POLLINATOR–FRIENDLY PARKS

How to Enhance Parks, Gardens, and Other Greenspaces for Native Pollinator Insects

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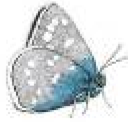
The Xerces Society for Invertebrate Conservation, Portland, OR



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Front cover photograph
This beautiful pollinator, a metallic green sweat bee (*Agapostemon virescens*), is common across the United States during summer and warm days in early fall. Usually these bees move very quickly, but this one stayed still long enough to be photographed foraging in a Nootka rose in Skinner Butte Park, a few blocks north of downtown Eugene, Oregon. (Photograph by Bruce Newhouse, Salix Associates.)

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Chapter 1
Introduction

In a time when towns and cities are spreading rapidly and wild spaces are quickly disappearing, parks and other greenspaces are increasingly important to the vitality of our communities. In addition to providing a wealth of opportunities for recreation and relaxation, and aiding community development, parks help maintain a clean, healthy environment.

Once formal landscapes designed for relaxation, parks now encompass everything from intensively managed sports fields to natural areas managed primarily for wildlife. Hand in hand with the changing character of parks are the changing expectations for what parks should provide. In an increasingly urbanized nation—it has been calculated that more than two million acres of land in the United States are swallowed up by urban sprawl each year—greenspaces are a welcome break from the hard surfaces of towns and cities.

At the most basic level, healthy parks mean healthy people and healthy communities. At the core of a healthy environment are pollinators—animals that move pollen among flowers, thus ensuring that the plants can form seeds and fruits. The work of pollinators touches our lives every day through the food we eat, and even in how we mark the seasons: think of the bloom of springtime meadows, berry picking in summer, and pumpkins in the fall.

Native bees and butterflies—along with flies and beetles—are among the more important wild pollinators in North America. Unfortunately, pollinators, like all wildlife, are suffering as landscapes change and habitats are broken up or lost. Pollinator conservation aims to support populations of pollinators.

Why Pollinator–Friendly Parks?

Recent studies demonstrate the value of parks and other greenspaces for wild pollinators—even fragments of habitat in urban areas. For example, San Francisco's parks support significant, and diverse, populations of bumble bees. Fifty-four species of bees were discovered in community gardens in East Harlem and the Bronx, New York, and sixty-two species of bees were found in fragments of desert scrub habitat in Tucson, Arizona. More than seventy species of

Parks provide many recreational opportunities and environmental benefits to neighborhoods and local communities. (Photograph by Matthew Shepherd.)

Bees provide flowers with the vital service of pollination. Native bees are the most important single group of pollinators in North America. (Photograph by Edward S. Ross.)

bees were identified in the gardens of Albany and Berkeley, California. Greenspaces in towns and cities are clearly important for pollinators.

The National Academy of Sciences report, *Status of Pollinators in North America* (NRC 2006), identified habitat loss and degradation as two causes of pollinator decline, and emphasized the value of land managers adopting pollinator-friendly practices.

These guidelines offer easy–to–implement tips for providing habitat for native bees and butterflies. In addition to helping pollinators, these practices will benefit your park or greenspace in other valuable ways:

- Patches of native flowers—and the butterflies and bees supported by them—will add visual interest.
- Habitat patches will enhance visitors' experience of nature, as well as be a resource for community involvement such as environmental education programs or volunteer activities.
- Reducing the area of mown grass (in favor of pollinator habitat) can cut maintenance time and reduce chemical use.
- Providing habitat for pollinators will help gardeners, as well as any farms or natural areas, in neighborhoods and areas nearby your park.
- Habitat designed to support pollinators will benefit a wide range of other wildlife.
- Pollinator conservation efforts may help a park achieve "green" certification through programs such as SalmonSafe or Audubon International.

How to Use These Guidelines

The guidelines are divided into three major sections:

- **Pollinator Basics** explains what pollination is and how it benefits us, which animals pollinate, and what they need to thrive.
- **Conservation Action** gives practical advice on how to identify existing pollinator habitat, assess your site for conservation opportunities, and implement habitat enhancements.
- The **appendices** contain extensive plant lists, resources, and notes on the natural history of native bees and nest site care.

If you are new to native pollinators and pollinator conservation, we suggest you start with Pollinator Basics. If you know some about native bees and butterflies, you might want to skim the first section and then delve more deeply into Conservation Action. If you already have significant experience with planning for pollinators, you may find the appendices especially helpful; use the first sections for training staff and volunteers, or share them with neighbors.

POLLINATOR BASICS—CHAPTER 2

THE ROLE AND VALUE OF POLLINATORS

All ecosystems have "keystone" species without which the ecosystem would gradually unravel and potentially collapse. Discussions of keystone species often revolve around large, mammalian predators—bears and wolves, for example. But for many land managers, especially those working in urban or suburban areas, these are rare visitors, if they occur at all. By contrast, small pollinating insects are keystone species that all managers will encounter. The service these vital animals provide is a fundamental component of a healthy environment.

Pollination is the movement of pollen grains within and between flowers. It is essential for plant reproduction and the health of our environment. Some plants use wind to move pollen, but most rely upon animals—pollinators—to move it for them. Pollination is a pivotal process essential to the health and productivity of almost all terrestrial ecosystems.

The contribution that pollinators make to our lives can be measured in monetary terms. In the U.S., 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 U.S. is almost $20 billion per year, of which more than $3 billion is provided by wild-living native insects. (The rest is from managed honey bees.) This value would be many more billions if indirect products, such as the milk and beef from cattle fed on alfalfa, were considered.

As agriculture varies from region to region, so does the benefit from pollinators. In the Pacific Northwest, for example, pollinator–dependent crops are a mainstay of the agricultural economy. Oregon ranks first in the U.S. for harvest of blackberries, loganberries, black raspberries, and boysenberries. Washington ranks first in the U.S. for apples, sweet cherries, and pears. Both states also produce substantial crops of vegetable and flower seed and are major producers of alfalfa. In 2001, the combined value of these crops for both states was nearly $2 billion.

> *"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*

HOW DOES POLLINATION WORK?

In order to produce seed, plants must move pollen grains either within or between flowers. Pollen grains carry gametes, the flower's male sex cells, and must transfer from the flower's anthers, where they are formed, to the tip of a stigma. Once there, the male gametes can reach and fertilize the ovules, which then develop into seed or fruit.

Pollination is often divided into two categories based on where the pollen moves and what allows the plant to set seed. Self–pollination is the movement of pollen within a flower or between flowers on a single plant. Cross–pollination is the movement between flowers on separate plants.

A significant number of plants—including grasses, rushes, and many trees—use the wind to transport pollen. These plants release huge quantities of dry, dust–like pollen grains to ensure that an adequate number will arrive at their target. Most of this pollen, however, ends up elsewhere, such as our eyes and noses: wind–blown pollen is the cause of many seasonal allergies.

Most plants—approximately 70 percent of species—have evolved an intimate relationship with one or more animals to ensure that their pollen is reliably and accurately moved. These plants produce relatively small amounts of large, sticky pollen grains that can only be carried by pollinators. Almost all pollinators are insects.

The work of pollinators has value beyond the economic impact of commercial agriculture. Pollinators are responsible for 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 diet of approximately 25 percent of birds, as well as for mammals, from red–backed voles to grizzly bears. 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 away in the tree back into the ecosystem. The larvae of many syrphid flies (as adults, important pollinators of many plants) reduce damage to plants by eating aphids and other soft–bodied plant pests.

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.)

POLLINATOR BASICS —CHAPTER 3

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 white–winged doves and long– and short–nosed bats (restricted to deserts in the Southwest) and hummingbirds. It is not known exactly how many pollinator species exist on this continent, but the total number is certainly in the thousands, given that there are four thousand species of bees alone.

Almost all pollinators are insects. The four principal pollinating insect orders with members that regularly visit flowers are bees and wasps (Hymenoptera), butterflies and moths (Lepidoptera), flies (Diptera), and beetles (Coleoptera). Others that occasionally visit flowers include stoneflies (Plecoptera), true bugs (Hemiptera), scorpion–flies (Mecoptera), and thrips (Thysanoptera).

Insects visit flowers for a variety of reasons. Some are looking for food, generally nectar or pollen. Others are in search of warmth or a mate. Whatever the reason, as they go about their daily tasks flower–visiting insects transfer grains of pollen from the anthers of one flower to the stigma of the same or another flower. This transfer is not a conscious act by the pollinator. A female bee, for example, does not set out each morning with the intention to pollinate, but instead follows her instinct to feed and to collect pollen and nectar to supply her nest—incidentally spreading the pollen.

The effectiveness of insects as pollinators, however, is no accident. Over the past 150 million years, flowers and their pollinators have evolved in parallel. Insects have adapted to get the nectar and pollen (or in some cases, floral oils or other rewards) offered by the flowers, and the flowers have adapted to present pollen in a way that ensures pollination.

Pollinator–Friendly Parks focuses on native bees and butterflies. 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 purposefully

NATIVE BEES

The diversity of bees is astonishing. About four thousand species have been identified and catalogued in North America. Only a handful of these (including the honey bee) are not native. Most native bees do not fit the stereotypical image of a bee—yellow–striped, living in a hive with thousands of others, and apt to sting—and are therefore easily overlooked.

Native bees can be dark brown, black, or metallic green and blue, with stripes of red, white, orange, yellow, or even opalescent colors. They can be as little as a tenth of an inch long, or more than one inch. Most are solitary, meaning each female creates her own nest with just a few brood cells. Most are unlikely to sting. Common names reflect nest–building habits: plasterer, leafcutter, mason, carder, digger, carpenter. Other names depict traits. Cuckoo bees lay eggs in other bees' nests. Sweat bees like to drink salty perspiration. Bumble bees make a loud humming noise while flying.

Keep in mind that the yellowjackets you see eating rotting fruit and hanging around picnics are not bees, nor are they significant pollinators.

Many native bees are tiny, as demonstrated by this sweat bee that is dwarfed by the oxtongue flower on which it forages. (Photograph by Mace Vaughan.)

collect pollen to take back to their nests for their offspring. By contrast, other insect visitors to flowers merely brush against pollen by chance, indirectly pollinating flowers. Also, native bees make repeated trips from their nest, constantly working the same plants in a limited area, such as a single greenspace.

Winsome animals that can be used to introduce people to conservation issues, butterflies are important to consider, too. In addition to attracting the attention of people, butterflies contribute to pollination. Because they may have a close association with native plants, or be found only in specific habitats, butterflies can also be indicators of overall biodiversity and measures of ecosystem health.

Another reason to focus on native bees and butterflies is that the natural history and habitat needs of these insects are better understood than those of pollinating flies or beetles. Consequently, there are well–established conservation techniques for bees and butterflies, practices that will also benefit other pollinators and species of wildlife.

Valuable pollinators include (from lower left) wasps, butterflies, and beetles. (Photograph by Jeff Adams.)

POLLINATOR BASICS—CHAPTER 4

HABITAT NEEDS OF BEES AND BUTTERFLIES

Native bees and butterflies share the same basic life cycle—egg, larva, pupa, and adult—and also the same basic habitat needs: somewhere to lay eggs, and adequate flowers on which to forage for nectar or pollen. The main difference in habitat needs is where eggs are laid. Butterflies lay their eggs on plants that are suitable for their caterpillars to eat, whereas bees create a nest in a secure location and stock it with food for their offspring.

"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*

Hostplants for butterflies

Some butterflies are very particular about which hostplants they use. Monarch caterpillars are renowned as picky eaters, that will dine only on milkweeds; thus, adult monarchs lay eggs only on these plants. 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 caterpillars of the anise swallowtail have been recorded feeding on more than sixty different plants in the carrot family. Although a butterfly may carefully choose a hostplant, her parental responsibility ends when she lays her eggs. Eggs and subsequently caterpillars are left to fend for themselves.

Nest sites for bees

A female bee creates a secure nest, stocks the nest with nectar and pollen for the larvae to eat, and lays eggs. The majority of bees are solitary. Approximately 70 percent nest in the ground, digging tunnels in patches 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 percent of solitary bees nest, for the most part, in existing narrow holes such as old beetle tunnels in snags, or in the center of pithy twigs. Females of these wood–nesting bees create a line of brood cells, often using materials such as leaf pieces or mud as partitions between cells. The female then dies. The offspring of solitary bees typically remain in the nest for about eleven months, passing through the egg, larva, and pupa stages before emerging as an adult to renew the cycle the next year.

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.

The nests of native bees are quite different. Almost all of the four thousand species of 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 and dies after her nest is completed.

Bumble bees are social bees and live in a colony and share the labor. But, unlike honey bee nests, most bumble bee nests are a random–looking cluster of ball–shaped brood cells and waxy pots, and are occupied by less than a few dozen bees. Because bumble bees store only a few day's supply of nectar, the colony does not survive beyond the fall.

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

As social bees that live in a colony, bumble bees need a small cavity, such as a discarded mouse nest, in which to build a cluster of waxy, ball–shaped brood cells. A queen founds a colony in spring after she emerges from hibernation. Depending on the species, the colony may be active for only a few weeks or for several months into the fall, at which time most members of the colony die. The last generation to emerge from a colony are queens and males; they mate, the males die, and the mated queens enter hibernation.

Forage needs

A butterfly forages solely for its own nutrition. 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 species feed at dozens of different flowers—but they are limited by the length of their proboscis. Skippers and swallowtails, for example, have a long proboscis and will feed on tubular flowers such as penstemon.

Bees forage for themselves and to supply their nest. Like butterflies, solitary bees will drink nectar from any flower into which they can reach (the length of a bee's tongue varies by species). They are, by contrast, more particular about the flowers from which they gather pollen. *Generalists* gather pollen from a wide range of flower types and species. *Specialists* rely on a single plant species or on a closely related group of plants. The lifecycles of specialist bees are often closely tied to the lifecycles of their preferred host plant(s); adult bees will emerge from their brood cells right when a specific plant blooms.

Bumble bees are generalist foragers. Since the colony lives for several months, the bees must be able to collect pollen from many different flowers that bloom in succession throughout summer.

Threats to pollinator habitat

Secure, stable nesting sites and flower–rich forage areas are key components of pollinator habitat. The outright loss of this habitat is the greatest direct threat to pollinators. Sometimes the loss is dramatic—a meadow converted to a shopping mall, for example—but often it is more subtle. Sites may remain green but still lose plant diversity or nest sites; an agricultural field or an expanse of mown grass usually is of little interest to a bee or butterfly.

Flowers providing nectar and pollen are a necessary part of pollinator habitat. (Photograph by Mace Vaughan.)

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 in the foreground, are increasingly important refuges for pollinators and other wildlife. (Photograph by Matthew Shepherd.)

Fragmentation of habitat is a second threat. The patches of habitat left after conversion to housing, industry, or agriculture—such as hedgerows or grassy verges—might be too small to support adequate nest sites, hostplants, or forage areas. Or, they may be too far apart. 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 too fragmented.

Pesticides are another significant threat. Insecticides can directly kill or injure bees and butterflies. Herbicides can reduce the availability of forage flowers. Unfortunately, both are used extensively and often without thought of pollinators. Many insecticides carry a caution notice for when they are to be used on flowering crops, intended to reduce honey bee kills. When the same pesticide is used for landscape maintenance or in a garden, the caution notice will not apply. This is not because the toxicity changes—it does not—but because it is assumed that pollinators are not useful in these other landscapes.

The good news is that, in general, insects are able to exploit small patches and partial habitats that are suitable only for nesting or only for foraging. Wooden buildings and ornamental trees might become sites for nests; nearby neighborhoods might have an attractive diversity of weeds and garden plants. Small improvements to habitat may have dramatic results, at least for generalist species. Creating flower–rich field margins or hedgerows, installing bee–nesting blocks, or reducing herbicide use are ways in which you can enhance parks and greenspaces for butterflies and bees.

CONSERVATION ACTION—CHAPTER 5

STRATEGIES FOR SUCCESS

One of the encouraging aspects of pollinator conservation is the ease with which it can be adapted to different sites. Pollinators can benefit from even minimal changes, such as reducing the intensity of maintenance efforts in order to lessen the disturbance to existing habitat features. We recommend a three–step approach.

1) **Recognize the habitat and native pollinators** that are already on your site;
2) **Adapt current land management practices** to avoid causing undue harm to the pollinators that are already present; and
3) **Enhance, restore, or create habitat** for native bees and butterflies.

A fourth strategy that should be pursued as a component of each of these steps is to **tell people what you are doing and why**. This is especially important with regards to public parks, where both advisory committees and park users will want to know what is happening. In all greenspaces, managers and staff should be kept informed about the conservation plan.

RECOGNIZE EXISTING HABITAT AND POLLINATORS

The first step in pollinator conservation is simple and requires only a small amount of money and time. You probably already regularly see butterflies and some bees. By closely observing flowers, you may start to notice more species of bees and even discover that these other species are abundant, especially if your park has or is located close to natural areas. (See Appendix C for resources on identifying native bees and butterflies.)

After discovering which native bees and butterflies are present, look for nest sites, hostplant patches, and other significant foraging patches. The next chapter, "Finding the Best Places," has details about recognizing these sites. 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.

"Taking action now in response to these early alarms might allow North Americans to avert the very real and widespread declines that are now being detected among Central European bee faunas."

Jim Cane and Vince Tepedino
USDA–ARS Logan Bee Laboratory

Protecting existing native plants, such as the aster shown here, or planting new patches of plants will beautify parks and increase forage for nectar–drinking insects. (Photograph by Bruce Newhouse.)

This unassuming bank, on the side of a well–used trail between sports facilities, has at least three species of bees nesting in it. Identifying and protecting such places is an important first step in implementing pollinator conservation. Existing habitat patches can form a framework within which additional areas of habitat can gradually be developed. (Photograph by Matthew Shepherd.)

Adapt Current Land Management

Maintenance practices can be adjusted to take into account pollinator conservation. As much as possible, leave areas that might support native bees and butterflies alone. Protect sites with potential forage plants and hostplants from mowing, herbicides, and insecticides. Reducing pesticide drift and creating buffer zones around treatment areas will go a long way toward protecting native bees that live in or use adjacent natural areas. Leave places such as forest margins and little–used field corners unmown, reduce the frequency of mowing, and/or raise the height of the cutting blades in these areas. This will allow flowers like clover and bird's–foot trefoil to bloom, providing additional forage. 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).

If good forage plants also happen to be weeds—an unfortunate clash of good and bad traits—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 noxious weeds, but give a second thought to less–invasive weeds, especially if they flower in the spring and can help jumpstart populations of native bees.

Enhance, Restore, or Create Habitat

If you want to take a more active role in increasing the numbers of native pollinators, try these four steps. First, increase the available foraging habitat to include a range of plants (preferably native species) blooming at different times, in order to provide nectar and pollen throughout the season. Second, plant caterpillar hostplants appropriate for the butterfly species in your area. Third, create bee nesting sites by providing suitable ground conditions, tunnel–filled lumber, and nesting materials. Fourth, reduce the risk to pollinators from insecticides and herbicides. These substances

can directly kill bees, butterflies, and other insects, as well as the plants upon which pollinators rely for forage. Instead, select less–toxic insecticides or utilize alternative strategies to manage pest insects.

TELL PEOPLE WHAT YOU ARE DOING

Education and outreach is vital to gaining the support and engagement of key people. Telling park committees, staff, and local community members what you are doing and why should be an integral component of your conservation efforts. Getting approval from advisory or management committees early in the process is also wise.

For example, explain to maintenance staff why they will be asked to avoid mowing in some places and why these insects—often mistakenly seen as nothing more than pesky stinging bugs—are, in fact, important. Post notices on a bulletin board, have information sheets such as those produced by the Xerces Society available to read, or make pollinator conservation an agenda item at a staff meeting.

Local citizens 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 them from complaining. On–site signs (whether temporary notices or permanent interpretive panels), flyers for park users, articles in neighborhood newsletters, or news briefs in local media—maybe a morning spent in the park talking to walkers—all could be effective.

The following sections cover in greater detail how to enhance habitat, how to provide necessary resources, and how specific park management practices may be altered to reduce negative impacts on our native pollinators.

The wide–open spaces under power lines contain acres of grassland that could support abundant populations of butterflies, bees, and other pollinators. (Photograph by Matthew Shepherd.)

Conservation Action—Chapter 6

Finding the Best Places

Almost all parks and greenspaces can make positive contributions to the abundance of pollinators. Even small, urban parks will have room for forage flowers, caterpillar hostplants, or bee nests. Because insects can utilize partial habitats—areas with nectar or pollen forage, or egg–laying sites, but not both—you can take advantage of places that are suitable for only one component of pollinator habitat. Although each single partial habitat may not provide everything bees and butterflies need, taken all together they will greatly benefit and improve your park for native pollinators.

Identifying Current Habitat

By knowing where in your park bees and butterflies nest, lay eggs, forage, and overwinter, you will be able to protect and enhance these areas.

Spotting good foraging areas

A good foraging area contains a diversity of flower species that, ideally, offer blooms 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. You will notice many insects, mostly bees, around the best of these flowers. 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 that are already growing in your park and that seem most attractive to native bees. This will make it easier to choose plants for subsequent restoration projects.

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

Locating butterfly hostplants

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

Finding bee nest sites

Because the only outward signs of many bee nests are tiny holes in the ground, finding nest sites may take more effort than finding foraging areas. Also, because different species are active at different times of the day and year, search several times during the warmest months, and take into consideration the time of day. Most bees are active on warm sunny days from mid–morning 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.

Ground nests. Species such as mining bees and sweat bees build their nests in the ground. 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. 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.

Wood nests. Many bees, such as leafcutters and masons, nest in beetle tunnels in snags or similar holes. Snags support other wildlife in addition to bees, so if the snags on your grounds do not pose a hazard, keep them. (For advice on how to retain snags and make them safe, see *Landscaping for Wildlife in the Pacific Northwest*, by Russell Link.) 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.

Two types of bees can chew out their own nest tunnels. Small carpenter bees will nest in twigs with a soft pith, such as elderberry, sumac, or blackberry; the twig might have to be broken for the bee to access the pith. Large carpenter bees usually make nests in the soft deadwood of plants such as pine and agave, but will tunnel into exposed timber of buildings.

Bumble bee 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 long, tussocky grass or

Two examples of ground nests. On the left are 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. On the right is a 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 Matthew Shepherd.)

overgrown hedge bottoms—areas preferred by mice—are typical places to find bumble bees nesting. In addition, there is at least one species that regularly nests in hollow snags or bird nesting boxes.

PARK FEATURES FRIENDLY TO POLLINATORS

Parks, even formally landscaped ones, contain many places that could benefit pollinators

Existing habitat

Your park may already support pollinators in areas such as forest edges, hedgerows, riparian areas, utility easements, and conservation areas, as well as unused land around maintenance buildings and service areas. These sites have relatively stable conditions that allow forage plants, butterfly hostplants, and bee nests to become well established. Careful management of these areas and protecting them from pesticides may create more nesting and foraging opportunities for pollinators. Existing habitat may also be enhanced with the addition of key native flowering plants and/or nesting materials.

Marginal areas

Awkward–to–mow corners, fencerows, trail and road verges, 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.

Marginal areas can provide significant habitat. This rock-strewn bank between a light rail line and a ditch offers flowers, bare ground for nesting, and warm rocks for basking. (Photograph by Matthew Shepherd.)

Community gardens and orchards

Community gardens and orchards located in parks will benefit directly from abundant pollinators, as well as provide important habitat for the insects. Install nest sites in community gardens and sow cover crops on fallow plots or around the perimeter of the garden. Plant orchards with a cover crop, such as clover, thyme, low–growing yarrow, or other plants that are sources of nectar and pollen. This is especially important before and after orchard trees bloom. A cover crop underneath orchard trees will provide food when the trees' flowers are not present, leading to large numbers of native bees and butterflies and fully pollinated orchard trees.

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 hostplants can be valuable for pollinators. Butterfly gardens are already being installed in many public places. Small alterations to a butterfly garden, such as adding bee nesting blocks, 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. Examples include sunflowers, coreopsis, purple coneflower, and black–eye Susan. Other garden plants originally from Europe and elsewhere provide abundant nectar and pollen. Lavender and most culinary herbs are good examples. As a general rule, older varieties of perennials and herbs are the best sources of nectar or pollen. Newer varieties have often been bred for color, size, or flower structure. In the process, they may have inadvertently lost their ability to produce nectar and pollen. Modern roses, for example, may have multiple petals in the place of pollen–bearing stamens. Wooden blocks and similar bee nest sites can be a helpful, even attractive, component of these areas.

Pollinator conservation can be incorporated into any area of a park, including places traditionally not considered to be wildlife habitat. Formal landscaping, such as the rhododendron garden shown here, offer sources of nectar and pollen. (Photograph by Matthew Shepherd.)

Ecolawns

Allowing low–growing flowers to bloom in lawns is another way to incorporate pollinator habitat into more formal locations. There is a growing movement promoting low–maintenance “ecolawns,” a mix of grasses and low–growing perennials that will thrive and bloom beneath the cutting height of a mower (two inches is often the preferred cutting height). An ecolawn may be appropriate where short grass is preferred and a less–manicured sward is acceptable.

Ecoroofs

Ecoroofs can reduce storm run-off, insulate the building against heat and cold, and provide habitat. 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 also provide nesting habitat. A deep substrate may be shaped to form micro-topography, diversifying the ecological niches on the roof. Add some nest blocks and you have a complete habitat.

Site Characteristics to Consider

Once you have identified potential places for improvement, decide where to start, perhaps 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 deciding among locations.

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.

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.)

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 and connect them with habitat corridors. The greater the area of habitat, the greater the likelihood that forage, hostplants, nest sites, and nesting materials will be available throughout the flight season and within the bees' flight range.

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 that harbor native pollinators. 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.

For example, larger bees (such as bumble bees) can fly half a mile or more to forage, but most bees probably travel no more than a couple of hundred yards from their nests. Some spend their whole lives in a single habitat patch, while others have territories of a few hundred yards. The distance butterflies will fly similarly varies significantly by species. Connecting habitat patches will make them more valuable.

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

Trees and forest

The presence of trees has several positive effects. Trees may act as a windbreak, making it easier for butterflies and bees to visit flowers and to stay warm on cooler days. (In cooler regions, bees may be less likely to build nests in areas that receive too much shade; in hot locales, shade is less likely to be a problem.) Some species of flowering trees can be excellent sources of nectar and pollen. Trees also serve as landmarks for foraging bees as they navigate to and from their nests. In addition, trees may be important hostplants for some of our most spectacular butterflies. Forest edges, with their early–successional habitat of forbs, tall grasses, and shrubs, can be valuable foraging and nesting locations for native bees. Even snags riddled with abandoned beetle tunnels might provide wood–nesting bees with nesting sites.

Maintenance access

In the long term, the effort to maintain areas of pollinator habitat should be minimal. During the establishment period, weed control and irrigation will be required. Because plants in new areas of habitat will benefit from irrigation during the first summer, keep in mind the need for access to a water supply and irrigation equipment.

CONSERVATION ACTION—CHAPTER 7

CREATING FORAGING PATCHES

Providing flowers for butterflies and native bees will make your park more attractive to pollinators, as well as be aesthetically pleasing to visitors. To be of the greatest benefit, foraging habitat should contain a range of plants that will provide a succession of flowers, and thus nectar and pollen, through as much of the growing season as possible. Carefully choose plants for a forage patch or hedgerow that will require minimal maintenance once they are established. Native plants are frequently the best choice: they are usually better adapted to grow in the climate and soils of your region, and they require less attention after they are established.

Below are tips on selecting the best plants to help bees and butterflies. See Appendix A, which has lists of native plants that are especially good for pollinators, and garden plants (non–native) that are excellent sources of pollen and nectar. See Appendix C for web sites and publications that focus on how to prepare a site, choose and procure seeds, sow seeds and establish plants, and maintain a site.

CHOOSING PLANTS FOR POLLINATORS

Patches of forage habitat can be created in many different places in a park, including edges of fields, hedgerows and forest edges, sides of ditches or creeks, and along trails. Formal landscaping and flower borders can also offer plenty of food for pollinators. When planning forage habitat, consider the following ten points.

Ensure plants flower throughout the season

Pollinators will be active anytime there are flowers. 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 through October. Most species of bee or butterfly have a limited period of activity; the adults of any given species may be seen for only 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. Therefore, 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 plants flower at the same time

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.

Choose a range of flowers with diverse colors

Plants use colored flowers to attract pollinators; consequently, flower–visiting insects have good color

Good colors of flowers for bees are blue, purple, violet, white, and yellow (such as this tall Oregon grape). Butterflies like many of these colors and are also attracted by red. (Photograph by Matthew Shepherd.)

The shape of the flower will limit which insects—in these two photos, all bees—can reach the nectar or pollen. Planting a diversity of flowers with a range of shapes—and colors—will support a diversity of pollinators. (Photographs by [L] Whitney Cranshaw, Colorado State University; bugwood.org and [R] Edward S. Ross.)

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 also 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 blanket-flower, are indeed valuable for bees because of their high UV reflectance.

Choose a range of 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 tube 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 insects of all sizes, including short–tongued bees such as mining (*Andrena* spp.) and polyester (*Colletes* spp.) bees, as well as many flies and beetles. Other flowers, such as lupines and penstemons, have nectar that is harder to reach and is accessible only to bees that are robust enough to push between the petals (e.g., *Anthophora* spp.) or have long tongues (e.g., some bumble bees, *Bombus* spp.). A variety of flower shapes will increase the diversity of bees and other pollinators your park can support.

Use native plants

Native plants are usually well–adapted to your growing conditions, 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 four times more attractive to bees than non-native plants. Horticultural varieties and hybrids, in contrast, are not necessarily suited to local conditions. Also, sometimes, breeding to improve flowers, such as producing double petals, inadvertently results in the loss of the plant's ability to produce nectar or pollen.

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.

Match plants to site conditions
Environmental conditions will influence your choice of plants. A plant community designed to suit existing conditions is simpler and less expensive to establish and maintain than changing pre–existing local conditions to suit a new plant community. 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.

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 the maintenance needs.

Avoid invasive species
Avoid non–native plant species known to be highly competitive. These invasive species will spread quickly and dominate other species, reducing the diversity and value of the habitat and increasing maintenance demands. They may also cause problems in neighboring areas. There may be city, county, or state code restrictions on certain noxious weed species. 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 lists of noxious weeds (plants that should be contained and controlled to avoid further spread); the thistle is listed in thirty-three states!

Avoid rare species
Usually, species are rare for a reason: they may require very narrow conditions for establishment, a particular habitat, or one specific pollinator. Do consider rare plant species if you know you can provide the management input or specialist knowledge required.

NON–FLORAL NUTRITION FOR BUTTERFLIES
Although flower nectar is their primary food source, 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 muddy puddles, animal carcasses, dung, and urine. You may want to allow some fruit to rot or to 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 plastic jug will also suffice.

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. (Photograph by Matthew Shepherd.)

Conservation Action—Chapter 8

Providing Butterfly Hostplants and Overwintering Sites

Planting flowers that offer nectar during summer and providing fruit and damp ground are excellent ways to help adult butterflies. It is equally important to provide habitat for the other stages of a butterfly's life. Having appropriate plants for caterpillars to eat and offering shelter during the winter will boost butterfly numbers in your park.

Caterpillar Hostplants

Caterpillars of butterflies are often highly specialized with regards to which plants they can eat, and for good reason. During this stage of its life the butterfly grows most rapidly—a caterpillar may grow thirty–fold within two or three weeks—and it is vital that it gets the proper nutrition. The range of plants on which the females of different butterfly species will lay their eggs varies enormously. The monarch (*Danaus plexippus*), for example, has a very restricted range of larval hosts; she lays her eggs only on milkweed plants. At the other extreme, the anise swallowtail (*Papilio zelicaon*) can utilize over sixty different species in the carrot family as larval hosts.

To provide the appropriate hostplants, first identify the butterflies most likely to be found in your local area, and then match them with hostplants from the region. In the Pacific Northwest, for example, planting milkweed in most places west of the Cascade Range is highly unlikely to draw monarchs to a park, because these butterflies are uncommon in the northern Willamette Valley and the Puget Trough. On the other hand, anise swallowtails are common across all of the region, so planting desert parsley, cowparsnip, or angelica—or dill in gardens—will attract them. Appendix B lists larval hostplants for a range of common or widespread butterflies. A regional butterfly guide will contain hostplant information for your area. Other good sources of information include *Butterfly Gardening: Creating Summer Magic in Your Garden* by the Xerces Society and the Smithsonian Institution, and *Butterfly Gardening: Creating a Butterfly Haven in Your Garden* by T. Emmel.

No Hostplants, No Butterflies

Caterpillar hostplants are a vital component of butterfly habitat. It is often a lack of hostplants rather than nectar plants that limit the presence of a butterfly species.

Here are examples of hostplants and their butterflies:

- **Lupine—sulphurs, gray hairstreak, painted lady, and various blues**
- **Mallow—gray hairstreak, painted lady, and checkered skipper**
- **Thistle—painted lady and Mylitta crescent**
- **Nettle—question mark, Milbert's tortoiseshell, and red admiral**
- **Violet—various fritillaries**
- **Bluegrass—Juba skipper, common roadside skipper, and common ringlet**
- **Milkvetch—sulphurs, silvery blue, and tailed blue**
- **Bunchgrass—Juba skipper and common ringlet**
- **Willow—tiger swallowtails, green comma, question mark, mourning cloak, and viceroy**
- **Oak—Propertius duskywing**
- **Milkweed—monarch**

The Propertius duskywing nectars on many flowers as an adult, but its caterpillars will only eat Garry oak and California live oak. (Photograph by John Davis/GORGEous Nature.)

Hostplants on which caterpillars can feed are a critical part of butterfly habitat. Here, a silvery blue lays eggs on a lupine. (Photograph by Jeff Adams.)

OVERWINTERING SITES

Most butterflies spend their entire life in one locale, including over the colder months. Depending on the species, butterflies may survive the winter in any of the four life stages: egg, caterpillar, pupa, or adult. For those species that pass the winter as eggs or caterpillars, the best protection you can offer is to leave larval host plants undisturbed during the winter months. To help butterflies that pass the winter as pupae, leave some untidy corners and piles of debris alone. Tall grass, bushes, trees, fence posts, the outside of a house or other building, or inside a pile of leaves or sticks are all places to which caterpillars will crawl to pupate. Sometimes these sites may be many yards away from larval host plants.

Under natural conditions, butterflies that overwinter as adults are likely to take shelter in tree cavities, under logs, behind loose bark, under rocks, or within evergreen foliage. Human activities have inadvertently created other viable sites, such as stone walls, buildings, and fences—even inside houses. Although many backyard–bird or gardening stores sell attractive overwintering boxes for butterflies, there is no evidence that the boxes work, at least not for butterflies; spiders will move in, so the boxes do have some benefit.

As an alternative to boxes, create an overwintering site for adults by building a pile of logs or rocks. Logs should be stacked criss–crossed with gaps of about 6 inches between logs. Protect the stack from rain and wind with a sheet of plastic or roofing felt. (A more extensive description of how to build an overwintering pile can be found in *Mindful of Butterflies* by Bernard Jackson and Valerie Baines.) You can disguise the pile by planting nectar and larval plants around it or a creeper over it. Rock piles will also give shelter from prevailing winds and rain. You do not have to use natural rock; this can be an opportunity to dispose of chunks of unwanted concrete.

Evergreen climbers growing over walls or buildings can also provide good overwintering niches for adult butterflies, as can the dense foliage of conifer trees.

Maintain shelters—such as reattaching a covering if it blows loose, replacing rotten logs, or pruning back climbers—in the summer, so that the sites are undisturbed between late fall and early spring, when they are likely to be occupied.

MIGRATION

Several butterfly species may migrate northward in the spring and summer, covering hundreds of miles. The painted lady (*Vanessa cardui*) and orange sulphur (*Colias eurytheme*) move northward in an irruption—an outward migration from a core breeding area into new territory, triggered by high population density. This does not necessarily occur every year, and during an irruption year, the adults of the final generation of the summer do not make a southward journey. Instead, they die as winter encroaches.

In contrast, one butterfly does fly south to avoid winter. Monarch butterflies overwinter in tree groves in California and in forests in the mountains of Michoacan, Mexico. The population's northward

journey the following spring occurs over a series of generations. Along the way, adults lay eggs on plants of milkweed (*Asclepias*) and then die. Gradually, as successive generations hatch, feed on milkweed, pupate, emerge as adults, and then fly north, the monarchs spread as far as southern Canada.

Migrating butterflies require foraging and egg–laying resources in two types of sites: their summer breeding sites, and in a corridor of habitat patches along their migration routes—which are usually across landscapes altered by agriculture and urbanization. Stepping–stone habitat patches, which may be nothing more than "weeds" growing in a field margin or on a road verge, can meet these needs. A tolerant maintenance crew that leaves these areas to grow rather than cutting or spraying them may help provide the feeding or egg–laying resources these migrating pollinators require. So too with each small area of pollinator habitat created in parks and greenspaces. Left undisturbed, a patch of forage habitat or host-plants may reward you with the sight of a newly emerged butterfly warming its wings on a cool morning.

Depending on the species, butterflies overwinter as an egg, caterpillar, chrysalis, or adult. Those that overwinter as a chrysalis, such as this anise swallowtail, generally find sheltered vegetation on which to spend the winter months. (Photograph by Mace Vaughan.)

CONSERVATION ACTION—CHAPTER 9

CREATING BEE NESTING SITES

As with hostplants and butterflies, a lack of nest sites may pose a bigger constraint on native bee populations than a lack of flowers. 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 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 you 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.

There are several simple ways to make nest sites for wood– and ground–nesting solitary bees and for bumble bees. These methods mimic the natural features that today are found less frequently in the landscape. If you create the right conditions, bees may begin to use the nests right away.

SITES FOR WOOD–NESTING BEES

Several commercially managed wood–nesting solitary bees have been studied extensively, and therefore their nesting needs are well understood. The blue orchard (or orchard mason) and alfalfa leafcutter are two such bees. A growing number of closely related species are now being studied for their ability to pollinate crops such as cane fruits. The techniques developed from this work have been adapted for the creation of nests for other native bee species. The two styles of nests described below—wooden blocks, and stem or straw bundles—are effective ways to create nests for a variety of bees.

Placing the nests in an appropriate location is important. Situate nesting sites so the open holes catch the morning sun (i.e., facing east or southeast). Most bees cannot heat themselves efficiently and, especially in the spring or early morning, need sunshine to provide enough warmth to become active. Also protect nests from the worst of the weather.

VIEWING WILDLIFE

Bee nests are fun and informative to watch. By observing the bees' comings and goings, you will see the different loads of nest materials or pollen and discover how bees enter their nest forwards or backwards, depending on what they are delivering. You can make an observation nest by placing an acrylic sheet over the top of a grooved board, and covering that with a lumber roof (Plexiglas discolors more quickly than acrylic). You can lift the roof occasionally to see the nest construction and subsequent development of the larva and pupa.

Some solitary wasps might also occupy the nest blocks. Wasps are predators and will stock their nests with larval or adult insects or spiders.

Distinctive white or pale yellow markings on its abdomen, as well as the cottony tufts at the entrance to its nest, help to identify this block occupant as a carder bee. 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. (Photograph by Jeff Adams.)

In addition to having the right amount of sun and shelter, nests need to be close to foraging habitat rich with nectar and pollen. Some wood–nesting bees may also forage for materials with which to construct brood cells. The less time and energy used in flying between forage areas and nest, the more time the female bees can spend preparing nests and storing food for her offspring.

Wooden blocks

Nurseries, garden centers, and wild–bird shops often stock commercially made wooden nests. These are usually wooden blocks drilled with many holes or a stack of grooved boards. Holes are most likely 5/16-inch in diameter, the size preferred by blue orchard bees.

It is simple to make your own block and adapt it to accommodate species other than orchard bees by changing the diameter of the holes.

We recommend using a block of preservative–free lumber, such as Douglas-fir. The block should be at least 8 inches tall and at least 4 inches thick, preferably 6 inches (4x6 or 2x6 are recommended for blocks that will have larger–diameter nesting holes). Nesting holes should be between 3/32- and 3/8-inch in diameter. Because bees may avoid an interior that is rough, use a sharp bit and drill holes perpendicular to the grain. Drill smaller holes that are 1/4 inch or less in diameter 3 to 5 inches deep. Drill holes that are larger than 1/4 inch 5 to 6 inches deep. (A female bee controls the gender of her offspring, and will finish the nest with a few male brood cells. A deeper hole ensures space for more female brood cells before the final male ones.) Make the holes about 3/4 inch from center to center, and no closer than that to the edges.

Whenever possible, when using 4x4 or 2x4 lumber, drill all the way through and then attach a backing board. This achieves maximum depth and a hole that is closed at one end. If you are using a smaller–diameter drill bit that cannot achieve the recommended minimum depth of 3 inches, simply drill as deeply as you can. The bees that use these smallest holes will often nest successfully in shallower holes.

You can drill holes of various diameters in a single block, but a block with holes all the same size is easier to clean. (See “Nest site maintenance” on the next page.) A better strategy is to make several blocks, each with a different size of hole.

Many guides recommend lining the holes with paper straws. This may be an important step for farmers raising bees for crop pollination (straws make it easier to clean the nests), but it is less so for nests made primarily for conservation purposes. Plus, paper straws are not available for most diameters of holes. If you do decide to use straws, bees seem to prefer it if you paint the outer tips of the straws black or red.

Whether or not you need to close one end of the holes, a backing board makes it easier to mount the nest on a post or other structure. Put fixing screws through the backing board, rather than through the block itself. Affix the nests to a firm support, with the nesting tunnels horizontal and facing the morning sun. An overhanging roof on the nest will provide additional shelter but is not necessary.

The exterior of the block can be rustic or fancy, and any color you like. The bees care more that the holes are of appropriate diameters and depths and that the block is erected in the right location. In some urban sites where vandalism is an issue, blocks have been painted with “camouflage” patterns of greens and browns so that they are less obvious in the bushes. In more formal gardens, nests can be painted to coordinate with a floral color scheme or designed as ornate garden features, styled to match fences, trellises, and gazebos.

As an alternative to using sawn lumber, you can drill holes in a log and erect it like a fence post to simulate a beetle–tunneled snag. Or, simply drill holes in a stump or standing dead wood. This can be an effective technique for blending into natural areas or avoiding vandalism.

Stem bundles

Another option for solitary, wood–nesting bees are nests made from bundles of hollow stems. Bamboo, teasel, and common reed are good choices. Cut each stem below the nodes (usually indicated by a ridge or a leaf branch) to create a handful of tubes, each with only one open end. Strap the stems together into a tight bundle with wire, string, or tape, or pack them

A selection of artificial nests for wood–nesting bees. Clockwise from top right: a commercially made mason bee nest 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 Matthew Shepherd and Mace Vaughan.)

into a box or pipe. Make sure the closed ends of the stems are at the same end of the bundle. Another variation is to tightly pack paper tubes—open ends out—into a milk carton or into a short section of PVC pipe in which the back end is sealed. The bundles should be placed in a sheltered location with the stems horizontal to the ground and the holes facing east to get the morning sun.

You can also use freshly cut twigs and stems of pithy, soft–centered plants, such as elderberry, sumac, or blackberry to provide nesting sites for small carpenter bees. Or make a "fence" of agave stems for large carpenter bees.

Nesting materials

Wood–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 do so, 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.)

Nest site maintenance

For farmers or gardeners raising bees for reliable crop pollination, cleaning the nests is an important annual task. In parks and other greenspaces where nests

have been created mainly to support native populations, nest cleaning is less of a concern. Cleaning will help to reduce parasites, fungi, and diseases that might affect the developing bees in their brood cells (after three or four years, the nest could produce more parasites than bees!). These are threats that bees naturally face—a nest full of nutritious nectar and pollen or protein–packed larvae or pupae is an attractive food source for many creatures, from tiny wasps to woodpeckers—and are unlikely to be a significant maintenance concern.

You may prefer to clean nests that are located in formal gardens or demonstration sites to keep them tidy and occupied by bees each year. See Appendix E for more about cleaning nest sites.

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.

Bare ground

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.

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. (Photograph by Matthew Shepherd.)

Mound or pit of sand/loam

Another approach is to create a mound of sand or sand/loam or to dig a pit and fill it with a similar sand/loam mix. Ground–nesting bees are certainly attracted to artificial nest sites: there are several examples of packed-sand baseball diamonds that were occupied by mining bees soon after construction.

To make a pit, dig a hole 2 feet deep and 5 or 6 feet wide. The sand/loam should be tamped down and compacted. In damp areas, a mound will provide drier nesting conditions than a pit. You can edge the area with lumber or bricks to create a more clearly defined feature (effectively making a raised bed).

It is difficult to give precise guidelines on preparing soil mixtures: different species of bees prefer different soil textures and structures. In general, bees nest in soil that is at least 35 percent sand and avoid soils that are more than 40 percent clay. Use sand that is fine–grained and pale in color; larger–grained, gritty sand is too unstable for bees to tunnel in. Experiment, placing pits or mounds with different mixtures in locations receiving different amounts of sun. Observe what combination of factors is most effective, and change your strategy as needed.

Shallow trench

The eroded sides of creeks or ditches often house bee nests. A shallow trench dug about a foot deep, with the soil mounded up along one side, may successfully mimic this. There is no limit on how long the ditch may be. Orient the ditch from east to west or form a gently curving crescent, with the open ends facing south, which will create a variety of exposures. In both cases mound up the excavated soil along the northern side. This will expand the area of suitable for nesting and make the ground conditions more diverse.

Adobe blocks

In desert or semi-arid areas, the ground-nesting equivalent of a wooden block nest is a wall made from adobe blocks. Construct the wall with the front facing east or southeast to catch the morning sun, and drill nesting holes between 3/32 and 1/2 inches (2.5 mm to 12 mm) diameter and 3 – 5 inches (7.5 cm and 12.5 cm) deep into the front face. If you build the wall with a wooden backing and put a roof or plank over the top layer of bricks, it will last longer. As with wooden blocks, adobe walls can be as decorative or rustic as you like.

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 digging deeply into the soil when weeding.

Bumble Bee Nests

In addition to protecting known colonies of bumble bees, you can increase bumble bees in your park by two methods: create habitat in which bumble bees will nest naturally, or construct artificial nest boxes and place them in suitable locations. Unfortunately, unlike with wooden nesting blocks, which are usually successful in attracting residents, there is no guarantee the bumble bee boxes will be occupied. Even in the best situations, at most 25 to 30 percent will be used. We recommend focusing on providing and protecting habitat as your first step.

Providing bumble bee habitat

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 rodent burrows. The combination of tall, fallen grass adjacent to or mixed in with the cover provided by shrubs and trees creates conditions sought by nesting rodents—resulting in an abundance of potential sites for the bees. Places suitable for rodent and bumble bee nests should include a mix of native (non–invasive) bunch grasses abutting shrubs or trees. Plant grass in a strip at least 5 feet wide and refrain from mowing. Ideally, the grass will grow tall and fall over in clumps, under which rodents 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 rodents.

Another option is to let a small patch of the park grow wild for a year or two without cutting the plants. Near

Davis, California, dozens of queen bumble bees were collected in such a place: an abandoned army barracks. This site was probably pesticide–free and had large areas of lawn and hedge that grew out of control for several years, creating optimal conditions for bumble bees. It also likely supported a large population of mice.

Bumble bee nest boxes

There are no strict size requirements for constructing nest boxes. A simple wooden box made from preservative–free lumber, with internal dimensions of about 7 inches by 7 inches by 7 inches, will be fine. Drill a few ventilation holes near the top and cover them with window screen to deter ants; drill drainage holes in the bottom. Make an entrance tunnel from 3/4–inch plastic pipe and mark the outside of the pipe with a contrasting color. Fill the box with soft bedding material, such as upholsterer's cotton, short lengths of unraveled, soft string, or dry moss. The box must be weather–tight; if the nest gets damp, the larvae may become too cold, and mold and fungus may grow.

Choose an undisturbed site in partial or full shade (bumble bees are able to warm themselves in cold weather, and so are not limited to sunny spots), where there is no risk of flooding. The box should be on or just under the ground. If you bury it, extend the entrance tube so it gently slopes up to the surface. Put the nesting box out when you first notice bumble bees in the spring, or when the first willows and other flowers are blooming. If there are no inhabitants by late July, put the nesting box into storage until the next spring. If the box is occupied, at the end of fall remove the old nest materials, clean the box with a mild bleach solution, and put in new nesting materials before returning the box to its location.

In the spring, bumble bees emerge from hibernation and search for a place to establish a colony. They naturally nest in a cavity in the ground or in a tree, but may adapt to a wooden box filled with soft nesting materials and fitted with an entrance pipe. (Photograph by Matthew Shepherd.)

Conservation Action—Chapter 10

Reducing the Impact of Pesticides

Pesticides can kill bees, butterflies, and other pollinator insects. The impact of pesticides on pollinators can be lethal or nonlethal, fast–acting or delayed, limited to insects in the area sprayed or—as with bees—transferred to insects in the nest.

Foraging pollinators are poisoned by pesticides when they absorb the toxins through their integument (the outer "skin" that forms their exoskeleton), drink toxin–tainted nectar, or gather pesticide–covered pollen or micro–encapsulated pesticides. If pollinators are foraging during pesticide application, the spray or dust will cover them; this may kill significant numbers of bees in the treated area. Pollinators foraging in recently sprayed areas absorb toxins from the residues on flowers.

Lower doses of pesticides may not kill pollinators but can affect their behavior. Bees that are exposed while foraging may have trouble navigating their way back to the nest, or they may simply be unable to fly. Other symptoms include agitated behavior, jerky or wobbly movements, or paralysis. All of these reactions make foraging and nest building difficult and may, ultimately, kill the affected insect. Sublethal doses—such as those that result from toxins brought into a nest along with nectar and pollen—may reduce egg–laying or stall the larval growth.

Reducing the Need

The first step to protect pollinators is to reduce the need for pesticides. Pests can be controlled naturally, with a little patience on the part of staff. A healthy, diverse pollinator habitat has all the elements needed to encourage other beneficial insects, such as native predators or parasites of pest insects. The use of pesticides, however, often causes long–term problems by eliminating these natural enemies and upsetting the balance in the ecosystem. Whereas pests can quickly colonize and multiply in new areas of habitat, pollinators and beneficial predators may take years to return to pre–spray levels. In the weeks after an area is treated with insecticides, the pests will return, but beneficial insects will not.

Pesticides impact pollinator insects in many ways. Reducing the risk from pesticides is an important step toward creating healthy habitats for pollinators. (Photograph by Chris Evans/forestryimages.com)

Butterflies and Btk

Many different pesticides impact butterflies. One in particular causes significant risk, in part because it is considered environmentally friendly and thus its use is growing. *Bacillus thuringiensis* var. *kurstaki* (Btk) is a naturally occurring bacteria found in soils. Its use is allowed under organic growing standards, and it is also considered safe for humans and other mammals. Although it has fewer nontarget impacts than broad–spectrum pesticides such as malathion or carbaryl, Btk is not harmless to nontarget insects.

Btk kills the caterpillars of all butterfly and moth species. Lepidoptera (the butterflies and moths) is one of the most diverse insect orders, with approximately fourteen thousand species in North America. An application of Btk can kill at least two-thirds of the Lepidoptera species in the treatment area—a significant side effect, especially considering that, in addition to the adults being pollinators, caterpillars and adult Lepidoptera are a major food source for many animals such as birds and bats.

Suggestions for eliminating or reducing the need for pesticides in landscape maintenance—such as organic techniques or integrated pest management (IPM)—are available from local extension offices, resource conservation districts, and other extension support. Best management practices for organic landcare have now been developed for the U.S. and Canada (see Appendix C).

Minimizing the Risk

Pesticides are labeled with guidelines for their use. While the labels often include protections for bees, these guidelines were developed to protect honey bee hives (and, sometimes, the few other bee species managed for pollination, such as mason and leafcutter bees). They often do little to protect native bees. For example, the guidelines may require that beekeepers move hives away from spray areas or shut the bees in and cover their hives during spraying operations. Obviously, these measures are not possible with wild bees. Furthermore, beekeepers who have protected their hives are told when the area is safe for the bees again. There is nothing to prevent native bees from foraging in the sprayed area during the entire time the area is toxic, which may be an hour or last up to two weeks.

If using pesticides, take steps to minimize the damage to pollinators and other beneficial insects. For example, choose formulations that will offer the least threat to pollinators (see Table 1, opposite). When choosing a pesticide, use a liquid formulation instead of a dust. Apply in the lowest concentration possible, only for approved uses, and only by the methods listed on the label. Avoid micro–encapsulated products: bees mistake it for pollen and will collect it to take back to the nest, which can result in the destruction of the nest.

Apply pesticides only when pollinators are inactive, such as at night or during those seasons when there are no flowers. Staff (or contractors) can learn to recognize and avoid spraying bee nest sites. Pesticide applicators should choose equipment such as hand sprayers, which will minimize drift onto adjacent plants that may be in bloom—and therefore attracting bees and butterflies—even when flowers in the treatment area are not.

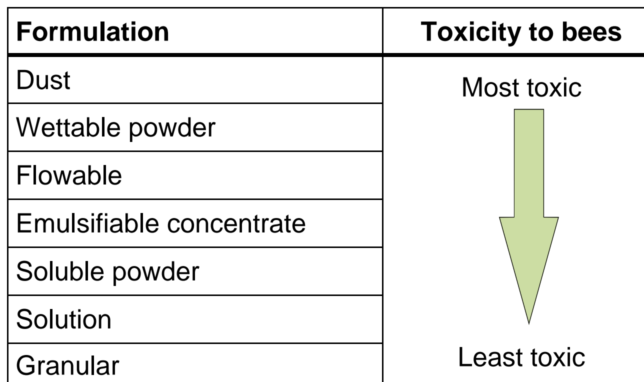
Bees and Pesticides

Both the toxicity of a pesticide and the length of time recently sprayed areas remain toxic vary depending on the size of the bee. A honey bee, the standard bee by which pesticides are assessed, is a large bee with a relatively small surface–area–to–volume ratio. Because native bees are generally smaller than honey bees, with a greater surface–area–to–volume ratio, they absorb a relatively higher dose of and are more sensitive to pesticides. Thus, smaller bees will be killed by lower concentrations of insecticides, and the ones that survive will be susceptible for a longer time to the residues remaining on plants.

The foraging that makes bees such important pollinators exposes them to further risk. Slow–acting toxins may be carried back to the nest and stored in the pollen and nectar eaten by the young bees. Contaminated pollen can remain toxic for as long as a year, killing the larvae or (in colonies of social bees) the other adult bees in the nest.

Solitary–nesting bees tend to be impacted more by toxins than social bees, because the egg–laying solitary female both forages and works in the nest. A social queen remains in the nest, isolated from direct contact with pesticides, and may continue laying eggs. The effects of pesticides—and how to reduce the impacts—are discussed in great detail by C. Johansen and D. Mayer in *Pollinator Protection*. See also Riedl et al (2006), listed in Appendix C, which gives details of toxicity and residue periods for commonly used pesticides.

Table 1. Relative toxicity to bees of different pesticide formulations.



Formulation	Toxicity to bees
Dust	Most toxic
Wettable powder	
Flowable	
Emulsifiable concentrate	
Soluble powder	
Solution	
Granular	Least toxic

(Adapted from Johansen and Mayer, 1990.)

Chapter 11
Conclusion

An encounter in an urban greenspace with a butterfly—a beloved symbol of beauty that is associated with a well–functioning environment—elicits oohs and ahhs from adults and an excited chase from children. The contributions these and other keystone pollinator insects make to our parks goes beyond visitors' aesthetic appreciation and emotional response. The services provided by butterflies and bees are critical components of the habitats in our parks, potentially having a ripple effect to neighborhood gardens and even nearby farms.

Increasingly, parks departments are expected to take a lead role in environmental management. Individual park departments care for hundreds, even several thousands, of acres, and half or more of these lands may be natural areas. Maintaining pollinator populations is one of the most valuable ways in which parks can contribute to a healthy environment and the conservation of biodiversity.

Pollinators are one of the most important groups of animals in any terrestrial environment. Providing habitat for them will bring benefits to more than just your park. (Photograph by Mace Vaughan)

Pollinator conservation is well–suited to sites of all sizes and types, from expansive natural areas to narrow marginal strips to heavily visited formal gardens. By providing and managing for bee nest sites, caterpillar hostplants, and flower–rich forage patches, park managers and staff will make significant contributions to the populations of pollinators in and around their parks—as well as to the health of the entire community.

Now you have read this far, you likely have an idea of how you can begin to implement pollinator conservation and what might work in your parks. The best approach is to be flexible. This also lets you see what is working, what's not, and allows conservation efforts to evolve as circumstances change. Even small steps matter, and many steps require little output of time or money. More major projects can be planned to happen over a period of years.

We also hope that you will share the information in these guidelines with staff and volunteers in your park, or maybe colleagues at other parks or neighboring cities and park districts. Pollinator-friendly gardening may also be a convenient approach for promoting sustainability in neighborhoods and reducing pesticides or other contaminants reaching creeks and ponds.

These guidelines are just a start. They contain an overview of pollinator natural history and guidance on ways to increase diversity of plants and nest sites. The appendices include many useful references that will increase your knowledge. In addition, the Xerces Society can provide technical advice and detailed information about designing and implementing habitat projects.

Undoubtedly, parks can play an enormous role in sustaining populations of native pollinator insects. Many people look to park mangers to take leadership roles in environmental management, not surprising given that parks departments are major landowners that serve multiple constituencies. We hope the suggestions in this guide will inspire you to plan and act for insect pollinators. By enriching your parks for pollinators, you will be enriching your neighborhood and entire community.

Appendix A

Pollinator-Friendly Plants

This appendix includes two lists of plants that are good sources of nectar or pollen.

The first list is of North American native plants. These would be suitable for natural areas, habitat areas in parks, and also for gardens. The second list gives garden plants (i.e., plants not native to North America) that would be suitable for formal landscaping. In drawing-up these lists, we have tried to avoid invasive plants. Thus some well-known butterfly plants such as buddleia, lantana, and fennel are not included

In these lists we give only common names and genera. We recommend that you consult a wildflower guide, a native plant society, or your local native plant nursery to find species for your area.

The plants are listed alphabetically by scientific name. Plant names generally follow the USDA–NRCS PLANTS database (http://plants.usda.gov/).

For many plants, there is an indication of whether it is a caterpillar hostplant; it is suitable for, in List 1, formal landscaping or gardens ("Gard"), or, in List 2, eco-lawns; it is deer resistant; and its bloom season.

Other plant resources

The plant lists in this appendix are by no means comprehensive for the whole country. There are more detailed plant lists available for some regions of the country. For example, regional fact sheets about plants for bees can be downloaded from the Xerces Society's web site, www.xerces.org. These fact sheets cover the Pacific Northwest, California, and the Upper Midwest.

There are also a growing number of NRCS Technical Notes for separate states. The tech note for Oregon is available at ftp://ftp-fc.sc.egov.usda.gov/OR/Technical_Notes/Plant%20Materials/PMC13.pdf, and the note for Illinois is at http://efotg.nrcs.usda.gov/references/public/IL/BTechNote23.pdf.

The North American Pollinator Protection Campaign is developing plant guides for different ecoregions across the country. The first guides in the series are available from www.pollinator.org.

For gardens, the Urban Bee Gardens web site, http://nature.berkeley.edu/urbanbeegardens/, contains a wealth of information about Californian bee plants.

List 1: Native Plants

Plant	Host-plant	Gard	Deer resist	Bloom period
Yarrow (*Achillea*)	x	x	x	mid - late
Giant hyssop (*Agastache*)	x	x		mid - late
Serviceberry (*Amelanchier*)				early
False indigo, leadplant (*Amorpha*)				mid
Pearly everlasting (*Anaphalis*)		x		mid - late
Mule-fat, coyotebush, baccharis (*Baccharis*)				early - mid
Balsamroot (*Balsamorhiza*)				early - mid
Wild indigo (*Baptisia*)				early - mid
Mountain aster (*Canadanthus*)	x	x		late
Plumeless thistle (*Carduus*)	x			mid
Ceanothus, buckbrush, New Jersey tea (*Ceanothus*)		x		mid - late
Buttonbush (*Cephalanthus*)		x		mid
Fireweed (*Chamerion*)				mid

Plant	Host-plant	Gard	Deer resist	Bloom period
Rabbitbrush (*Chrysothamnus*)		x		mid
Tickseed, coreopsis (*Coreopsis*)		x	x	mid - late
Southwestern cosmos (*Cosmos*)			x	mid - late
Hawthorn (*Crataegus*)		x	x	early - mid
Prairie clover (*Dalea*)				mid
Wild carrot (*Daucus*)	x	x		mid
Larkspur (*Delphinium*)		x	x	mid
Purple coneflower (*Echinacea*)		x	x	mid
Willow-herb (*Epilobium*)				mid
Rabbitbrush (*Ericameria*)		x		mid
Fleabane (*Erigeron*)		x		mid - late
Buckwheat (*Eriogonum*)	x	x	x	mid
Rattlesnake master, eryngo (*Eryngium*)		x	x	mid
California poppy (*Eschscholzia*)		x	x	early - mid
Aster (*Eucephalus*)		x	x	mid - late
Aster (*Eurybia*)		x	x	mid - late
Blanket-flower (*Gaillardia*)		x	x	mid
Teaberry, snowberry (*Gaultheria*)	x	x	x	early - mid
Sunflower (*Helianthus*)		x		mid - late
Ipomopsis, gillia (*Ipomopsis*)		x		mid
Sweetverbena (*Lantana*)	x			early - mid
Pea (*Lathyrus*)				mid
Creosote bush (Larrea)				(varies with rains)
Blazing star (*Liatris*)				mid
Desertparsley, biscuitroot (*Lomatium*)	x	x		early - mid
Deervetch (*Lotus*)				early
Lupine (*Lupinus*)	x	x	x	mid
Barberry, Oregon grape (*Mahonia*)	x	x	x	early - mid
Crabapple (*Malus*)	x	x		early
Sweetclover (*Melilotus*)				mid
Bee balm (*Monarda*)				mid
Cholla, prickly pear (*Opuntia*)			x	mid
Penstemon, beardtongue (*Penstemon*)		x	x	mid
Phacelia (*Phacelia*)		x		mid
Mock orange (*Philadelphus*)		x		early
Ninebark (*Physocarpus*)		x		mid
Cherry, chokecherry (*Prunus*)	x	x	x	early - mid
Rhododendron, azalea (*Rhododendron*)	x	x	x	early - mid
Currant, gooseberry (*Ribes*)		x	x	early
Blackberry, dewberry (*Rubus*)				early - mid
Black-eyed Susan (*Rudbeckia*)		x	x	mid - late
Willow (*Salix*)	x			early
Sage (*Salvia*)		x	x	mid
Stonecrop (*Sedum*)		x		mid - late
Ragwort (*Senecio*)				early - late
Whitetop aster (*Sericocarpus*)		x	x	late

Plant	Host-plant	Gard	Deer resist	Bloom period
Goldenrod (*Solidago*)		x	x	mid - late
Hedgenettle (*Stachys*)				mid
Aster (*Symphytotrichum*)		x	x	mid
Spiderwort (*Tradescantia*)		x		early - mid
Triteleia, brodiaea (*Triteleia*)				early - mid
Vervain (*Verbena*)		x	x	early - late
Violet (*Viola*)	x	x		early - mid
Zinnia (*Zinnia*)		x	x	mid - late

List 2: Garden Plants

Plant	Host-Plant	Eco-lawn	Deer resist
Yarrow (*Achillea*)		x	x
Giant hyssop (*Agastache*)			x
Hollyhock (*Alcea*)	x		
Thrift (*Armeria*)			x
Borage (*Borago*)			
Daisy (*Chrysanthemum*)			x
Cosmos (*Cosmos*)			x
Foxglove (*Digitalis*)			x
Globe thistle (*Echinops*)			x
Sea-holly (*Eryngium*)			x
Wallflower (*Erysimum*)			x
Hyssop (*Hyssopus*)			x
Sweat pea (*Lathyrus*)			
Lavender (*Lavandula*)			x
Bird's-foot trefoil (*Lotus*)		x	
Apple (*Malus*)	x		
Mallow (*Malva*)	x		
Medick (*Medicago*)		x	
Mint (*Mentha*)			x
Basil (*Ocimum*)			
Marjoram, oregano (*Origanum*)	x		x
Poppy (*Papaver*)			x
Selfheal (*Prunella*)		x	
Rosemary (*Rosmarinus*)			x
Pin cushion (*Scabiosa*)			x
Sedum "Autumn Joy" (*Sedum spectabile*)			
Lamb's ear (*Stachys*)			
Thyme (*Thymus*)		x	x
Clover (*Trifolium*)		x	
Nasturtium (*Tropaeolum*)	x		x
Mullein (*Verbascum*)	x		
Violet (*Viola*)		x	

APPENDIX B

BUTTERFLIES AND THEIR HOSTPLANTS

This appendix lists a diversity of butterflies that are common or widespread in North America. Your park might attract other species; this is not a comprehensive list of the butterflies.

- Known hostplants are listed for each butterfly.
- Hostplant lists are based on *Butterflies and Moths of North America*, supplemented by *The Butterflies of North America. A Natural History and Field Guide* by James A. Scott (Stanford University Press, 1986).
- All hostplants are native to North America unless marked.
- Butterfly names follow *Butterflies and Moths of North America* (www.butterfliesandmoths.org).
- Plant names follow the USDA-NRCS PLANTS database (http://plants.usda.gov/).

SKIPPERS (HESPERIIDAE)

Butterfly	Hostplants
Silver-spotted skipper (*Epargyreus clarus*)	Big deervetch (*Lotus crassifolius*), wild licorice (*Glycyrrhiza lepidota*), false indigo (*Amorpha*), black locust (*Robinia pseudoacacia)*, honey locust (*Gleditsia triacanthos*)
Propertius duskywing (*Erynnis propertius*)	California live oak (*Quercus agrifolia*), Oregon white oak (*Quercus garryana*)
Persius duskywing (*Erynnis persius*)	Broadleaf lupine (*Lupinus latifolius*), silky lupine (*L. sericeus*), goldenbanner (*Thermopsis*), milkvetch (*Astragalus*), deervetch (*Lotus*)
Common checkered-skipper (*Pyrgus communis*)	Wide variety of mallows, including cheeseweed (*Malva parvifolia*), common mallow (*M. neglecta*), alkali malllow (*Malvella leprosa*), Munro's globemallow (*Sphaeralcea munroana*), poppy mallow (*Callirhoe*). Introduced: hollyhock (*Althea*), velvetleaf (*Abutilon*)
Juba skipper (*Hesperia juba*)	Various grasses, including Kentucky bluegrass (*Poa pratensis*), brome (*Bromus*), hairgrass (*Deschampsia*) Introduced: needlegrass (*Stipa*)
Leonard's skipper (*Hesperia leonardus*)	Various grasses, including little bluestem (*Andropogon scoparius*), blue grama (*Bouteloua gracilis*), and bent grass (*Agrostis*)
Sachem (*Atalopedes campestris*)	Crabgrass (*Digitaria*), red fescue (*Festuca rubra*), St. Augustine grass (*Stenotaphrum secundatum*) Introduced: goosegrass (*Eleusine indica*), Bermuda grass (*Cynodon dactylon*)
Woodland skipper (*Ochlodes sylvanoides*)	Various grasses, including bluebunch wheatgrass (*Pseudoroegneria spicata*), Siberian wildrye (*Elymus sibiricus*), giant wildrye (*E. condensatus*) Introduced: bearded wheatgrass (*Agropyron fragile*), colonial bentgrass (*Agrostis capillaris*), common wild oat (*Avena fatua*)

Dun skipper (*Euphyes vestris*)	Sedges (*Carex*)
Common roadside skipper (*Amblyscirtes vialis*)	Various grasses, including bluegrass (*Poa*), bentgrass (*Agrostis*), wild oats (*Avena*), Bermuda grass (*Cynodon dactylon*), and Indian woodoats (*Chasmanthium latifolium*)
SWALLOWTAILS (PAPILIONIDAE)	
Anise swallowtail (*Papilio zelicaon*)	Huge range of plants in the parsley family (Apiaceae), including cow parsnip (*Heracleum*), desert parsley (*Lomatium*), wild carrot (*Daucus pusillus*), angelica (*Angelica*) Introduced: Queen Anne's lace (*Daucus carota*), fennel (*Foeniculum*)
Western tiger swallowtail (*Papilio rutulus*)	Broadleaved trees, including bigleaf maple (*Acer macrophyllum*), willow (*Salix*), aspen (*Populus tremuloides*), black cottonwood (*P. balsamifera* ssp. *trichocarpa*)
Eastern tiger swallowtail (*Papilio glaucus*)	Broadleaved trees, including wild cherry (*Prunus*), sweetbay (*Magnolia*), basswood (*Tilia*), tulip tree (*Liriodendron*), birch (*Betula*), ash (*Fraxinus*), cottonwood (*Populus*), mountain ash (*Sorbus*), and willow (*Salix*)
Black swallowtail (*Papilio polyxenes*)	Many plants in the parsley family (Apiaceae) including wild carrot (*Daucus pusillus*), and plants in the citrus family (Rutaceae). Introduced: Queen Anne's lace (*Daucus carota*), celery (*Apium*), dill (*Anethum graveolens*)
WHITES AND SULPHURS (PIERIDAE)	
Checkered white (*Pontia protodice*)	Plants in the mustard family (Brassicaceae), particularly pepperweed (*Lepidium*), and in the caper family (Capparidaceae), including beeplant (*Cleome*) Introduced: pepperweed (*Lepidium*), tumblemustard (*Sisymbrium altissimum*), cabbage (*Brassica oleracea*)
Clouded sulphur (*Colias philodice*)	Large number of hostplants in the pea family (Fabaceae), including milkvetch (*Astragalus*), wild sweet pea (*Lathyrus*), sweet clover (*Melilotus*), vetch (*Vicia*), sweetvetch (*Hedysarum*), lupine (*Lupinus*), goldenbanner (*Thermopsis*) Introduced: alfalfa (*Medicago sativa*), white clover (*Trifolium repens*), red clover (*T. pratense)*
Orange sulphur (*Colias eurytheme*)	Large number of hostplants in the pea family (Fabaceae), including milkvetch (*Astragalus*), wild sweet pea (*Lathyrus*), sweet clover (*Melilotus*), vetch (*Vicia*), sweetvetch (*Hedysarum*), lupine (*Lupinus*), goldenbanner (*Thermopsis*) Introduced: alfalfa (*Medicago sativa*), white clover (*Trifolium repens*), red clover (*T. pratense*), bird's-foot trefoil (*Lotus corniculatus*)
Sleepy orange (*Abaeis nicippe*)	Legumes (Fabacaea), including senna (*Senna*), clover (*Trifolium*) and partridge pea (*Chamaecrista fasciculate*) Introduced: golden shower (*Cassia*)

Gossamer-Wings (Lycaenidae)

Butterfly	Hostplants
American copper (*Lycaena phlaeas*)	Plants in the buckwheat family (Polygonaceae) including mountainsorrel (*Oxyria digyna*) Introduced: sheep sorrel (*Rumex acetosella*), curly dock (*Rumex crispus*)
Juniper hairstreak (*Callophrys gryneus*)	Eastern redcedar (*Juniper virginiana*), California juniper (*J. californica*), Rocky Mountain juniper (*J. scopulorum*), Utah juniper (*J. osteosperma*)
Brown elfin (*Incisalia augustinus*)	Wide range of plants, including salal (*Gaultheria shallon*), madrone (*Arbutus*), kinnikinnick (*Arctostaphylos uva-ursi*), rhododendron (*Rhododendron*), bitterbrush (*Purshia*), big-basin sagebrush (*Artemisia tridentata*), buckwheat (*Eriogonum*), buckthorn (*Rhamnus*), Oregon grape (*Mahonia*), Blue Ridge blueberry (*Vaccinium pallidum*), Labrador tea (*Ledum groenlandicum*)
Gray hairstreak (*Strymon melinus*)	Common hostplants include clover (*Trifolium*), lupine (*Lupinus*), milkvetch (*Astragalus*), rose (*Rosa*), mallow (*Malva*) Introduced: clover (*Trifolium*)
Eastern tailed blue (*Cupido comyntas*)	A range of legumes including vetches (*Vicia*), milkvetches (*Astragalus*), locoweed (*Oxytropis*), peavines (*Lathyrus*), sweetclover (*Melilotus*), bush clover (*Lespedeza*) Introduced: alfalfa (*Medicago sativa*), clover (*Trifolium*)
Spring azure (*Celastrina "ladon"*)	Osier dogwood (*Cornus*), elderberry (*Sambucus*), madrone (*Arbutus*), oceanspray (*Holodiscus discolor*), huckleberry (*Vaccinium*), cherry (*Prunus*), hardhack (*Spiraea douglasii*), meadowsweet (*S. salicifolia*), New Jersey tea (*Ceanothus americana*)
Silvery blue (*Glaucopsyche lygdamus*)	Various species of lupine (*Lupinus*), vetches (*Vicia*), milkvetches (*Astragalus*), locoweeds (*Oxytropis*), peavines (*Lathyrus*), sweetclover (*Melilotus*),

Brush foots (Nymphalidae)

Butterfly	Hostplants
Great spangled fritillary (*Speyeria cybele*)	Various species of violet (*Viola*)
Pearl crescent (*Phyciodes tharos*)	Several species of aster, including hairy white oldfield aster (*Symphyotrichum pilosum*), Drummond's aster (*S. drummondii*), smooth blue aster (*S. leave*)
Mylitta crescent (*Phyciodes mylitta*)	Edible thistle (*Cirsium edule*), white thistle (*C. hookerianum*), fewleaf thistle (*C. remotifolium*), wavyleaf thistle (*C. undulatum*), blessed milkthistle (*Silybum marianum*) Introduced: Canada thistle (*Cirsium arvense*), bull thistle (*C. vulgare*); yellow star-thistle (*Centaurea solstitialis*), diffuse knapweed (*C. diffusa*)
Question mark (*Polygonia interrogationis*)	American elm (*Ulmus americana*), slippery elm (*Ulmus rubra*), hackberry (*Celtis*), nettles (*Urtica*), smallspike false nettle (*Boehmeria cylindrica)*

[Question mark]	Introduced: Japanese hop (*Humulus japonicus*)
Green comma (*Polygonia faunus*)	Willow (*Salix*), birch (*Betula*), aspen (*Populus tremuloides*), alder (*Alnus*), rhododendron (*Rhododendron*)
Mourning cloak (*Nymphalis antiopa*)	A large number of trees and shrubs, including willow (*Salix*), alder (*Alnus*), birch (*Betula*), American elm (*Ulmus americana*), maple (*Acer*), poplar (*Populus*), hackberry (*Celtis*), rose (*Rosa*), apple (*Malus*), spirea (*Spiraea*)
Milbert's tortoiseshell (*Aglais milberti*)	Sting nettle (*Urtica dioica*) Califonia nettle (*U. procera*)
Gulf fritillary (*Agraulis vanillae*)	Various species of passion-vine including purple passionflower (*Passiflora incarnata*) and fetid passionflower (*P. foetida*)
Painted lady (*Vanessa cardui*)	Thistle (*Cirsium*), plumeless thistle (*Carduus*); a wide range of plants when thistles are not available, including lupine (*Lupinus*), mallow (*Malva*), globemallow (*Sphaeralcea*), yarrow (*Achillea millefolium*), pearly everlasting (*Anaphalis margaritacea*) Introduced: Canada thistle (*Cirsium arvense*), bull thistle (*C. vulgare*), hollyhock (*Alcea rosea*)
Red admiral (*Vanessa atalanta*)	Stinging nettle (*Urtica dioica*), Canadian woodnettle (*Laportea canadensis*), small-spike false nettle (*Boehmeria cylindrica)*, pellitory (*Parietaria*), hop (*Humulus lupulus*)
Common buckeye (*Junonia coenia*)	A wide range of plants, including plantain (*Plantago*), penstemon (*Penstemon*), paintbrush (*Castilleja*), speedwell (*Veronica*), monkeyflower (*Mimulus*), wild petunia (*Ruellia nudiflora*) Introduced: toadflax (*Linaria*), snapdragon (*Antirrhinum*)
Viceroy (*Limenitis archippus*)	Willow (*Salix*), poplars and cottonwood (*Populus*), serviceberry (*Amelanchier*), steeplebrush (*Spiraea*), oceanspray (*Holodiscus*), apple (*Malus*), cherry (*Prunus*), hawthorn (*Crataegus*), basswood (*Tilia*), birch (*Betula*), goldenrod (*Solidago*), Joe-pye weed (*Eupatorium*) Introduced: Canada thistle (*Cirsium arvense*)
Common ringlet (*Coenonympha tullia*)	Kentucky bluegrass (*Poa pratensis*). Introduced: needlegrass (*Stipa*)
Common wood nymph (*Cercyonis pegala*)	Tridens (*Tridens*) Introduced: needlegrass (*Stipa*), oat (*Avena*)
Monarch (*Danaus plexippus*)	Various milkweeds (*Asclepias*)

APPENDIX C
RESOURCES: BOOKS, ARTICLES, AND WEBSITES

This appendix lists books, articles, and URLs of websites that might be of interest. The focus is on materials that are written for the general public (i.e., those that avoid "heavy science") or that are easily available. For example, many of the articles can be found online.

We highly recommend five books:

- *The Forgotten Pollinators* by Buchmann and Nabhan
- *The Natural History of Bumblebees* by Kearns and Thomson
- *Bees of the World* by O'Toole and Raw
- *The Natural History of Pollination* by Procter, Yeo, and Lack
- *Pollinator Conservation Handbook* by Shepherd, Buchmann, Vaughan, and Black.

Together, these books provide a comprehensive overview of the biology of bees, the conservation issues affecting them, and practical information on what can be done to help.

For both the articles available online and the websites, the URLs were correct in September 2008. If the link doesn't work, try the "root" homepage or search for the specific resource via Google or a similar search engine.

POLLINATOR BIOLOGY AND CONSERVATION

WEBSITES

The Xerces Society for Invertebrate Conservation
http://www.xerces.org

Pollinator Partnership/North American Pollinator Protection Campaign
http://www.pollinator.org

Urban Bee Gardens
http://nature.berkeley.edu/urbanbeegardens

Butterflies and Moths of North America
http://www.butterfliesandmoths.org

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Wildflower and Prairie Establishment

Web Sites

Blackburn Nursery: *Weed Control for Wildflowers*
http://www.blackburnnursery.com/tips/weed_manage_wildflower.shtml

Garden Guides: *Solarization Techniques and Wildflower Establishment*
http://www.gardenguides.com/TipsandTechniques/solarization.htm
http://www.gardenguides.com/TipsandTechniques/wildflower.htm

Georgia Cooperative Extension: *Wildflower Establishment & Culture: Meadows, Beauty Spots, and Roadsides*
http://pubs.caes.uga.edu/caespubs/horticulture/wildflowers.html

Lady Bird Johnson Wildflower Center: Many good articles on growing native plants and habitat restoration.
http://www.wildflower.org/howto/

North Carolina Cooperative Extension Service: *Weed Management for Wildflowers*
http://www.ces.ncsu.edu/depts/hort/hil/hil-645.html

Prairie Frontier: *Wildflower and Prairie Grass Establishment*
http://www.prairiefrontier.com/pages/plantipsb.html

Prairie Nursery: *Prairie Establishment Guide*
http://www.prairienursery.com/howTo/guide/prairie_estab_guide.htm

Oregon State University Cooperative Extension Service: *Landscaping with PNW Native Plants*
http://extension.oregonstate.edu/yamhill/pages/gardening_natives.html

Oregon State University: *Low Maintenance Turf*
http://www.ofm.wa.gov/sustainability/agencies/interagency/toolkit/turf.pdf

University of Florida Extension: *Establishment of Native Wildflower Plants by Seed*
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Appendix D

Natural History of Native Bees

Bees are considered the most important group of pollinators for a simple reason: Female bees collect nectar and pollen from flowers as food for their offspring and, in doing so, carry large quantities of pollen from flower to flower. Both male and female bees feed on nectar, but only the females gather pollen and nectar to take back to her nest. A single female bee may visit tens or even hundreds of flowers on a foraging trip, actively gathering and moving pollen. Female bees have special structures on their legs and bodies to carry pollen, but some of it brushes off when they visit other flowers. This is the fundamental service of pollination.

Life cycle of bees

Like a butterfly, a bee undergoes complete metamorphosis, passing through four stages during its lifetime: egg, larva, pupa, and adult. It is only the last of these, the adult, which we see and recognize as a bee. During the first three stages, the bee is inside the brood cell of the nest. How long each stage lasts varies greatly by species, and to a great extent is defined by whether the bee is solitary or social.

Generalist or specialist?

Bees can be divided into two loose groups according to their foraging habits. *Generalists* are bees that gather nectar and pollen from a wide range of flower types and species. The majority of bees, including the social species, are generalists. *Specialists*, on the other hand, rely on a single plant species or a closely related group of plants. The life cycle of these bee species is often closely tied to their host plant(s), and the adults will emerge from their brood cells just when the plant is flowering.

Solitary or social?

Bees can also be divided into two groups according to lifestyle: social or solitary. Contrary to the stereotypical image of a bee living with thousands of sisters in a hive, only a few species are in fact social. Social bees live as a colony in a nest and share the work of building the nest, caring for offspring, and foraging for pollen and nectar. The truly social bees in the U.S. are the non–native European honey bee (*Apis mellifera*) and the bumble bees (genus *Bombus*; about forty–five species), although about two hundred species of sweat bees exhibit some level of social behavior. Just about all of the rest of the nearly four thousand species of bees in the U.S. are solitary. Each solitary female creates and provisions a nest on her own, without cooperation from other bees. Although solitary bees often will nest together in great numbers when a good nesting area is found, these bees are only sharing a nesting site, not cooperating.

Solitary Bees

Solitary bees generally live for about a year, although we see only the active adult stage, which lasts about three or four weeks. These creatures spent the previous eleven months hidden in a nest, growing through the egg, larva, and pupa stages. After emerging from the nest, a male bee typically hangs around a nesting area or a foraging site hoping to mate with a female. The female bee will mate once and then spend her time creating and provisioning a nest in which to lay her eggs.

Female native bees have amazing engineering skills, going to extraordinary lengths to construct a secure nest. About 30 percent of solitary bee species use abandoned beetle burrows or other tunnels in snags (dead or dying standing trees) or chew out a nest within the soft central pith of stems and twigs. The other 70 percent nest in the ground, digging tunnels in bare or partially vegetated, well–drained soil.

Each bee nest usually has several separate brood cells in which the female will lay her eggs. The number of cells varies by species. While some nests may have only a single cell, most have ten or more. Female wood–nesting bees make the cells in a single line filling the tunnel. Females of ground–nesting species may dig complex, branching tunnels. To protect the developing bee, the cell may be formed or lined with waxy or cellophane–like secretions, pieces of leaf or petal, soil, or chewed–up wood.

Before she closes each cell, the bee provisions it with food for her offspring. She mixes together the nectar and pollen she collected to form a loaf of “bee bread” inside the brood cell. She then lays an egg in the cell, usually on the loaf, and seals the cell. When she has completed and sealed all the cells in her nest, the bee will cap the nest entrance and leave.

A female solitary bee may lay up to twenty or thirty eggs in her life. Each egg resembles a tiny white sausage. One to three weeks later, the egg hatches and a white, soft–bodied, grub–like larva emerges. All of the bee’s growth occurs during this larval stage. Feeding on the bee bread, the larva grows rapidly for six or eight weeks before changing into a pupa. During the dormant pupal stage, which may last eight or nine months, the bee transforms within a protective cocoon into its adult form. When it emerges, the adult bee is fully grown, ready to mate and continue the cycle.

SOCIAL BEES

Most social bees live very much like solitary bees—digging and provisioning a nest in the ground before sealing it and abandoning it—except that they have a few helpers.

Bumble bees are the best known social bees native to the U.S. Like non–native honey bees, bumble bees live in colonies, share the work of foraging and nest construction, and have multiple, overlapping generations throughout the spring, summer, and fall. However, unlike honey bees, bumble bee colonies are seasonal. At the end of the summer most of the bees in the colony die, leaving only a few fertilized queens to hibernate through the winter. In the spring, each surviving queen will start a new nest, which may eventually grow to include dozens to hundreds of individuals, depending on the species. Bumble bees are often the first bees active in late winter and the last to be foraging in fall. Therefore, a wide range of plant species must be available all season long to support the colony.

Bumble bees are generalist foragers, visiting a diversity of flowers, although a few groups of flowers are especially important to them. Lupines, for example are an excellent source of nectar. Bumble bees practice “buzz pollination,” in which they grab onto the anthers of certain flowers and vibrate their flight muscles—with an audible buzz—to release the pollen.

Bumble bees need a suitable cavity in which to nest. Sometimes they build nests above ground, such as in hollow trees or walls or under a tussock of grass, but mostly they nest underground. Abandoned rodent holes are common nest sites, as this space is easily warmed and already lined with fur. The queen creates the first few pot–like brood cells from wax, lays eggs, and then forages to provide them with pollen and nectar. It will take at least a month for her to raise this first brood. When they emerge, these bees become workers. They take on the task of foraging and help the queen tend the growing number of brood cells. The workers may live for a couple of months. As the queen continues to lay eggs, the colony grows steadily through the summer. At the end of summer, new queens and drones will emerge and mate. When the cooler weather of fall arrives most of the bees, including the old queen, will die, leaving only the new, mated queens to overwinter.

Appendix E
Cleaning Wood Nests

For farmers or gardeners who are raising bees to provide reliable crop pollination, nest hygiene is important, and cleaning bee nests is an annual task. In parks and other greenspaces where nests have been created mainly to support native populations, nest cleaning is less of a concern. Locations where block cleaning may be more of a priority are formal gardens or demonstration sites, if it is important that the blocks look tidy and are occupied by bees every year.

Cleaning will help reduce parasites, fungi, and diseases that might affect the developing bees in their brood cells (after three or four years, the nest might produce more parasites than bees). These are threats that bees naturally face and are unlikely to be a significant maintenance concern.

The easiest blocks to clean are those with paper straws. For blocks without straws, those with one size of hole are easier to clean than those with multiple hole sizes. Nests made of bundles of stems cannot be cleaned; the holes are too irregular and vary too much in dimension.

Cleaning blocks with straws

At the end of summer, use tweezers or forceps to pull out the straws. Remembering that there are live bees inside, carefully store the straws in a cool place over the winter, perhaps in an unheated but frost–free shed or garage or even a refrigerator. The straws should be in a ventilated container to minimize the growth of mold, and protected from mice. Be gentle with the occupied straws and keep them horizontal. Wash the empty blocks with a mild bleach solution (0.05%; 1 tablespoon of bleach to a gallon of water), dry them, and store them for the winter.

In the spring, do not put the occupied straws back into the blocks; instead, insert new straws to create clean nesting sites and return the blocks to their previous locations. Then, take the occupied straws from storage, bundle them, and place them in a box with a single exit hole that is one inch in diameter. Place the box near to the new straws. When the bees emerge, they will leave the box through the exit hole and should not return to the old straws. After the bees emerge, discard last year's abandoned straws.

Cleaning blocks without straws

Cleaning these nests is more difficult. It is easier simply to make new nests each year and destroy the oldest nests every three or four years. Although you will lose some bees, this strategy guarantees that parasites and diseases are disposed of. Another option is to redrill the holes every three or four years; even when done with great care, this also results in the loss of some bees.

To minimize the loss of bees before destroying or redrilling the blocks, first allow any surviving bees to emerge. Place the blocks in a larger box that has a single one–inch–diameter exit hole. When the bees emerge, they will leave the box through the exit hole and will not return. Place the box in a shady location to make it even less likely that the bees will return to nest in their natal blocks. Check the blocks occasionally; when the plugs sealing the nests are broken, the bees have emerged. You can either remove and destroy the blocks, or redrill the holes and clean them with a mild bleach solution (0.05%; 1 tablespoon of bleach to a gallon of water).

For more detailed information about cleaning nest blocks and reducing parasites, read *How to Rear Blue Orchard Bees* by J. Bosch and W. Kemp, and *Pollination with Mason Bees* by M. Dogterom.

Parks contribute broadly to the vitality of their community. In an increasingly urbanized nation, greenspaces give a welcome break from the hard surfaces of towns and cities and offer residents many opportunities. At the most basic level, healthy parks mean healthy people and healthy communities.

At the core of a healthy environment are pollinators, animals that move pollen among flowers, thus ensuring that the plants can form seeds and fruits. These beautiful animals not only keep plants healthy in the park—which in turn provide homes and food for other wildlife—but also benefit nearby natural areas and neighboring gardens or farms. Like all wildlife, pollinators are losing places to live and the essential service they provide is at risk. Conserving them is becoming an increasingly urgent concern.

Pollinator–Friendly Parks contains practical advice on how to provide for the habitat needs of native bees and butterflies—including choosing plants that offer nectar and pollen, hostplants for caterpillars, and creating nest sites for solitary bees—in all types of parks and greenspaces.

(Photograph by Matthew Shepherd.)

The Xerces Society for Invertebrate Conservation

The Xerces Society for Invertebrate Conservation is an international, nonprofit, member–supported organization dedicated to preserving wildlife and its habitat through the conservation of invertebrates. The Society promotes protection of invertebrates and their habitat through science–based advocacy, conservation, and education projects. Its work focuses on three principal areas—endangered species, watershed health, and pollinator conservation.

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