Managing Eastern Apple Orchards for Pollinators and Other Beneficial Insects

Integrated Pest and Pollinator Management, Habitat Enhancement, and Managed Bees

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We dedicate this guide to our friend, the late Dr. Jackie Robertson, formerly of the USDA Forest Service and recognized expert in pesticide toxicological analysis. Her guidance through two CRC Press books on pesticide bioassays for arthropods and her development of the statistical package known as POLO continue to serve as the standard for conducting valid bioassays that demonstrate pesticide effects on insect pests, beneficials, and pollinators. She inspired multiple generations of students, faculty, and conservationists.

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Introduction

Apples are a valuable crop in the United States, with an estimated worth of about $3 billion annually. Important apple-producing states include the northeastern and mid-Atlantic states, which have over 110,000 acres in apple production valued at over $330 million.

However, pest management in eastern apple orchards can be challenging. Cosmetic standards for fresh apples are very high, yet growers must contend with a wide range of pests and diseases that attack apples, as well as quarantine issues with apple exports. With such a low tolerance for damage to the fruit, commercial orchards usually require intensive management that includes the use of pesticides, whether conventional, organic, or biologically based. Eastern apple orchards face particular challenges of higher disease and insect pressures due to much greater rainfall and pest diversity than the arid apple-growing regions of the Pacific Northwest.

Kelly Gill/Xerces Society

Apples are a valuable crop, and the Northeast is important in apple production.

Though insect pests are often on the mind of growers, they are not the only important insects present in orchards. Insects comprise a large portion of the biodiversity found in agricultural landscapes, not only in terms of the tremendous variety of insects present on farms, but also in terms of the diverse ecological functions they perform. The majority of insects are beneficial or benign to apple production and can perform a number of valuable ecosystem services such as pollination and biological pest management. In particular, the generally smaller size of eastern apple orchards and closer proximity to diverse plant communities in fencerows and wooded areas compared to the arid western U.S. regions of production allow for a great diversity and economic contribution of pollinators and biological control agents.

Insect pollinators are crucial to apple production; without a pollinator to transfer pollen between apple flowers of different varieties, fruit set could not occur. Many orchardists hire beekeepers to supply colonies of honey bees during bloom. While honey bees are the most widely used managed pollinator species, they are not the only species that make important contributions to apple pollination. Several species of alternative managed pollinators are also utilized in apple production. Additionally, many species of wild native bees provide significant free pollination services to northeastern apple orchards.

Beneficial insects and other arthropods that prey on or parasitize apple pests are also important in orchards by contributing biological control services. Beneficial arthropod predators of apple pests include lacewings, lady beetles, minute pirate bugs, predatory mites, and more. Many parasitoid wasps and flies also help control apple pests. While predatory arthropods are often generalists that feed on many individuals of several different species of prey, parasitoids are often specialists on certain pests, with the adults feeding on nectar and pollen and the larvae completing development on a single individual. Eastern apple production focuses on conserving predators and parasitoids in order to control secondary pests of apples, pests that do not cause direct damage to apples and whose populations are tolerated at the levels of control provided by beneficial insects (pests that injure fruit cannot be tolerated at these levels for fresh market production).

Beneficial insects and pollinators are susceptible to many of the pesticides used in orchard pest management. However, controlling pests does not have to come at the expense of beneficial species and the ecosystem services they provide. By adjusting crop management practices, particularly pest management practices, orchardists can accommodate diverse and healthy populations of pollinators and beneficial insects. In particular, integrated pest and pollinator management (IPPM) can effectively incorporate protection of pollinators as well as beneficial insects that provide pest control.

Nancy Lee Adamson/Xerces Society

This female mining bee is collecting pollen from an apple blossom, and her work is critical for apple production. Bees are the most important pollinators of apple.

This guide focuses on balancing pest management in orchards with the protection of managed and wild pollinators as well as beneficial insects. Sections 1 and 2 provide information about the biology and habitat needs of pollinators and beneficial insects. Section 3 outlines potential harm to pollinators and beneficial insects from pesticides, and provides general risk reduction strategies. In addition to honey bee pesticide protection, recommendations in this guide consider the dozens of other important wild pollinators and beneficial insects that are vulnerable to pesticides because they are fixed in the landscape and cannot be removed from orchards as colonies of honey bees can be during spray applications. Section 4 provides specific strategies to include pollinators and beneficial insects in integrated pest and pollinator management practices in apple orchards. IPPM recommendations within this guide are based on the latest scientific evidence, including research conducted by Penn State tree fruit specialists. Section 5 includes tips on identifying existing pollinator and beneficial insect habitat, and outlines opportunities for enhancing or restoring additional habitat. Section 5 also includes guidance on finding technical and financial assistance with habitat installation or trying new integrated pest management tactics. Section 6 outlines the use of honey bees and alternative managed bees in apple orchards. Additional resources, such as tables of pesticide toxicity to bees and beneficial insects, are included in the appendix. We hope this guide is useful for orchardists looking to conserve pollinators and beneficial insects and the services they provide!

Betsy Betros

Lady beetles are important predators of apple pests in orchards. Here, a polished lady beetle adult and larva feed on aphids.

1. Pollinators in Apple Orchards

Importance of Pollinators in Apple Production

Apples are among the many crops that depend on pollinators, relying on insects to transfer pollen between blossoms (see Table 1-1). Apples require cross-pollination, often with a different variety, in order to set fruit. Pollination influences the quality of the fruit as well as overall yield; inadequate pollination can reduce the size and shape of the fruit and its storage quality.

Table 1-1. Insect-pollinated crops require different levels of pollination to produce a commercial crop.

Crop	% Dependency on Insect Pollination	Fruit Set Range (as percentage of flowers)
Apples	100	2–8
Cherries	90	20–75
Pears	70	3–11
Peaches	60	15–20
Strawberries	20	77–97
Grapes	10	30–70

Sources: Percent dependency on insect pollination from Morse and Calderone (2000) and fruit set range from Chaplin and Westwood (1980).

Bees are the most important pollinators of apple. Many apple growers rely on the introduced and managed European honey bee (*Apis mellifera*) to provide pollination, electing to pay professional beekeepers to bring honey bee colonies into orchards during bloom. Honey bees are the most widely managed crop pollinator, primarily because their use has some flexibility. Honey bees are effective pollinators of many crops, their colonies can be concentrated in high densities in crops, and the care and maintenance of colonies by beekeepers buffers honey bees from some environmental threats.

Although honey bees do pollinate apple, they are not the most efficient of apple pollinators. They can be distracted from apple blooms by other sources of forage—of the pollen honey bees bring back to the hive, only 10 percent may be from apple—and can rob apple flowers of nectar while failing to transfer any apple pollen. The cost and availability of honey bee hives can also be a concern for growers. As honey bee populations have declined in the United States (see sidebar), hive rental rates have increased. In eastern apple orchards, rental rates have tripled since 2006, now costing more than $100 per hive. As the demand for bee-pollinated crops continues to rise, honey bees may not be available to meet pollination requirements.

Nancy Lee Adamson/Xerces Society

Honey bee hives can be brought in during apple bloom to increase the number of bees in the orchard in order to augment apple pollination.

Wild native bee populations can supplement apple pollination by honey bees or, depending on the situation, provide all the pollination needs of an orchard. For example, recent surveys of apple growers in Pennsylvania and New York found that about half are currently not using honey bees for pollination. Instead, these growers are relying on wild bees such as bumble bees and solitary bees to meet their pollination needs.

In addition to wild bees, alternative managed bees, several species of mason bees (*Osmia* spp., also known as orchard bees), and the eastern bumble bee (*Bombus impatiens*) can be deployed for pollination in orchards. The concept of balancing the use of honey bees, wild bees, and alternative managed pollinators is

Emily May/Xerces Society

Pollination can affect fruit quality. Blossoms that have not been fully pollinated result in poor-quality apples.

Nancy Lee Adamson/Xerces Society

Wild, unmanaged bees play an important role in apple pollination. They are often highly efficient at transferring pollen, and apple orchards with greater numbers of species of wild bees have higher fruit and seed set.

David Biddinger

Orchards that have habitat for pollinators within or near the orchard can have more stable pollination over time and higher yields.

called integrated crop pollination (for more information, visit http://icpbees.org/). Integrating strategies to support wild and managed pollinator in crop systems is now a component of IPPM.

Wild bees can act as an insurance policy against changes in the availability of managed bees. For example, wild bees increase fruit set even when managed bees are present in large numbers. A recent study carried out in Wisconsin found that apple fruit set did not increase with the presence of honey bee colonies or even the number of honey bees per orchard. Instead, orchards with greater numbers of wild bee species had higher fruit set.

Wild bees have a number of characteristics that contribute to their efficiency as crop pollinators. In apples, certain wild bees carry and deposit more apple pollen than do honey bees. Wild bees fly in the early spring during apple bloom, are adapted for flying in cool and cloudy conditions, and continue to visit flowers and provide pollination when honey bees are less active. The weather during the seven-to-ten-day bloom period of apple is often cool, wet, and windy, with only short windows of optimal honey bee foraging conditions.

Additionally, on a bee-per-bee basis, wild bees can be more effective pollinators of apple than honey bees, meaning that they do not need to be as abundant as honey bees in orchards in order provide quality pollination. For example, only 250 female blue orchard bees (*Osmia lignaria*) are needed to effectively pollinate an acre of apples, a task that would require 1.5 to 2 honey bee hives—approximately 15,000 to 20,000 foragers. Similarly, one individual Japanese orchard bee (*Osmia cornifrons*) has been shown to pollinate and set as many as 2,500 apple blossoms in a day, while an individual honey bee may set only 50 apple blossoms per day. Orchard bees, which forage for both nectar and pollen on every flower visit, contact both stamens (pollen-producing structures) and stigmas (pollen-receiving structures) on each visit to flowers, with the result that only a single visit is necessary for fertilization. In contrast, apple flowers often require multiple visits from honey bees to obtain pollination. In varieties such as Red Delicious where the flower morphology allows it, honey bees will often "steal" nectar and provide almost no pollen transfer.

Eastern apple orchards with habitat nearby and pesticide protection methods in place can support a diverse community of wild bees. In turn, a diversity of bee species increases the stability of pollination over time and can buffer pollination from yearly fluctuations in pollinator abundances. If bee diversity is high in an orchard, when populations of one or several species fluctuate due to natural cycles of parasites or disease, other bee species continue to be a source of stable, reliable pollination. In New York orchards, researchers found that as the number of wild bee species increased, apple seed set increased and pollen limitation decreased; greater abundances of honey bees did not lead to an increase in seed set. And apple orchards with a diversity of bee species produce greater yield and high-quality fruit than orchards with fewer, closely related bee species. Synergy between bee species may also occur. Aside from the pollination services they provide, wild bees can alter the behavior of honey bees, increasing the effectiveness of honey bees as pollinators and increasing yields overall. In apple orchards in Israel, the presence of bumble bees increased the mobility of honey bees between orchard rows, increasing cross-pollination, seed number, and fruit size. Supporting a diversity of bees in orchards results in more reliable pollination services than depending on a single species to provide pollination.

Honey Bee Declines

There were approximately 5 million honey bee colonies in the United States in the 1940s. Today, there are about 2.5 million. Losses vary from year to year, but on average since 2010/2011, beekeepers have lost between 25 and 45 percent annually, according to Bee Informed Partnership surveys. In 2017/2018, beekeepers lost an estimated 40.1 percent of their colonies, with summer losses nearly as high as winter losses. Backyard beekeepers lost colonies at a higher rate than commercial beekeepers. Annual colony losses are attributed to a number of factors, including parasitic mites; viral, fungal, and bacterial diseases; pesticide poisonings; and poor diet due to a lack of forage. Despite the decline in honey bee colonies, demand for crop pollination services continues to increase.

Pollinators of Eastern U.S. Orchards

The United States is home to over 3,600 species of native bees, including more than 500 species common throughout the eastern apple-growing states. Many of these bee species can be found within apple orchards. For example, of the 437 species of bees known to Pennsylvania, nearly half are found in fruit orchards during the growing season. At least 50 bee species actively pollinate tree fruit crops, according to research by Penn State and the Pennsylvania Department of Agriculture, and about 100 species visit apple flowers in New York. For a list of bees found

Theresa Pitts-Singer

Orchard mason bees are solitary bees, with each individual building her nest and providing for her young. Although they are less abundant in orchards than honey bees, they are far more effective apple pollinators.

NY State IPM Program

Approximately 70 percent of native bees in the United States nest underground, like the cellophane bee seen here.

Nancy Lee Adamson/Xerces Society

About 30 percent of wild bees nest in tunnels or cavities, such as hollow stems or old beetle borer tunnels, or by excavating pithy stems.

Kent McFarland

Bumble bee queens build their colonies within existing insulated cavities, with some species preferring to nest above ground and others below ground.

during the apple bloom period in New York and Pennsylvania apple orchards, see Appendix A.

In contrast to the large colonies formed by honey bees, most native bees lead solitary lives. Each individual female builds her own nest and supplies it with provisions of pollen and nectar so her offspring have plenty to eat while they grow. She lives only a few weeks as an adult and dies after her nest is completed. Solitary bees produce fewer offspring in comparison to honey bees, so orchards pollinated primarily by native bees, managed or wild, may have a noticeably lower abundance of bees than orchards stocked with honey bee hives. However, fewer individual native bees does not necessarily mean that orchards receive inadequate pollination; some wild bees such as orchard mason bees (*Osmia* spp.) are up to 80 times more effective in pollinating apple than honey bees on a bee-per-bee basis.

Many of the native bees found in orchards are ground-nesting species. These bees dig slender tunnels underground in which they build cells for each egg and its provisions of pollen and nectar. Many prefer to nest in bare patches of well-drained soil, and some will line nest cells with a waxy substance to protect their offspring from fluctuating soil moisture levels. While some people express concern over aggregations of ground-nesting bees, almost all of these insects are very docile and will not sting or defend their nest sites. Important ground-nesting bees in orchards include mining bees (*Andrena* spp.), cellophane bees (*Colletes* spp.), and sweat bees (*Lasioglossum* spp., *Halictus* spp., *Augochlorella* spp., and more).

Other native bees common in orchards nest in wood tunnels made by boring beetles, or the bees may chew into the old growth of pithy stems to create their own tunnels. Some bees use materials such as mud, resin, and portions of leaves or flower petals to line or separate the cells in their nests. The most valuable tunnel-nesting bees in orchards include mason bees (*Osmia* spp.), small carpenter bees (*Ceratina* spp.), and large carpenter bees (*Xylocopa virginica*). One common eastern

species, *Augochlora pura*, is a metallic green bee that digs tunnels in rotting wood.

Large, fuzzy, and charismatic, bumble bees (*Bombus* spp.) also visit apple flowers. Bumble bees are social bees that live in colonies founded by a queen in the spring. Worker bees, the daughters of the queen, help with nest building, brood rearing, and defense of the nest. Bumble bee colonies are established within an existing insulated cavity, either below or above the ground. Wild queen bumble bees are usually the only individuals that are active during the period when orchards are in bloom. However, fruit growers are increasingly purchasing and deploying commercial bumble bee colonies in large numbers each season in blueberries and tree fruit, though the efficacy of this strategy is still unknown and there are risks of spreading diseases to wild bumble bees (see Section 6 for more on the use of commercial bumble bees).

Whitney Cranshaw

Although yellowjackets may be mistaken for bees at a glance due to their color patterns, they are aggressive in defending their nests and may be a nuisance to workers in orchards.

MJ Hatfield

When their large, globular paper nests found in tree branches are disturbed, bald-faced hornets can be quite aggressive in response.

Social Wasps in Orchards

Yellowjackets (*Vespula* spp.) and other social wasps that may eat damaged or overripe fruit in orchards are often mistaken for bees. In contrast to bees, wasps such as yellowjackets have a relative lack of body hair and do not carry pollen or have pollen-carrying structures on their bodies as female bees do. They are also not significant crop pollinators. These wasps may be quick to defend their nests by stinging and can be a nuisance to orchard fruit pickers; by contrast, most native bees are unlikely to sting.

Some social wasps are beneficial predators that feed on various insect pests early in the season. However, they may later switch to feeding on injured and overripe fruit in the fall. One introduced species is even considered to be a crop pest: the European hornet (*Vespa crabro*) will injure and then feed on undamaged fruit in the fall. Looking like a much larger version of a yellowjacket, it will use its massive jaws to attack undamaged fruit just before maturity to get the sugary pulp. Significant fruit loss has been seen in some commercial orchards, especially in Asian pears and early season, softer apples such as McIntosh, Honeycrisp, and Golden Delicious. Homeowners often see them girdling lilac branches to get the sugary sap in the fall.

In eastern orchards, the black and white bald-faced hornet (*Dolichovespula maculata*) is likely to pose the greatest threat to humans. These wasps build large, football-shaped paper nests that house their colonies attached to limbs of fruit trees, hidden among branches and leaves. Bald-faced hornets individually pose little threat and are typically docile when feeding, but when their nests are inadvertently disturbed by farm workers or fruit pickers, the wasps become defensive and are more likely to sting.

Nancy Lee Adamson/Xerces Society

Female mining bees (*Andrena* spp.) carry pollen on their hind legs to transport it back to their nests as food for their young.

Jason King

Cellophane bees (*Colletes* spp.) are named for the cellophane-like lining females use within their nest to protect their young from fluctuating soil moisture.

Wild Bees in Orchards

Mining Bees

Order: Hymenoptera
Family: Andrenidae
Genus: *Andrena*

Identification: Mining bees range in body size from 7 to 14 millimeters. Most have dark bodies with pale hairs on their thorax and pale stripes on their abdomen. Females carry pollen on hairs (known as scopa) on their hind legs. One common species, *A. carlini*, has yellow hairs on the thorax and resembles a small, less rotund bumble bee.

Life cycle: These solitary bees have a single generation per growing season. Many species fly in the spring.

Foraging habitat: The maximum flight range for large mining bees is estimated to be between 500 yards and one mile, but it may be less than this for smaller species. Some species visit a wide range of flowers to collect pollen, while others only collect pollen from a small subset of flowering plants. Over 30 *Andrena* species have been found during apple bloom in New York and Pennsylvania.

Nesting habitat: Nests are built in the ground, with some species nesting in aggregations. Some species may nest in apple orchards.

Cellophane Bees

Order: Hymenoptera
Family: Colletidae
Genus: *Colletes*

Identification: Cellophane bees have a medium build and body size (up to 13 millimeters). Like mining bees, they have dark bodies and pale hairs on their thorax and pale stripes on their abdomen. Females carry pollen on hairs (known as scopa) on their hind legs.

Life cycle: These solitary bees have a single generation per growing season.

Foraging habitat: Cellophane bees have a flight range of up to a mile or more from their nest site. Most species visit a wide range of flowers, but several collect pollen only from a small subset of flowering plants. One species, *C. inaequalis*, is a common pollinator of apple in New York, but it is more common on the earlier blooming stone fruits in Pennsylvania than in apples.

Nesting habitat: Nests of cellophane bees are built in the ground, sometimes in large aggregations with hundreds of nests in one area.

Brett Whaley

Dark sweat bees will sometimes land on people to lap up perspiration from skin, which contains salt and minerals they need.

Jennifer Hopwood/Xerces Society

Some green sweat bees have two or more generations a growing season and thus can be found from spring through fall.

Dark Sweat Bees

Order: Hymenoptera
Family: Halictidae
Genera: *Halictus*, *Lasioglossum*

Identification: Dark sweat bees can be as tiny as 5 millimeters or a medium-sized 10 millimeters. Their narrow bodies are often dull metallic (blue, green, or gold) but may also be dull brown or black with pale stripes on their abdomen. Females carry pollen on hairs (known as scopa) on their hind legs.

Life cycle: Sweat bees are a very diverse group; some species are solitary, some nest in aggregations, and others form semi-social colonies where they live cooperatively with their sisters. Some species have one generation per growing season, while others have multiple generations during the growing season.

Foraging habitat: These bees may fly between 500 yards and a mile from their nest (the larger *Halictus* species will fly farther than many of the much smaller *Lasioglossum* species). They visit a wide range of flowers to collect resources.

Nesting habitat: These bees build their nests in the ground, sometimes in aggregations.

Green Sweat Bees

Order: Hymenoptera
Family: Halictidae
Genera: *Agapostemon*, *Augochlorella*, *Augochlora pura*

Identification: These bees are a stunning bright metallic green and can range in body size from 7 to 12 millimeters. Females carry pollen on hairs (known as scopa) on their hind legs. Males become common in mid-summer and fall; males of a few species have yellow-striped abdomens.

Life cycle: Sweat bees are a very diverse group; some species are solitary, some nest in aggregations, and others form semi-social colonies where they live cooperatively with their sisters. Some species have one generation per growing season, while others have multiple generations during the growing season.

Foraging habitat: Green sweat bees visit a wide range of flowers and may fly between 500 yards and a mile from their nest.

Nesting habitat: Most of these bees build their nests in the ground (sometimes in aggregations), though *Augochlora pura* will utilize rotting logs or soft wood.

Nancy Lee Adamson/Xerces Society

Bumble bees can generate their own body heat and fly in cooler weather when other pollinators are not active.

Bumble Bees

Order: Hymenoptera
Family: Apidae
Genus: *Bombus*

Identification: Bumble bees have large (up to 23 millimeters in queens), robust, extremely hairy or fuzzy black and yellow bodies, sometimes with additional orange, red, or brown coloration. Seven different species have been found pollinating apple in the east (see Appendix A). Females carry pollen within a corbicula, a concave cavity surrounded by a fringe of hairs on their hind legs.

Life cycle: Bumble bees are social and live in colonies of between 25 and 400 bees, founded by a queen. Mated queen bumble bees hibernate through the winter, initiate a nest in the early spring, and forage widely to provision that nest. Queen bumble bees are usually the only individuals that are active during orchard bloom. Worker bees, the daughters of the queen, help with nest building, brood rearing, and defense of the nest as the colony grows in size through the spring and summer. In the late summer and fall, new queens and males are reared and leave their nests to find mates. Males, workers, and old queens will die off when winter arrives.

Foraging habitat: Bumble bees can fly up to a mile or more, depending on availability of food resources. They visit a vast range of wildflowers, shrubs, and trees.

Nesting habitat: Queens select an insulated cavity in or above the ground. Nest sites include old rodent burrows, cavities beneath a clump of bunch grass, or old bird nests. In the winter, queens hibernate in shallow underground burrows, often under forest humus, rock piles, or brush piles.

Stephen Goddard

A mason bee seals off her nest entrance, leaving her young with their food provisions to grow inside.

Mason Bees

Order: Hymenoptera
Family: Megachilidae
Genus: *Osmia*

Identification: Most mason bees are between 8 and 16 millimeters in length and have dull metallic blue, green, or copper bodies, though metallic coloration may not be readily apparent in several species with dense body hair (e.g., *O. bucephala*). Females carry pollen on hairs on the underside of their abdomen. The blue orchard bee (*O. lignaria*), named for its metallic blue coloration, has natural populations across the country but is also managed in the western United States for almond and fruit pollination. The Japanese orchard bee (*O. cornifrons*), introduced into Pennsylvania from Japan, is naturalized in most of the eastern United States and managed for tree fruit pollination to a limited extent. Also known as horn-faced bees, Japanese orchard bee females have two large horns on their faces above their mandibles that they use for carrying mud for nesting. Another introduced species, *O. taurus*, also has this identifying feature.

Life cycle: These solitary bees are among the earliest bees to emerge in the spring (end of March to mid-April) and have a single generation each growing season. Natural emergence for *O. lignaria* and *O. cornifrons* is synchronized more with apricot and red maple bloom than with apple bloom, which normally occurs at least two weeks later. Through management, *O. lignaria* and *O. cornifrons* can be manipulated by refrigeration to emerge later in the season for a specific crop like apple or blueberry. Adult flight for most species will end naturally soon after apple petal fall (mid-May), but at least three *Osmia* species

that pollinate apple (*O. bucephala*, *O. georgica*, and *O. pumila*) have longer flight periods that extend into June and can also be found pollinating blackberry and other cane fruits.

Foraging habitat: Mason bees have a flight range of up to about 500 yards, though *O. cornifrons* prefers to forage within 50 to 70 meters of their nest. Mason bees will visit a wide variety of spring or early summer blooming plants during their limited flight season.

Nesting habitat: Mason bees use mud and masticated plant materials to build partitions within their tunnel nests that separate individual cells and seal nest entrances. Many mason bees will nest readily in artificial nest blocks or substrates constructed of reeds, bamboo, or holes drilled into hard wood. New nesting materials should be provided and old nesting materials destroyed periodically to prevent the buildup of parasitic mites (*Chaetodactylus* spp.) or parasitic wasps (*Chrysus* spp., *Monodontomerus* spp., *Sapyga* spp., or *Leucospis* spp.). When most mason bees emerge in the spring as adults, they and often their parasitic wasps are attracted to an aggregation pheromone in their cocoon. Keeping cocoons from which mason bee adults have emerged next to new nesting sites will help retain them in the desired nest areas. Supplemental sugar water for food will help retain most mason bees in within new nest sites but avoid attracting ants. See Section 6 for more information about managing mason bees.

Cam Miller

Large carpenter bees resemble bumble bees in color and size but have shiny abdomens and carry pollen on long hairs on their hind legs.

Large Carpenter Bees

Order: Hymenoptera
Family: Apidae
Species: *Xylocopa virginica*

Identification: Large carpenter bees have large (up to 23 millimeter), robust bodies. Their abdomen is shiny and less hairy than bumble bees, while their thorax is entirely covered in dense yellow hairs. Females carry pollen on dense, long hairs (known as scopa) on their hind legs. Males have a yellow marking on the face.

Life cycle: These bees have one generation a growing season. Adults overwinter and then mate and nest in the spring.

Foraging habitat: Large carpenter bees visit a wide range of flowers and have a flight range of up to a mile or more from their nest site.

Nesting habitat: These bees create their nests by chewing directly into soft wood, including human-made structures. Over time, an accumulation of large carpenter bee nest tunnels may cause structural damage to decks, eaves, picnic tables, and barns. Therefore, large carpenter bees can be considered pests. However, they can be effective pollinators of fruit trees.

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