Pollinator-Friendly Parks

ENHANCING OUR COMMUNITIES BY SUPPORTING NATIVE POLLINATORS IN OUR PARKS AND OTHER PUBLIC SPACES

Stephanie Frischie, Aimee Code, Matthew Shepherd, Scott Black, Sarah Hoyle, Sharon Selvaggio, Angela Laws, Rachel Dunham, and Mace Vaughan

XERCES SOCIETY
for Invertebrate Conservation

Pollinator-Friendly Parks

Enhancing Our Communities by Supporting Native Pollinators in Our Parks and Other Public Spaces

Stephanie Frischie, Aimee Code, Matthew Shepherd, Scott Black, Sarah Hoyle, Sharon Selvaggio, Angela Laws, Rachel Dunham, and Mace Vaughan

The Xerces® Society for Invertebrate Conservation is a nonprofit organization that protects wildlife through the conservation of invertebrates and their habitat. Established in 1971, the Society is at the forefront of invertebrate protection, harnessing the knowledge of scientists and the enthusiasm of citizens to implement conservation programs worldwide. The Society uses advocacy, education, and applied research to promote invertebrate conservation.

The Xerces Society for Invertebrate Conservation
628 NE Broadway, Suite 200, Portland, OR 97232
Tel (855) 232-6639 Fax (503) 233-6794 www.xerces.org

Regional offices coast to coast.

Acknowledgments

We thank Sarah Foltz Jordan, Debbie Roos, Sarah Meadows, Phyllis Simon, Stephanie Trueblood, Rebekah Berkov, and Candace Fallon for writing case studies. We also thank Kelly Gill, Kaitlin Haase, Rich Hatfield, Eric Lee-Mäder, Ray Moranz, Emma Pelton, Rae Powers, Mace Vaughan, and Brent Hefley for their contributions to this guide.

Thanks to all the communities, large and small, for creating pollinator-friendly parks.

Funding for this publication has been provided by:

Anthrocean
Carroll Petrie Foundation
Cinco
Ceres Trust
California Community Foundation
CS Fund
Disney Conservation Fund
J. Crew
Ned and Sis Hayes Family Fund of The Oregon Community Foundation
The Dudley Foundation
Turner Foundation
White Pine Fund
Whole Foods Market

Layout and Design by Sara Morris. Figures 11 & 44 developed by Xerces Society / Sara Morris incorporating Public Domain resources.

Photographs

We are grateful to the many photographers and designers for allowing us to use their wonderful photographs. The copyright for all photographs is retained by the creators. None of the photographs may be reproduced without permission from the creator. Cover photographs: FRONT—Lupines and other native plants bloom along a path in an Oregon park; BACK—a profusion of shade-tolerant spring wildflowers bloom on the forest floor at a botanical garden in Delaware. (Photographs by Matthew Shepherd [front] and Xerces Society / Kelly Gill [back].)

Disclaimer

This document is provided only as a guide. It offers science-based information to help you make informed decisions to reduce the risk of pest management efforts to pollinators and other beneficial insects. It may also contain specific pest management suggestions, including pesticide uses, but does not guarantee the efficacy of these uses. While based on guidance, advice, research literature, or other documentation, these recommendations are just that: recommendations for applicators and land managers to consider when developing or refining a specific pest management plan.

In the event of a conflict between this guide and the pesticide label, the pesticide user has sole and complete responsibility to comply with the applicable laws and the pesticide label instructions. Xerces and Xerces employees are not licensed pesticide applicators or advisors. Xerces makes no warranty, expressed or implied, regarding the accuracy, adequacy, completeness, legality, reliability or usefulness of any information contained in this document and assumes no liability resulting from use of such information. Risk of personal injury or property damage from any pesticide use is assumed by the pesticide user.

Any trade names contained in this document are for identification and reference only, and no product endorsement or discrimination against similar materials is intended.

Contents

Introduction

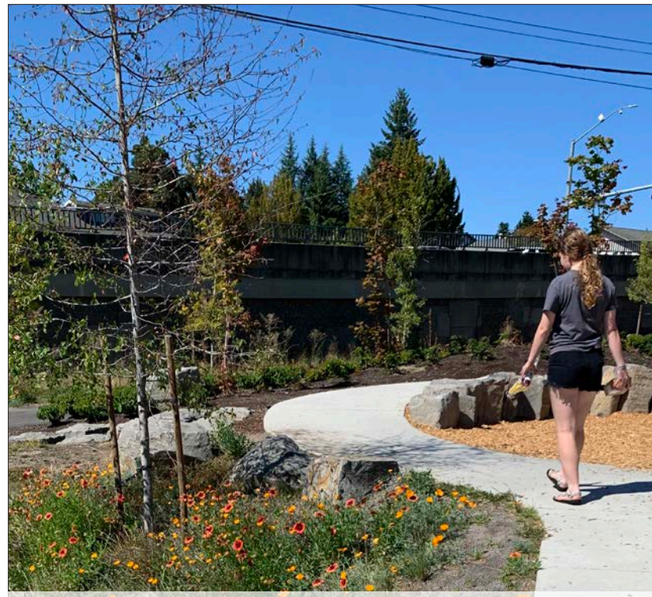
Urban sprawl swallows up more than two million acres of land in the United States each year. As towns and cities spread rapidly and wild spaces are lost, parks, gardens, and other greenspaces are increasingly important to the vitality of our communities and individual well-being. In addition to providing recreation and relaxation, when managed with care, parks and other greenspaces can also serve as places where wildlife—including pollinators—can thrive.

While the term "park" often brings to mind a neatly maintained area with vegetation limited to turf, lawn, and trees—the naturalistic landscapes created by park architects of past centuries, for example—parks can be so much more than places with tidy plants. The inventory of a park department or district may include swim centers, sports fields, and playgrounds, but increasingly it includes creeks, wetlands, woodlands, forests, prairie, and other natural areas. Parks departments have become significant natural resource managers tasked by their communities to care for and take leadership on a multitude of environmental concerns, from waste reduction and recycling to water quality and wildlife.

Traditional playgrounds with slides and swing sets are being reimagined as nature play areas where children can explore and get grubby—and gain the emotional benefits from time spent outdoors. Multipurpose parks provide sports fields and restored creek corridors, support regional greenways and neighborhood trails, and offer spaces for family picnics or friends to gather for coffee. Informal recreation in the form of walking, running, biking, birdwatching, and other individual pursuits have become the dominant uses of increasingly varied park facilities.

At a fundamental level, parks that provide a healthy environment also support healthy people and healthy communities. At the heart of a healthy environment are pollinators—animals that move pollen among flowers, thus ensuring that the plants can form seeds and fruits.

Figure 1—Parks provide many recreational opportunities and environmental benefits to neighborhoods and local communities. Pollinator plants border the walkways (below) and playground (opposite) of this Oregon park, enriching the landscape for humans and wildlife. (Photographs by Matthew Shepherd.)



Why Pollinator-Friendly Parks?

Around the world, bee and butterfly populations are experiencing declines. A United Nations report found that up to 40% of pollinators were at risk of extinction in the coming decades. In North America, 28% of bumble bee species are already at risk of extinction. Monarch butterfly populations have declined by more than 80% in the Eastern US and more than 99% in the West. Several long-term studies have shown that diversity and abundance of butterflies are in rapid decline.

When it comes to wildlife conservation, many people discount the importance of town and cities but wildlife, including pollinators, can thrive in the seemingly inhospitable environment of developed areas. Butterflies are easy to spot and their presence in parks is widely noted. Bees, in contrast, are typically overlooked, but there are many examples of their diversity, even in densely developed neighborhoods. In California, more than 70 species of bees were identified in the gardens of Albany and Berkeley, and San Francisco's parks support significant, and diverse, populations of bumble bees. In Tucson, Arizona, 62 species of bees were found in fragments of desert scrub habitat. In New York, 54 species of bees were discovered in community gardens in East Harlem and the Bronx, and over 100 species were found in suburban gardens just north of New York. Even rare species like the rusty patched bumble bee can be found in cities and towns in the upper Midwest. Clearly, greenspaces in towns and cities are important for pollinators.

Pollinators are only one group of wildlife that frequent urban greenspaces, but they are a fundamental building block of a healthy environment. Ensuring that you provide for their needs will bring numerous benefits:

- Add visual interest and beauty to public open spaces
- Improve the appearance, safety and economy of neighborhoods
- Provide beneficial wildlife habitat

Figure 2—This beautiful pollinator, a metallic green sweat bee (*Agapostemon virescens*), is common across the United States during the summer and warm days in early fall. Usually these bees move very quickly, but this one stayed still long enough to be photographed foraging on a native wildflower (Photograph by Emily May.)

- Build opportunities to spend time outdoors in nature and fresh air for individual wellbeing as well as community involvement in environmental education programs or volunteer activities.
- Reduce costs associated with equipment, fuel, pesticides and labor for maintaining turf lawns.
- Improve a landscape's climate resiliency, such as tolerance for drought or flooding.
- Increase carbon sequestration services
- Increase yields and fruit size in home gardens and nearby farms
- Enhance pollination and plant regeneration in natural areas
- Assist towns, cities, schools or other groups achieve sustainability goals or meet guidelines for programs such as Bee City USA or Bee Campus USA.

Around the nation, the value that nature in parks offers to local residents is being recognized and acted upon. The High Line in New York City is a decommissioned railway bed that was redeveloped to create a linear park and habitat. It is planted with native plants and naturalized species, designed to reflect the natural communities of the region such as woodlands and meadows. Throngs of people enjoy the greenery amid skyscrapers. Studies in North America and the UK have shown that dense urban areas with a variety of flowering plants cultivated in gardens, parks, along sidewalks or in yards, or those growing spontaneously, such as in vacant lots, support a diversity of native pollinators. Research on vacant lots in Cleveland, Ohio, is looking at how vacant lots with a diversity of plants and sites for ground-nesting bees support pollinators as well as changing the way residents value their neighborhood. Community gardens for food and for pollinators engage neighborhood residents and deepen the connections to each other and the place.

Pollinator-friendly parks not only support the physical and emotional benefits gained from independent recreation, they are also excellent settings for guided group activities such as nature watching, whether that is for birds, butterflies, dragonflies, or bees—or just quiet contemplation of sitting among flowers and the hum of insect life. This is a wonderful way to learn about local pollinators, collect data to contribute to community science projects and is accessible to people of many ages and physical abilities. By making parks more pollinator-friendly, they are also more human-friendly.

What to Expect from This Publication

Our goal with this publication is to provide helpful information so parks can be planned and managed with pollinators and other insects in mind. The Xerces Society's Bring Back the Pollinators campaign promotes the conservation of native bees and butterflies based on four principles that can be adapted to any location: grow flowers for nectar and pollen, provide places for nesting and egg laying, avoid pesticide use, and share the word about what you're doing. The structure of this handbook reflects this framework, with chapters (Chs. **6**, **7**, **8**, **9**) that provide detailed information on each of the principles. We also included chapters on the diversity and natural history of bees and butterflies (Ch. **2**), the threats they face (Ch. **3**), the opportunities offered by different types of public greenspaces and park facilities (Ch. **4**), and some ways to start thinking about how to address pollinator conservation in your own parks (Ch. **5**). We hope that the guidelines will provide enough information to enable you to plan and take action. To further expand your knowledge, **Appendix A** and **Appendix B** contain additional sources of information including lists of books, web sites, and other resources so you can explore the topic more deeply.

2

Pollinator Basics

The Role and Value of Pollinators

Next time you're watching a bee zip between flowers, consider all the important work that she is doing. Not only is she collecting food for her offspring, she is also providing an amazing ecosystem service, pollination. Most plants—more than 80% of flowering species—have evolved an intimate relationship with one or more animals to ensure that their pollen is transferred reliably and accurately. These plants produce relatively sticky pollen grains that can only be carried by pollinators.

All ecosystems have "keystone" species, whose presence is considered significant to the well-being of the environment and without which the ecosystem would gradually unravel and potentially collapse. Discussions of keystone species often revolve around eagles, bears, wolves, and other large predators. For many land managers, especially those working in urban or suburban areas, such animals are rare visitors, if they occur at all. By contrast, pollinating insects are keystone species that can be encountered anywhere. The service these animals provide is a vital part of a healthy environment and a vibrant community.

Figure 3—Large, hairy, and usually black with yellow, orange, or white stripes, bumble bees are easy to recognize. These native bees are important pollinators and are among the first bees to be active in late winter or early spring. (Photograph by Mace Vaughan.)

The contributions that pollinators make to our lives are sometimes measured in monetary terms. In the US, farmers grow more than one hundred crop plants that need pollinators. Pollinators are directly responsible for fruits and vegetables, as well as fibers such as cotton and flax. The economic value of insect-pollinated crops in the US is estimated at $34 billion per year.

> "These insects, so essential to our agriculture and indeed to our landscape as we know it, deserve something better from us than the senseless destruction of their habitat."
>
> —Rachel Carson, *Silent Spring*

But the benefits from pollinators cannot be truly measured in dollars. They enrich our lives from the blueberries in our breakfast muffin to the apples we munch for lunch, even the cotton in our bedding and clothes. They help define our seasons: springtime flowers, summer trips for berry picking, scary Halloween jack-o'-lanterns, Thanksgiving pie—these all come thanks to a pollinator. Pollinators are fundamental to countless harvests gathered in backyards and community gardens. They support plant communities that provide food and shelter for many other animals. Fruits and seeds derived from insect pollination are a major part of the adult diet of mammals from red-backed voles to grizzly bears as well as approximately 25% of birds—and 95% of songbirds rear their young on caterpillars. In some places, pollinator-supported plant communities bind the soil, thereby preventing erosion and conserving an important agricultural resource, as well as keeping creeks clean for aquatic life.

In addition, pollinators help plants in other ways beyond pollinating flowers. The tunneling activities of ground-nesting bees, for example, improve soil texture, increase water movement around roots, and mix nutrients into the soil. The larvae of pollinating beetles that tunnel in old trees increase soil fertility by helping to break down decaying wood, thus returning the nutrients locked in the tree back to the ecosystem. The larvae of many syrphid flies (which, as adults, are important pollinators of many plants) reduce damage to plants by eating aphids and other soft-bodied plant pests.

Figure 4—Bees provide flowers with the vital service of pollination. Native bees are the most important single group of pollinators in North America. (Photograph by Nancy Lee Adamson.)

Who Pollinates?

North American pollinators are a diverse category of animals that includes multitudes of insects and a handful of mammals and birds. The few vertebrate pollinators include and long- and short-nosed bats (restricted to deserts in the Southwest), white-winged doves, and hummingbirds.

Figure 5—Many native bees are tiny, like this sweat bee that is so small that individual pollen grains are approximately the same diameter as her antennae and legs. (Photograph by Sara Morris.)

Figure 6—The honey bee is not native—it is a managed pollinator that originated in Europe. See Considering the Role of Managed Honey Bees on p. 17 for more information. (Photograph by Stephen Ausmus /. USDA–ARS.)

Some of the Non-Bee Pollinators

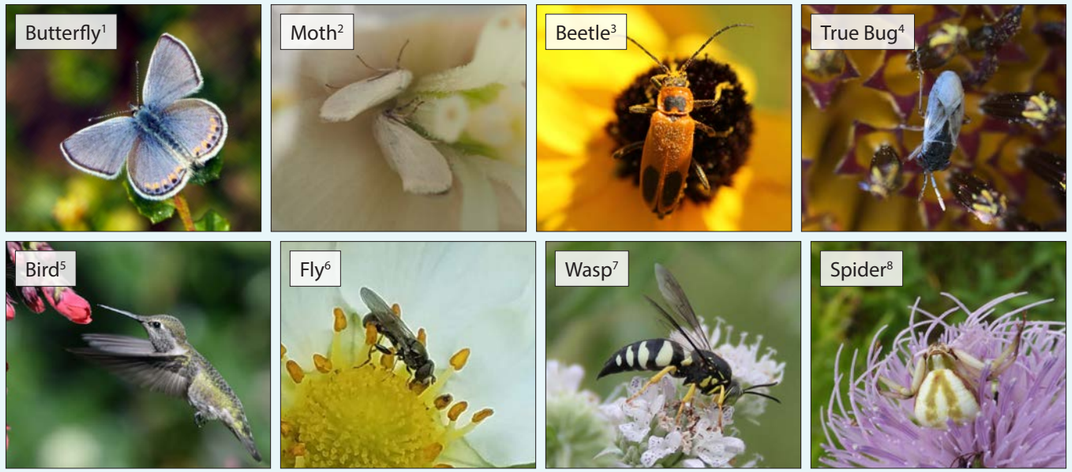


Figure 8—While bees are our most familiar and effective pollinators, various insects and animals are also valuable pollinators. (Photographs by Xerces staff members: Mace Vaughan[1], Nancy Lee Adamson[2], Jennifer Hopwood[3,7], Sara Morris[4,5], Alina Harris[6], and Sarah Foltz Jordan[8].)

Almost all pollinators are insects that visit flowers to feed on nectar and /or pollen. There are six main groups of insect pollinators: butterflies, moths, beetles, flies, wasps, and bees. Native bees are the most important wild pollinators in North America. There are more than 3,600 species of bees native to the United States and Canada (if you include Mexico, the number rises to 4,500).

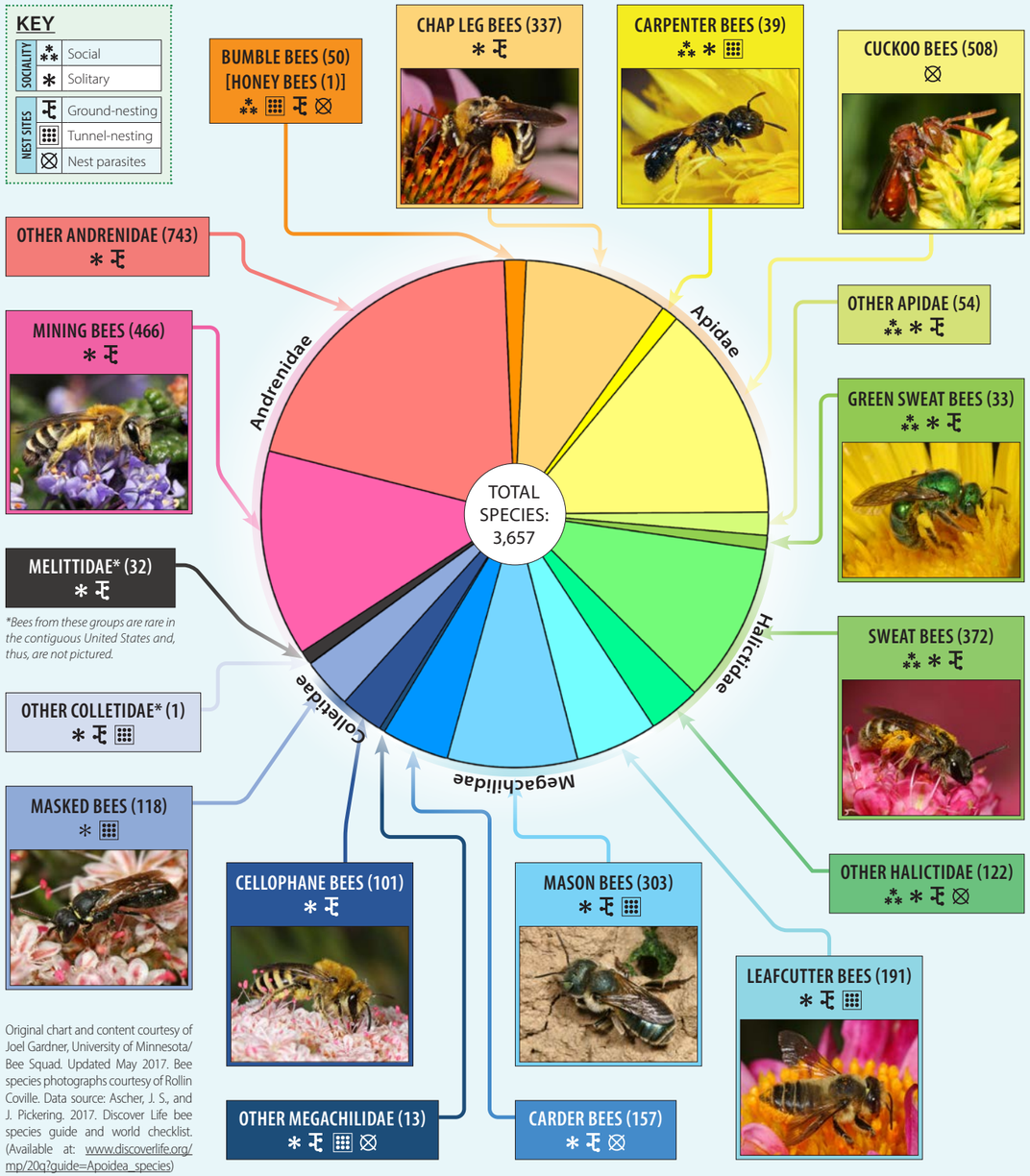
Life Cycles, Diets, and Related Habitat Needs of Bees

Figure 7—Beetle–tunneled snags, like this one, and patches of bare ground are important nesting sites for solitary bees. (Photograph by Matthew Shepherd.)

Native bees are generally considered the most important group of pollinators in temperate regions. They are (with the exception of a small group of pollen wasps) the only insects that actively collect pollen, which they gather from multiple plants to take back to their nests for their offspring. It is this intentional movement of pollen that makes them so effective as pollinators. Native bees make repeated trips from their nest, constantly working to gather pollen and nectar from the plants in a limited area. By contrast, other insects visit flowers to feed or mate or find warmth and brush against pollen in the process, indirectly pollinating flowers. That said, all pollination is by chance. Bees don't visit flowers to pollinate, but because they need to supply their nest. While gathering pollen and moving between flowers, some of the pollen brushes off.

Bee Species Diversity in the United States

Figure 9—There are over 3,600 bee species in the United States from six families: Andrenidae, Apidae, Halictidae, Megachilidae, Colletidae, and Melittidae. The figure below breaks down the number of accepted species in each family, organized by subgroups with social behavior and nesting habits.



Original chart and content courtesy of Joel Gardner, University of Minnesota/ Bee Squad. Updated May 2017. Bee species photographs courtesy of Rollin Coville. Data source: Ascher, J. S., and J. Pickering. 2017. Discover Life bee species guide and world checklist. (Available at: www.discoverlife.org/mp/20q?guide=Apoidea_species)

Solitary or Social?

Asked to think of a bee nest, many people will picture the hexagonal comb and humming activity of a honey bee hive, created by the shared labor of thousands of workers, with enough stored honey to feed the colony through winter. A honey bee queen can lay up to 2,000 eggs a day and a colony can support 50,000 bees or more. This, however, does not represent the nests of the more than 3,600 species of bees that are native to the US and Canada. Almost all native bees in North America are solitary. Each female constructs and supplies her own nest, which consists of a narrow tunnel and a few brood cells stocked with nectar and pollen. She lives only a few weeks, lays only a few dozen eggs, and dies after her nest is completed.

Bumble bees are social bees and live in a colony and share the labor. Unlike honey bee nests, most bumble bee nests are clusters of ball-shaped brood cells and waxy pots, and are occupied by less than a few dozen bees as they raise 30–400 offspring per colony per year. Because bumble bees store only a few day's supply of nectar, the colony does not survive beyond the fall.

Figure 11—Solitary bees come in every size, shape, and color—including metallic blue and purple—like this stunning sweat bee from Florida. (Photograph by Bob Peterson / flickr.)

Figure 10—Above, the entrances of numerous ground nests are clustered together in this aggregation of mining bee nests. Below, a female mining bee arrives back at the entrance to her nest with a full load of pollen. (Photographs by Matthew Shepherd.)

The diversity of bees astonishes most people. Most native bees do not fit the stereotypical image of a bee—striped, living in a hive with thousands of others, and apt to sting—and consequently are frequently overlooked.

Native bees can be dark brown, black, or metallic green or blue that shimmers in the sunshine. They can have stripes of red, white, orange, yellow, or even opalescent bands that change color with the angle of viewing. They can be smaller than a tenth of an inch long, or well over one inch. Most are solitary, meaning each female creates her own nest with just a few brood cells, without division of labor such as worker bees. Most are unlikely to sting, because they are too busy gathering food for the young in the nest and the nests are small, with less reason for defense. Some common names reflect nest-building habits. Mining and digger bees excavate nest tunnels in the ground. Leafcutters collect leaf pieces to construct brood cells. Mason bees use mud to divide the nest tunnel, carpenter bees use wood chips, and carder bees use downy hairs gathered from plants. Other names depict behaviors. Cuckoo bees lay eggs in other bees' nests. Sweat bees are known to drink salty perspiration. Bumble bees make a loud humming noise while flying.

Considering the Role of Managed Honey Bees

A diversity of pollinators is vital to ecosystems, and pollinators' contributions to biodiversity are well documented. As such, efforts to maintain a diverse suite of pollinators should be a priority for any area of land. Honey bees are not native to North America, but play an essential role for pollination in agriculture. Conservation measures such as the creation of high-quality, pesticide-free foraging habitat—particularly in agricultural landscapes—are necessary for long-term honey bee health.

Parks and natural areas are essential for our native pollinator and plant populations as they serve as important refugia from ongoing threats in more populated and manipulated landscapes. Studies show that due to competition for nectar and pollen, disease transmission, and foraging habits such as preference for invasive plant species, honey bees have the potential to negatively affect native bee and plant populations in these habitats. This is a particular concern when honey bees are at high densities and at times when flowers are less abundant such as early spring or during drought, making it difficult for native bees to access sufficient resources.

To many people, adding honey bee hives to a park is considered a good thing. However, because of the potential threats to our native pollinators from honey bees, we urge land managers to consider carefully the potential impacts and their relevance when deciding whether to place hives on parks, public lands, and natural areas. In addition, land managers need to ensure that honey bee placement is consistent with existing legislation and with ongoing and future management priorities. In short, hosting a few honey bee hives in a park is not bee conservation. Bee conservation revolves around creating the right conditions for bees to thrive: habitat that is rich in flowers and free of pesticides.

Bees are an insect group that goes through four life stages: egg, larva, pupa, and adult, during which they undergo complete metamorphosis. Bees generally do not migrate; they are active and reproducing during the growing season and then typically overwinter as pupa or adults, depending on the type of bee.

Life Cycles, Nesting Behavior, and Overwintering of Bees

Bees create a nest in an appropriate location and stock it with food for their offspring. The majority of bee species are solitary. This means that a female bee builds the nest on her own, supplies the nest with nectar and pollen for the larvae to eat, and lays eggs. There are no worker bees or other division of labor, and once she has laid the egg, the bee seals the cell and never meets her offspring. The young typically remain in the nest for most of a year, passing through the egg, larva, and pupa stages before emerging as adults to renew the cycle. During their larval phase, they eat "bee bread," pollen and nectar packed into the brood cell by the mother bee.

Approximately 70% of solitary bee species nest in the ground, digging a narrow tunnel in a patch of bare or sparsely vegetated soil. From this tunnel, the bee excavates a series of brood cells, into which she places a mixture of pollen and nectar and lays an egg. The remaining 30% of solitary bee species are cavity nesters, using existing narrow holes such as old beetle tunnels in trees or the hollow center of pithy stems. Females of these cavity-nesting bees divide the tunnel into a line of brood cells using materials such as leaf pieces or mud as partitions. She provisions each cell with bee bread, lays an egg, seals it, and then repeats this until the tunnel is filled.

Figure 12—Bee larva feeding on a bee bread "loaf" made of pollen mixed with nectar. (Photograph courtesy of Jim Cane, USDA–ARS.)

The Bumble Bee Colony Life Cycle

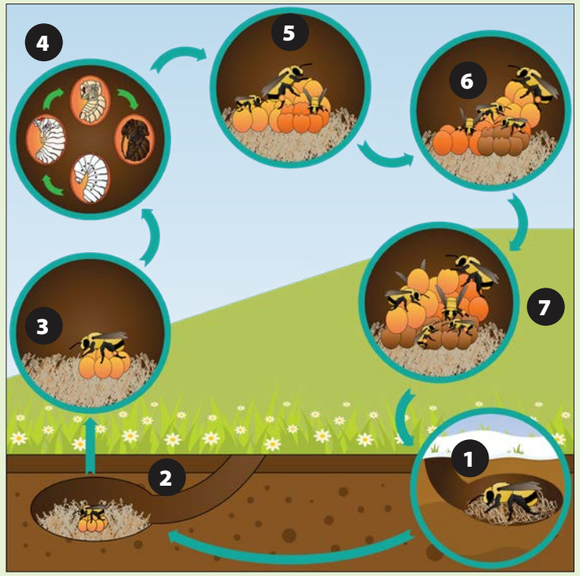


Figure 13—After hibernating through the winter (1), a bumble bee queen emerges in early spring and finds a location to nest (2). She forages and broods the nest cells (3) while the first generation of workers matures (4). The first generation of workers emerge and assist the queen in rearing the next generation of workers (6). In late summer, the last generation of the colony produces queens and males (7), who will emerge at the end of summer, mate, and then start the process over again the next year.

Not all bees are solitary. Bumble bees are the best known native species that lives in a colony. They are considered a social species, raising young cooperatively through division of labor and with overlapping broods in the same nest. A bumble bee nest is quite different from a honey bee hive. Both will build a nest in an existing cavity, but that's about where the similarity ends.

Bumble bee colonies are small (a few dozen to a few hundred bees), don't have honeycomb, and are seasonal. Bumble bees need a small hollow space, such as a vacant mouse burrow, in which to build a cluster of waxy, ball-shaped brood cells. A queen founds a colony in spring after she emerges from hibernation. She begins the colony as a solitary bee. When the eggs hatch, the queen forages for pollen and nectar and brings it to feed the developing larvae in the nest. When her first brood is adult, the fresh bees will take over foraging tasks and the queen will remain in the nest, laying eggs and tending the young.

Depending on the species, the colony may be active for only a few months through to the end of summer. Males and new queen adults are produced late in the season. After mating, the males die and each mated queen leaves the nest to find a suitable overwintering spot. The following spring, she will emerge and found a new nest.

Bee Diets

Bees feed on floral resources as larvae and adults. The larvae are cared for in nests, and have chewing mouthparts to eat bee bread. Adult bees have tongues and feed mainly on nectar and some pollen from flowers. Bees will drink nectar from any flower into which they can reach (the length of a bee's tongue varies by species). They may be more particular about the flowers from which they gather pollen. Some species rely on a single plant species or on a closely related group of plants for pollen; they are referred to as specialist bees. Specialist bees are solitary, with their life cycle closely tied to that of their preferred host plant(s); adult bees will emerge from their nest right when a specific plant blooms.

Mitigating Climate Change in Your City

As the effects of climate change become increasingly apparent, it is more important than ever to consider climate change when designing landscapes for our communities. The biodiversity found in pollinator-friendly parks and landscapes is key to creating resilient, climate-smart habitat for pollinators. Some plant species will grow and bloom in drier, hotter weather, while others will provide a balance of foliage and flowers when the weather is wetter and cooler. This variety improves the likelihood that landscaping, gardens, and other managed habitats will withstand and persist in variable, hard-to-predict conditions, such as droughts and storm events.

The native plant diversity within a pollinator habitat makes the habitat more resistant to climate change than landscapes with fewer plant species. At the same time, a diversity of native plants creates good habitat for pollinators and other wildlife. In general, habitats that are larger and better-connected support a higher number of species and more individuals of each species (population size) than a smaller or more isolated habitat. Bees and butterflies with larger populations are more likely to withstand the bad years and extreme weather events that will become more frequent with climate change than those with smaller population size. So providing pollinator habitat in parks, and increasing the connectivity among parks, natural areas, creek corridors, and other greenspaces will further increase pollinator climate resilience. Pollinator gardens and landscapes also provide important microhabitats (small spaces that differ from the surrounding habitat) for pollinators. Often these microhabitats are cooler or more protected, providing important refuge for pollinators and other insects during heatwaves and extreme weather events. Plant cover and deep root systems soften the impact of rainfall and reduce stormwater runoff through improved infiltration into the soil, where the moisture is held and used by the plants over time, increasing drought tolerance.

Diverse, native pollinator habitat will also help to mitigate climate change by contributing to natural climate solutions. Healthy ecosystems store much more carbon than degraded habitat. Research has shown that soils in grasslands and meadows with a variety of plant species store much more carbon than weedy areas and areas with low plant diversity. This means that every habitat you plant and manage is an important part of the solution to climate change.

There are several actions you can take to build climate resilience into pollinator gardens and habitat. These practices also reduce the urban heat island of your city or town and help manage stormwater and/or periods of drought.

1. **Choose a variety of native plants that are drought tolerant** and mix (as desired) with plants that are less drought tolerant to help a planted area withstand extended dry periods while maintaining flowers and shelter for pollinators. Likewise, for regions that are likely to receive more rainfall, flooding, or periods of inundation (such as the northeastern and southeastern US), include additional native plant species that are adapted to wet soils. Using a variety of native plants also means you are more likely to include host plants for specialist pollinators that have narrow resource requirements. Such specialist pollinators are typically more vulnerable to climate change than generalist pollinators.
2. **Plant native trees and other vegetation** to shade and cool urban areas, while providing important resources for pollinators.
3. **Remove impervious surfaces** such as concrete or asphalt and replace with vegetation, permeable pavers or gravel. This reduces the surface temperature and has the added benefits of reducing flood risk and the amount of pollutants running off into surface and ground water.
4. **Invest in green infrastructure** such as green roofs and bioswales, and support policies that promote its expansion.
5. **Reduce your carbon footprint.** Several websites such as Carbon Offsets to Alleviate Poverty or Global Stewards offer advice on how to reduce your carbon footprint

Generalist bees gather pollen from a wide range of flower types and species. Bumble bees, for example, are generalist foragers. To support and rear young over several months, they need to collect pollen and nectar from many different flowers that bloom in succession throughout spring, summer, and into fall.

Life Cycles, Diets, and Habitat Needs of Butterflies

With their bright colors and large wings, butterflies are probably the most obvious daytime flower visitors. At night, their close relatives, moths, replace them at flowers—although there are daytime moths that are as colorful as a butterfly. For both butterflies and moths, the attraction is nectar rather than pollen. Butterflies and moths are not as centrally critical for pollination as bees, but they do play a significant role in plant pollination. Moths, with their especially shaggy bodies, are recognized as important pollinators for night-blooming flowers.

The life cycle of a butterfly or moth is similar to a bee's. It includes four stages and the insect undergoes complete metamorphosis. Unlike a bee, butterflies and moths lay their eggs on plants and they complete their life cycle without the protection of an enclosed nest or food gathered for them.

Some butterfly species (known as univoltine species) produce only one generation per year, while many complete two or more generations per year. In each generation, an adult butterfly lays its eggs and the caterpillar grows and pupates and emerges as an adult. Regardless of the season in which breeding occurs, univoltine species take twelve months to complete their life cycle. The life span of species that have two generations, varies with the generation: Those from eggs laid during the spring or summer will complete their life cycle within three to eight weeks; those that overwinter, which may happen as eggs, larvae, or pupae, may take six to eight months.

Butterfly Diets

Like bees, butterfly only feed as larvae (caterpillars) and adults, but have a very different diet during the two stages. Caterpillars have chewing mouth parts and eat plants. Adult butterflies have a proboscis, a straw-like tube that rolls and unrolls to drink or suck liquids such as flower nectar. The specialization between larvae and adults means these life stages do not compete against each other for the same food sources, but it does mean that a butterfly needs two very different food sources in its lifetime.

Unlike bees, however, an adult butterfly forages solely to feed itself (not it's young). Its principal food is nectar from flowers, though it will also suck fluids from other sources, such as mud, sap, fruit, and dung. In general, adult butterflies are not choosy about which flower they drink from—most feed at dozens of different flower species—but the nectar chemistry of certain plant groups is especially attractive, such as blazing star (*Liatris* spp.). The length of their proboscis also determines which flowers a butterfly can feed on. Skippers and swallowtails, for example, have long proboscises and feed on tubular flowers such as penstemon.

Figure 14—Monarch butterflies are well-known for their dependence on milkweeds as larvae (left). But adult monarch butterfies will feed on nectar from a variety of plants, like *Liatris* (right). (Photographs by Sarah Foltz Jordan and Katie Lamke.)

Butterfly Host Plants

Another distinction from bees is that butterflies do not make nests. Butterflies lay their eggs on or near plants that are suitable for their caterpillars to eat, but don't otherwise provide food or the shelter of a nest for their young. The plants that a caterpillar eats are called host plants. Ensuring that the correct host plants are available is an essential step in conserving butterflies.

Plants have myriad chemical defenses that make them unpalatable or cause indigestion to the animals that eat them. Depending on the species, caterpillars are adapted to tolerate or minimize the effect of defensive compounds in single or closely related plant groups, allowing them to specialize and depend upon those plants as their single source of food as larvae.

For example, the caterpillars of the monarch butterfly consume milkweed plants as their sole food. There are around 90 different species of milkweeds that are native to the US and nearly all of these are used as host plants by monarchs. Similarly, many of the blues are specialists on lupines. Most other butterflies are less choosy about where to lay eggs, because their caterpillars will eat several plants. Caterpillars of the woodland skipper, for example, feed on many grasses, and those of the anise swallowtail are known to feed on more than 60 different species within the carrot family. The extreme may be the gray hairstreak, whose caterpillars have been recorded eating plants from dozens of different plant families, anything from clover to oaks, even palms! Although a butterfly may carefully choose a host plant, her parental responsibility ends when she lays her eggs. Eggs and the hatched caterpillars are left to fend for themselves out in the open.

> "The evidence is overwhelming that wild pollinators are declining… Their ranks are being thinned not just by habitat reduction and other familiar agents of impoverishment, but also by the disruption of the delicate 'biofabric' of interactions that bind ecosystems together."
>
> —E. O. Wilson. Foreword, *The Forgotten Pollinators*

3

Threats to Pollinators—and How You Can Counter Them

Studies have shown that the diversity and abundance of pollinators have declined across North America. Managing parks with pollinators in mind—ensuring they have a diversity of plant species, appropriate nesting sites, and limited exposure to pesticides—can help stem this loss by providing habitat for pollinators such as bees and butterflies as well as beneficial insects, birds, and a host of other wildlife.

Habitat Loss

Secure, stable nesting sites and flower-rich forage areas are key components of pollinator habitat. The outright loss of this habitat is one of the greatest direct threat to pollinators. Sometimes the loss is dramatic—a meadow converted to a shopping mall or an agricultural field, for example, or a hedgerow ripped out to widen a road—but often it is more subtle, a gradual ecological degradation. Habitats are fragmented into smaller, more isolated patches. A tree snag is removed because a neighbor complained that it was an eyesore. Flowers are sprayed or mowed because they are considered to be weeds. A street tree is treated against aphids, making all the flowers toxic to bees. The list could go on and on, but they all result in the piecemeal loss of species diversity or ecosystem services that supports the life on which we all rely.

Figure 15—Formerly a prairie frequented by bird watchers, this once-diverse habitat area was cleared for development. (Photo by Kenneth Cole Schneider / flickr.)

Some sites may be full of plants yet fail to provide for basic needs of pollinators. Ornamental plant varieties are bred for appearance, often with a tradeoff between showy flowers at the expense of offering food to pollinators. A highly manicured flowerbed of these plants without nectar, pollen, or a flower shape that pollinators can use is of little value to a bee or butterfly. Additionally, many parks are dominated by mown expanses of turf grass which provides minimal habitat value for bees or butterflies.

Habitat broken into small and isolated habitat fragments is a significant problem in developed areas. Although bees do not require large, contiguous areas of habitat, patches need to be within flying distance of each other. Most bees fly a couple of hundred yards or less between nest and forage. Butterflies can also suffer if habitat is fragmented.

Pesticides

The use of pesticides, even when label language is followed, can harm pollinators. Insecticides pose the most direct and obvious risk as they can kill or injure bees and butterflies, but some fungicides can weaken bee health and herbicides can lead to habitat loss by reducing the availability of forage flowers. Bee habitat in both urban and agricultural areas is often contaminated with a wide variety of pesticides.

Invasive Plant Species and Disease

Invasive plant species take over and dominate their environment, upsetting the balance and generally reducing biodiversity, since other plants or animals are outcompeted by the invasive species. An area dominated by one or a few invasive plants lacks the diversity of bloom times, flower types, host plants, and nesting material that a habitat should provide.

Managed Pollinators

Managed pollinators (honey bees and commercially reared bumble bees) are important for the pollination of many agricultural crops; honey is also an important industry. However, as more areas of natural habitat are converted to agricultural and suburban uses, the pressures to use parks and other natural areas for placing honey bee hives are increasing. This can be an issue because honey bees can directly compete with native pollinators for resources or make an area less beneficial for native bees by affecting the plant community and transmitting diseases. (Commercially reared bumble bees are widely used in greenhouses. While there is no pressure to place colonies in parks—they are destroyed when crop pollination is done—there are problems with disease transfer to wild bumble bees from individuals that escape.)

Figure 16—The construction of new neighborhoods is one cause of habitat loss and fragmentation, and one reason why parks, such as the power–line trail park, are increasingly important refuges for pollinators and other wildlife. (Photograph by Matthew Shepherd.)

Figure 17—Flowers providing nectar and pollen (such as cosmos, left) are a necessary part of pollinator habitat. However, many plants frequently included in urban flowerbeds—such as tulips—provide little to no value to pollinators (right). (Photograph by Mace Vaughan [left] and Kristi Decourcy / flickr [right].)

Climate Change

Bees and other insects are sensitive to changing temperature, which affects survival, reproduction, and behavior. Consequently, climate change can have a variety of effects on pollinators. While some pollinators may fare better under climate change, many will be negatively impacted.

Some of the effects of climate change on pollinators include:

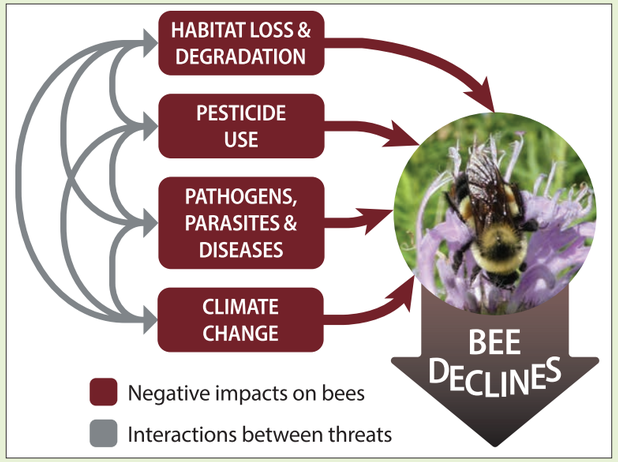
1. **Shifting phenology**, which is the timing of biological events. For example, the emergence of many species of bees and other pollinators matches the flowering of their preferred nectar plants in spring or summer and is often dependent on temperature. A "phenological mismatch" may occur if pollinators and their host plants respond to climate change differently;
2. **Changes in the plant community**, which may alter the diversity, quantity, and quality of floral resources available for pollinators;
3. **Altering species interactions**, such as which species of pollinators visit which species of flowers; and
4. **Shifting species distributions** as some insects or plants try to track more favorable climatic conditions.

Temperatures in urban areas are already warmer than in the surrounding landscape due to the large amount of impervious surfaces (concrete, asphalt, etc.), a phenomenon known as the urban heat island effect. The heatwaves and increased temperatures expected to become more common with climate change will be exacerbated by the urban heat island effect. Temperatures that are not lethal but are outside the optimal temperature range for pollinators can have a variety of negative effects, including reductions in survival, growth rates, or reproduction.

These different possible effects of climate change are not mutually exclusive, and most species will likely experience multiple different effects of climate change.

Figure 18—Careful planning of parks and natural areas to avoid pesticide use can go a long way to protecting pollinators from harmful exposures. Native plant gardens are often more adapted to area pests and less likely to require intervention. (Photograph by Matthew Shepherd.)

Figure 19—Replacing highly cultivated species with native relatives doesn't have to be drab. Wild roses are beautiful additions to any garden and provide a wealth of brightly colored flowers bees love. (Photograph by Matthew Shepherd.)



Interaction of Threats

Bees are often impacted by multiple threats. Any given population will likely face unpredictable weather caused by climate change, pesticide exposures, degraded habitat and disease. Unfortunately, these threats can compound each other, magnifying the overall harm to bees. For example, along with causing potentially toxic exposures, some pesticides also make bees more vulnerable to parasites and disease. Concerted efforts to limit these threats and create more resilient landscapes can go a long way to restoring pollinator populations.

Figure 20—Interaction of threats to bees. (Graphic concept by Xerces Society / Emily May. Photograph by Xerces Society / Sarah Foltz Jordan.)

The threats outlined above do not act in isolation. The bees in one location will not suffer only from pesticides or only from habitat loss or only climate change. Unfortunately, when stressors interact they can magnify the impacts. For example, some pesticides can make bees more vulnerable to diseases, and/or alter foraging behavior thus contributing to poor nutrition. The effects of climate change can interact with other threats to pollinators, such as pesticides or habitat loss to magnify negative effects on pollinators. Multiple threats may interact in synergistic ways, meaning that the effects of multiple threats combined are greater than expected. Reducing threats to pollinators as much as possible will help pollinators be more resilient.

Mitigating Threats

There are steps that can be taken in parks and other pubic greenspaces to reduce the risks associated with these threats. The following chapters of this guide describe actions that can be taken. Small improvements to habitat can have dramatic results, especially for generalist species. Planting and maintaining park areas with a diversity of flowering perennial plants is great way to provide for pollinators and add beauty to an area. Choosing non-invasive plants and removing existing invasive species promotes a balanced diversity of flowers and resources for pollinators. Supporting and maintaining nesting sites in habitats as diverse as wooden structures, ornamental trees, and areas with suitable soil will provide an important resource to support native bees. Chapter 4 provides an overview of what can be done in different places. Chapters 5–7 offer detailed guidance on creating suitable foraging and nesting conditions.

It is also important to rethink pest management to reduce the use of and risks from pesticides. This includes incorporating practices that prevent pests, avoiding pesticide use—especially if the use is for aesthetic purposes—and mitigating risks when pesticides are used. Chapter 8 offers more information. Jointly these actions can go a long way to helping pollinators flourish in densely populated, managed landscapes.

You can also spread the word about the opportunities to support pollinator conservation and build healthy communities for humans and nature. See Chapter 9 for suggestions on community engagement.

Table 1. Simple Solutions to Address Pollinator Decline in Parks and Greenspaces.

THREATS	SOLUTIONS
Habitat Loss and Degradation	⊰ Recognize, restore, and protect existing habitat. ⊰ Establish new habitat and connect habitat to create corridors. ⊰ Manage habitat to provide for pollinator needs (diverse flowering plants for forage, nesting sites and butterfly host plants, overwintering sites).
Pesticides	⊰ Avoid pesticide use that is purely for aesthetic or cosmetic purposes. ⊰ Implement cultural, mechanical, or other non-chemical pest management practices. ⊰ Establish habitat in areas protected from pesticide contamination. ⊰ If pesticides are used, take steps to mitigate their risks.
Disease and competition from non-native and commercial bees	⊰ Avoid or limit honey bee hives near natural areas. ⊰ Provide natural nesting habitat and materials. ⊰ Use artificial nests for public engagement not for conservation and, if you do place artificial nests, ensure that they are cleaned or replaced regularly.
Invasive species	⊰ Limit establishment and spread of invasive plants in habitat areas.
Climate change	⊰ Select plants adapted to your region's climate, taking into account drought and other climate-related issues that affect plant health. ⊰ Ensure plant diversity to support numerous pollinator species. ⊰ Convert hardscapes to habitat when possible. ⊰ Plant native trees. ⊰ Try to connect habitat patches to create corridors whenever possible.

Urban Land Managers in Minnesota Respond to Needs of Endangered Rusty Patched Bumble Bee

Contributed by Sarah Foltz Jordan, Xerces Society for Invertebrate Conservation

Listed as federally endangered in 2017, the rusty patched bumble bee (*Bombus affinis*) has declined in relative abundance by 95%. This once common bumble bee has largely disappeared from the landscape, and currently occupies a small fraction of its historic range. Small, remnant populations are still holding on in cities and towns of the upper Midwest, making park management an important consideration in its future. By creating and carefully managing native habitat, urban land managers in these areas are not only enriching and diversifying their communities, but also providing an opportunity for an endangered bee to recover.

In St. Paul, Minnesota, land managers at Great River Greening, a community-based organization focused on habitat restoration via volunteer engagement, have been actively implementing bumble bee best management practices throughout the land the organization helps manage. The rusty patched bumble bee is known from several of the sites where Great River Greening works, including Pilot Knob Hill, a 24-acre culturally and ecologically significant site in the south metro area, known to the Dakota people as Oheyawahi, "the hill much visited."

With funding from the Minnesota Environment and Natural Resources Trust Fund, Great River Greening recently partnered with the Xerces Society and the University of Minnesota Bee Lab to complete three years of "catch-and-release" bumble bee surveys open to the public. Over the course of that work, we observed and identified 806 bumble bees of nine species, including one rusty patched bumble bee and a few American bumble bees (another at-risk species in Minnesota). The presence of these species at the Pilot Knob Hill restoration site is of great significance to the conservation community and to the site's managers as they make decisions on the ground to best protect and benefit wildlife.

After learning more about bumble bee biology, Great River Greening land managers have made significant changes to their management. These changes include:

Figure 21—Participants in the Pilot Knob training practice photographing bumble bees on flowers. (Photo: Xerces Society / Sarah Foltz Jordan.)

Figure 22—A rusty patched bumble bee was spotted during the Pilot Knob training. (Photo: Xerces Society / Sarah Foltz Jordan.)

Figure 23—A training participant shows off a bumble bee marked with red ink to prevent duplicate records from the survey. (Photo: Xerces Society / Sarah Foltz Jordan.)

filling spring and early summer bloom gaps by planting hundreds of native flower plugs; implementing conservation grazing with sheep and conservation haying in a patchy mosaic (no more than one-third of the site per year); prioritizing controlled burns at times when bumble bee nests aren't active; and maintaining woodland edge and woody debris habitat for bumble bee nesting and overwintering.

This project has also succeeded at training 129 community members in basic bumble bee identification and pollinator conservation practices that they could bring home. Participants were also introduced to Bumble Bee Watch, a continent-wide community science effort to track and conserve bumble bees. In the Twin Cities area of Minnesota, alone, over 1,860 records have been submitted to Bumble Bee Watch since the program launched, including over 200 detections of the rusty-patched bumble bee.

Clearly, towns and cities around the country provide important food and shelter for many of our threatened and endangered pollinators. By establishing and carefully managing pollinator habitat in your community's parks and open spaces, you, too, can be an active part of restoring species on the brink

4

Opportunities for Pollinator-Friendly Parks by Landscape Type

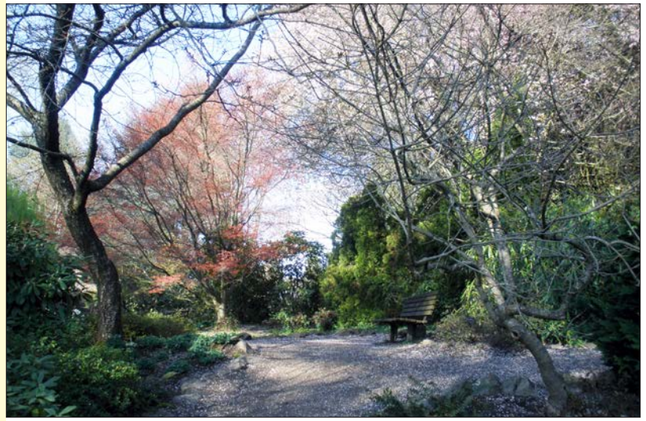
Parks, even formally landscaped ones, contain many places that could benefit pollinators. The following chapters provide guidance on how to plan and implement changes in park management that will help pollinators, such as creating habitat and adjusting pest management practices. Before we dive into those details, let's take a quick tour of eleven different types of places that a typical parks department might oversee and that can be protected, developed, and managed for pollinators.

Flower Gardens and Formal Landscaping

Although formal landscaping is not usually thought of as habitat, flower borders with pollen- and nectar-rich flowers and butterfly host plants can be valuable for pollinators. Butterfly gardens are already being installed in many public places. Small alterations to a butterfly garden, such as ensuring areas of bare soil remain or adding plants for natural bee nesting sites, can provide a more inclusive garden for pollinators.

Quite a few landscaping plants native to North America, but perhaps not specifically to your region, are wonderful pollinator plants and a mainstay of many gardens. Lavender, cosmos and sunflowers are a few examples.

Figure 24—Pollinator conservation can be incorporated into any area of a park, including places traditionally not considered wildlife habitat. Formal landscaping with ornamental plants like rhododendrons offer sources of nectar and pollen (left: Crystal Springs Rhododendron Garden; right: bumble bee foraging inside a rhododendron flower). (Photographs by Sara Morris [left] and Matthew Shepherd [right].)



Landscape management choices also affect pollinators. When managing weeds in garden beds, adapt management to support nesting sites for ground and tunnel nesting bees. For example, if you use mulches, do so sparingly, so that ground-nesting bees can access the soil; and choose organic, untreated mulches rather than colored or rubber mulch. Since many native bees overwinter in pithy stemmed plants, you can also adjust your pruning activity to support tunnel-nesting bees. See **Appendix A** for more information on native nesting materials.

Formal gardens often require higher inputs to maintain a certain aesthetic. If these areas are to serve as pollinator habitat, consider accepting a higher level of pest damage before intervening with pesticide options. Also, keep in mind that many beneficial insects eat or otherwise use plants. Consequently, holes in the leaves of your plants may be a sign of butterfly caterpillar activity or native bee presence—a good pollinator gardener will be happy to see blemished leaves!

No Mow May

No Mow May is what it sounds like—a recommendation and reminder to not mow lawns in May. This allows the flowers that are in ecolawns or other normally mowed areas to bloom and provide nectar and pollen to bees, flies, butterflies, and other pollinators during the season when flowering resources can be in short supply.

It also helps incrementally reduce the negative effects of mowing on pollinators and wildlife—loss of habitat, disturbance of nesting sites, loss of food sources, and direct mortality. Skipping the mowing for a month also reduces overall air and noise pollution.

Figure 25—No Mow May and pollinator habitat signs. (Photograph by Xerces Society / Molly Martin.)

Turf Alternatives: Flowering Lawns and Ecolawns

Turf grass on its own does not provide food for pollinators. However, small changes in lawn management that encourage a mix of grasses and low-growing flowering perennials can make a big difference for pollinators. Flowering lawns are also lower-maintenance; rather than spending time and resources attempting to remove all plants except grasses, a diversity of plants is encouraged. A flowering lawn may be appropriate in any location where short grass is preferred and a less-manicured sward is acceptable. Parks and other areas with existing large expanses of lawns have an opportunity to transform turf to pollinator habitat as well as providing an example to homeowners about options for their lawns.

If you have existing flowering species in the lawn, encourage their growth or consider seeding or planting flowering species into lawns. Selecting species that are unlikely to spread can help keep flowering lawns in areas where they are desired. Some examples of flowering plants that can tolerate mowing and foot traffic are: violets, spring beauty, common selfheal, clovers, and wild strawberry. Some flowering bulbs can also be planted into warm-season turfgrass and provide an early source of nutrition to pollinators. Examples include species of crocus and grape hyacinth. Native fine fescues are a good choice for grass if you are establishing a new lawn because they grow slowly and do not compete against bee-friendly plants.

A diversity of plants in the lawn also builds soil structure, which helps the lawn absorb water in wet periods; plant diversity can also be used advantageously so that some plants enter dormancy during different seasons, keeping an overall green appearance year-round.

Altering mowing practices is one of the simplest ways to assist development of pollinator habitat. Reducing mowing frequency has been found to increase bee abundance and diversity, and make grass more resilient to drought. Setting mower blades higher, at 3–4", will let low-growing flowering plants thrive. Flushing bars are useful for minimizing damage to pollinators while mowing areas of longer grass. In large areas of lawn, consider mowing sections on a rotation instead of all at once to allow insects to move between different areas and flowers to remain intact. Some areas of lawn and grassy fields may be able to be left unmown, especially in corners.

In regions with lower rainfall, replacing traditional turf grasses with an ecolawn creates a low-maintenance landscape that also provides ecological benefits. Ecolawns are typically made up of resilient, low-lying grasses such as buffalograss that do not require mowing, irrigation, or fertilization. They often incorporate a diverse mix of low-growing perennials such as short-statured varieties of common yarrow or common selfheal. These diverse lawnscapes provide more forage for pollinators and require much less intensive management than typical lawns.

As you maintain lawns, avoid using pesticides and synthetic fertilizers. Preventative maintenance strategies, such as ensuring aeration to support grass roots, and proper watering to keep lawns healthy can help limit weed growth. Manage any unwanted weeds through physical methods, when possible, and reseed areas where weeds are removed or turf has been damaged. To reduce or eliminate synthetic fertilizer use, consider applying a thin layer of compost in the spring, and leaving grass clippings in place. Including legume species such as clovers in lawns can reduce the need for fertilizer as they fix nitrogen that can be used by other plants. If fertilizers are used, apply when grass is actively growing to increase uptake and avoid over-application. If there are lawn areas that you wish to maintain as turf-only (e.g., playing fields or golf courses) seek out natural or organic turf management methods.

Figure 26—In addition to supporting pollinators with pollen and nectar, including legumes like clover in ecolawns can improve the soil by fixing nitrogen and reduce the need for fertilizer. (Photograph by Thelma Heidel-Baker.)

Figure 27—Some pollinator-friendly low-growing perennials tolerate frequent mowing and produce a thick mat of flowers over time. A blanket of selfheal in this sunny playing field in an Oregon park attracted several bumble bee species. (Photograph by Sara Morris.)

Trees and Shrubs

While we usually think of wildflowers for pollinator habitat, trees and shrubs are also critical resources, and form a notable part of many parks and recreation facilities. Trees provide much denser forage for bees, meaning that the bees do not have to travel as far between blooms or spend additional time searching. Shrubs and trees also provide nesting sites, shelter during wind and rain events, may grow in locations otherwise devoid of flowers, and may help bees create a cognitive map of foraging areas to aid in navigation. Beyond bees, the larvae of many butterflies and moths feed on tree foliage, in turn providing a food source for birds that rely on caterpillars. Research has found that native trees and shrubs support a much higher number of butterfly and moth larvae—both in terms of species diversity and caterpillar abundance—than non-native species.

While many factors must be considered in selecting appropriate trees for urban areas, prioritize native tree species that provide forage to native pollinators, and include species that bloom at different times than forb species. Many flowering trees bloom early in the spring and provide an important source of nutrition for overwintered pollinators. Since street trees and those surrounded by other impervious surfaces can be more susceptible to pest and disease pressure, take care to select trees that are more resilient to common pests and diseases.

Marginal Areas

Many greenspaces have small areas that can be given over to pollinators, often just by reducing maintenance pressure. Awkward-to-mow corners, fencerows, the bases of hedgerows, trail and road sides, the margins of sports fields, and banks of creeks and drainage ditches offer nesting and foraging habitat. If disturbance to these marginal areas is avoided, the conditions can be relatively stable over time, which will allow the soil structure and plants to mature. Additionally, these areas often connect other patches of habitat, providing a corridor along which pollinators (and other beneficial insects and wildlife) can move through the landscape.

Figure 28—Some of the earliest-blooming native pollinator plants are trees, like cherries (below). Many of which have co-evolved with native bee species to bloom when these early-emerging bumble bees and mining bees are active. (Photograph by Sarah Foltz Jordan.)

Figure 29—Marginal areas can provide significant habitat. This creek lies between sports fields, a playground, and a parking lot, yet provides flowers for foraging and on the far bank, bare ground for nesting. (Photograph by Matthew Shepherd.)

Insect Management for Pollinator-Friendly Trees

Contributed by Aimee Code, Xerces Society for invertebrate Conservation

Bees, butterflies, and other pollinators are vulnerable to insecticide exposure when foraging or otherwise utilizing trees treated for insect pests. Many insecticide product labels include language prohibiting or warning against applications to blooming plants. Still, systemic treatment (e.g., tree injection and soil drench) of trees and other woody plants can cause harmful exposures even when applications occur months prior to bloom. A recent study of neonicotinoid insecticides found potential risk to bees when trunk injections occurred the fall prior to bloom. The researchers concluded that use of these pesticides on woody bee-attractive landscape plants poses a risk to pollinators even when applicators follow label directions and bee precaution language. They went on to recommend avoiding the use of the neonicotinoids on bee-attractive trees and shrubs unless there is no other way to prevent significant pest damage.

These findings are corroborated by a number of incidents that occurred in recent years when bumble bees were killed after foraging on linden (*Tilia* spp.) trees treated with neonicotinoids. Regulators investigated and confirmed incidents in Virginia, Oregon, and Delaware. While all the incidents were slightly different, many of them involved systemic applications of a neonicotinoid, at label rates, months prior to bloom. Subsequently, during bloom, bumble bees were found dead and dying under the trees. Testing of the bees as well as the blooms found harmful levels of the insecticides. These incidents are confounded by the fact that *Tilia* trees produce a natural toxin, mannose, which could increase risk to bees and other pollinators. Regardless, the incidents offer a cautionary tale when insecticides are used to manage pests in woody pollinator-attractive plants, even when the application is well outside the bloom window. (For more information on bumble bee incidents see the report *How Neonicotinoids Can Kill Bees*, produced by the Xerces Society.)

To protect bees and other pollinators from exposure to systemic insecticides:

- Select trees and shrubs resistant to insect pests.
- Prevent pest outbreaks by maintaining healthy trees and avoiding stressors such as lack of water, restricted root space, and compacted soils.
- Avoid insecticide use for "nuisance" pests that do not harm the health of the tree.
- If the insect threatens the tree's health or otherwise poses an economic threat, consider non-chemical options first. For some pests, there are physical or cultural management options.
- If you expect the tree will need continual insecticide treatments to survive, consider removing the tree.
- If you plan to apply an insecticide systemically (e.g., trunk injection or soil drench), consider covering blooms with netting for two bloom cycles after the application. The treated tree should also be covered if it is a butterfly or moth host plant (e.g., dogwood, ash, and willow), as foliage can have even higher residues than nectar.

Trees and woody shrubs can provide pollinators with numerous resources to complete their life cycle (from forage to nesting materials). Incorporating actions to manage these trees in ways that protect pollinators from potentially harmful insecticide exposures is a great way to help ensure parks and open spaces provide safe and healthy habitat.

Figure 30—Linden (*Tilia* spp.) trees (left) are highly attractive to pollinators, because their flowers (right) produce copious amounts of nectar. (Photographs by Matthew Shepherd.)

Figure 31—Community garden with pollinator plants. (Photograph by Matthew Shepherd.)

Figure 32—Native wildflowers and other pollinator plants border a recreational path. (Photograph by Matthew Shepherd.)

Community Gardens and Orchards

Community gardens lend themselves well to native pollinator conservation. Native bees are especially effective crop pollinators, so the entire garden will benefit from their presence. Habitat for pollinators also supports other beneficial insects, such as predators, which can keep pest problems in check without the use of pesticides. These "natural enemies" often rely on flowering plants for food for at least part of their life cycle.

Many fruits and vegetables, such as squash, tomatoes, and berries, as well as a number of common herbs, such as lavender, oregano, and mint are highly attractive to bees and other beneficial insects. If allowed to bolt (go to flower), unharvested plants such as radishes, broccoli, basil, and carrots will support bees and beneficial syrphid flies. As adults, syrphid flies eat pollen and nectar but as larvae are voracious eaters of aphids and other pest insects. Other non-crop flowering plants can be incorporated in or between the plots, or flowering shrubs can be used as hedge borders around the garden.

Edible and permanent shrubs and trees are also valuable additions, since many of these plants provide human foods along with food and/or nesting habitat (in the hollow stems) for native pollinators. Good choices include raspberry, gooseberry, hazel (filbert), elderberry, blueberry, and grape.

To manage community garden beds without pesticides, take special care to select locally appropriate varieties and to space plants adequately. Agronomic practices such as incorporating compost and organic fertilizers, companion planting, cover cropping, and crop rotation can help keep vegetable and fruit crops healthy, preventing pest and disease issues.

Trails and Bike Paths

The greenspaces along trails and bike paths can act as valuable corridors to allow pollinators to move between habitat sites. Consider improving these corridors—whether they are lawn, meadow, or a forested creek corridor—to increase pollinator forage and nesting opportunities. For many park departments, the lands associated with trails represents a major proportion of the parks land holdings, sometimes greater than the land in formal parks or sports facilities. They also offer additional recreation opportunities like birdwatching.

Trails and bike paths may be local, provide neighborhood connections, or be part of a regional network, but they all offer opportunities for wildlife conservation and frequently partnerships with local community organizations, businesses, or other agencies. For example, a trails following a powerline easement or creek corridor can be jointly managed to ensure safety or water quality, as well as habitat benefits and recreation opportunities.

Natural Areas, Wetlands, and Riparian Zones

Natural areas are not just important for pollinators, pollinators are also vital to the functioning of these ecosystems. Pollination results in seeds, nuts, fruit, and berries that are critical food sources for many wildlife as well as maintaining the plant community that provides shelter and habitat to many animals, and shade, water filtration, and other benefits to people. Pollinator conservation provides a framework for enhancing and managing natural areas with benefits that extend to the rest of the ecosystem.

Figure 33—Native pollinators can utilize a variety of habitats. The snags in this urban wetland can serve as an important nesting place for wood–nesting bees. (Photograph by Matthew Shepherd.)

Pollinators may be found utilizing a variety of habitats. Sunny, open patches in natural areas often contain a mix of flowering plant communities where pollinators thrive. Transitional areas or forest edges typically have the snags and fallen logs that can provide nest sites, as well as shrubs and other plants that offer foraging opportunities for pollinators. Riparian zones offer nesting sites and forage plants, as well as wet soil for partitioning brood cells. In general, aiming for heterogeneity—diversity in vegetation, structure, and management practices—helps maximize biodiversity.

When designing pollinator management strategies, it is important to determine if there are any specialist pollinators in the area. As discussed in Chapter 2, many pollinators are generalists that can easily utilize a wide variety of plants, but some are specialists that rely on a more limited in range of plants. Management techniques that emphasize the broad habitat requirements of pollinators may promote generalist species while overlooking the more particular requirements of specialists. Since no single management plan can provide ideal habitat for all pollinators, the conservation priority of specific pollinators in the area should be considered. This often means that specialist pollinators should be a higher priority in natural areas (most generalist species can adapt to the range of habitats found in more developed areas).

Consider management activities in relation to their impact or benefit to pollinators. For example, some natural areas are beset by invasive weeds. In these areas, management activities such as mowing and/or herbicide use may be the appropriate management strategies. Such methods can benefit pollinators and their habitat in the long term, but can also cause damage in the short run. In general, reducing the number of times a site is mowed and delaying mowing until later in the year is beneficial to pollinators.

When mowing is occurring, the following considerations will help pollinators escape being killed by the mower: mow during the middle of the day when adult pollinators are most active, mow at reduced speeds (less than 8 mph); and mow from the center outward (these practices will also help other wildlife). Any herbicide use for restoration should be weighed against other management choices such as physical controls. To minimize harm when herbicides are used, select the most targeted product available that is effective for the weeds of concern and use it in the most selective manner possible. Herbicide use to remove invasive plant species should be follow up with replanting with desirable plants to avoid reestablishment of invasive plants.

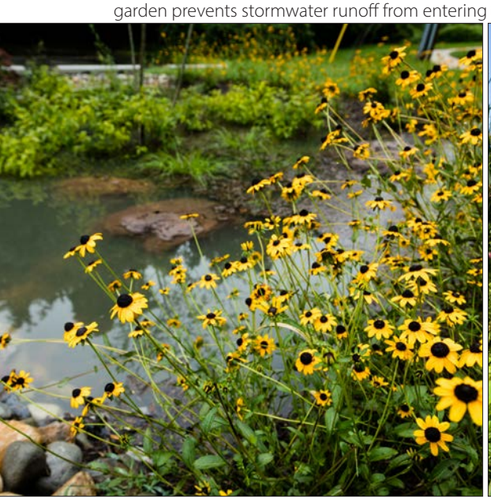
To minimize potential damage from any site management, it is always important to leave some areas of the site untreated. A good rule of thumb is to treat no more than a third of the site with any particular management technique in a year. Where treating in thirds is not feasible, consider patch management to retain landscape diversity and heterogeneity. An adaptive management approach will help to improve management effects over time based on the unique conditions and pollinator communities at your site.

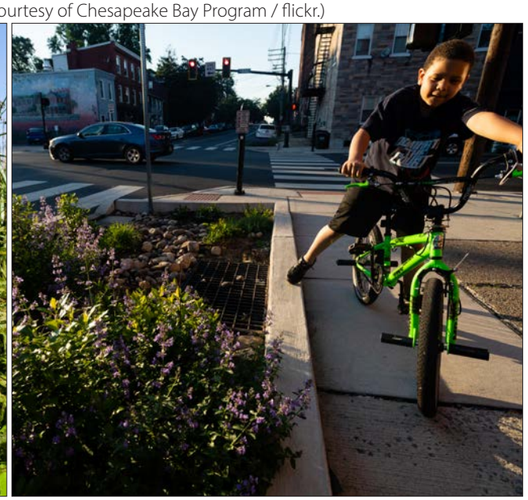
Rain Gardens, Retention Areas, and Bioswales

Constructed features that capture, slow, and infiltrate or hold water are increasingly utilized in urban landscapes. By capturing water, these areas serve to reduce flooding, minimize the erosion and contamination associated with runoff, and slowly release water back to plants and wildlife during drier periods. These sources of wet soil or water are important to pollinators for hydration, mineral nutrition (the reason that butterflies gather around a puddle edge), or mud for their nests.

As appropriate, these areas can be planted with flowering plants that beautify the site, hold the soil in place and provide pollinator resources. For example, spirea shrubs (which are highly attractive to pollinators) are often used on the upper edges of rain gardens.

Figure 34—From left to right: bio-retention cell in an urban rain garden absorbs stormwater; a mason bee home in a rain garden provides safe nesting spaces for pollinators above the ground; sweat bee on spring beauty (*Claytonia virginiana*) at the Jug Bay Wetland Preserve; a small urban rain garden prevents stormwater runoff from entering the local watershed. (Photographs courtesy of Chesapeake Bay Program / flickr.)





Street Medians, Large Planters, and Parking Lots

As communities look for ways to green up their neighborhoods, medians, large planters, and curb areas within parking lots are becoming more common. These areas can have the added benefit of providing habitat for pollinators but they also have unique considerations, such as aesthetics or providing shade.

Plants grown in planters are more exposed to environmental conditions, such as fluctuations in water availability and temperature, than plants grown in the ground. Plants in containers can also become root-bound. Selecting hardy plants that can handle these harsher conditions is important when selecting species for planters. Along streets or in parking lots, choose salt-tolerant plants if salt is used nearby as a de-icing agent. See **Appendix A** for suggested plants.

Figure 35—Parking lot pollinator planting. (Photograph by Kathryn Prince.)

Recreation Centers, Offices, and Maintenance Facilities

The landscaping around recreation centers, offices, and maintenance facilities are full of opportunities for creating and enhancing pollinator habitat. Many of the landscape types listed in this section could be present in these places.

One relatively unique opportunity they offer is to provide open habitat areas with a diversity of flowers that grow taller than a typical mowed turf area. They can also be high-profile locations with significant community presence. Habitat here will help spread the word about the important work being done or changes being made, and encourage community members to adopt them at home or in their own neighborhoods.

Figure 36—Pollinator garden outside an office building. (Photograph by Matthew Shepherd.)

Figure 38—This Portland ecoroof is a pollinator bonanza with native wildflowers. (Photograph by Multnomah County Green Team/ flickr.)

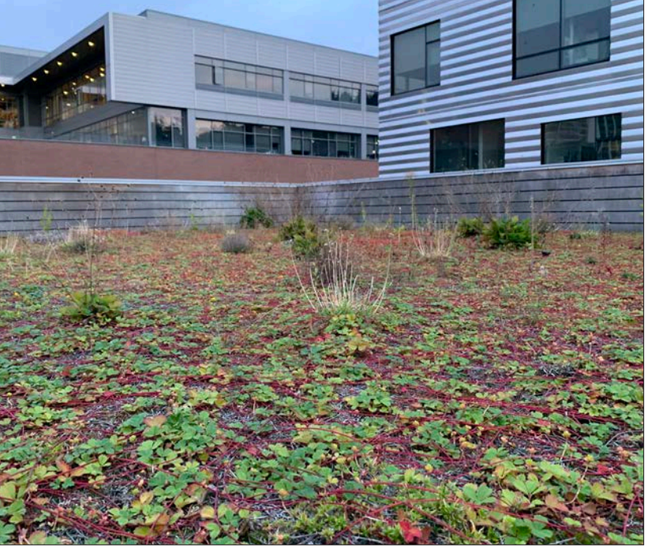


Figure 37—Green roof at Portland State University. (Photograph by Matthew Shepherd.)

Green Roofs and Ecoroofs

Another possibility for incorporating pollinator habitat around buildings are green roofs, specially designed surfaces of living plants on rooftops. They can vary from a mat of sedums to a rooftop garden with shrubs and trees to an ecoroof with a more natural design that mimics local habitats. Green roofs can reduce stormwater runoff, insulate a building against heat and cold, and provide habitat for pollinators. A roof with a shallow substrate can support sedums and other drought-tolerant species, which will offer nectar and pollen. A roof with a deeper substrate (8 inches or more in depth) may support a wider range of native plants and provide nesting habitat. A deep substrate may be shaped to form micro-topography, diversifying the ecological niches on the roof. Drought-adapted flowering plants like succulents and native grassland forbs and grasses are excellent choices for roofs. In urban settings, ecoroofs provide critical islands of food sources for pollinators. They can also help offset the effect of urban heat islands, and provide an outdoor oasis for the building's occupants.

Pollinator Paradise Demonstration Garden Inspires Pollinator Tourism

Contributed by Debbie Roos, North Carolina Cooperative Extension

The Chatham Mills Pollinator Paradise Garden was started in 2008 as a demonstration site by the Chatham County Center of North Carolina Cooperative Extension. Chatham County is one of the state's fastest growing, and faces significant development pressure and loss of habitat for pollinators. Covering one third of an acre, the garden includes over 220 unique species of perennials, shrubs, vines, and grasses, 85% of them native to North Carolina. The garden is managed organically and is maintained by a Cooperative Extension Agriculture Agent and a small group of volunteers.

As a demonstration garden, the Pollinator Paradise is an excellent and important tool for Cooperative Extension outreach efforts, continually inspiring residents to plant pollinator habitat at farms, schools, parks, businesses, and backyards. A multi-faceted outreach program includes all-day workshops and public and private garden tours.

Thousands of farmers, gardeners, beekeepers, Master Gardener volunteers, conservationists, green industry professionals, educators, and students of all ages have toured the garden. Guided tours highlight the diversity of plants and pollinators, the importance of emphasizing native plants, plant and insect identification, natural history and needs of native bees, nesting habitat, garden installation and maintenance, and organic management strategies.

Figure 39—Leafcutter bee foraging on dwarf indigo bush in early June. (Photograph by Debbie Roos.]

Figure 40—Metallic green sweat bee foraging on Joe Pye weed in mid-July. (Photograph by Debbie Roos.]

Figure 41—Tiger swallowtail on ironweed in late August. (Photograph by Debbie Roos.]

Figure 42—One of the paths in the Pollinator Paradise Garden. (Photograph by Debbie Roos.]

Figure 43—Farmers, gardeners, landscapers, nursery growers, beekeepers, and Master Gardener volunteers from 11 counties at a Pollinator Garden Design Workshop. (Photograph by Debbie Roos.)

High-quality photographs of flowers in bloom and pollinators visiting the garden play a key role in extending the educational and inspirational impact of the garden. Social media is used effectively to excite, inspire, and educate: hundreds of photos and videos of the garden on Facebook, Instagram, and Twitter—as well as the garden's website, www.carolinapollinatorgarden.org—cultivate a high level of engagement and encourage viewers to visit the garden and attend educational programs. The website features recommended plant lists, workshop and tour schedules, a current "What's in Bloom" feature, a list of local nurseries that supply pollinator plants, and other resources.

The garden staff surveyed its visitors and discovered the far-reaching impacts of the demonstration garden:

- the garden has inspired hundreds of visitors to plant their own garden;
- the garden attracts "pollinator tourists" from across North Carolina and beyond; 88% of visitors said they spent money eating out and shopping in Pittsboro when they came to see the garden, and 74% of survey respondents reported they bought plants from North Carolina nurseries as a result of visiting the garden; and
- many garden visitors take the recommended pollinator plant lists (developed by the Cooperative Extension Agriculture Agent) to local nurseries when they shop, prompting a few nursery managers to add new species for sale that are in the pollinator garden.

Visitors to the Pollinator Paradise Garden have also shared how the garden has made them less fearful of stinging insects, inspired them to adopt organic management practices, and opened their eyes to the amazing diversity of pollinators and other beneficial insects and plant-insect interactions—all of which enable them to be better stewards of the environment and advocates for pollinators.

5

Getting Started: Strategies for Success

Good habitat for bees and butterflies provides three important things:

1. Food in the form of nectar, pollen, and host plants
2. Shelter and nest sites
3. Protection from pesticides and high levels of pathogens

At both the local- and landscape-level there is a fourth aspect that makes habitat even better—connections to other habitat so that pollinators can move through developed areas.

The following chapters mirror this structure, giving more detail on how to plan and create flower rich habitat, how to provide nest sites and host plants, and how to reduce pesticide use. There is also a chapter on community engagement. In this chapter we offer a brief overview of some successful ways to get things going and make the shift toward encouraging pollinators through your park management practices.

One of the encouraging aspects of pollinator conservation is the ease with which it can be adapted to different sites. Even minimal changes, such as reducing the intensity of maintenance efforts in order to lessen the disturbance to existing habitat features, can benefit pollinators.

Food Sources

Flowering plants provide the nectar and pollen. Adult bees and butterflies require nectar for energy, and bees will collect pollen for their larvae. In addition, butterflies and moths require caterpillar host plants such as forbs, grasses, shrubs, or trees.

Providing a diverse, abundant, and season-long supply of food sources is an important component of good pollinator habitat.

Figure 44—The reliance on specific or limited host plants can make it difficult for butterflies to find suitable places to lay their eggs. Gulf fritillary caterpillars require passionflower vines to complete their life cycle. (Photograph by Dan Mooney / flickr.)

Aim to have at least three different species blooming at any point during the growing season to provide nectar and pollen. Three is only a minimum threshold—the more species the better! Include a wide range of flower structure, shape, color, and size as certain flowers are more attractive to some pollinator species than others (e.g., long, tubular flowers are often more attractive to butterflies than bees). Early- and late-season flowering resources can be especially important for bumble bees, which are often active in the "shoulder seasons," as well as migrating monarch butterflies (which, depending on region, may be migrating between late August and November).

Provide a diversity of native plant food sources: wildflowers, perennial bunch grasses, sedges, trees, and shrubs. Some examples of trees and shrubs that support pollinators and have native species across North America are oaks (genus *Quercus*), willows (genus *Salix*), wild cherries (genus *Prunus*), wild lilac/New Jersey Tea (genus *Ceanothus*), sumac (genus *Rhus*), and meadowsweet/spirea (genus *Spiraea*). There are hundreds of additional locally native herbaceous and woody native species to choose from. See **Appendix A** for plant lists.

Shelter and Nest Sites

At some point in a pollinator's life, it will need to take shelter to survive a storm, form a chrysalis, build a nest, or overwinter. Some bumble bees and butterflies crawl down into the bases of bunch grasses; others seek shelter under tree leaves, rock crevices, litter, woody material, or abandoned rodent nests.

Leave some woody-, hollow-, or pithy-stemmed vegetation and ground litter intact and in place permanently. These materials can often be used by native bees (as well as syrphid flies, soldier beetles, and a host of others) to overwinter.

Leave some bare ground and abandoned rodent nests, and preserve microtopography such as grass tussocks. Many native bees nest below ground and require bare ground or existing cavities to nest in.

Avoid mowing, burning, or grazing an entire area down to the ground. Overwintering pollinators, even adults, are generally immobile at low temperatures and unable to escape blades, flames, or livestock.

Figure 45—Some native species of lady beetles—such as the convergent lady beetle (below)—overwinter in groups under leaves, in bunchgrasses, or cavities. (Photograph by Gary Chang / flickr.)

Pesticides

Pollinators need habitat that is protected from pesticides. See **Pest Management and Pesticide Use on page 66** to learn more about the importance of creating and maintaining habitat that is safe for pollinators.

Diseases

Pollinators also need habitat that is safe from high levels of pathogens, such as those that can spread from managed to native pollinators.

Recognizing Existing Pollinator Habitat

Pollinators will be found visiting any urban greenspace and consequently, all parks and greenspaces can add to the habitat available to support pollinators in a town or neighborhood. Even small parks will have room for flowers, caterpillar host plants, or bee nests. A site may provide one or more of these components of pollinator habitat. While every site may not provide everything bees and butterflies need, taken together they will greatly benefit and improve your community for native pollinators.

The first step in pollinator conservation is simple: to recognize and protect existing pollinator habitats in your park. A brief stroll in a park will reveal butterflies and some bees, patches of flowers, and maybe potential nesting sites. Start by identifying the locations in your park where bees and butterflies forage. Once you become aware of pollinator activity on plants and flowers, closely observe flowers to notice which bee species are present and abundant. Next look for nest sites, host plant patches, and other significant foraging patches. When you find nest sites and forage areas, mark them on a map of the park. This permanent record of the significant spots for pollinators will be useful when you plan maintenance work and as you work to develop new habitat. Careful management of these areas, including protecting them from pesticides, may create more nesting and foraging opportunities for pollinators.

Spotting Good Foraging Areas

A good foraging area contains a diversity of flower species that offer blooms of different shapes over the entire season. An area with a profusion of only a few species can also be important, especially if it is one of several patches in a landscape. Look along forest margins, riparian areas, utility easements, road edges, and conservation areas, as well as in unused land around sports fields and maintenance buildings. These sites have relatively undisturbed conditions that allow nectar- or pollen-rich plants to become well established. As you observe flowers, create a list of plants already growing in your park that seem most attractive to native bees. This will make it easier to choose plants for subsequent restoration projects.

Identifying Butterfly Host Plants

To a great extent, good host plant areas will be the same as good foraging areas. Diverse forage patches will almost certainly include a variety of host plants. Because the caterpillars of many butterflies feed on trees, be sure to inventory your tree resources. For example, host plants of the tiger swallowtail include willow and black cottonwood, Propertius duskywing caterpillars feed on oaks, and juniper hairstreak caterpillars eat red cedar and junipers. Pay particular attention to native plants, as your local butterfly fauna is adapted to feed on these species.

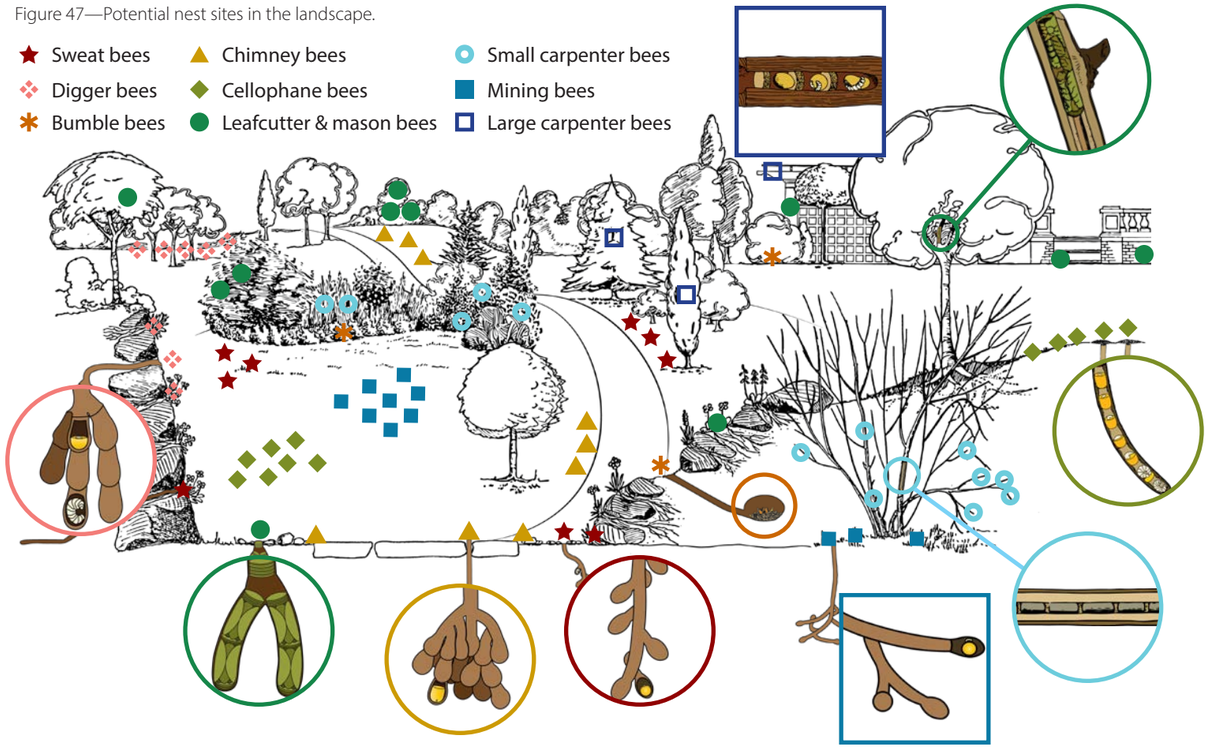
Figure 46—Many skippers have grasses as their host plants, like these little Least Skippers. (Photograph by Judy Gallagher / flickr.)

Finding Bee Nest Sites

Nest sites are just as important as flowers are for quality pollinator habitat. Flowers are usually encouraged to grow. But natural nest sites such as beetle-bored snags; patches of bare, undisturbed ground; or areas of long, tangled grass and bushes where small mammals like chipmunks and mice might nest are often considered eyesores or hazards to be removed. Developing a tolerance for these places is a valuable first step. Search for existing natural nest sites and do all you can to protect them. Knowing where nests already occur will give insight into the local conditions and locations that bees in your area prefer to use—valuable information when you get ready to create new habitat.

Because the only outward signs of many bee nests are tiny holes in the ground or a hole in a tree, finding nest sites may take more effort than finding foraging areas. Additionally, different species are active at different times of the day and year, so nest sites may not have observable comings and goings. For the best chance at success, search several times during the warmest months, and take into consideration the time of day. Most bees are active on warm sunny days from midmorning through the afternoon. Some may be active primarily early in the morning. Others, such as bumble bees, will continue foraging late into the evening. In the southern tier of states, where winters are mild, you may find bees active all year. In northern states, February or March may be the earliest month with active bees, with different species active at different times until September. Nest sites for each of these bees will have signs of activity during brief periods, but at other times will appear to be unoccupied.

Figure 47—Potential nest sites in the landscape.



Ground Nests

Over 70% of our native bee species nest in the ground, including species such as mining bees and sweat bees. Ground nests are often located on banks surrounding stormwater basins, ditch sides, the edges of tracks and trails, or on gently sloping hillsides with areas of sparse grass. Examine open patches of undisturbed soil and sunny, bare slopes. Nesting sites can be inconspicuous; start by looking for bees entering and exiting a hole the ground. At first, all you may see is a patch of bare ground. A closer look will reveal a scattering of small holes across the bare soil, or small mounds of soil poking up between vegetation. These mounds are sometimes mistaken for ant nests. Pause for a few minutes, and you may notice bees flying in or out of the nest entrances. Sometimes you might see low-flying males in search of a mate, punctuated by a frenzied scramble when a female appears.

Stem Nests

Many bees, such as leafcutters and masons, nest in pithy-stemmed plants. Small carpenter bees will nest in twigs with a soft pith, such as elderberry, sumac, or blackberry. A list of plants with pithy stems that are used by stem-nesting bees is given in the **Appendix A on page 85**. Stem-nesting bees overwinter in the stems and so it is important to leave the stems standing and not clean them up in the fall. Leave leaves and stems over the winter to provide shelter and insulation to overwintering bees and other pollinators. Unlike honey bees, most native bees overwinter individually.

Wood Nests

Smaller bees may nest in the tunnels and tracks that beetles have made in snags (dead limbs on standing trees) or branches with similar holes. Snags support other wildlife such as ants and woodpeckers, in addition to bees, so if the snags on your grounds do not pose a hazard, keep them. Stem- and wood-nesting bees will take advantage of any hole of the correct size. It is not unusual to find them nesting in the gaps between shingles or other small crevices on buildings. These bees do not harm the building; they merely utilize existing spaces.

Figure 48—Creek banks, hedgerows, and awkward corners by sports fields are among the areas that contain pollinator habitat. (Photograph by Matthew Shepherd.)

Figure 49—Small carpenter bees nest in pithy-stemmed plants by digging the pith out to create a long tunnel. (Photograph by Sara Morris.)

Figure 50—Holes capped with mud indicate a mason bee or wasp has made a nest. (Photograph by Heather Holm.)

Table 2. Pollinator Flower Preferences, Food Resources, and Shelter Needs

RESOURCE TYPE	VERTEBRATE POLLINATORS		INVERTEBRATE POLLINATORS & BENEFICIAL INSECTS‡									
	BATS	HUMMINGBIRDS	FLIES				BEETLES		BEES & WASPS		LEPIDOPTERA	
	Both	Both	Adults	Larvae			Adults	Larvae	Adults	Larvae	Adults	Larvae
SPECIFIC HABITAT GOALS	Diverse plant communities that provide:											
Flower Value	Dull	Bright	Pale & dull to dark				Dull		Bright		: Pale & dull | : Bright colors	
Flower Color(s)	White, Green or Purple	Scarlet, Orange, Red or White	Brown or Purple*				White or Green		White, Yellow, Blue, or Ultra-Violet		: Red, Pr, Pk or White : Incl. Red and Purple	
Flower Shape(s)	Regular; bowl-shaped—closed during day	Large funnel-like; cups, strong perch support	Shallow; funnel-like or complex & trap-like				Large bowl-shaped flowers		Shallow; have landing platform; tubular		: Regular; tubular w/o a lip | : Narrow tube w/ spur; wide landing pad	
Nectar & Pollen	(+fruit)											
Larval host plants			[1]	[1]			[1]	[1]	[1,2]	[2]		
Bunchgrasses							[3]		[4]			
Pithy-stemmed plants												
Prey or host insects			[1]	[5]	[5]				[1]	[1] [5] [5]		
GENERAL HABITAT GOALS	Areas of refugia free from disturbances; which include:											
Vegetation				[3,6]			[3]	[3]				
Bare ground / access to (loose) soil				[3,6]			[3]	[3]				
Mud / puddles / access to safe water				[3,6]			[3]	[3]				
Tree sap / resin / oil												
Salts / minerals												
Cavities / burrows / caves / mines								[3]				
Leaf litter or mulch								[3]				
Rocks / rock pile								[3]				
Brush or log pile								[3]				
Dead wood / standing snags								[3]				

KEY Food / nutritional supplement | Egg-laying site | Prey / host source | Nest / colony site | Nest materials | Overwintering site | Pupation site | Perching site

NOTES:

† Flower color and shape preferences, food resources, and shelter and nesting needs and general habitat goals for pollinators. (Adapted from Marks 2005; Lee-Mäder et al. 2014; Hopwood et al. 2015; The Xerces Society 2018)

‡ Pollinators & Beneficial Insects includes predatory and parasitoid species of flies, beetles, and wasps that act as pollinators during certain life stages and predators or parasitoids of pest species (like aphids or bark beetles) as others. (Egg-laying, primary habitat, overwintering habitat adapted from Hopwood et al. 2016.)

* Flecked with translucent patches.

1. Host plant for prey or host species (i.e., predatory or parasitoid FLY or WASP with a specialist host)
2. Specialist BEES collect pollen from specific plant taxa (e.g., family or genus)
3. Refers to habitats the predatory life stage resides/lays in wait—or hunts—for prey
4. Some cavity-nesting WASP species collect grasses to create nest cells
5. Parasitoid FLIES & WASPS may pupate / overwinter within their host
6. Includes non-predatory FLIES that feed on rotting vegetation/organic matter as larvae and act as important pollinators as adults

Figure 52—Bumble bees frequently nest in old rodent burrows. (Photograph by yaquina / flickr.)

The exception are large carpenter bees. They usually make nests in the soft deadwood of plants such as pine and agave, but may tunnel into exposed timber of buildings. (See **Carpenter Bees** below.)

Cavity Nests

Bumble bees require a small cavity, such as an abandoned mouse nest. Most species of bumble bees prefer to nest at or below ground level. Patches of leafy bunchgrasses or overgrown hedge bottoms—areas preferred by mice—are typical places to find bumble bees nesting. In addition, at least one species, the black-tailed bumble bee, regularly nests in hollow snags or bird nesting boxes.

Carpenter Bees

The aptly named large carpenter bees (genus *Xylocopa*) are the largest native bees in the United States, similar to bumble bee queens in size. Large carpenter bees can be found from coast to coast in North America. They occur throughout the eastern states and Midwest as far north as Canada, in the Great Plains to Nebraska, and in the western states as far as Oregon. (There are a couple of historical records from Idaho and Montana, and with climate change, maybe those will become the norm.)

They get their name because they excavate tunnels inside wood to make their nests. Using their broad, strong mandibles (jaws), they chew into dead but non-decayed limbs or trunks of standing dead trees as well as the stems of plants like agave. Inside their rounded branched galleries, they place bee bread of pollen and nectar upon which they lay their eggs—which are giant, relative to the female. The eggs are up to 0.6" [15 mm] long, half the length the female!

Continued on next page…

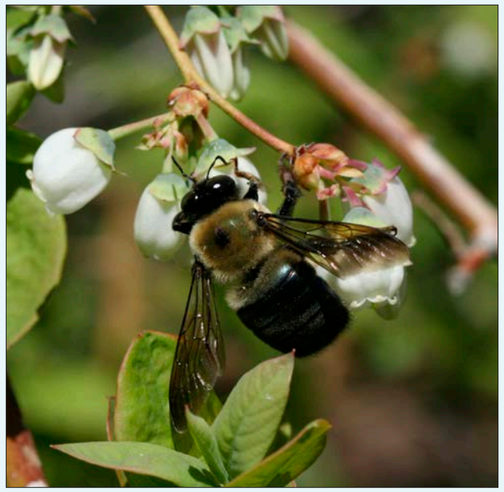


Figure 51—Eastern carpenter bees are widespread and easily mistaken for bumble bees. (Photograph by Emily May.)

"Carpenter Bees" continued…

Carpenter bees are one of the more commonly noticed bees in urban areas, likely because of their size and because they live close to people. They also are easy to spot as they are loud and boisterous, but they are not aggressive. Large carpenter bees are sometimes confused with bumble bees. Like bumble bees, they can be active in cooler or wetter weather than other bee species. One way to tell carpenter bees apart from bumble bees is that they have hairless, shiny abdomens.

Some species, such as the eastern carpenter bee (*Xylocopa virginica*), will nest in fence posts or structural timbers, and become a minor nuisance. Fortunately, because their nests tend to be a single tunnel, carpenter bees are unlikely to cause structural damage. Still in some instances, you may want to deter carpenter bees from nesting. To prevent carpenter bees from nesting in structures, keep exposed wood in vulnerable areas covered with paint, varnish, metal, or fiberglass. Fill depressions in wood, which will attract female carpenter bees, before painting. Repaint as often as necessary to keep up with weathering, paying particular attention to undersides of siding and trim. Using hardwoods will also help.

If you already have carpenter bees, take action as soon as a nest is detected. However, spring is the ideal time to take action by plugging holes in wood with steel wool and stapling on metal screen. Soft material such as wood putty or caulk will not prevent bee re-entry. You can also use aluminum, asphalt, or fiberglass materials. Another option is to drill a half-inch-diameter hole three-quarters of an inch deep in a 2×4 or 2×6 board. Then, during the day when the bee is out foraging, clamp the board over the entry to the previous nest. This will give the carpenter bee a place to continue working without damaging the structural wood. The board can be moved in the fall to a more suitable location.

Figure 53—An eastern carpenter bee closing her nest in a cypress tree. (Photograph by Johnny N. Dell, Bugwood.org.)

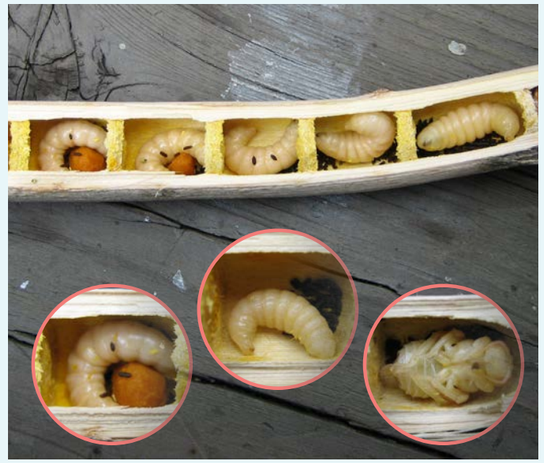


Figure 54—Located in a yucca stem, this opened large carpenter bee nest shows multiple cells. In the cells closest to the nest entrance, larvae are still consuming pollen; while, further into the nest, larvae have consumed their provisions and are preparing to pupate. (Photographs by Katharina Ullmann.)

Repellents offer a temporary solution until physical alterations can be made. Almond oil and almond essence placed around the nest may repel the carpenter bees.

6

Providing Plants for Foraging

Plants are a fundamental component of parks, adding beauty and structure to the landscape. For people, it may be enough that they create a peaceful green setting and offer colorful flowers. But for a pollinator, a flower garden or lawn may be a food desert. However, a well-maintained park providing recreation opportunities for the local community need not be in conflict with pollinator conservation. By thinking about plant choice and management, a greenspace that meets community expectations can be a place that supports a vibrant pollinator community, too.

Adjusting Maintenance for the Benefit of Pollinators

The first step in improving parks for pollinators can be to do less. Maintenance practices can be adjusted to take pollinator conservation into account. As much as possible, leave alone areas that might support native bees and butterflies.

Figure 55—High mowing can benefit pollinators in more than one way—protecting forage plants and leaving nesting plants intact. (Photograph by Xerces Society / Kelly Gill.)

Limit mowing in areas with potential forage plants and host plants. Leave places such as forest margins and little-used corners unmown. If mowing is needed, reduce the frequency, and/or raise the height of the cutting blades. Long grass can be left for bumble bees to nest in, and snags riddled with beetle tunnels should be left for mason and leafcutter bees (so long as the snags are not a hazard).

Protect sites with potential forage plants and host plants from pesticides. As much as possible, pollinator habitat should not have pesticide use. Still, when plant diversity is threatened by invasive weeds, land managers might include targeted use of herbicides as part of an integrated vegetation management plan. Parks staff may decide to review overarching pest management practices (see Chapter 8) to expand the use of cultural, physical, and mechanical methods that will reduce reliance on pesticides. When pesticides are employed, mitigation strategies such as only making very targeted applications and timing those applications for when bees are not expected to be present will help protect native bees that live in or use adjacent natural areas.

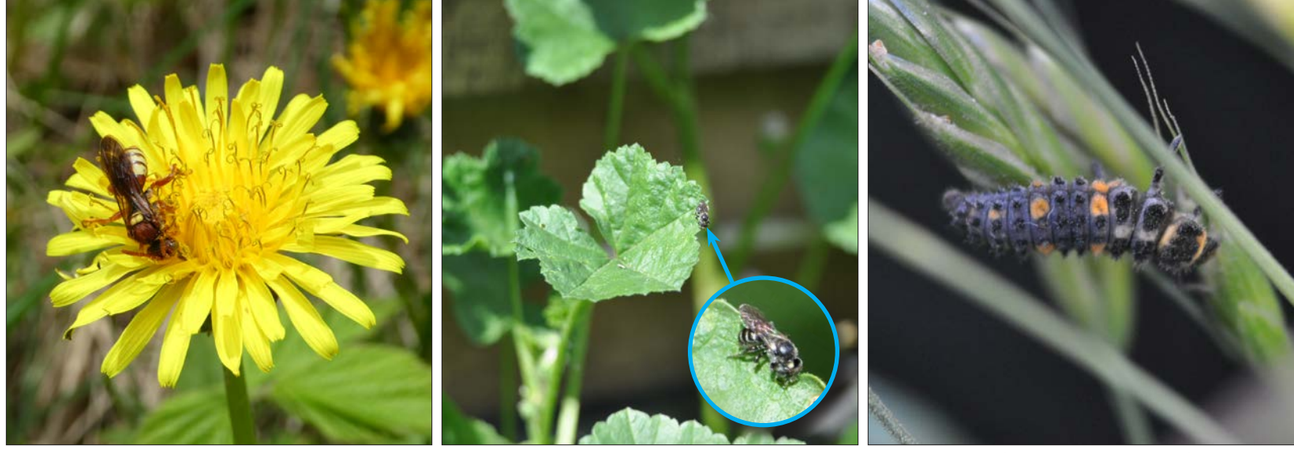


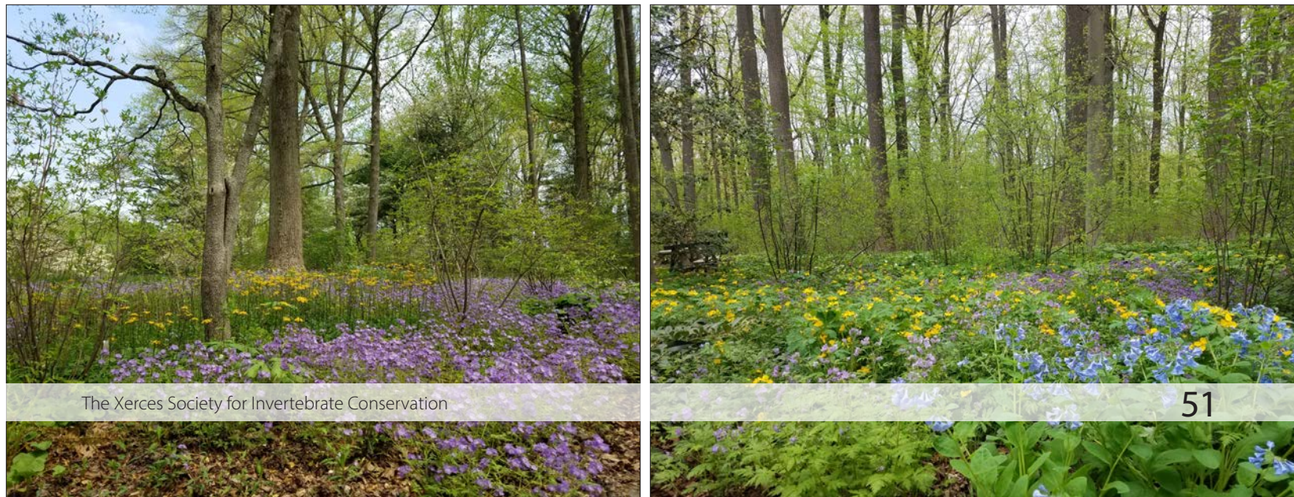
Figure 56—While they may be unwanted additions to a lawn or garden, some "weedy" species provide critical resources for pollinators and beneficial insects looking for places to forage or collect nesting materials. From left to right: cuckoo bee foraging on dandelion; a small mason bee collecting pieces of mallow leaves for lining the cells of her nest; convergent lady beetle larva seeking smaller insect prey in a grass that has been left to flower. (Photographs by Sarah Foltz Jordan [left] and Sara Morris [middle, right].)

If good forage plants also happen to be weeds, rethink whether the need to remove the weeds outweighs the value to the pollinators these plants may support. It makes sense to remove the source of invasive and noxious weeds, but give a second thought to less-aggressive weeds, especially if they flower in the spring and can help jumpstart populations of native bees. Selfheal, dandelion, violets, purple deadnettle, and henbit are examples of hardy plants that provide food for pollinators and tolerate the tough conditions of lawns.

Enhance, Restore, or Create Habitat

Changing where, when, and how maintenance is done can bring some benefits to pollinators, but the greatest benefits will be gained restoring or creating habitat to bring an abundance of native plants into the landscape. Existing habitat may also be enhanced with the addition of key native flowering plants and/or nesting materials.

Figure 57—Sun–dappled forest edges can make excellent foraging habitats. The combination of annual and perennial forbs, as well as flowering shrubs, provides nectar and pollen. These areas also tend to have sparsely vegetated soil as well as mature trees, both good places for nests. (Photographs by Xerces Society / Kelly Gill.)



Site Characteristics to Consider

Once you have identified potential places for improvement, decide where to start. Perhaps there is an area in which you will have the greatest impact, one that is easier to do, or one whose improvements fit best with your overall park management plan. Here are several issues to consider when identifying, evaluating, and deciding among locations.

1. Sunshine and Drainage

Topography influences drainage rates, moisture levels, sun exposure, and wind exposure, and is a significant factor on the potential value of a site for pollinators. For instance, south-facing areas are usually warmer. This tends to create better foraging and egg-laying conditions for sun-loving insects, as well as offering the drier, warmer, well-drained slopes preferred by ground-nesting bees. Plants on such sites, however, will dry out more quickly and/or need to be more drought tolerant. Therefore, establishing or protecting forage in nearby low-lying or north-facing areas may be a critical additional step for maintaining pollinators throughout the hot summer months.

2. Size of Habitat Patch

Make habitat patches as large as is feasible within the constraints of the park. Ideally, create as many patches as possible. The greater the area of habitat, the greater the likelihood that forage, host plants, nest sites, and nesting materials will be available throughout the flight season and within the bees' flight range.

3. Connections Between Patches

In many modern landscapes, much of the natural habitat has been replaced with inhospitable land uses, resulting in significant distances between habitat patches. Greater connectivity between fragmented patches can increase the value of the habitat to pollinators. Habitat corridors—continuous, permanent strips of vegetation that link these patches—can potentially increase the rate at which pollinators and other wildlife can colonize new areas of habitat. If a contiguous strip isn't possible, islands of habitat can also act as way stations or "stepping stones" for species to move across larger areas.

Natural resource managers frequently think of corridors for mammals, which need minimal breaks between habitat patches. Pollinators move in a more diffuse way across neighborhoods and cities, able to fly from patch to patch and utilize relatively isolated or small places. This is one reason why pollinator conservation is a good fit for parks and other greenspaces.

The distance between habitat patches should be planned based on how far a bee can fly, which is largely dependent on its size. For example, larger bees (such as bumble bees) can fly half a mile or more to forage, but most bees are much smaller, and their flight distance is considerably less. They probably travel no more than 150 yards from their nests, a couple of city blocks. The distance butterflies will fly similarly varies significantly by species.

Look beyond the boundaries of your greenspace for connections. An adjacent power line easement, roadside, or railroad embankment, for example, could provide a corridor between habitat patches within parks.

4. Proximity to Pesticide Use

As you evaluate which sites are best suited for pollinator habitat, consider surrounding land use. Is there adjacent land where pesticides are commonly employed to control weed, disease, or insect pests (e.g., a formal garden with non-native plants susceptible to pests)? If so, consider selecting a site where drift or other off-site movement is less likely to contaminate habitat.

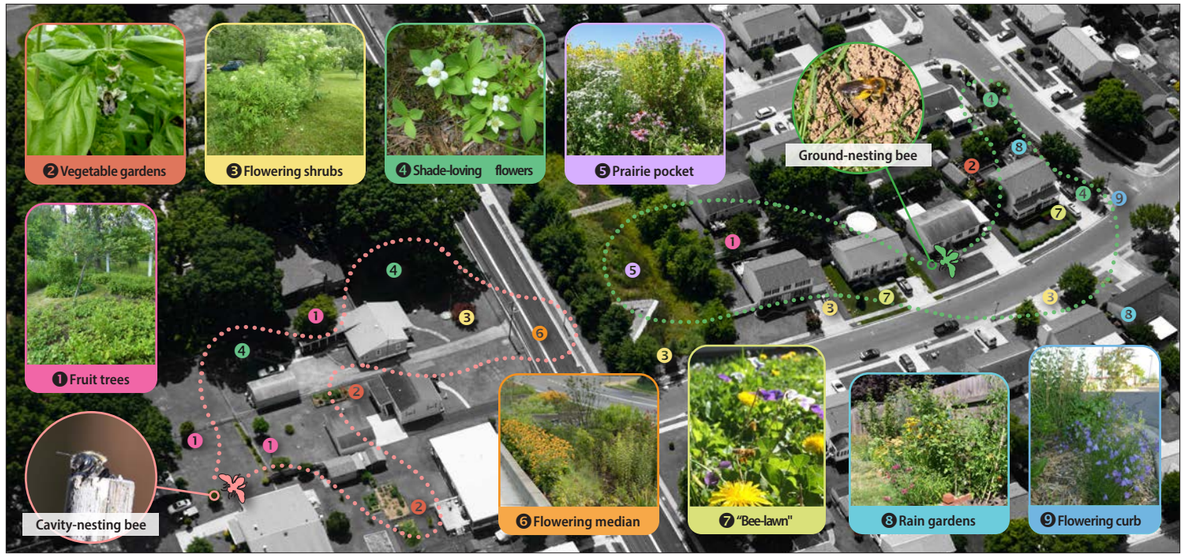


Figure 58—Abundant natural areas and wildflower landscaping in an area can help facilitate the movement of pollinators from one patch of habitat to another, and increase the likelihood that they will have enough food and nesting sites to build healthy populations. (Photographs by Nancy Lee Adamson [2]; Sarah Foltz Jordan [1, 3, 4, 5, 9]; Toni Genberg [6]; Emily May [7]; Sara Morris [cavity-nesting bee]; Matthew Shepherd [ground-nesting bee, 8]; Will Parson, Chesapeake Bay Program / flickr.)

5. Maintenance Access

In the long term, healthy pollinator habitat doesn't need intensive management. During the establishment period, weed control and irrigation are important. Because plants in new areas of habitat will benefit from irrigation during the first summer or two, keep in mind the need for access to a water supply and irrigation equipment.

Choosing Plants for Pollinators

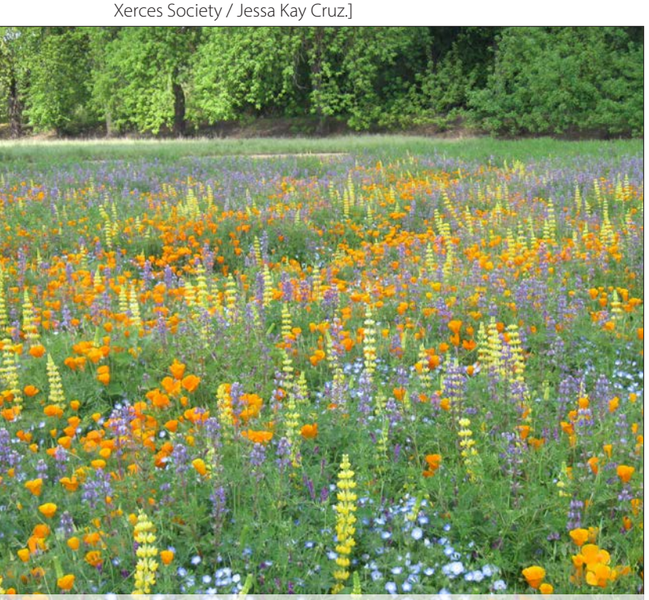
When planning forage habitat, consider the following nine points.

1. Ensure Plants Flower Throughout the Season

Pollinators will be active for several months, if not the entire year. In the southern states, butterflies or bees can be seen during any month. Across the northern tier of states, their active season may be limited to April (February where winters are mild) through October. Within this period, different species will be active at different times, with the adults of any given species active for two to six weeks. The active adult life of many solitary-nesting bees is synchronized with the flowering period of particular plants. Bumble bees are an exception; they may be seen any time during the growing season and need food sources for a much longer period. All of this is to illustrate that a sequence of plants that provide flowers through the growing season will support a wider range of pollinator species with differing flight times than will flowers that all bloom at the same time. Ensure several plant species flower at the same time. We recommend a minimum of three species, but research shows that sites with at least eight species of plants flowering simultaneously attracted a greater number and diversity of bees. This strategy will enhance your park's ability to attract and keep pollinators.

Figure 59—Good flower colors for bees are blue, purple, violet, white, and yellow. Butterflies like many of these colors and are also attracted by red. (Photograph by Mark Starrett, University of Vermont.)

Figure 60—The shape of the flower will limit which insects can reach the nectar or pollen. Planting a diversity of flowers with a range of shapes—and colors—will support a diversity of pollinators. (Photograph by Xerces Society / Jessa Kay Cruz.]



2. Select Plants in a Range of Colors

Choose a variety of flowers with diverse colors. Plants use colored flowers to attract pollinators; consequently, flower-visiting insects have good color vision to help them identify the best food sources. Bees find it hard to separate red from green, so good flower colors for these insects are blue, purple, violet, white, and yellow. Butterflies like many of these colors and are attracted by red—as are hummingbirds. Many flowers have ultraviolet "nectar guide" markings, which we cannot see but which are highly attractive to bees and help them locate the nectar. Some red flowers, such as blanketflower, are indeed valuable for bees because of their high UV-reflectance that is very striking to bee vision.

3. Choose Flowers with Diverse Shapes

Butterflies have long tongues that can probe many different flower shapes. Bees, however, differ by species in tongue length. There is a rough correlation between the depth of the flower and the length of the tongue of the bees that visit them. Some very open flowers, such as aster and yarrow, have nectar and pollen that is readily accessible to short-tongued insects of all sizes, including mining (*Andrena* spp.) and polyester (*Colletes* spp.) bees, as well as many flies and beetles. Other flowers, like lupines and penstemons, have nectar that is harder to reach, accessible only to bees that are robust enough to push between the petals or with long tongues (e.g., digger bees [*Anthophora* spp.] and bumble bees [*Bombus* spp.]). A variety of flower shapes will increase the diversity of bees and other pollinators your park can support.

4. Use Native Plants

Native plants are usually well adapted to their region's growing conditions. They can thrive with minimum attention after they are established, and may compete better with weed species than can non-native plants. In addition, research suggests that native plants are more attractive and accessible to native bees than non-native plants. Horticultural varieties and hybrids, which usually have a cultivar name, in contrast, are not necessarily suited to local conditions. Changes to the appearance of flowers, such as double petals, results in the loss of the plant's ability to produce nectar or pollen.

5. Get Plants from Local Sources

The origin of wildflower seeds or plants is important. We recommend that you select plants native to your ecoregion and use seeds or plants that originate from as close to your site as possible. When buying native species, always ask where the seed originates. See **Appendix A on page 85** for more information.

6. Match Plants to Site Conditions

Environmental conditions will influence your choice of plants. A plant community designed to suit existing conditions is is more likely to successfully establish. Note which native plants grow wild in similar conditions near to your park; this will give you some ideas about what might flourish in your site.

7. Think Five Years Ahead

Consider the use of the land immediately around the habitat and how it will be affected five or ten years down the road by the size, structure, and/or needs of the plants you choose. For example, in a hedgerow next to a road or ditch or around a service area, larger trees and shrubs may be desirable to serve both as forage for pollinators and as a screen. For habitat next to sports fields, it may be better to use plants that are shorter or have a more open structure in which home-run hits and stray balls can more easily be found. Planning ahead will allow you to take into account the suitability of the mature growth forms (e.g., trees, shrubs, forbs, grasses) for a particular site, and to consider and prepare for their maintenance needs.

8. Avoid Invasive Species and Noxious Weeds

Avoid plant species known to be highly competitive or otherwise problematic. Invasive species spread easily and exclude other species, reducing the diversity and value of the habitat and increasing maintenance demands. They may also cause problems by spreading to neighboring areas. Examples of species that can be invasive and should be avoided, even though they attract bees and butterflies, include butterfly bush (*Buddleja davidii*), Canada thistle (*Cirsium arvense*), Scotch broom (*Cytisus scoparius*), sweet fennel (*Foeniculum vulgare*), and lantana (*Lantana camara*). All of these are on state noxious weeds lists, meaning that by law, they must be contained and controlled to avoid further spread. Check for city, county, or state code restrictions on certain noxious weed species.

9. Use Plants Grown without Systemic Insecticides

Source plants grown organically or at least without the use of highly toxic and persistent systemic insecticides that can remain in the plant tissue long after purchase (see Chapter **8** for more detail on the risks of systemic insecticides). Ask your nursery or seed vendor for information on their use of pesticides to produce the plants or seeds you are buying (See **Appendix B** for more information). Pesticide ingredients to avoid if used in production include, but are not limited to, dinotefuran, cyantraniliprole, flupyradifurone, imidacloprid, clothianidin, and thiamethoxam. If you propagate the plants that will be used in landscaping, take steps to limit pesticide use, especially the use of persistent systemic insecticides.

Figure 61—When plants are small—before they have reached full size—install a habitat sign marking the site while the plants mature. (Photograph by Suzanne Granahan.)

Native Plant Meadows: Their Benefits in Parks and Greenspaces

Ecological Value

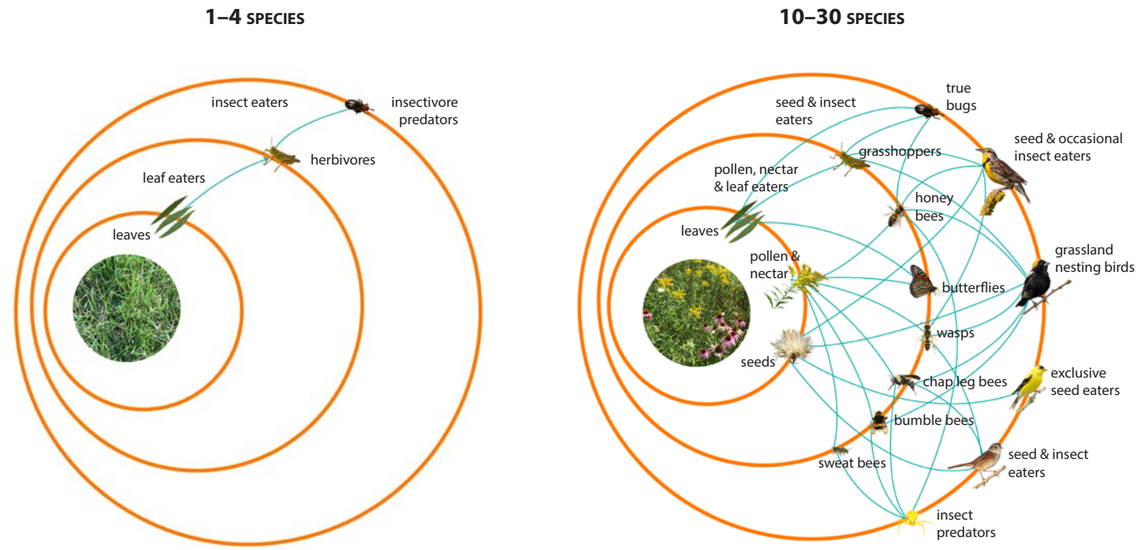
With hundreds of native species available to work with for any given region, the plants that are cultivated in parks can form very diverse landscapes of trees, shrubs, wildflowers, grass, and grass-like species. A planting or area of native species offers an attractive, climate-smart alternative to intensively developed landscapes, invasive plants, and pesticide-heavy maintenance regimes that limit good-quality habitat for wildlife. Native plant diversity provides food and habitat for pollinators such as bees and butterflies, beneficial insects, and birds, which depend heavily on insects as food for raising chicks. Adult birds feed on insects and seeds and use a variety of plants for nesting material.

Climate Resiliency

As the effects of climate change become increasingly apparent, it is more important than ever to consider climate change when designing landscapes for our communities. For some regions, extreme downpour events will become more common, as will flooding. Drought will also occur more frequently, along with other extreme weather events. Increases in temperatures include higher high temperatures and higher lows—meaning it won't cool down as much at night. The biodiversity and adaptations of plants in native landscaping increase their resilience to ever more frequent extreme weather events. Some species will grow and bloom in drier, hotter weather, while other species will provide a balance of foliage and flowers when the weather is wetter and cooler. This flexibility improves plants' persistence in variable, hard-to-predict conditions. The leaves, leaf litter, and deep root systems soften the impact of rainfall and reduce stormwater runoff through improved infiltration into the soil, where the moisture is held and used by the plants over time, increasing drought tolerance.

The native plant diversity within a meadow also helps increase climate resiliency for pollinators and other wildlife. High plant diversity supports a diverse pollinator community, which will be important for maintaining pollinator services under future climate scenarios. In general, larger and interconnected habitats support a higher number of species and individuals than smaller habitats. Larger meadows or multiple, connected meadow patches support

Figure 62—As plant species diversity and climate resiliency increase on a site, so does the habitat's pollinator and wildlife diversity. (Graphic by Mahan Rykiel Associates / The Xerces Society.)



"Native Plant Meadows" continued…

larger populations of wildlife, which are more likely to withstand bad years and extreme weather events that will become more frequent with climate change than smaller populations. Meadows also provide important pollinator microhabitats are cooler or more protected than surrounding environments, providing important refuge for pollinators and other insects during heatwaves and extreme weather events.

Planting meadows can also help mitigate climate change through natural climate solutions. Healthy, diverse ecosystems store much more carbon than degraded habitat. Research has shown that soils in grasslands and meadows with a variety of plant species store much more carbon than weedy areas and areas with low plant diversity. This means that every meadow you plant is an important part of the solution to climate change.

Aesthetics

The love affair with the lawn may never fully go away—but in terms of seasonal color and variation, lawns tend to have two seasons: "good" and "bad." On the other hand, meadows offer a range of textures, fragrances, heights, shapes, and colors that vary not only over the seasons, but across years as longer-lived perennials emerge from three to eight years after the initial planting. Over time, meadows reveal more about a site's personality—its micro-topographies and underlying geologies. Instead of failure or success, as experienced with containerized plantings, a meadow will see certain species cluster in wetter areas and others thrive in shady corners. Unlike most types of ornamental plantings, the species composition in meadows will also adjust to changing site conditions and variable weather patterns.

Economics

While landscape maintenance costs vary widely by region and standard of care, for most locations, seeded meadows will likely be significantly cheaper to install and to maintain than seeded lawns.

Because meadow plants thrive on "poor" soils and can be seeded onto raked subsoil, seeded meadows are less expensive to install than seeded or sod turf lawns (except in the uncommon case when site topsoil has been protected in place during construction or a park redesign project). A native meadow seed mix is often more expensive than a turf mix, but this initial seed cost is offset by the cost of site preparation needed for lawns. During the establishment period, meadows are also mowed less frequently than lawns—greatly reducing costs, from fuel to operator hours to wear and tear on mowers.

Post-installation operational differences when choosing meadow over turf result in a number of benefits. Irrigation, pest control, and applications of fertilizer and lime are not a regular part of meadow maintenance. Pesticides are also not recommended, not only because they would interfere with the ecological goals of a meadow, but also because problematic pest infestations are less likely in such a diverse landscape. Meadows need to be mowed about once per year after establishment, and meadows reduce or eliminate demand for energy—usually fossil fuel—from mowing and repeated inputs of fertilizers and herbicides. Permanent irrigation is not needed on meadows, although temporary irrigation is sometimes beneficial for spring installations.

In contrast with turf lawns or containerized plantings, meadows can flourish and look good under heat, drought, and excess rainfall and meadows don't usually build up disease pressure, reducing the need to spend money on irrigation or pesticides. Meadows with plants that don't need as much water will survive and persist through periodic drought, which is expected to become more frequent. Deep-rooted plants common in meadows infiltrate more rainfall and runoff than lawns, improving water quality and reducing water pollution; some jurisdictions provide environmental mitigation credits for this. When water management in the face of climate change is taken into consideration during planning, meadows can provide cost savings through reduced volume of stormwater and water-treatment infrastructure, irrigation, and pesticide costs.

7

Nesting Sites, Host Plants, and Other Needs

Creating habitat for bees, butterflies, and other pollinators means providing for their entire life cycle. Ensuring nest sites are available is a second essential component of pollinator habitat. Flowers give nectar for adults and pollen that bees can collect and take back to their nests—but without nest sites bees are unable to complete their life cycle. Similarly, providing the right host plants to support butterfly and moth caterpillars is necessary if you wish to see these beauties on flowers in a future year.

Bee Nesting Sites

Nest sites are just as important as food sources for native bee populations. Flowers are usually encouraged to grow. But natural nest sites—such as beetle-bored snags; patches of bare, undisturbed ground; or areas of long, tangled grass and bushes where small mammals like chipmunks and mice might nest—are often considered eyesores or hazards to be removed. Developing a tolerance for these places is a valuable first step. Search for existing natural nest sites and do all you can to protect them. Knowing where nests already occur will give insight into the local conditions and locations that bees in your area prefer to use, valuable information when you get ready to create new habitat.

Sites for Ground-Nesting Bees

Despite the fact that most native bees nest in the ground, not nearly as much is known about the precise conditions preferred by these species compared to what is known about the habits of wood-nesting bees. Even so, you can create nesting conditions in your park that are suitable for a variety of ground-nesting species.

The most straightforward approach to providing nesting habitat is to clear some of the vegetation from a gently sloping area in an undisturbed spot. Choose a site that is well drained, in an open sunny place, and, where possible, on a southeast-facing slope. Remove the dense root mat and thatch layer to give bees access to the soil below. Leave some clumps of grass or other low-growing plants to reduce erosion. You might also place a few rocks in the cleared area for bees to bask on. Different ground conditions—from vertical banks to flat ground—will draw different bee species. Create suitable habitat in a variety of areas, determine which ones ultimately attract bees, and adjust your conservation plan as necessary.

Different species of bees prefer different soil textures and structures. In general, bees nest in soil that is at least 35% sand and avoid soils that are more than 40% clay. The eroded sides of creeks or ditches often house bee nests.

Figure 63—Two examples of ground nests. On the left, a close-up of the small mounds (tumuli) that surround the entrance to each nest of mining bees; there may be as many as thirty nesting bees per square foot of grass (middle). On the right is a metallic green sweat bee nest site. These nests are marked by little more than a small hole in bare ground. When the site is active, you may notice the constant movement of low–flying males searching for emerging females. (Photographs by Heather Holm [left, middle], Sara Morris [right].)

Nest Site Maintenance

In general, it is important that ground-nesting sites receive direct sunlight and that the soil is kept bare. Trim back bushes or trees from time to time and keep thatch, weeds, grass, or moss from becoming too dense. Avoid walking across the site while adult bees are active. During the rest of the year, remember that buried under the ground are possibly thousands of bees! For this reason, avoid harmful activities such as digging deeply into the soil when weeding or using pesticides. Signs or temporary fencing can be used to alert visitors about bee nesting behavior and why bare, exposed areas are important and are intentionally protected and maintained.

Sites for Stem-Nesting Bees

Mason bees, leafcutter bees, and yellow-faced bees are among the many that nest in pre-existing tunnels such as a hollow twig or a beetle-boring in a snag. Wherever possible, these kinds of features and plants should be retained or the appropriate plant species should be prioritized when designing planting projects. There are several plants with pithy, hollow stems that are natural sites for tunnel nesting bees. For a list of plant species that are used as nesting material or nesting sites by pollinators, see **Appendix A**.

Figure 64—Stem "stubble" created from the previous year's wildflowers and shrubs provides excellent nesting opportunities for stem-nesting bees, such as small carpenter bees. (Photographs by Sara Morris.)

Figure 65—Provide potential nesting habitat for ground–nesting bees by clearing vegetation to create a patch of bare ground, or by digging a pit and filling it with sand. This mining bee dug her nest in a newly planted raised bed filled with a sand-loam soil mix. (Photograph by Sara Morris.).

Figure 66—A selection of artificial nests for wood–nesting bees. Left to right: commercially made mason bee nest blocks constructed from a series of grooved boards; a hand–painted, multiple–hole–size block; a bundle of bamboo stems wedged between beams of a back porch. (Photographs by Emily May [;eft], Mace Vaughan [center, right].)

Figure 67—Distinctive white or pale yellow markings on her abdomen (left) and cottony tufts at the entrance to this nest (right), help to identify these two nest occupants as carder bees. Carder bees use downy hairs scraped from the leaves of plants such as mullein or lamb's ears to divide the nesting tunnel into brood cells. (Photographs by John Kehoe / flickr [left] and Sara Morris [right].)

There has been a movement in some places to build large "bee walls" or to launch design competitions for ornate bee hotels. If not conscientiously maintained, these large nest structures typically become a focus for parasites and diseases, and quickly lose their value for bees. At some point, they become a project that is more for people than bees! We strongly recommend installing only small, well-spaced nest blocks. They will still require attention, but in the long term will be better for bees than a large structure. This ties back to why natural nest sites are preferable.

Nest Construction Materials

Stem nesting bees construct dividing walls to separate brood cells and to seal the nest. A few bees (e.g., yellow-faced bees, which may occupy smaller diameter holes) secrete a cellophane-like substance to partition cells, but most bees gather materials. Leafcutter bees and many mason bees use pieces of leaves or petals; orchard bees use mud. Other bees might use fine pebbles or tree resins. Most likely these materials are already present in your park; make sure some, especially damp ground or muddy puddles and a variety of native plants, are near the nests. (The puddles will also help butterflies that drink from such sites.)

Sites for Bumble Bees

You can increase bumble bees in your park by focusing on providing and protecting habitat as your first step. Bumble bees are often found in the grassy interface between open fields and hedgerows or woods, because of the great number of available nest sites in these habitats. Bumble bees often choose to nest in abandoned burrows of chipmunks, voles, and other ground dwelling mammals.

The combination of fallen long grass adjacent to or mixed in with the cover provided by shrubs and trees creates conditions sought by small ground-nesting mammals—resulting in an abundance of potential sites for the bees. Places suitable for bumble bee nests should include a mix of native (non-invasive) bunchgrasses abutting shrubs or trees.

Native bunch grasses that are left to grow will develop older leaves at the base, under which small mammals will build nests or burrow into the ground. A row of shrubs, forbs, and grasses could be planted behind this swath of tall grass, thus providing cover and forage for both bees and mammals.

Figure 68—In the spring, bumble bee queens emerge from hibernation and search for a place to establish a colony. They often nest in cavities found in the ground or in a tree. (Photograph by Ellen MacDonald / flickr.)

Another option is to let a small patch of the park grow for a year or two without cutting the plants. Near Davis, California, dozens of queen bumble bees were observed in such a place—an abandoned facility that became overgrown. This site likely hadn't had any pesticides applied to it and had large areas of lawn and hedge that grew freely, creating optimal conditions for bumble bees.

Shelter

Bees generally don't need alternative places to shelter; they remain in the nest until they are adult. After emerging, female bees will create a new nest for their offspring, to which they return at night or during inclement weather. Male bees play no part in nest construction and once the male of a solitary species has emerged and left its natal nest, it does not have a nest to return to. During bad weather, male bees will shelter in vegetation, and they will "sleep" overnight on plants. Some species will clamp onto a plant stem using their mandibles and rest overnight, sometimes forming sleeping aggregations of a dozen or more bees.

Bumble bees are one of the exceptions. At the end of the breeding season, most of the bees in a colony will die, leaving only the new queens to overwinter. They will burrow into leaf litter, forest duff, the top layer of the soil, and other places to wait out the winter.

Provide Butterfly Host Plants

Like a young child, caterpillars grow rapidly and may be very picky about what they eat. A caterpillar grows at a remarkable rate—thirty-fold or more within a couple of weeks—and must receive the proper nutrition. Some caterpillars are highly specialized with regard to which plants they can eat. For example, the future of the monarch butterfly is closely tied to the availability of milkweed plants, the essential food for its caterpillars. At the other extreme, caterpillars of the gray hairstreak have been recorded eating plants from dozens of different plant families. Having appropriate plants for caterpillars to eat will boost butterfly numbers in your park.

Many host plants are also nectar sources, so they can be included in plantings, or trees and shrubs, so you may already have them growing. If you are in in the Midwest, for example, native milkweed is an excellent choice as it will support monarchs and is a rich source of nectar for many other flower visitors. In the Pacific Northwest, however, planting milkweed in most places west of the Cascade Range is highly unlikely to draw monarchs, because these butterflies are uncommon in the northern Willamette Valley and the Puget Trough. The plant lists in **Appendix A** include larval host plants for a range of common or widespread butterfly species.

Provide Non-Floral Nutrition for Butterflies

Although flower nectar is their primary food source, adult butterflies also get energy from the sugars in overripe fruit, tree sap, and aphid honeydew. Male butterflies gather essential nutrients and amino acids from non-plant sources such as mud puddles, animal carcasses, dung, and urine. Consider allowing some fruit (from wild plants or from a community garden or orchard) to rot in place, or provide a water source. Dampen a shallow depression of sand and let it dry out each day. A moist area from a (deliberately) dripping irrigation nozzle or water-filled jug will also suffice.

Figure 69—Depending on the species, butterflies and moths overwinter as an egg, caterpillar, chrysalis, or adult. Those that overwinter as a chrysalis, such as this cecropia giant silk moth, generally find sheltered vegetation on which to spend the winter months. (Photograph by Susy Morris / flickr)

Butterflies and Moths Need Safe Places to Take Shelter

Butterflies are particularly vulnerable to predators during pupation, and safe places of refuge are critical. They also need places to overwinter, whether as eggs, caterpillars, chrysalises, or adults. And they need places to spend the night or to escape storms, especially as adults. The type of shelter a butterfly seeks out varies depending upon the habitat in which it lives and the particular species of butterfly. Many species that live in prairies and meadows crawl down into the bases of grasses. Woodland butterflies may seek shelter under tree leaves or behind loose bark, and elsewhere they may take advantage of rock crevices or artificial structures such as fences or buildings. Most butterflies spend the night on their own, but some species, such as zebra longwings, can form large communal roosts in trees.

All butterflies must pupate. Caterpillars often pupate on or near their host plants. Chrysalises can be hidden away and hard to find—under duff or leaf litter, in a tree crevice, in tall grasses or bushes, or attached to a shrub, fence post, or building—but they have also been found in exposed places such as the strands of a barbed wire fence or bars of a gate.

Figure 70—Many giant silk moth species hibernate through the winter under piles of old leaves. Clockwise from top right: the caterpillars of some species, like the luna moth, wrap their cocoons with leaves for added insulation, then emerge as adults in late spring. (Photographs by Lisa Brown / flickr [top right, left], Aleta Rodriguez / flickr [bottom right].)

Many butterflies undergo a period of suspended development known as diapause, which enables them to survive stretches of inclement weather. During diapause, no growth or development occurs, and most feeding is also halted. Usually this happens during the cold winter months (overwintering or hibernation) or during the summer dry season (aestivation), when vegetation is no longer succulent or nectar-producing flowers are scarce. Strict summer aestivation is uncommon in North American butterflies and usually precedes an overwintering period (for example, a species goes into diapause during the summer dry period and remains in this state until the following spring).

The majority of butterflies pass through diapause as a caterpillar or chrysalis, but some overwinter as eggs or adults. Species that go through diapause in the egg stage usually hatch in the spring and feed rapidly on tender new foliage. The adults that emerge then lay eggs that remain dormant from summer to the following spring. Groups of closely related butterflies often employ similar strategies when it comes to diapause, with some exceptions in each group.

Many hairstreaks overwinter as eggs, while checkerspots often hibernate as partially grown larvae. White admirals and viceroys do the same but often wrap leaves around themselves and secure the leaves to twigs with silk to provide a secluded location. Duskywing skippers overwinter as fully developed caterpillars, pupating in the spring and emerging shortly thereafter.

Butterflies that overwinter as adults include anglewings, tortoiseshells, and the monarch. Anglewings and tortoiseshells tend to take shelter in both natural and manmade areas, including tree cavities, under logs or rocks, behind loose bark, within evergreen foliage, or tucked into stone walls, buildings, and fences. Most butterflies overwinter in or near the same place they were born. The most famous exception to this is the monarch, which may travel hundreds or thousands of miles each fall to overwintering sites along the California coast or in fir forests in Mexico. Other migrant species include cloudless sulphur, painted lady, and buckeye. Some migrant species do not make a return journey; individuals in the northern parts of their range die with the arrival of winter. While some of these species are known to lay eggs throughout their journey, these northern regions are often repopulated by new migrants the following year.

No matter which family they belong to, butterflies need larval host plants, nectar plants, and sheltering habitat to support the various stages of their life cycle.

CASE STUDY

Restoring Habitat for Monarch Butterflies at the Presidio of San Francisco

Contributed by Rebekah Berkov, Field Education Specialist, Presidio Trust

Parks, yards, and natural areas along the coast of California are vital habitats for the western monarch butterfly. The Presidio of San Francisco is an urban park and historic site covering 2.3 square miles in the Golden Gate National Recreation Area. The groves of mature trees in the park are overwintering sites for western monarch butterflies. In turn, the monarch is an emblematic and treasured animal associated with the Presidio. Monarchs from across the western United States and British Columbia migrate to coastal areas of California for the winter, where temperatures are cool and stable. They cluster on tree branches for several months, in a state of semi-hibernation. As spring arrives, the butterflies migrate inland to breed.

Annually, researchers and volunteers participating in the Xerces Western Monarch Thanksgiving Count visit overwintering sites, and count the number of butterflies in each cluster. The counts from each site (there are hundreds of known sites) are summed to determine the total population of western migratory monarchs. By analyzing decades of counts, researchers estimate that the monarch population overwintering in California has declined by over 99%—from more than four million to less than 2,000 in 2020. Monitoring at the Mexico overwintering sites show that the eastern monarch population has declined over 80%.

To begin to reverse these declines, monarchs need good habitat, and parks can provide that. Another major way—besides restoring habitat and participating in community science—that parks can help monarch conservation is through public outreach and education about the decline in monarchs and other species. See Chapter **9** for more on winter monarch counts along the Pacific coast and other community science efforts.

The habitat areas for monarchs in the Presidio are particular tree groves and nectar plants. With the goal of providing attractive overwintering sites and abundant nectar to fuel the butterflies as they arrive and depart from overwintering, the natural resources staff at the Presidio has planted more than a dozen different species of native, flowering nectar plants for monarchs, including coyote brush and Pacific aster. There are two restoration areas (over 4,000 square feet in total) of dedicated monarch nectar plantings, located adjacent to the park's most well-known monarch overwintering site, Rob Hill. Quarterly garden maintenance events for youth and adult volunteers ensures that the plantings continue to thrive.

Figure 71—Overwintering monarchs clustered on a branch at Rob Hill site at Presidio. (Photograph by Liam O'Brien.)

Figure 72—Visitors observing monarchs at the overwintering site at Rob Hill Campground in the Presidio of San Francisco. (Photograph by Rebekah Berkov.)

Figure 73—Presidio Education interns are responsible for removing weeds from the native nectar plant habitat in the Central Magazine area of the park. (Photograph by Rebekah Berkov.)

In 2019, the Presidio Trust Forestry team initiated a major invasive species removal project to clear non-native ivy from the forest understory. In 2020, park volunteers and Presidio Trust field staff, planted additional native nectar plants near the overwintering site.

The Presidio's monarch work figures prominently in education and community science programs for the public. The park has regularly participated in the Western Monarch Thanksgiving Count since 2007 and hosts film screenings of monarch documentaries and programs on the status of monarchs. During winter, local experts lead field trips to see overwintering monarchs in the trees, provide updates on monarch research, and give practical tips on how individuals can support monarch conservation, such as by native nectar plants, reducing pesticide use, and contributing to community science in their home yards or nearby parks.

The Presidio's work on monarch habitat is an example of conservation in a dense urban center that engages local residents and visitors and raises awareness about the amazing behavior, threats, and needs of this iconic butterfly.

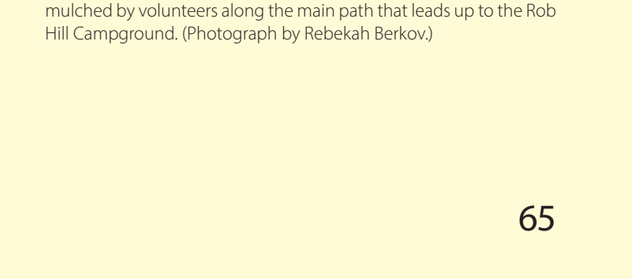


Figure 74—California bee plants and California asters planted and mulched by volunteers along the main path that leads up to the Rob Hill Campground. (Photograph by Rebekah Berkov.)

8

Pest Management and Pesticide Use

Following on from ensuring pollinators have flowers to forage on and places to nest or lay eggs and complete their life cycle, the third component of creating safe places for these insects is to reduce the risk to them from pesticides. When responding to pest pressures in parks and open spaces, it is helpful to always consider how those decisions could impact pollinators. Many of the risks of pest management to pollinators can be avoided by using an integrated pest and pollinator management (IPPM) structure to make decisions. This chapter provides an overview of the potential risks pesticides pose to pollinators and offers suggestions of practices that could be incorporated into your management programs to reduce pesticide use.

What Is Integrated Pest and Pollinator Management?

Integrated pest management (IPM) is a term that has been used for years. While there are numerous definitions, at its core IPM emphasizes prevention first, seeking to eliminate the underlying causes of plant diseases, weeds, and insect problems rather than relying on routine use of pesticides. Practitioners discourage pests through techniques such as modifying irrigation, amending soil, and preventing weeds from setting seed. Pesticides are available if other methods fail to keep pests at acceptable levels, and any applications focus on minimizing unintended consequences. Adding pollinators to IPM makes it explicit that pest managers will consider the specific risks pollinators might face from pest management decisions whether it be the impact of tilling an area where ground nesting bees are present or injecting a tree with an insecticide that could be expressed in pollen and nectar. First coined by agricultural researchers at Penn State University, IPPM was designed to broaden the reach of integrated pest management to ensure it included measures to protect the insects that are essential to crop pollination but IPPM can also be used to update and strengthen "urban" pest management.

Pesticide Concerns

Pesticides, which include insecticides, herbicides, fungicides, and miticides, among others, can have a variety of impacts on pollinators. Some can harm pollinators directly, causing mortality or sublethal effects such as decreased reproduction. Pesticides can also cause indirect harm, for example, when herbicides remove forage plants.

Insecticides generally pose the most obvious concerns for pollinators as they are designed to harm insects and most pollinators are insects. Still, there are some insecticides that are worth highlighting for their unique and particularly concerning effects they can have on pollinators. Neonicotinoid insecticides have high toxicity and ability to move through plants, thus contaminating pollen and nectar. These characteristic can cause bees and other pollinators to be exposed to harmful levels of these chemicals. Most neonicotinoids are also long lived, meaning that bees can be exposed to toxic levels months to years after an application. There are other long-lived systemic insecticides (such as flupyradifurone and cyantraniliprole) that show similar characteristics to neonicotinoids and may pose similar risks. Insect growth regulators (IGRs) are generally classified as lower toxicity relative to other insecticides. However, caution is warranted because toxicity assessments are performed on adult bees, while the harm from IGRs is caused to immature insects. Some IGRs also target butterfly and moth pests, as such they can be of concern for other non-pest species. For example, the IGR methoxyfenozide is classified as practically non-toxic to bees yet it was highlighted by the U.S. Environmental Protection Agency as potentially harmful to at-risk butterflies, including the monarch.

Even when the least-toxic insecticide options are used, care should be taken to limit negative impacts. *Bacillus thuringiensis* var. *kurstaki* (Btk), a naturally occurring bacteria found in soils, is an insecticide often considered environmentally friendly because it is allowed under organic growing standards and is considered low risk for humans and other mammals. Although Btk shows significantly fewer risks than broad spectrum insecticides, it can harm beneficial insects as it kills the caterpillars of butterfly and moth species.

Looking beyond insecticides, fungicide use can also negatively impact bee populations. While most fungicide exposures won't kill a bee immediately fungicides have been linked with adverse effects to development, behavior, immune response, and reproduction. Additionally, some combinations of fungicides and insecticides may increase the toxicity of one or both pesticides to bees when applied together.

Herbicides are most often linked to indirectly harming pollinators by removing floral resources. Recent studies are also finding that some herbicides may cause more direct harm to bees including impeding navigation, harming bee brood, or increasing bees' susceptibility to infection. While herbicides can be part of pollinator habitat restoration projects, their use must be weighed against the potential concerns they pose to pollinators.

Pesticide Exposure

When we think of bees being exposed to a pesticide, most people imagine a bee being sprayed while foraging. While that is a very real concern, it is not the only way that bees are exposed to harmful pesticides. We can understand these potential exposure pathways by taking a deeper look at the behavior and life cycle of native bees as well as how pesticides move and act in the environment. Pesticide exposures can occur at the site of application as well as in areas that have not been treated but become contaminated when the chemicals drift, leach, or otherwise move off the intended site.

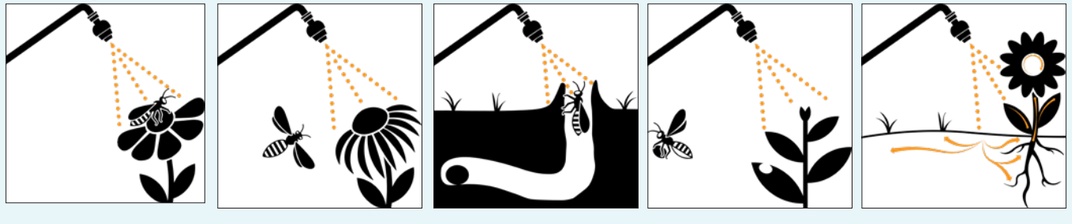
Direct Contact Exposure

This is the most obvious route of exposure, when bees encounter a direct hit from a pesticide application while flying or visiting flowers in an area where pesticide(s) are being or were recently applied. Such exposures can result in severe harm or death.

Pesticide Pathways

When people think about a bee being exposed to a pesticide they often imagine droplets of a pesticide application landing on a bee. Yet, there are many other routes by which a bee can be exposed. If you decide to use a pesticide it is important to consider all these potential exposure routes in order to better protect bees.

Figure 75—Potential pesticide pathways, from left to right: direct exposure, residue exposure, contaminated nesting sites, contaminated nesting materials, and systemic pesticides.



Residual Contact Exposure

Bees can pick up pesticides by contact hours to days after a pesticide has been applied, such as when walking across treated leaves or flowers, or when visiting flowers in habitats that were contaminated with spray drift from a nearby application. Different pesticides and pesticide formulations have different residual toxicity concerns. Some pesticides break down quickly once dried and exposed to sunlight, others are more resistant to decomposition and persist longer in the environment. While data on residual toxicity isn't always available, knowing if a pesticide is persistent can help avoid harmful exposures.

Contaminated Forage

Systemic insecticides, such as neonicotinoids, can be transported through plants and expressed in pollen and nectar. Pollen and nectar can also be contaminated when drifting pesticides settle out on flowers. Bees foraging on contaminated flowers can carry pesticides back to the nest to feed to developing offspring. Similarly, butterfly larvae (caterpillars) can be at risk from ingesting residue left on leaves since they feed directly on plants that may have been treated or otherwise contaminated. These exposures can occur immediately after an application, or long after treatment for highly persistent pesticides.

Contaminated Nesting Areas or Materials

Pesticide applications may contaminate the nesting materials used to construct bee nests, such as the mud used to construct mason bee nest cells or the leaves used to partition cells of leafcutter bee nests. Pesticide applications can also contaminate the soils where bees nest. Ground nesting bees could be exposed to pesticide uses that occur even when no flowers are present as they are present in the soil all year long (see Chapter 2 for information about life cycle and nesting behaviors).

Rethinking Pest Management to Support Pollinators

To conserve pollinators in the landscapes you oversee, consider incorporating IPPM. Below are some broad-brushstroke concepts to help guide changes to protect pollinators.

Know Your Pests

Identify and monitor for pests in your area to make informed decisions about if and when management is needed. Pesticides (even organic products) should only be considered after monitoring indicates pest populations have reached pre-determined thresholds to justify intervention. Knowing a pest's life cycle also helps determine the best management method. When out monitoring for insects, take the time to familiarize yourself with the various beneficial insects in your area, as they are often a free source of pest control. To learn more about insect identification consult your state cooperative extension service or other knowledgeable local sources.

Emphasize Non-Chemical Methods

Move away from chemical controls and toward methods that prevent plant diseases, weeds, and problematic insects. For example, consider replacing plants prone to disease or infestations with tougher, low-maintenance choices. Also, incorporate diverse floral plantings, which can encourage natural enemies and help resolve pest issues, a practice known as conservation biological control. Effective non-chemical techniques are available from a variety of sources. Consider reaching out to peers in other cities that are practicing pollinator-friendly pest management.

Maintain Landscape Aesthetics without Pesticides

Urban pesticide uses are often done to keep an area looking nice. But striving for a highly manicured aesthetic can be harmful, elevating use of herbicides, fungicides, and insecticides. Accept a few weeds and minor plant damage, which doesn't impact the overall beauty of an area. This can be a valuable step toward reducing pesticide use and contamination.

Transition Away from Hazardous Chemicals

Some chemicals pose a high risk to pollinators or people. To minimize risk, develop and maintain an approved list of least-toxic pesticides. Some municipalities prioritize organic pesticides. Alternatively, you can develop and maintain a list of prohibited chemicals.

Mitigate Risks When Pesticides Are Used

Designate pollinator plantings and other sensitive sites as off-limits to pesticides. If you decide to use a pesticide, seek out the least-toxic option. Organic options often have fewer risks than their conventional counterparts. Careful consideration of the formulation is also important. Avoid micro-encapsulated products: bees mistake it for pollen and will collect it to take back to the nest. Apply pesticides in the lowest effective labeled rate. Time pesticide applications to avoid direct pollinator exposure, such as

during those seasons when there are no flowers. If you plan to make applications when flowers are in bloom, consider mowing or otherwise removing blooms prior to treatment. Train staff and contractors to recognize and avoid spraying bee nest sites. Use targeted methods such as painting herbicides directly on problem plants that ensure a pesticide reaches its target pest and limits off-site movement.

Formalize Pollinator-Friendly Practices

Create a written IPPM policy to formalizing your entity's commitment and goals. More detailed plans or operations handbooks are also helpful, providing clear guidance to staff and contractors. To facilitate implementation of the program, train staff in pest and natural enemy identification, non-chemical suppression strategies, pesticide safety, and pollinator conservation.

A Note About Pesticide Labels

Some pesticide labels include either suggestions or requirements to minimize bee exposures. Always read product labels and follow all actions to limit the impact of pesticide use. Even when labels are followed, there is still a chance that pollinators can be harmed.

Most practices outlined on labels were developed with consideration for honey bees. Because the scale and structure of a hive is so different from the nesting behaviors of native bees, these practices lack specific protections for native bees and butterflies. For example, label directions may require that beekeepers move hives away from spray areas or cover hives during spraying operations.

Obviously, these measures fail to protect wild bees that could continue to forage during an application. There are also label advisories to limit bloom-time applications of some highly toxic pesticides. There are no corresponding measures required to protect ground-nesting bees that could be exposed to a soil drench or other application method that contaminates soil.

Figure 76—The front side of the Oregon Bee Project's graphic Protect Bees Read Pesticide Label. (Graphic by Iris Kormann & Andony Melathopoulos / Oregon State University and Gilbert Uribe / Oregon Department of Agriculture.)

Pesticide labels can also lack warnings for the subtle concerns posed to both honey bees and native bees. For example, many fungicide products lack advisories to limit exposure even when research shows that the particular fungicide can negatively impact bees. (See the fungicide fact sheet in **Appendix B**.) To conserve pollinators in the landscapes you manage, seeking out non-chemical prevention and management is the best way to avoid harmful pesticide exposures. Even products that don't include warnings for bees should still be used with caution.

Final Thoughts on Pollinators and Pesticides

As you enhance your landscape to support pollinators be sure to take the time to evaluate your pest management protocols in order to protect pollinators. While there will always be gaps in knowledge around the risks of pesticides to bees and other pollinators, there is enough evidence of the potential for harm to seek alternative management methods and to take precautions when deciding how to manage for pest problems.

A Roadmap to Pollinator-Friendly Pest Management

Cities and towns across the country have implemented pest management plans that provide a helpful roadmap for how best to protect pollinators from pesticides. Below we highlight a few example programs that use IPM methodologies to reduce reliance on pesticides and protect human health and the environment. While these IPM plans were not all created with the express goal of protecting pollinators, the practices they implement offer numerous benefits including better protection for pollinators.

- **Ashland, Oregon**, limits the exposure of both human and insect visitors to pesticides by prohibiting pesticide sprays in city parks between Memorial Day and Labor Day.
- **Boulder, Colorado**, established a thoughtful IPM process that emphasizes pest prevention over pesticide use and individually assesses every proposed application to apply the most appropriate management strategy.
- **Davis, California**, and **North Miami, Florida**, both have IPM plans that strongly emphasize the importance of staff skill sets to ensure the success of their IPM plan. Some of the skills that they value are the ability to monitor for pests and knowledge about alternative control strategies.
- **Newton, Massachusetts**, created an IPM advisory group that provides guidance to the city on IPM practices and pesticide use.
- **New York City, New York,** avoids the use of high hazard pesticides through an IPM plan that prohibits the use of three categories of pesticides: products carrying the "Danger" signal word; pesticides deemed possible, probable, or known human carcinogens by the EPA; and products classified as developmental toxicants.
- **San Francisco, California,** an early pioneer in urban IPM principles and practices, has a comprehensive program that includes requirements to document and confirm pest pressure before considering treatment, limit overall pesticide use, and avoid the most harmful pesticides.
- **Seattle, Washington,** has an extensive IPM plan in which the city established a goal to reduce overall pesticide use by 30%, manages some landscapes without pesticides, and is restoring 2,500 acres of urban forest.
- **South Portland, Maine**, and **Irvine, California**, have both established policies that avoid conventional pesticides and are working to shift pest management to organic land care practices.

Pollinator-friendly pest management takes work. Fortunately, there are time-tested practices that can help guide your process. The investment is worth it, as you'll be creating a healthier community where pollinator populations can flourish.

9

Outreach and Education

The Xerces Society's Bring Back the Pollinators campaign is based on four principles. The first three—provide foraging habitat and nesting sites, and avoid pesticides—have already been covered. The fourth is the share the word, something parks departments are eminently well situated for! Entire communities can engage in pollinator conservation; there is something for everyone. Activities and events that capture people's interest and share ideas on how to improve greenspace is a great way to mobilize civic involvement and to improve quality of life. This chapter provides ideas of how community members can become involved in conserving pollinators.

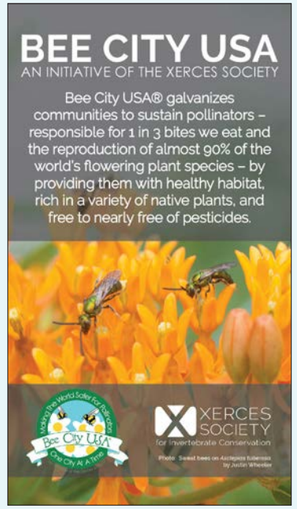
Figure 77—In parks or other places, informative signs that explain the reasons that land or vegetation looks a certain way can be helpful for the public to understand and appreciate how it is being managed for pollinators. In this example, where a portion of the plant stems are left uncut each fall, while the rest of the garden is trimmed down, a sign explains how these stems and litter create shelter for overwintering and nesting. (Photograph by Stephanie Frischie.)

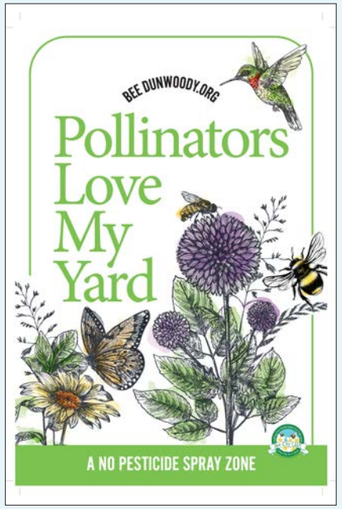
Programming and Events

Kids, parents, gardeners, and the public frequently demonstrate a keen interest in pollinator life history and conservation. Opportunities abound to expand public awareness, and promote meaningful conservation of pollinators by offering information and activities to educate, inspire, and provoke public action.

Below are a few examples and helpful tips on utilizing programing and events to engage the public in pollinator conservation.

Programs such as workshops, presentations, and garden tours are a few ways to provide educational opportunities for the public. (See **Pollinator Paradise Demonstration Garden Inspires Pollinator Tourism on page 39** for one example of a successful program.) Topics can vary from general information about native pollinators to specific information such as regional landscaping recommendations. Choosing a topic and target audience first will determine the type of event necessary to achieve the desired outcome. Think about joining with other organizations to deliver programs; it is a great way to leverage the strengths of various organizations and expand outreach to new audiences.





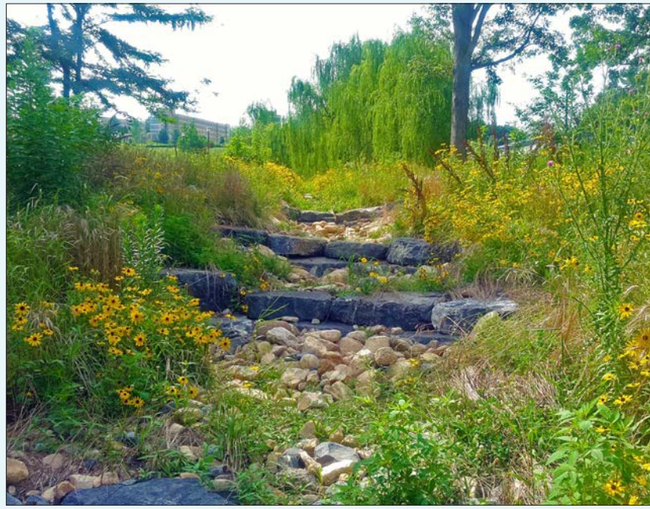


Figure 78—Bee City USA promotes local action and advocacy (left to right): Bee City brochure, a custom yard sign the Bee City of Dunwoody, Georgia, commissioned for residents, and a pesticide-free riparian buffer planted along a restored stream channel at Bee Campus James Madison University (Virginia). (Photographs courtesy of Bee City USA, Bee City Dunwoody, and Dale Chestnut.)

Special events are another great way to bring communities together and build momentum around conservation efforts. Consider planning events around Earth Day, Pollinator Week, or any other environmental celebration. These events tend to attract audiences who are already interested in nature and are more open to learning about how they might play a role in conserving it. Plant sales and community plantings are also good opportunities for providing educational content. Again, inviting and collaborating with other organizations to put on events or simply participate in an event is a valuable way to network, unify communities, and engage a broader audience.

For example, a local wildlife refuge in Oregon was able to take an annual plant sale and turn it into an Earth Day event by adding various public activities. They included guided nature walks and tables with educational activities, some of which were run by outside organizations invited to participate. One of the highlights was the mason bee expert who came with mason bee houses to purchase as well as directions on how to make bee houses at home. Incorporating educational activities and expanding the plant sale into a larger event provided a more enriched and inspiring experience for visitors, increased the number of people attending, and increased native plant sales.

Bee City USA and Bee Campus USA

Bee City USA and its sister initiative, Bee Campus USA, raise awareness of the role that pollinators play in our communities and what each of us can do to provide them with healthy habitat.

Together, the two initiatives provide a framework for communities to work together to conserve native pollinators by providing them with healthy habitat, rich in a variety of native plants, and free to nearly free of pesticides. The program establishes a set of commitments, defined in a resolution, for participants to create habitats and promote awareness of pollinators. Communities across the United States can make these commitments and become certified as an affiliate: towns and cities can join Bee City USA, colleges Bee Campus USA.

Becoming a Bee City USA affiliate formalizes the local government and community's commitment to pollinator conservation and provides support for widespread collaboration to establish and maintain healthy pollinator habitat on public and private land. Bee Campus USA works with institutions of higher education, including colleges and universities, which adopt a set of commitments similar to those expected of cities, but tailored to the frameworks and opportunities unique to campuses.

Affiliates are active participants in a national movement committed to pollinator conservation supported by Xerces resources, staff assistance, and opportunities to promote sharing and collaboration among affiliates. Bee City USA disseminates information regarding pollinator research, habitat enhancement, and funding opportunities, through email, e-newsletters, the Bee City USA website, and social media channels. Being a Bee City or Campus affiliate also provides accountability for achieving pollinator conservation results each year, to be shared with one another and the public through annual reporting.

Affiliate Commitments: Both city and campus affiliates are expected to meet minimum requirements to maintain their affiliation:

- Establish a standing committee to advocate for pollinators.
- Create and enhance pollinator habitat on public and private land by increasing the abundance of native plants and reducing the use of pesticides.
- Incorporate pollinator-conscious practices into policies and plans.
- Host annual pollinator-awareness events.
- Publicly acknowledge affiliation with signs and an online presence.
- Report annually on previous year's activities.
- Bee Campus USA affiliates must also offer courses or continuing education classes that feature pollinators and undertake service learning projects.

Benefits of Being a Bee City or Bee Campus

- Build community locally and nationally: Bring your community together around a positive, shared cause and connect with communities across the country that have made the same commitment.
- Ensure survival of vital animal species: Help to ensure the survival of vital animal species crucial to our planet's functioning ecosystems.
- Create a healthy environment: Raise community awareness of the least-toxic ways to confront home and garden pest problems. Mobilize your community to remove non-native invasive plants to make way for locally native plants.
- Opportunities for local businesses: Support the growth of local businesses including native plant nurseries and pollinator-friendly landscaping services.
- Improve local food production: Raise community awareness of how our food grows and improve local food production through expanded pollination.
- Heighten awareness of biological diversity: Raise community awareness of the local environment's diversity of plant and pollinator species.

To learn more about Bee City USA and Bee Campus USA and how your community can adopt pollinator-friendly practices and become an affiliate, visit **beecityusa.org**.

Pollinator Week, a Community-Wide Celebration of Pollinators by Bee City USA – Hillsborough (NC)

Contributed by Sarah Meadows, Chair, Bee City Subcommittee and Hillsborough Garden Club member; Phyllis Simon, Hillsborough Tree Board member and an Orange County Master Gardener; and Stephanie Trueblood, Public Space Manager, Town of Hillsborough

A small town of roughly 6,000 residents in north-central North Carolina, Hillsborough is a proud Bee City USA affiliate and has made a community-wide commitment to pollinator awareness, appreciation, and conservation. All three aspects come together during events and activities celebrating National Pollinator Week, observed the third week of June each year. Hillsborough's pollinator week efforts are a close collaboration between the city council and local businesses and organizations. As such, Hillsborough achieves a win-win-win: people in the community enjoy an educational and festive atmosphere focused on pollinators, local businesses who participate are promoted, and the value and benefits of protecting pollinators and pollinator habitat are emphasized.

The community recognized the wide-ranging benefits and wanted more towns to participate. The Hillsborough Garden Club, the Town of Hillsborough, and the Tree Board sent letters to the North Carolina Governor requesting that he declare Pollinator Week to be recognized statewide. The Governor issued the proclamation and Hillsborough's mayor read it at an event in the town park. The mayor and town council declared Pollinator Week for the Town of Hillsborough as well.

The pollinator week theme and special events are jointly promoted by the city and garden club through their website event pages and Facebook posts. This content is picked up and reposted by partners and other sponsors. Advance press releases also ensured media coverage and publicity. In addition, to promote pollinator week activities, the Bee City USA committee gave away free seed packets of mountain mint, a great native pollinator plant, from the NC Botanical Gardens and developed and distributed publicity materials, including stickers.

Numerous businesses and organizations offered educational, awareness or promotional sales activities throughout the week. The activities offered were creative and engaging for the public. For example:

- A jewelry store offered a unique window display and bee-themed jewelry.
- The public library hosted local monarch conservationist, Phyllis Simon, to talk about flowers for pollinators and monarch butterflies, had pollinator story time, and showed the "Wings of the Butterfly" video.
- The Hillsborough Garden Club put up a display at the library lobby about the role of native bees as the "superheroes" of the pollinator world.
- The local history museum had a station for kids and families to learn about bees, butterflies, and beekeeping equipment as well as an activity for children to decorate seed packets with the pollinator they would like to see in their yard.
- A co-working space held a pollinator art exhibit and interpretive signage.

Figure 79—Presentation by Phyllis Simon about pollinators and monarch conservation. (Photograph by Phyllis Simon and Bruce Taggart.)

CASE STUDY

- An art gallery organized a pollinator art exhibit and a reception to open the exhibit.
- The senior center had a pollinator art exhibit and honey tasting.
- A local bookstore featured books on bees and butterflies.
- A beekeeping supply company gave away free buckwheat seed (a cover-crop rich in nectar) to people attending programs on bees and pollinators. They also donated a native bee hotel for a prize draw.
- A pizzeria and pub added several honey-infused cocktails and desserts to their menu. Patrons enjoyed a view of their pollinator garden.
- The frozen custard shop sold a honey sundae
- A pharmacy displayed honey-based products such as lipgloss and honeysticks.
- The plant nursery garden shop featured a display of pollinator plants.
- A hair salon offered honey-colored hair highlights.
- Orange County Master Gardeners gave a pollinator paradise presentation at the pollinator garden in a town park.
- A private pollinator garden hosted a tour and presentation about how to create a pollinator garden.

Pollinator Week in Hillsborough brings together the whole town for pollinators and is loads of fun, but it isn't the only time of year in which Hillsborough considers pollinators. Maintaining a high quality of life for people and for pollinators is a year-round priority. For example, Hillsborough has passed town ordinances limiting the use of pesticides in public green spaces. When a new playground was being planned, the original designs called for the play area to be surrounded by a chain link fence and the land that slopes downward from the play area was to be covered in riprap. Instead, the town chose to revegetate the slope with native pollinator plants and not put up the fence. With this design, children can play on the equipment and explore the natural playground around them. More efforts are in the works including policies to help homeowners create pollinator-friendly yards and landscaping.

To learn more about Hillsborough's pollinator projects, visit:

- https://www.hillsboroughnc.gov/government/advisory-boards/tree-board/bee-city-usa/
- http://www.hillsboroughgardenclubnc.com

Figure 80—One of the Hillsborough library's pollinator week displays. (Photograph by Sarah Meadows.)

Engaging the Community in Science

Community science (sometimes referred to as "participatory science" or "citizen science") is a form of research that provides everyone, regardless of their background, an opportunity to contribute meaningful data to further our scientific understanding of key issues. By engaging community members, researchers can collect a larger amount of data, and often span more geographic regions, in a shorter amount of time. In turn, this data underpins and shapes larger conservation efforts. It's also a great opportunity for participants to learn more about species that interest them, and can build an informed community of conservation advocates. It's a win-win situation for all of us—including pollinators!

The Xerces Society manages several community science initiatives and is grateful to the thousands of volunteers who share precious time to contribute to our projects with their observations. Community science initiatives include Bumble Bee Watch; regional bumble bee atlas projects in the Pacific Northwest, California, Nebraska, and Missouri; Western Monarch Milkweed Mapper; and Western Monarch Count. Xerces partners also offer many community science opportunities. For more details, see **Appendix B**.

There are many other community science programs run by other organizations, both national and local. The National Recreation and Parks Association, for example, has an ongoing Parks for Pollinators campaign to raise public awareness and encourage local action to help pollinators. An important part of this campaign is the annual bioblitz, during which parks encourage community members to take photos of bees, butterflies, and other wildlife in parks and submit them via the iNaturalist app.

Organizing Volunteers to Help

Engaging volunteers can provide a meaningful and productive way to build community around conservation and have a positive impact on pollinators. With minimal training, one-day events such as plantings, invasive species removal, and making bee hotels, lend themselves to include volunteers with any skill level.

Volunteers who have a specific skill set such as administrators and educators, and those with a conservation background, make great volunteers for outreach and education. Volunteers can help develop and deliver regular programs, organize special events, assist with outreach, and much more. Volunteers can greatly expand staff capacity and are often highly effective advocates for organizations in their own communities. Depending on the greenspace, a local, regular user group or board might create a volunteer "pollinator committee" to plan and carry out education and outreach events.

Figure 81—Volunteers working together to respond to weed issues so that pesticides are not needed. (Photograph by Nancy Lee Adamson.)

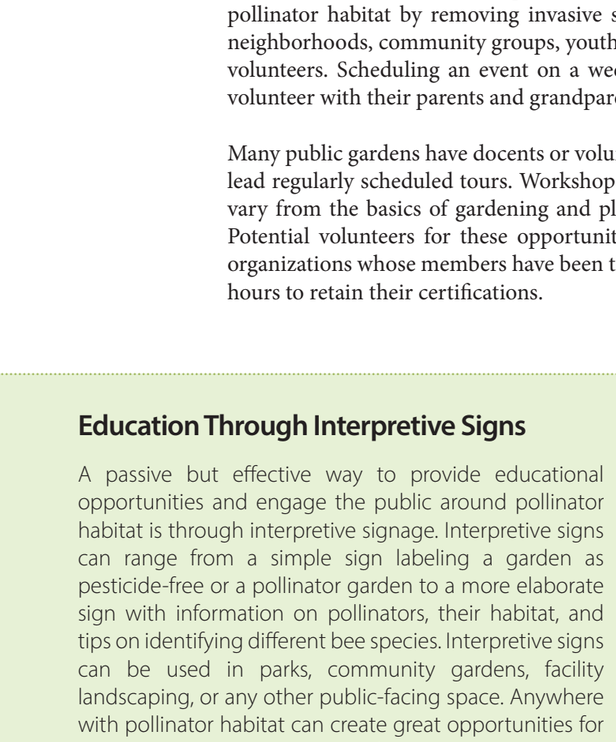
Parks or other natural areas open to the public can organize volunteer events to maintain or create pollinator habitat by removing invasive species or planting pollinator plants. Reaching out to local neighborhoods, community groups, youth organizations, or faith communities is a great way to recruit volunteers. Scheduling an event on a weekend and turning it into a family activity, where kids can volunteer with their parents and grandparents, creates a more inclusive and accessible event.

Many public gardens have docents or volunteers who provide information to visitors and in some cases lead regularly scheduled tours. Workshops are another example of a volunteer-led activity. Topics can vary from the basics of gardening and plant selection to comprehensive landscaping for pollinators. Potential volunteers for these opportunities include Master Gardeners and Master Naturalists, two organizations whose members have been through relevant training and are required to put in volunteer hours to retain their certifications.

Education Through Interpretive Signs

A passive but effective way to provide educational opportunities and engage the public around pollinator habitat is through interpretive signage. Interpretive signs can range from a simple sign labeling a garden as pesticide-free or a pollinator garden to a more elaborate sign with information on pollinators, their habitat, and tips on identifying different bee species. Interpretive signs can be used in parks, community gardens, facility landscaping, or any other public-facing space. Anywhere with pollinator habitat can create great opportunities for communicating conservation values.

Figure 82—Urban rain garden with forbs and sign in Lafayette, Indiana. (Photograph by Stephanie Frischie.)



Keeping the Community Informed of Pollinator Protection Efforts

Pollinator conservation efforts can affect the way public spaces are managed and look, which can be challenging for some people. It is very helpful to engage with park users, staff, and managers to facilitate understanding, acceptance, and ultimately, success. Advisory committees and visitors will want to know what is happening; and managers and staff should be consulted about plans and ongoing activities addressing habitat protection, enhancement, and management.

Communicating with local community members about what you are doing and why should be an integral component of your conservation efforts. Posting notices on a bulletin board, making information sheets (such as those produced by the Xerces Society) available to read, or including pollinator conservation as an agenda item at a staff meeting are simple ways to engage people and explain what's happening. Local residents walking in their park may be surprised to find grass left to grow long or patches of "weeds" appearing where they are used to seeing even-length turf. Informing them why these changes are happening may intrigue them in your new management approach—or at the very least prevent complaints.

Flyers for park users, articles in neighborhood newsletters, or news briefs in local media—maybe a morning spent in the park talking to walkers—could be effective. On-site signs, whether temporary notices or permanent interpretive panels, are an excellent way to communicate to parkgoers a range of information about pollinator biology, habitat needs, and the ongoing conscious choices in the park to provide pollinator habitat. For example, consider "Pollinator Habitat Under Construction" signs for sites being prepared or seasonal signs highlighting what people might see. Once habitat or pollinator gardens are planted and growing, signs that identify it as pollinator habitat teach visitors about what they are seeing and why.

Constructed Bee Nests, Bee Boxes, and Insect Hotels for Native Bees and Other Insects

Bee nests (wild or constructed) are fun and informative to watch. Observers can watch bees coming and going, with different loads of nest materials or pollen and discover how bees enter their nest forwards or backwards, depending on what they are delivering. One way to recognize solitary wasps coming and going from their nests is that they and other predators will stock their nests with prey such as larval or adult insects or spiders.

Xerces recommends creating and maintaining suitable habitat with food, nesting, and overwintering sites provided by the nature of the plants and management provided. Constructing nesting boxes is a useful educational and demonstration activity, but it is not a primary conservation activity. For more on plants that provide natural nesting habitat, see **Appendix A**.

If you are using artificial nest boxes, cleaning and maintenance is an important annual task. Cleaning will help to reduce parasites, fungi, and diseases that might affect the developing bees in their brood cells (after two or three years, the nest could produce more parasites than bees!).

Figure 83—Insect Hotel installed at the Bee Campus University of Michigan Dearborn. (Photograph by David Susko.)

Figure 84—Pollinator conservation education display and mason bee hotel in Bee City USA Carson, Nevada. (Photograph by David Susko.)

Broader Benefits from Pollinator Conservation: Conserving the Jewels of the Night

Contributed by Candace Fallon, Xerces Society for Invertebrate Conservation

Pollinators are fundamentally important to the health of our environment and deserve our attention in their own right. However, pollinator-friendly parks and greenspaces have numerous benefits for other wildlife, including possibly the most enchanting of all—fireflies. Every year, across yards and meadows, creeks and forests, fireflies' nighttime displays capture the hearts of children and adults. In many cases, parks and greenspaces provide the places where they can be enjoyed.

Over 150 species of fireflies are found in the United States and Canada. They are best known for their showy nighttime displays, but not all fireflies flash at night. The common name "firefly" not only includes familiar flashing species (aka lightning bugs), but also the more cryptic glow-worms and the daytime dark fireflies. Glow-worms, like flashing fireflies, are active at or after dark, but use glowing bioluminescent signals rather than flashes to communicate. While males look like typical fireflies, glow-worm females resemble larvae; they cannot fly because their wings are short or absent. Daytime dark fireflies, as their name suggests, are active during the day and don't light up; they rely on chemical pheromones rather than bioluminescence to communicate.

Fireflies are predators—their larvae hunt soft-bodied invertebrates such as snails, slugs, and earthworms. Most adults are not known to feed, although there are some exceptions. Female *Photuris* fireflies mimic the flash of other species to lure males in as prey. There are also limited observations of adult fireflies feeding on maple nectaries and sap as well as asters, goldenrods, and milkweeds. Although it is possible that these flower-visiting fireflies inadvertently move pollen from one plant to another, they are unlikely to be pollinators. However, they are an important part of the natural world, including habitats in parks and greenspaces

Like so many other invertebrate groups, firefly populations appear to be in decline. Baseline data are lacking for many firefly species, so the full extent of these declines are relatively unknown. However, most firefly researchers agree that habitat loss and degradation, light pollution, pesticide use, and climate change are the leading threats to fireflies. By understanding these threats, and knowing what fireflies need to thrive, land managers can take action to protect and enhance fireflies and their habitats. In many cases, the same guidelines that are suggested for pollinators also help fireflies.

Figure 85—Among glow-worms, it's the females that signal using bioluminescence. (Photograph by Ken-ichi Ueda / iNaturalist.)

Figure 86—Flashing fireflies are widely beloved residents of urban parks and recreational areas. (Photograph by Jessica Lucia / flickr.)

In general, fireflies need just a few basic things: food, shelter, moisture, protection from pesticides, and for many species, dark nights. By keeping these requirements in mind, you can easily provide for fireflies in your yard, park, or natural area. In particular, most fireflies need:

1. Abundant larval food sources: snails, slugs, and earthworms are the primary prey many young fireflies depend on for food;
2. Safe places to overwinter: trees, fallen logs, leaf litter or underground burrows;
3. Clean sources of water or sufficiently moist soil;
4. Protection from insecticides and other pesticides;
5. Undisturbed ground for burrowing;
6. Vegetation of varying heights; and
7. An absence of light pollution.

Figure 87—Synchronous fireflies require dark areas to effectively communicate with each other. From a lightning bug tourism perspective, darkness is key to these amazing displays. (Photograph by Ryan Atkins / flickr.)

Much like for pollinators, aim for leaving some areas a little wild. Ideally, your park or greenspace will provide varied habitats that are not overly manicured. Fireflies thrive in moist habitats with abundant native vegetation, dense leaf litter, and true nighttime darkness. These features provide not only the shelter needed by fireflies, but they also ensure the habitat components needed by fireflies' favorite prey are kept intact.

Dark nights are important for species that communicate with bioluminescent signals. Some parks or green spaces may be kept dark, but where outdoor lighting is used, look for ways to reduce the scope and severity of the lighting, especially during the season when fireflies are flashing and mating. This can involve directing the light so it only illuminates its intended target, such as a pathway; using red bulbs or filters, which appear to be less harmful to fireflies; or installing motion detectors or timers so lights are only on when needed.

In addition to providing habitat, another way to contribute to firefly conservation is through community science. Here are three projects that track where fireflies are present and build the knowledge base about these understudied animals, and which you can consider contributing to:

- Firefly Watch, massaudubon.org/get-involved/citizen-science/firefly-watch
- Western Firefly Project, nhmu.utah.edu/fireflies
- Fireflies of the USA and Canada on iNaturalist, inaturalist.org/projects/fireflies-of-the-usa-and-canada

By managing parks and green spaces to provide for fireflies' needs, your town contributes to their conservation and helps to ensure that the lights of fireflies persist for generations to come—and park patrons will be thrilled to know that local parks have thriving populations of these magical insects.

10

Final Thoughts

An encounter with a butterfly—a beloved symbol of beauty—elicits oohs and aahs from adults and an excited chase from children. The next time you enjoy watching a butterfly or buzzing bee, take a moment to recognize that the moment goes beyond delightful observation. Pollinators are also an indicator of a well-functioning environment. As keystone species, pollinators, provide our greenspaces with critical ecosystem services, benefiting wildlife habitat, neighborhood gardens, and nearby farms.

Parks staff and other urban land managers play a leading role in conservation within cities and towns of all sizes, both as managers of extensive areas of land and as a trusted source of information and guidance. There are many ways to include pollinator-friendly habitat and activities in initiatives to conserve biodiversity and to promote sustainability and human well-being in public spaces. And as the case study about fireflies shows, by focusing on the fundamental components of a healthy environment, you'll help a wide range of other wildlife.

We hope this guide leads you to generate ideas for pollinator conservation in the landscapes you manage. Remember to stay flexible, try easy steps first, see what is working and what's not, and allow conservation efforts to evolve as circumstances change. Even small steps matter, and many actions that support pollinators require little commitment of time or money. If larger projects seem daunting, take your time. Projects can happen over a period of years.

Parks and other greenspaces add to the quality of life for the neighborhood, providing a place to walk, play, rest, reflect, observe, breathe, and socialize. In an increasingly urbanized nation, greenspaces give a welcome break from the hard surfaces of towns and cities. Many of the same characteristics that contribute to good pollinator habitat—a variety of plants that flower across seasons, places for refuge in the winter, protection from pesticides, minimal mowing and

Figure 88—Opposite—Native plants flourish in this beautiful pollinator landscaping at an office campus in California. (Photograph by Xerces Society / Kathryn Prince.)

Figure 89—This native plant garden at the University of Wisconsin–Madison provides a habitat and forage for a variety of wildlife in addition to a relaxing space for the humans that live, study, or work nearby. (Photograph by Sarah Foltz Jordan)

associated noise and air pollution—also make spaces pleasant and healthy for people.

Whatever role you play in your local pubic greenspaces, whether as a park manager or community gardener, an advisory committee member or a trail user, we hope the suggestions in this guide will inspire you to speak up and begin to plan and act for pollinators. By enriching your parks for these essential animals, you will be enriching your neighborhood and entire community.

Appendix A

Pollinator-Friendly Plants

This appendix contains suggested plant groups (genera) that provide food, shelter or nesting sites for pollinators. The provided links will support planners in choosing and matching each group or species to the specific site conditions of sun, shade, soil moisture, desired height, and purpose or function of the vegetation within parks or public green spaces.

Xerces Society Resources

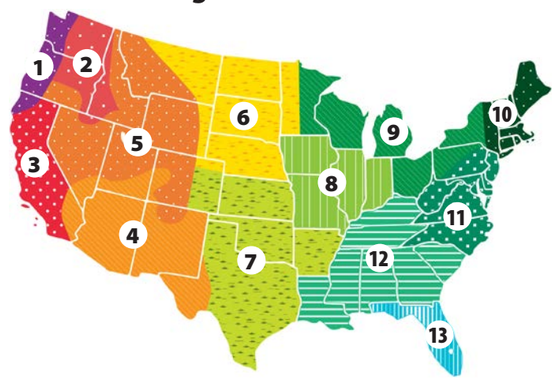
Pollinator Conservation Resource Center: **xerces.org/pollinator-resource-center**
Pollinator plant lists: **xerces.org/pollinator-conservation/pollinator-friendly-plant-lists**
Milkweed Seed Finder: **xerces.org/milkweed/milkweed-seed-finder**
Native Plant Nursery and Seed Directory: **xerces.org/pollinator-conservation/native-plant-nursery-and-seed-directory**

Native Plants

Native plant societies are great resources for learning about native plants as well as information about where to get them, how to grow them, and sharing that enthusiasm with others. Most states have a native plant society. For a directory of native plant societies in North America, see: **nanps.org/native-plant-societies/**

The Biota of North America Project (BONAP) North American Plant Atlas has maps that show the states and counties where a plant species is native as well as distribution maps for non-native species. **bonap.net/NAPA/Genus/Traditional/County**

Regions of the Contiguous United States



KEY

1 Maritime Northwest
2 Inland Northwest
3 California
4 Southwest
5 Intermountain West
6 Northern Plains
7 Southern Plains
8 Midwest
9 Great Lakes
10 Northeast
11 Mid Atlantic
12 Southeast
13 Florida

Recommended Plants with High Value for Pollinators

This is not an exhaustive list—there are thousands of native North American plant species that provide resources and habitat for pollinators. This is a streamlined list intended as a starting point. Instead of listing particular species, we have listed the genera. Not all species in each genus are native to all regions. To learn more about identifying, sourcing and planting native plant species for your park or green space, we suggest reaching out to local ecologists and native plant societies and native plant and seed suppliers (see the sections and links on the previous page). Plant names follow the USDA–NRCS PLANTS database (plants.usda.gov).

Additional Plant Features

- ★ **POLLINATOR "SUPERFOODS"**—Certain native plants are known to provide exceptional forage for a wide variety of bees and other pollinators, including monarchs. See table below for a list of some of these plants.
- **FOOD FOR SPECIALIST BEES**—Many native bees are "specialists," only collecting pollen and other resorces from specific plants. See table below for a list of plants known to provide food for a number of specialist bees.
- **LEPIDOPTERA HOST PLANTS**—The caterpillars of many butterflies and moths can only feed on specific plants. For example, great spangled fritillary larvae only feed on violet leaves. Some plants support an amazing diversity of lepidoptera; e.g., oaks support hundreds of butterflies and moths species. Since most native plants support at least one butterfly or moth, we use for a genus supports over five species ***OR*** one species that doesn't eat anything else.
- **BEE NESTING PLANT**—These plants are utilized by native bees that nest in cavities or tunnels, either as nesting structure (pithy-stemmed plants, etc.) or as a source for nesting materials like leaves, flower petals, or fiber.
- **MONARCH NECTAR PLANT**—Certain members of these genera have been documented as extremely attractive to adult monarch butterflies.
- ✓ Plants in this group are native to, or suitable for, the region.

SCIENTIFIC NAME	COMMON NAME	FORM†	FEATURES	1 Maritime Northwest	2 Inland Northwest	3 California	4 Southwest	5 Intermountain West	6 Northern Plains	7 Southern Plains	8 Midwest	9 Great Lakes	10 Northeast	11 Mid-Atlantic	12 Southeast	13 Florida
Abronia	Sand verbena			✓	✓	✓	✓	✓								
Acer	Maple		★	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Achillea	Yarrow			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Aesculus	Chestnut					✓				✓	✓				✓	✓
Agastache	Giant hyssop		★	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		
Ageratina	Snakeroot				✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Amelanchier	Serviceberry		★	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	
Amorpha[1]	Leadplant; false indigo		★			✓	✓		✓	✓	✓	✓		✓	✓	✓
Andropogon	Bluestem					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Apocynum	Dogbane			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Aquilegia	Columbine			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Arctostaphylos	Manzanita		★	✓	✓	✓	✓	✓	✓			✓	✓			
Artemisia[2]	Wormwood				✓	✓	✓	✓	✓	✓	✓	✓				
Asclepias	Milkweed		★		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

KEY FORM†: Herbaceous ( ) Woody ( ) Graminoid ( ) FEATURES‡: Pollinator "superfood" (★) Specialist bee plant ( ) Host plant ( ) Nesting plant ( ) Monarch nectar plant ( ) ‡See Additional Plant Features on p. 86 for more information

Continued on next page…

Recommended Pollinator-Friendly Plants continued

SCIENTIFIC NAME	COMMON NAME	FORM†	FEATURES	1	2	3	4	5	6	7	8	9	10	11	12	13
Atriplex	Saltbush					✓	✓	✓	✓	✓						
Baccharis	Baccharis; false willow; coyotebrush		★	✓	✓	✓	✓			✓				✓	✓	✓
Baptisia	Wild indigo									✓	✓	✓	✓	✓	✓	✓
Bebbia	Sweetbush					✓	✓									
Bidens	Beggarticks		★	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Blephilia[3]	Wood mint										✓	✓			✓	
Boltonia	Doll's daisy; false aster		★						✓	✓	✓				✓	✓
Borrichia	Seaside tansy									✓					✓	✓
Bouteloua	Grama			✓	✓	✓	✓	✓	✓	✓	✓					
Brickellia	False boneset				✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Callirhoe	Poppymallow						✓			✓	✓					
Camassia	Camas			✓	✓	✓		✓		✓	✓				✓	
Carex	Sedges			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Carphephorus	Vanillaleaf; chaffhead														✓	✓
Carya	Hickory									✓	✓	✓	✓	✓	✓	✓
Ceanothus	Wild lilac		★	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Cephalanthus	Buttonbush		★			✓	✓			✓	✓	✓	✓	✓	✓	✓
Cercis[4]	Redbud					✓	✓			✓	✓			✓	✓	✓
Chamaecrista	Partridge pea									✓	✓	✓	✓	✓	✓	✓
Chamerion	Fireweed			✓	✓	✓	✓	✓	✓			✓	✓	✓		
Chromolaena	Thoroughwort; Jack in the bush									✓						✓
Chrysoma	Chrysoma; woody goldenrod														✓	✓
Chrysothamnus	Rabbitbrush				✓	✓	✓	✓								
Cirsium	Thistle (native)		★	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Clarkia	Clarkia		★	✓	✓	✓										
Clematis	Clematis; leather flower			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cleome[5]	Spiderflower; bee plant; bladder pod		★		✓	✓	✓	✓	✓	✓						
Clethra	Sweetpepperbush													✓	✓	✓
Conoclinium	Mistflower; thoroughwort									✓	✓			✓	✓	✓

KEY FORM†: Herbaceous ( ) Woody ( ) Graminoid ( ) FEATURES‡: Pollinator "superfood" (★) Specialist bee plant ( ) Host plant ( ) Nesting plant ( ) Monarch nectar plant ( ) ‡See Additional Plant Features on p. 86 for more information

Continued on next page…

Recommended Pollinator-Friendly Plants continued

SCIENTIFIC NAME	COMMON NAME	FORM†	FEATURES	1	2	3	4	5	6	7	8	9	10	11	12	13
Coreopsis	Tickseed								✓	✓	✓	✓		✓	✓	✓
Cornus	Dogwood			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dalea	Prairie clover						✓	✓	✓	✓	✓				✓	✓
Dasiphora	Shrubby cinquefoil				✓	✓	✓	✓				✓	✓			
Delphinium	Delphinium			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Desmodium	Tick-trefoil						✓		✓	✓	✓	✓	✓	✓	✓	✓
Dichelostemma	Bluedicks			✓	✓	✓	✓									
Echinacea	Coneflower								✓	✓	✓					
Elymus	Wheatgrass; wildrye			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Encelia	Brittlebush					✓	✓									
Engelmannia	Engelmann's daisy						✓			✓						
Epilobium	Willowherb			✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		
Ericameria	Goldenbush; rabbitbrush			✓	✓	✓	✓	✓	✓							
Eriodictyon	Yerba santa					✓	✓									
Eriogonum	Wild buckwheat			✓	✓	✓	✓	✓	✓	✓					✓	✓
Eriophyllum	Wooly sunflower			✓	✓	✓	✓	✓								
Eryngium	Rattlesnake master; eryngo					✓				✓	✓			✓	✓	✓
Erysimum	Wallflower				✓	✓	✓	✓	✓	✓						
Eupatorium	Boneset; thoroughwort								✓	✓	✓	✓	✓	✓	✓	✓
Eustoma	Prairie gentian						✓			✓						✓
Euthamia	Goldentop			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Eutrochium	Joe Pye weed								✓		✓	✓	✓	✓	✓	
Fragaria[6]	Strawberry			✓	✓						✓	✓				
Gaillardia	Blanketflower				✓		✓	✓	✓	✓					✓	✓
Geranium	Wild geranium			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Glandularia	Mock vervain						✓			✓						
Grindelia	Gumweed			✓	✓	✓	✓	✓	✓	✓						
Hamelia	Firebush															✓
Helenium	Sneezeweed			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

KEY FORM†: Herbaceous ( ) Woody ( ) Graminoid ( ) FEATURES‡: Pollinator "superfood" ( ) Specialist bee plant ( ) Host plant ( ) Nesting plant ( ) Monarch nectar plant ( ) ‡See Additional Plant Features on p. 86 for more information

Continued on next page…

Recommended Pollinator-Friendly Plants continued

SCIENTIFIC NAME	COMMON NAME	FORM†	FEATURES	1	2	3	4	5	6	7	8	9	10	11	12	13
Helianthus	Sunflower				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Heliopsis	Smooth oxeye; false sunflower								✓	✓	✓	✓	✓	✓	✓	
Heliotropium	Heliotrope					✓	✓	✓		✓					✓	✓
Heteromeles	Toyon					✓										
Heterotheca	False goldenaster				✓	✓	✓	✓	✓	✓					✓	✓
Hibiscus	Rosemallow						✓			✓	✓			✓	✓	✓
Hierochloe	Sweetgrass								✓	✓	✓	✓	✓	✓		
Ilex	Holly									✓	✓	✓	✓	✓	✓	✓
Koeleria	Junegrass			✓	✓	✓	✓	✓	✓	✓	✓	✓				
Lantana[7]	Lantana (native)						✓			✓						✓
Larrea	Creosote bush					✓	✓			✓						
Liatris	Blazing star						✓		✓	✓	✓	✓	✓	✓	✓	✓
Linum	Wild flax				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lobelia	Lobelia					✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Lomatium	Desertparsley			✓	✓	✓	✓	✓	✓	✓						
Lupinus	Lupine			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Machaeranthera	Tansyaster						✓	✓	✓	✓						
Malvaviscus	Wax mallow									✓						
Mentzelia	Blazingstar				✓	✓	✓	✓	✓	✓						
Mertensia	Bluebells			✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	
Mikania	Hempvine													✓	✓	✓
Mimulus	Monkeyflower			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Monarda	Monarda; bee balm						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Monardella	Coyote mint; monardella				✓	✓	✓	✓								
Nemophila	Baby blue eyes			✓	✓	✓		✓							✓	
Oenothera[8]	Evening primrose			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Oligoneuron	Goldenrod						✓		✓	✓	✓		✓	✓	✓	
Packera	Ragwort			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Passiflora	Passionflower									✓	✓			✓	✓	✓

KEY FORM†: Herbaceous ( ) Woody ( ) Graminoid ( ) FEATURES‡: Pollinator "superfood" ( ) Specialist bee plant ( ) Host plant ( ) Nesting plant ( ) Monarch nectar plant ( ) ‡See Additional Plant Features on p. 86 for more information

Continued on next page…

SCIENTIFIC NAME	COMMON NAME	FORM†	FEATURES	1	2	3	4	5	6	7	8	9	10	11	12	13
Penstemon	Penstemon			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Phacelia	Phacelia			✓	✓	✓	✓	✓		✓	✓			✓	✓	
Philadelphus	Mock orange			✓	✓	✓	✓	✓							✓	
Phlox	Phlox (native)			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Physostegia	Obedient plant; false dragonhead								✓	✓	✓	✓	✓	✓	✓	✓
Pluchea	Sweetscent; camphorweed					✓	✓			✓				✓	✓	✓
Prosopis	Mesquite					✓	✓			✓						
Prunella[6]	Selfheal			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Prunus	Cherry; plum			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pycnanthemum	Mountain mint					✓			✓	✓	✓	✓	✓	✓	✓	
Quercus	Oak			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ratibida	Coneflower						✓		✓	✓	✓	✓				
Rhamnus[9]	Buckthorn				✓	✓	✓	✓	✓			✓	✓			
Rhus	Sumac			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ribes	Currant; gooseberry			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Rosa	Wild rose			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rubus[10]	Blackberry			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rudbeckia	Coneflower; black-eyed Susan				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Salix	Willow			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Salvia[11]	Sage				✓	✓	✓	✓	✓	✓	✓			✓	✓	✓
Sambucus	Elderberry			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Schizachyrium	Little bluestem						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Senecio	Groundsel			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sidalcea	Checkerbloom			✓	✓	✓	✓									
Silphium[12]	Cup plant								✓	✓	✓	✓	✓	✓	✓	✓
Simsia	Bushsunflower									✓						
Sisyrinchium	Blue-eyed grass			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Solidago	Goldenrod			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sphaeralcea	Globemallow				✓	✓	✓	✓	✓	✓						

KEY FORM†: Herbaceous ( ) Woody ( ) Graminoid ( ) FEATURES‡: Pollinator "superfood" ( ) Specialist bee plant ( ) Host plant ( ) Nesting plant ( ) Monarch nectar plant ( ) ‡See Additional Plant Features on p. 86 for more information

Continued on next page…

SCIENTIFIC NAME	COMMON NAME	FORM†	FEATURES	1	2	3	4	5	6	7	8	9	10	11	12	13
Spiraea[13]	Spirea; meadowsweet			✓	✓	✓		✓	✓			✓	✓	✓		
Sporobolus	Dropseed					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Symphyotrichum	Aster			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tilia[14]	Basswood			✓	✓					✓	✓	✓	✓	✓	✓	✓
Trifolium[6,15]	Clover			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Vaccinium	Blueberry; cranberry			✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓
Verbena	Vervain			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Verbesina	Wingstem					✓	✓	✓	✓	✓	✓			✓	✓	✓
Vernonia	Ironweed						✓		✓	✓		✓	✓	✓	✓	✓
Veronicastrum	Culver's root								✓		✓	✓	✓	✓		
Viburnum	Arrowwood; viburnum			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Viguiera	Goldeneye						✓									
Viola[6]	Violets			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Wyethia	Mule-ears			✓	✓	✓	✓									
Zizia	Alexanders; zizia								✓	✓	✓	✓	✓	✓	✓	✓

KEY FORM†: Herbaceous ( ) Woody ( ) Graminoid ( ) FEATURES‡: Pollinator "superfood" ( ) Specialist bee plant ( ) Host plant ( ) Nesting plant ( ) Monarch nectar plant ( ) ‡See Additional Plant Features on p. 86 for more information

* **NOTE:** This is not an exhaustive list—there are thousands of native North American plant species that provide resources and habitat for pollinators. This is a streamlined list intended as a starting point. Instead of listing particular species, we have listed the genera. Not all species in each genus are native to all regions. To learn more about identifying, sourcing and planting native plant species for your park or green space, we suggest reaching out to local ecologists and native plant societies and native plant and seed suppliers (see **Xerces Society Resources** for links).

† **GROWTH FORMS:** Herbaceous—wildflower/ forb ( ), Woody—shrub/ tree ( ), Graminoid—grass/ sedge ( ). NOTE: some genera are listed as both Herbaceous and Woody because they vary by species or region.

1. False indigo bush (*A. fruticosa*) is restricted as a noxious plant in some parts of the Northeast and the Pacific Northwest ⓘ.
2. Some non-native species of *Artemisia* are restricted as noxious ⓘ.
3. Good in shady areas.
4. Not native to most of Southwest but a popular landscape tree.
5. Not native to regions 9–13, but planted often in flower gardens.
6. Flowers at very low height, even in mowed areas or compacted soils. These genera are great choices for ecolawns and often grows spontaneously among turf grass.
7. Seek native lantana species and avoid the non-native *L. camara*.
8. All regions have native species of *Oenothera*, but some species are restricted as noxious in California ⓘ.
9. Many regions have native species of *Rhamnus*; but the invasive species, common buckthorn (*R. cathartica*) and glossy buckthorn (*Frangula alnus*), are restricted as noxious in some northern states ⓘ.
10. Many regions have native species of blackberry; but the invasive species, Himalayan blackberry (*R. armeniacus*), is restricted as noxious in some states ⓘ.
11. Many regions have native species of *Salvia*; several non-native cultivars are used in horticulture.
12. Cup plant (*S. perfoliatum*) is listed as a noxious plant in some parts of the Northeast ⓘ.
13. Many regions have native species of *Spiraea*; several non-native cultivars are used in horticulture.
14. Not native in all regions, but widely used as a street tree and valuable to pollinators.
15. Red clover (*T. pratense*) and white clover (*T. repens*) are native to Europe, but, like all clovers are excellent nectar plants. They are widely naturalized and sown as forages or cover crops. The flowers of white clover are very low to the ground and often persist in lawns, providing nectar for pollinators. Native *Trifolium* species occur in many regions of North America, especially in the West.

ⓘ Visit Invasive.org to check your state's list of prohibited or noxious species.

Appendix B

Resources

This appendix contains a collection of suggested books, conservation guidelines and factsheets, articles, and web pages that offer additional information for those who want to explore more deeply the topic of pollinators in parks and greenspaces. Many of the publications from the Xerces Society provide detailed guidance about how to create pollinator habitat. The appendix is organized by chapters.

Chapter 1: Introduction

Online article from the Xerces Society

Addressing Conservation in Urban Areas, xerces.org/blog/addressing-conservation-in-urban-areas

Chapter 2: Pollinator Basics

These books were all written by Xerces Society staff. They are available from our online Gift Center, **xerces.org/gifts**, or wherever you buy books, as well as libraries.

Attracting Native Pollinators: Protecting North America's Bees and Butterflies (2011, Storey Publishing).

100 Plants to Feed the Bees (2016, Storey Publishing).

100 Plants to Feed the Monarch (2021, Storey Publishing).

Gardening for Butterflies (2016, Timber Press).

Chapter 3: Threats

Publications available online from the Xerces Society

Pollinators and Climate Change. Climate-Smart Urban Habitat, xerces.org/publications/fact-sheets/pollinators-and-climate-change-climate-smart-urban-habitat

An Overview of the Potential Impacts of Honey Bees to Native Bees, Plant Communities, and Ecosystems in Wild Landscapes: Recommendations for Land Managers, xerces.org/publications/guidelines/overview-of-potential-impacts-of-honey-bees-to-native-bees-plant

The following pages on the Xerces Society website each contain useful information about pesticide use and reduction, as well as links to further relevant resources.

Reducing Pesticide Use & Impacts, xerces.org/pesticides

Managing Roadsides and Rights-of-Way for Pollinators, xerces.org/pollinator-conservation/roadsides

Effective Mosquito Management, xerces.org/pesticides/effective-mosquito-management

Chapters 4–7: Habitat Planning and Creation

Online resources and publications from the Xerces Society

Pollinator Conservation Resource Center: extensive collections of plant lists, conservation guidance, and other resources organized by regions, xerces.org/pollinator-resource-center/

Nesting Resources, xerces.org/pollinator-conservation/nesting-resources

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

Maintaining Diverse Stands of Wildflowers Planted for Pollinators, xerces.org/publications/guidelines/maintaining-diverse-stands-of-wildflowers-planted-pollinators

Xerces Habitat Assessment Guide for Pollinators in Yards, Gardens, and Parks, xerces.org/publications/habitat-assessment-guides/habitat-assessment-guide-for-pollinators-in-yards-gardens

Mid-Atlantic Native Meadows. Guidelines for Planning, Preparation, Design, Installation, and Maintenance, https://xerces.org/publications/guidelines/mid-atlantic-native-meadows

Bee-Safe Nursery Plants, https://xerces.org/pesticides/bee-safe-nursery-plants

Online resources and publications from other organizations.

Parks for Pollinators (National Recreation and Parks Association), www.nrpa.org/our-work/Three-Pillars/conservation/parks4pollinators/

Lawn to Wildflowers Initiative (University of Central Florida), www.lawntowildflowers.org/

The Meadow Project, themeadowproject.com/

BlueThumb – Planting for Clean Water, bluethumb.org/

A Guide to Native Plant Gardening (Lady Bird Johnson Wildflower Center), www.wildflower.org/learn/guide-native-plant-gardening

Turf Transformation into Beautiful, Sustainable, and Resilient Landscapes (Pacific Horticulture), www.pacifichorticulture.org/articles/turf-transformation-into-beautiful-sustainable-and-resilient-landscapes/

Chapter 8: Pesticides

The following pages on the Xerces Society website each contain useful information about pesticide use and reduction, as well as links to further relevant resources.

Reducing Pesticide Use & Impacts, xerces.org/pesticides

Understanding Pesticides and Their Risks, xerces.org/pesticides/understanding-pesticides

Rethinking Pest Management in Towns and Cities, xerces.org/pesticides/pesticides-urban-environments

Managing Roadsides and Rights-of-Way for Pollinators, xerces.org/pollinator-conservation/roadsides

Effective Mosquito Management, xerces.org/pesticides/effective-mosquito-management

Bee-Safe Nursery Plants, https://xerces.org/pesticides/bee-safe-nursery-plants

***Supporting information for* 9 on page 72**

San Francisco (California) Pest Management for City Departments: Description: Model Pest Management Ordinance, reduced risk pesticide list, pesticide use trends, example contract language, and research and reports. sfenvironment.org/pest-management-for-city-departments

City of Boulder (Colorado) Integrated Pest Management Program: IPM policies and procedures, summaries of city's mosquito and rat management strategies, educational fact sheets, pesticide application hotline, and other resources. bouldercolorado.gov/ipm

New York City (New York) Local Law 37, Pesticides Used by City Agencies: Summary of and FAQs about New York City's program to reduce dangerous pesticides, as well as information about the city's reporting system, notification requirements and waiver system. www1.nyc.gov/site/doh/health/health-topics/local-law-37.page

Grow Healthy South Portland (Maine): South Portland's ordinance which establishes organic land care as the primary means to care for and maintain public and private lawns, gardens, athletic fields, parks, and playgrounds. You'll also find practical tips and information about events, trainings, and demonstration projects. www.southportland.org/departments/sustainability-office/grow-healthy-south-portland/

Ashland (Oregon) Parks and Recreation IPM Policy: IPM policy adopted by the city's parks and recreation department as well as a summary of updates over the years. www.ashland.or.us/Files/IPM%20Policy_approved%20mods_Feb11-May17.pdf

Newtown (Massachusetts) IPM Advisory Committee: The advisory committee is designed for broad community representation and a clear steering role. www.greenpolicy360.net/w/Newton,_MA_Integrated_Pest_Management_Policy

City of Davis (California) IPM Policies and Procedures: Training requirements that Davis requires for any staff handling pesticides, as well as other procedural requirements related to pest management and pesticides. http://documents.cityofdavis.org/Media/Default/Documents/PDF/PW/Integrated%20Pest%20Management/07-IPM-Policy-ATT2-IPM-Policy-and-Procedures.pdf

City of Seattle (Washington) Parks and Recreation IPM Program: Information about the IPM program maintained by Seattle, including its pesticide reduction goal and limitations on the use of glyphosate and neonicotinoids. https://www.seattle.gov/parks/about-us/policies-and-plans/integrated-pest-management

Chapter 9: Outreach

Online resources from the Xerces Society

Bring Back the Pollinators, xerces.org/bring-back-the-pollinators

Pollinator Protection Pledge, xerces.org/pollinator-conservation/pollinator-protection-pledge

Bee City USA and Bee Campus USA, beecityusa.org

Community science projects managed by the Xerces Society

Bumble Bee Watch, bumblebeewatch.org

Regional bumble bee atlas projects, bumblebeeatlas.org

Western Monarch Milkweed Mapper, monarchmilkweedmapper.org

The Xerces® Society is a trusted source for science-based information and advice. We work with people from all walks of life to promote invertebrate conservation. Our team draws together experts in habitat restoration, entomology, plant ecology, and conservation biology with a single passion: protecting the life that sustains us.

We make the commitment to you that we will work every day to protect pollinators and their habitat. Will you support our work? Make a tax-deductible donation to the Xerces Society today!

Visit **xerces.org/donate** to learn more.

XERCES SOCIETY
for Invertebrate Conservation

Tel (855) 232-6639 • xerces.org

21-038_02