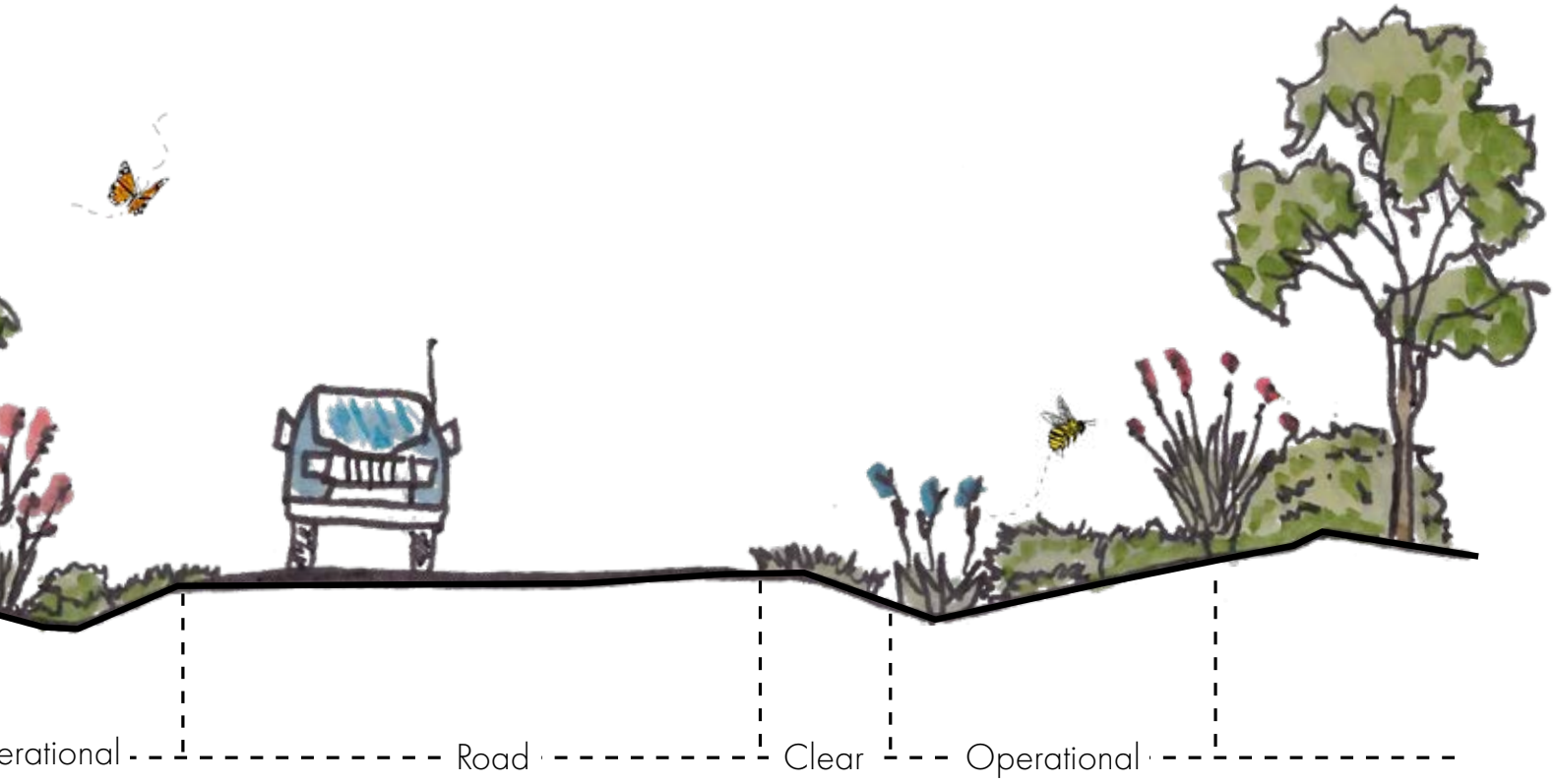
During the second year the faster growing perennials will begin to provide color, and the entire planting should be well enough established to allow a decrease in weed control. You will need to monitor the planting for those weeds that can cause problems for the meadow. If needed, control can be obtained through spot herbicide or horticultural vinegar application, manual weeding, or an additional mowing immediately following the most active growth period of the problem weed.

By the third year the native meadow plants should be fairly dominant on the site and able to resist weed invasion with minimal management. Once the meadow is mature, you should only mow or burn part of the planting in a single season—ideally one-third or one-fourth of the overall area in late winter or early spring. No single area should be burned or mowed more frequently than every two years, to protect dormant insects such as butterfly pupae or stem nesting bee larvae. After several years, re-seeding may be necessary to support long term plant diversity. For aggressive species, you may wish to remove seed heads to slow their expansion.

Adapted from US DOT Handbook, 2015

Managing Roadsides for Pollinators

Roadsides can function as linear pollinator corridors of flowering vegetation. By implementing the methods outlined on the following pages, plants flower longer during key larval stages while expanding pollinator habitat. Some key benefits to roadside meadows are reduced mowing cost, stormwater infiltration with native plant species, and invasive species reduction.



1. Assess Current Conditions

Identify the existing vegetation, soil type(s), sunlight levels, moisture levels, and adjacent land use to inform planting decisions and mowing schedules. Understanding what vegetation is present will help inform which pollinators are present. Milkweeds can commonly be found growing on roadsides (Hartzler, 2010). A key step in effective roadside management for pollinators is to identify native plant communities, as well as locations where invasive species are present. If maintenance staff does not have the expertise to conduct surveys, there are many public agencies or private organizations that would likely be willing to partner to the mutual benefit of all involved (Hopwood, et al., 2015).

2. Create Zones

- **Clear zone:** a narrow strip alongside the road that is routinely mowed, at a low-growing height of approximately 3 inches.
- **Operational zone:** mow once a year in winter to avoid encroachment of woody plants.
- **Buffer zone:** no mowing should occur here, to allow native or naturally occurring vegetation to grow unimpeded (Hopwood, et al., 2015).

It is recommended to routinely mow a low-growing 6-foot wide clear zone along roadsides, with an operational zone adjacent that is mowed once a year, and a buffer zone beyond, where native vegetation grows naturally (Hopwood, et al., 2015).

3. When to Mow

Understanding pollinators is important to determine mowing schedules. Mowing is detrimental for monarch butterflies if it takes place during peak reproduction times (Hopwood, et al., 2015). Monarch butterfly eggs are laid mid-March, so mowing during this period can destroy their caterpillars, as well as the nests of tunnel-nesting bees. At the same time, many overwintering pollinators depend upon standing dead matter for late season foraging. It is therefore recommended to do annual mowing in late winter as a general practice.

4. Emulate Native Plant Communities

Native plant communities support a healthy ecosystem as well as the natural heritage of an area. When seeding or planting roadsides for pollinator habitat, consider including:

- Host plants for specific pollinators (refer to **Plants for Pollinators**).
- A diversity in plant sizes, shapes and colors.
- Native clumping grasses, sedges, shrubs and trees.
- Increased floral abundance with varied bloom time, from early spring to late fall.
- Planting single species together in communities.

5. Post Signage

Signs along roadsides that inform the public that reduced mowing is intentional, rather than a lapse of management, can raise awareness.

6. Train Staff

Management personnel should be informed as to the importance of conserving pollinator habitat. Training includes:

- The role that roadsides have in pollinator conservation, and basic pollinator information
- Implementation guidelines and management techniques
- Plant identification of native versus invasive species
- Native plant establishment and basic design guidelines
- Education on the long-term economic and ecological value of native plants and pollinators (Hopwood, et al., 2015).

Operational zone with natural plantings (opposite). Photo courtesy of Robyn A. Jeney, New Jersey Pinelands Commission.

Some obstacles that risk impeding implementation of these protocols may need to be addressed:

Obstacles	Possible Solutions
DPW may not have the training necessary to conduct roadside vegetation surveys or identify plant species.	Partner with local horticultural or botanical experts, State agencies, and/or universities to conduct roadside surveys with maintenance staff. Create and distribute laminated flashcards of plant species to field staff.
The DPW may not have information on pollinator life cycles or the ability to identify certain pollinators.	Partner with entomologists to provide training on pollinator identification and their habitat. Create and distribute flashcards with pollinator images to field staff.
Town residents and visitors may perceive the wildflower vegetation as messy or unkempt, rather than as valuable pollinator habitat.	Partner with other town agencies and local businesses to display brochures or other educational information on the value of pollinators.
The major and minor roads in Great Barrington that cause some of the greatest fragmentation are maintained by MassDOT, not the DPW.	Contact MassDOT to request that strategic mowing practices are implemented to encourage pollinator habitat. Test a roadside area to implement and assess results.

(US Forest Service)

Limiting Exposure to Ticks

One concern many people have about meadows is the presence of ticks. Generally, ticks prefer moist, shady habitat to dry, sunny areas. Meadows in full sunlight do not provide these ideal conditions. In addition, there are a range of techniques for decreasing the presence of ticks in the landscape:

1. Mow Wide Paths

Maintaining wide, well-mowed edges between meadows (and wooded areas, which also provide good tick habitat) and where people walk and play can minimize the potential for contact. So too can edging meadows with wood chips, which ticks don't like to cross.

2. Raise Fowl

Chickens and Guinea hens love to eat insects. Both are an effective way to reduce the tick population—and provide you with fresh eggs. If you go this route, make sure you research the proper food and shelter these birds need and be sure to let them free range where you want the ticks removed.

3. Hang Bat Houses

70 percent of the more than 1,000 bat species are insectivores, meaning they feed solely on insects. Some insectivorous bats can catch up to 600 mosquitoes in an hour. Bats also east ticks. One of the most common bats, the little brown bat *(Myotis licifugus)* is known to consume one third of its body weight in as little as 30 minutes. Commercially made bat houses are available online and in hardware stores, and can be hung from trees facing east.

4. Exclude Key Wildlife

Deer are important to the reproduction of ticks. The exclusion of deer from large areas by fencing and hunting has been shown to significantly reduce tick abundance. According to a study conducted by the Connecticut Agricultural Experiment Station (CAES), deer tick larvae, nymphs and adults were reduced by 100, 85, and 74 percent, respectively, 300 feet within an area surrounded by an electric deer fence. Clean up stonewalls near the home that provide shelter for mice and chipmunks. Place wood piles away from the house.

Browsing by deer around the home can be discouraged by including landscape plants that are less palatable to deer. Plant the most deer resistant plants along the edge of the property to deter deer from entering your landscape to feed. A deer repellent such as *Plantskyyd* also reduces the attractiveness of plantings to deer.

5. Prescribed Burning

Mature meadows can be managed through prescribed burning — but in order to protect pollinator habitat, only one-third to one-fourth of the overall area should be burned, and not more often than every two years. According to University of Georgia research, tick populations can be managed through prescribed burning. At plots tested where there was no burning, tick counts were 10 times greater in the warm season than sites where prescribed burning occurred.

6. Remove Barberry

Japanese barberry *(Berberis thunbergii)* is a spiny, red-berried shrub that is one of the most widely used ornamental plants in the United States. It's also widely considered one of the main vectors for Lyme disease. Studies done by the University of Connecticut and CAES found that forests infested with Japanese barberry had 12 times more deer ticks than forests that were not: they observed 120 disease-infected ticks per acre in forests with barberry, compared with just 10 infected ticks per acre of forest without barberry.

Why Barberry?

Thanks to deer's distaste for its harsh chemicals and spiny branches, Japanese barberry is left alone to thrive while other plants such as red trillium get shaded out or nibbled to the ground. Barberry also has foliage that's denser than most native species: as a result, the plants retain higher humidity levels. Ticks need humidity to survive and thrive: relative humidity under a barberry is about 100 percent at night. The shrubs also provide nesting areas for white-footed mice and other rodents, which are primary carriers for *Borrelia burgdorferi* (lyme Disease).

Barberry is shade tolerant, drought resistant, and highly adaptable. It grows in open fields, wooded areas, wetlands, and disturbed habitats. It prefers full sun but will flower and bear oval berries even in heavy shade. It can live in a swamp or a parking lot.

The good news is that the researchers in Connecticut found that controlling Japanese barberry can cut tick populations by up to 80 percent.

Japanese barberry (Berberis thunbergii) *image courtesy of Plant Conservation Alliance's Alien Plant Working Group*

Barberry Control Methods:

Simply cutting barberry to the ground will not destroy the plant. Japanese barberry grows as a clump of semi-woody stems that emerge from the basal root crown. It quickly grows new sprouts after cutting.

1. Manual Removal

You can remove barberry bushes by pulling them out by hand, or using a tool like a "Puller Bear." Wear thick gloves and protective clothing, as the thorns are very sharp. If the plants you're pulling up have berries on them, it may be best to dispose of them by burning them, or by turning them root-side up and exposed to direct sunlight in a clearing.

2. Mechanical Removal

Cut or sever the aboveground portion of the plant by means of loppers, chainsaw, brush saw, brush mower, or drum chopper; then pull above-ground stems and roots together using a mattock or weed wrench.

3. Directed Flame

Propane torches or flame weeders can be used to apply high-intensity heat to above-ground portions and root crown of barberry clumps.

4. Prescribed Fire/Controlled Burning

Using carefully controlled conditions, prescribed fire can be an effective initial step to reduce the size and density of barberry infestations. This method requires highly specialized skills, planning and trained personnel.

5. Plant Something Native

If you don't plant something where the barberry was, there's a good chance that another Aggressive plant will move in.

Engaging the Public

There are many ways to engage the public on the value of pollinators and emphasize Great Barrington as a Pollinator-Friendly Community.

Pollinator Trail

A Pollinator Trail can link pollinator gardens and habitat areas throughout town. Local artists could be asked to create pollinator-inspired artwork or signage for placement in designated plantings. A pollinator network map could be displayed around the town and region for visitors to follow. Establishing an annual "Pollinator Garden Walk" similar to the Garden Walk in Buffalo, NY or Wasatch Gardens in Salt Lake City, UT is a way to get local homeowners and businesses involved. Neighborhood groups can offer tours through properties. Workshops could be held throughout the event. A pollinator trail could:

- Increase visitors to Great Barrington
- Amplify public awareness
- Create a revenue opportunity if a small entrance fee is charged
- Involve local businesses
- Provide an incentive for homeowners to establish pollinator habitat on their properties

Greenagers is a youth environmental organization based in the village of Housatonic, which is dedicated to community engagement through productive labor in local agricultural, gardening and conservation work. Greenagers' mission is "Youth working to strengthen the environment and our community." Greenagers has done so by pioneering a vibrant youth employment program in the southern Berkshire area, as well as furthering youth volunteering and service learning in the region. Executive Director Will Conklin expressed an interest at the first public meeting in having pollinator garden templates that he and his youth workers could offer to residential clients, in Great Barrington and throughout the southern Berkshires, as they already have a strong client base throughout the region.

Bee Involved

The University of Maryland's "Adopt a Pollinator" program has been a successful effort to further demonstrate pollinator habitat. This concept encourages departments at the University to plant and maintain pollinator gardens, or "Bee Involved". By doing this in Great Barrington, the public may feel included and challenged to take on a pollinator garden of their own. The "Bee Involved" project can be displayed in schools, markets, libraries, storefronts, and on the town website, promoting the significance of pollinators while educating the public.

Organizations such as the North American Butterfly Association certify gardens as "Pollinator Friendly." Placing signs in gardens that signify their "Pollinator Habitat" value raises public awareness. "Pollinator-Friendly Business" stickers can be placed in the windows of local businesses.

Pollinator Garden Kits

Gardening can be a daunting task for people who may not have experience or time to plant a garden. Pollinator Garden Kits can be created through the partnership of local nurseries, horticulturists, landscape professionals, and gardeners, and offered for sale at local nurseries or the town's website to promote pollinator habitat and generate revenue for future pollinator actions. These kits could consist of pollinator-friendly seeds, planting diagrams for various plot sizes and soil types, and a "How to Install" section that guides the user through the implementation process of a pollinator garden. Organizations like **Millionpollinatorgardens.org** also connect people with nurseries where they can purchase pollinator-appropriate plantings, while at the same time promoting a database for local pollinator gardens that is searchable based on zipcode.

Making bee hotels like these could be the perfect community workshop activity. Image courtesy of Marta Zientek and Wojciech.

The USDA's People's Garden encourages people to create habitats on their own to help pollinator species in Washington, D.C. Image courtesy of USDA.

Resources

Books:

100 Plants to feed the Bees by the Xerces Society

Bees: An Identification and Native Plant Forage Guide by Heather Holm

Bringing Nature Home by Douglas W. Tallamy

Caterpillars of Eastern North America by David L. Wagner

Farming with Native Beneficial Insects — a Xerces Society Guide

Native Plants of the Northeast: A Guide for Gardening and Conservation by Donald J. Leopold

Noah's Garden by Sara Stein

Peterson Field Guide to Moths of the Northeast by Beadle and Leckie

Planting in a Post-Wild World: Designing Plant Communities for Resilient Landscapes by Thomas Rainer and Claudia West

Pollinators of Native Plants by Heather Holm

The Bees in Your Backyard by Joseph S. Wilson and Olivia Messinger Carril

The Family Butterfly Book by Rick Mikula

The Green Garden by Ellen Sousa

The Living Landscape: Designing for Beauty and Biodiversity in the Home Garden by Doug Tallamy and Rick Darke

The Wildflowers of New England by Ted Elliman and the New England Wildflower Society

The Xerces Society Guide to Attracting Native Pollinators by Mader et al.

Online:

Bee Monitoring Protocol (for established plantings): http://xerces.org/streamlined-bee-monitoring-protocol/

Don't Mow Let it Grow: http://dontmowletitgrow.com

Establishing Pollinator Meadows from Seed: https://xerces.org/establishing-pollinator-meadows-from-seed/

Habitat Aid: https://www.habitataid.co.uk/

Habitat Planning for Beneficial Insects: http://xerces.org/habitat-planning-for-beneficial-insects/

New England Native Forbs of Short to Medium Stature: http://nenativeplants.uconn.edu/native

Organic Site Preparation for Wildflower Establishment: http://xerces.org/guidelines-organic-site-preparation/

Pollinator Habitat Assessment Guides: https://xerces.org/pollinator-conservation/habitat-assessment-guides/

Plants for Pollinators

The following lists are by no means comprehensive and only represent a starting point for pollinator habitat creation.

Wildflowers & Grasses

Andropogon gerardii: Big bluestem

Asclepias tuberosa: Butterfly weed

Baptisia species: False indigo

Boltonia asteroides: Thousand flowered aster

Eupatorium fistulosum: Joe Pye weed

Festuca longifolia: Hard fescue

Festuca ovina: Sheep fescue

Liatris species: Blazingstar

Lobelia cardinalis: Cardinal flower

Lobelia siphilitca: Blue lobelia

Monarda fistulosa: Bergamot

Schizacharium scoparium: Little bluestem

Solidago species: Goldenrod *(Do not use* Solidago canadensis, *as it overwhelms desired vegetation.)*

Sorghastrum nutans: Indian grass

Vernonia novaboracensis: Ironweed

Trees & Shrubs

Amelanchier stolonifera: Running service berry

Chamaedaphne calyculata: Leatherleaf

Diervilla lonicera: Bush honeysuckle

Hamamelis virginiana: American witchhazel

Ilex Verticillata: Common winterberry

Photinia melanocarpa: Black chokeberry

Vaccinium corymbosum: Highbush blueberry

Viburnum acerifolium: Mapleleaf viburnum

Photo courtesy of US Fish and Wildlife.

Photo courtesy of Flickr user pxhere.

Photo courtesy of Flickr user Arcacion.

Perennial Flowers

Aquilegia canadensis: Red columbine

Asarum canadense: Canadian wild ginger

Asclepias incarnata: Swamp milkweed

Cardamine concatenata: Cutleaf toothwort

Maianthemum racemosum: Feathery false lily of the valley

Penstemon hirsutus: Hairy beardtongue

Tiarella cordifolia: Foamflower

Trillium grandiflorum: White trillium

Uvularia grandiflora: Large bellwort

Zizia aurea: Golden zizia

Vines

Celastrus scandens: American bittersweet

Clematis virginiana: Virgin's bower

Mitchella repens: Partridgeberry

Cover Crops

Nitrogen Fixing: Alfalfa, White clover, Red clover, Cowpea, Lupin, Partridge pea, Sunn hemp, Vetch

Erosion Control: Cowpea, Crimson clover, White clover

Weed Management: Buckwheat, Cowpea, Sunflower

Nematode Management: Brassicas and Mustards

Cover Crop Cocktail Mix

Buckwheat, Phacelia, Crimson clover, Radish (daikon), Hairy vetch, Field pea, Turnip, Fava bean, Rye, Oat

Plant Lists Online

Massachusetts NRCS: https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/nypmctn11164.pdf

New England Wildflower Society: http://www.newenglandwild.org/grow/pollinators/pollinators.html

Pollinator Partnership: http://pollinator.org/PDFs/Adirondack.rx2.pdf

Xerces Society: https://xerces.org/pollinator-conservation/plant-lists/pollinator-plants-northeast-region/ and http://www.xerces.org/wp-content/uploads/2014/09/NortheastPlantList_web.pdf

Larry Weaner: Let's Get Real: http://lweanerassociates.com/?p=1203

University of New Hampshire: https://extension.unh.edu/resources/files/Resource005973_Rep8387.pdf

American Meadows. https://www.americanmeadows.com/wildflower-seeds/northeast

SARE: https://www.sare.org/Learning-Center/Bulletins/Cover-Cropping-for-Pollinators-and-Beneficial-Insects

Get Funded

There are many state-level and national programs providing financial assistance and incentives for creating pollinator habitat.

- MassWildlife Habitat Management Grant Program
- MA Department of Conservation and Recreation: Land and Recreation Grants and Loans, Forest Stewardship Program
- Natural Resource Conservation Service (NRCS): Conservation Stewardship Program (CSP), Environmental Quality Incentives Program (EQIP), Agricultural Conservation Easement Program (ACEP), Using Farm Bill Programs for Pollinator Conservation
- US Department of Agriculture (USDA): Conservation Reserve Program (CRP), Conservation Reserve Enhancement Program (CREP)
- US Forest Service (USFS): Pollinator-Friendly Best Management Practices for Federal Lands
- Seedmoney.org provides community groups with small starter grants to beautify their town or neighborhood
- The New England Grassroots Environmental Fund
- The National Forest and Wildlife Foundation offers a Monarch Butterfly & Pollinator Conservation grant, supporting habitat improvement, outreach and organizational coordination

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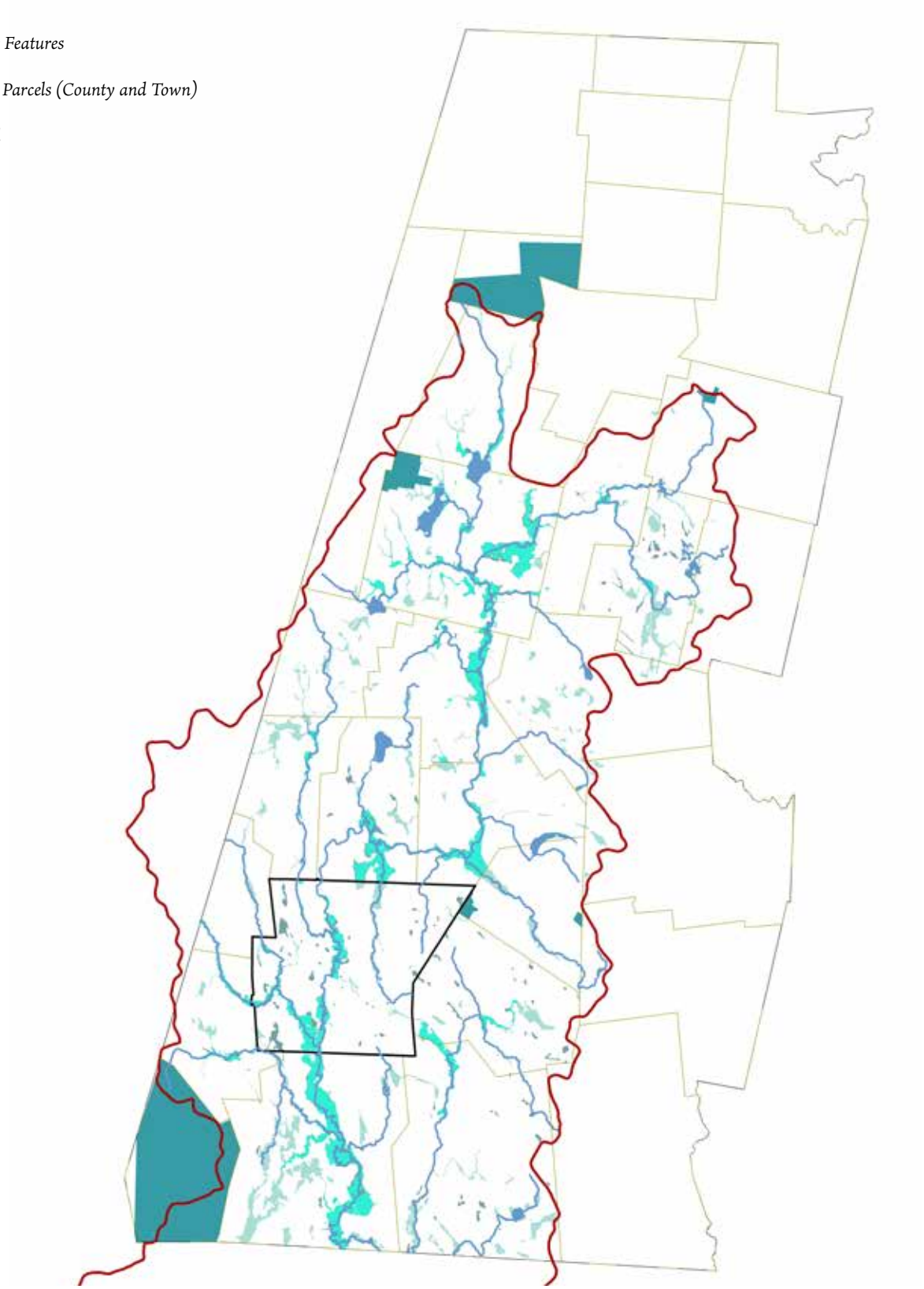
Watershed

(MassGIS)

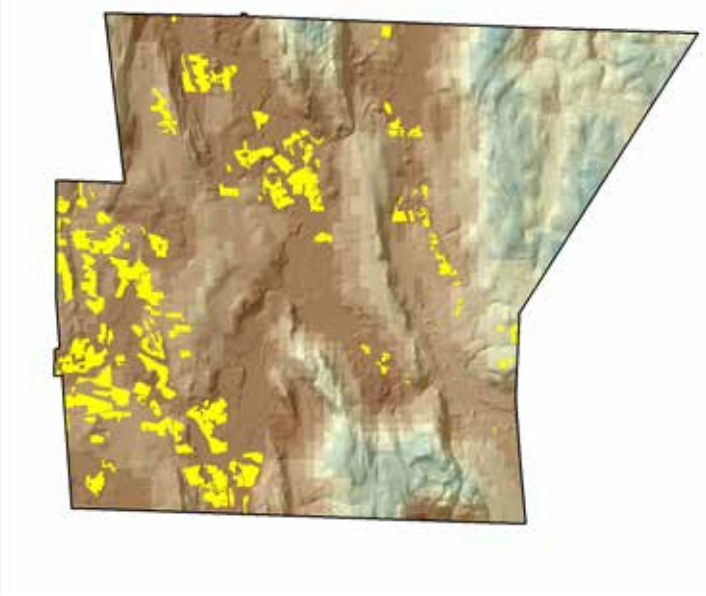
- *Hydrology Water Features*
- *Census 2010 Tax Parcels (County and Town)*
- *Major Watershed*



Wind

(MassGIS)

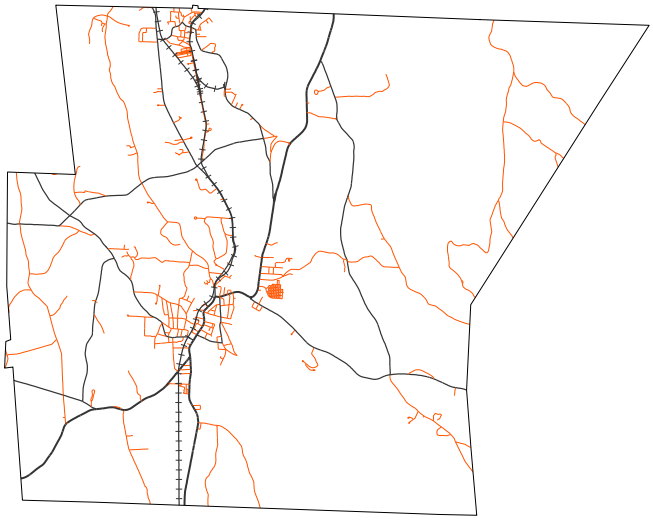
- *Modeled Wind Speed at 100m*
- *Land Use (Cropland)*



Roads

(MassGIS)

- *Major MassDOT*
- *Trains and Railroads*



Natural Communities

(Northeast Terrestrial Habitat Map Courtesy of the Nature Conservancy, NatureServe, Atlantic Conservation Data Center)

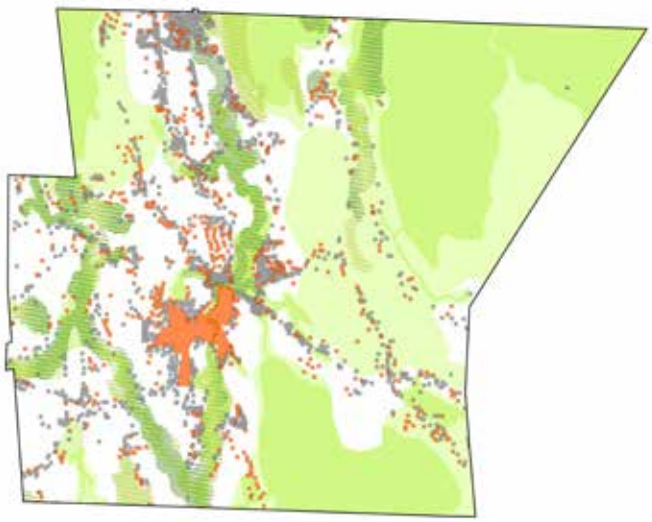
(MassGIS)

- *Major MassDOT*
- *Shaded Relief 2005*
- *Land Use 2005*
- *Major Rivers and Streams*

Habitat & Development

(MassGIS)

- *Census 2005*
- *Census 1885*
- *NHESP Priority Habitats for Rare Species*
- *NHESP Estimated Habitats for Rare Species*
- *BioMAP 2*

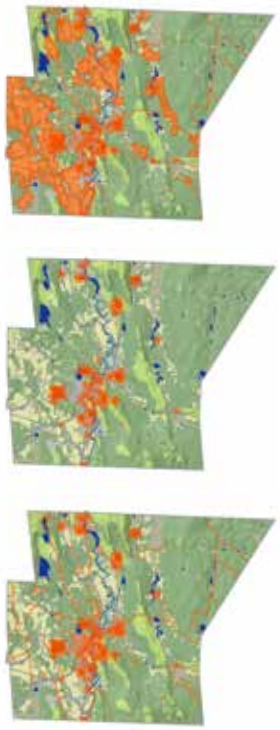


Pollinator Buffers

(Northeast Terrestrial Habitat Map Courtesy of the Nature Conservancy, NatureServe, Atlantic Conservation Data Center)

(MassGIS) 500' Buffer

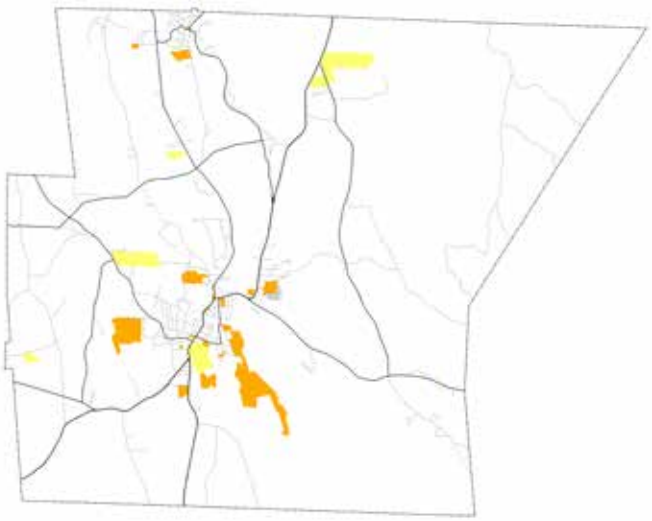
- *Major MassDOT*
- *Shaded Relief 2005*
- *Land Use 2005*
- *Major Rivers and Streams*
- *Census 2010 Tax Parcels*



Town Parcels

(MassGIS)

- *Census 2010 Tax Parcels (County and Town)*
- *Major MassDOT*
- *Schools and Institutions*



"If the bee disappeared off the surface of the globe, then man would have only four years of life left. No more bees, no more pollination, no more plants, no more animals, no more man."

– Albert Einstein

Image courtesy Isa Betancourt & The Frost Museum

The Great Barrington Pollinator Action Plan is an educational toolkit for identifying, prioritizing, and implementing pollinator habitat on sites across Great Barrington. While its analyses are specific to the town, its recommendations are broad enough to be used almost anywhere in the northeast United States. Anyone with access to a piece of land or sidewalk strip can use this plan. Through a collaborative effort, reaching across experiences, social strata, and ecosystems, the citizens of Great Barrington hope to establish a thriving, diverse, pollinator-friendly network, and inspire other communities to do so, too.

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