

# Farming for Native Bees in Delaware

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## ACKNOWLEDGMENTS

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Field guide prepared by Bonnie MacCulloch, December 2007





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## INTRODUCTION

The purpose of this guide is to provide information about native bees and their habitat requirements. It is designed to provide background on the biology of native bees and give practical advice to help increase the abundance of native bees on Delaware farms. Growers can follow some simple practices to make their farms and surrounding landscapes more suitable for native bee populations.

Managing marginal areas of a farm for native bees is a great way to provide habitat and resources for pollinators. Bees, our major pollinator group for example, need nesting sites, materials for nest building such as mud or leaves and foraging plants for access to nectar and pollen when target crops are not in bloom. Bees also need clean, fresh water, over wintering sites and protection from pesticides.

Farming for native bees is not to be confused with beekeeping. There are no hives to manage, no need for special safety equipment, and no reason to handle any bees. Farming for native bees is a renewable resource everyone can benefit from.

### How this field guide works

In the first part of this guide you will learn about native bees and how to establish bee-friendly environments. The main part of the guide is dedicated to introducing some of the native pollinators that are common in Delaware, specifically, in association with vine (cucurbit) crops. A list of suggested plants that are bee-friendly is provided. References used in the development of this guide and resources to obtain additional information about native bees are provided in the back of the guide.

*Special Note:* Taxonomic nomenclature used in this guide includes:

Common name (Family, Subfamily, Tribe) *Genus species* (followed by examples of species detected in Delaware)



# ALL ABOUT BEES

## Bee Life History

Bees have four distinctly different life stages: egg, larva, pupa and adults. The life span of these pollinators varies between species and may last from a few months to a couple of years. Bees have specific shelter and foraging needs at different stages of their lives, both during the larval and pupal stages when they are not pollinating, and during the adult stage when they are. It is important to understand the habits and life span of individual species to provide adequate habitats, nesting sites and foraging options.

Bees can be categorized in two ways; either they build and provision their own nests or they parasitize the nests of others. Most are solitary but a few, like bumble bees, are social species. A female solitary bee constructs a nest and gathers food for her offspring completely on her own and she normally dies before her young reach maturity. Social bees live in colonies ranging in size from a handful to a couple of hundred individuals where there is longer-term contact between the egg-laying queen and her female offspring. While the entire development of social bees may take no longer than three or four weeks, solitary bees may have a year or more between generations and can remain dormant for months during winter, periods of drought or other unfavorable conditions. Parasitic bees, both solitary and social, lay their eggs in the nests of other bee species, exploiting the stores of pollen and nectar gathered by their hosts.

### Solitary Nest-Building Bees

There are a range of nesting behaviors among the many solitary bee species. Solitary bees can share a nesting site with others and this sometimes occurs in clusters of great density. The location and manner by which solitary bees construct their nests can vary between species. Nests can be found in the ground, in holes in wood and within the hollow stem of certain types of plants.

### Social Nest-Building Bees

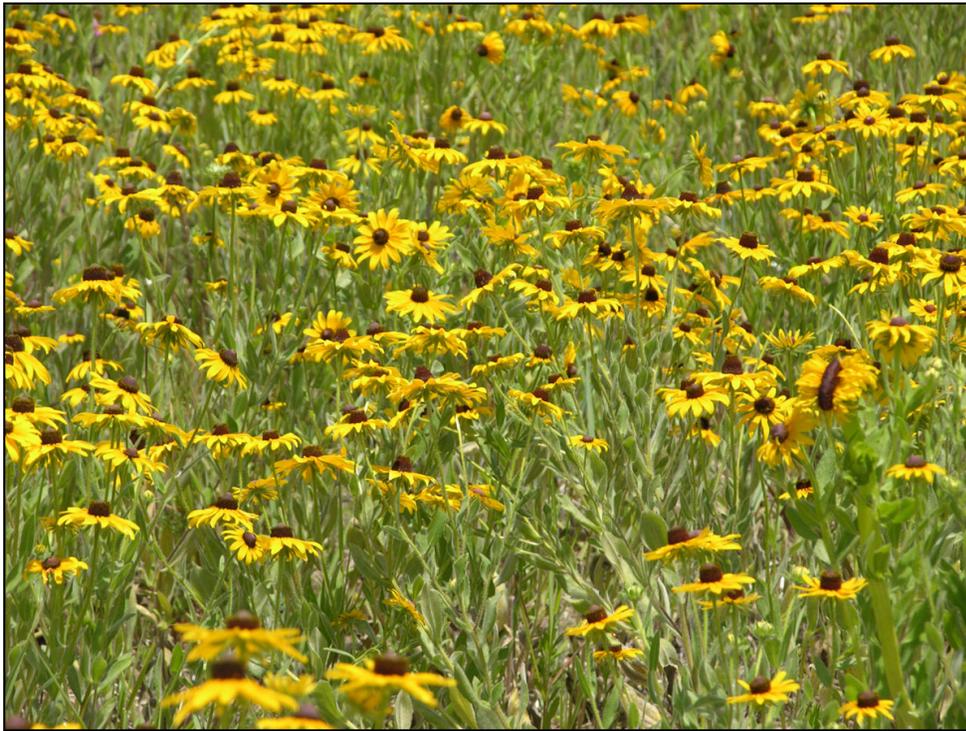
Bumble bees (*Bombus spp.*) are the best known social bees that are native to the United States. Social bees live in colonies which are defined as having at least two adult females, a queen and her daughter workers, who live in the same nest, share the work of constructing the nest, and provision the developing young. Unlike honey bee queens, bumble bee queens must gather nectar and pollen during early spring until their first offspring emerge.

The nests of most social bees are annual; the colony is founded in the spring by an individual queen when she emerges from hibernation and most of the bees die be-

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fore the end of the year. Social bees can have multiple, overlapping generations throughout the spring, summer and fall. The best way to ensure that these pollinators have a steady source of food is to plant a variety of plants and crops that bloom at various times throughout the year.

The social honey bee (*Apis mellifera*), the best known pollinator, is not native to the Americas. It nests in hollow cavities or in managed bee hives with populations ranging from 20,000 mid-winter to 60,000 workers at summers peak. They store reserves for over-wintering and the female queen only performs egg laying and pheromone production. Workers develop in 3 weeks and live for 5-6 weeks, with the last weeks spent outside the hive foraging for nectar and pollen where they accomplish crop and flower pollination.



*Rudbeckia hirta* by Heather Harmon, Delaware Department of Agriculture



## PLANNING FOR POLLINATORS

Farmers and land managers can do a number of things to encourage native bees and since many of the crops we grow need these pollinators, the benefits are mutual. Marginal lands, such as field edges, hedgerows, sub-irrigated areas, and drainage ditches, offer both nesting and foraging sites. Areas left untilled such as wood lots, conservation areas, utility easements and farm roads, all support native bees. These places can be especially valuable if they are enhanced with plants that are attractive to bees.

Ground nesting bees seldom nest in tilled soils; therefore untilled areas can provide both nesting and foraging habitat. Nesting boxes can be easily constructed and installed in or near untilled areas, next to structures, or along field edges. Bee areas do not have to be large; planting hedgerows with native shrubs and perennials, for example, can produce excellent bee habitat and will help to provide corridors across agricultural landscapes.

### **How to provide foraging habitat**

- Incorporate a succession of flowers and colors throughout the entire growing season to provide sources of nectar and pollen for a variety of bee species.
- Ensure that several different flowering species have overlapping bloom times.
- Combine annuals and perennials.
- Maintain areas with reduced pesticide applications.

### **Nesting and egg-laying sites**

Pollinator populations benefit the most from flower-rich, pesticide free foraging areas when there are also suitable egg-laying or nesting sites near by. Most of the solitary bee species, as well as all of the social sweat and bumble bees, nest in the ground. Nests can be shallow or deep, a single passageway or multiple branching tunnels. Bumble bees need a cavity in which to nest, typically under a grass tussock or in abandoned rodent burrows. Other species of solitary bees nest in dead trees or hollow limbs. By providing simple nest boxes, leaving snags (dead trees), and providing hollow plant material (i.e., joe-pye weed), the needs of most of these species can be met.

Keep natural areas, natural. Bark mulch used to cover bare ground can prevent bees such as digger bees, from burrowing. Cutting all of the patches of rough grass can deprive bumble bees of a home and removing logs, dead limbs, or snags reduces the number of natural nesting sites for cavity nesters.

## Creating artificial nesting sites

In addition to protecting nesting habitats for bees, you can create artificial nests that supply the conditions they need.

1. Nesting sites for wood- or tunnel-nesting bees (such as small carpenter bees, leaf-cutting and mason bees)

*Wooden Block Nest Construction:* The standard, commercially made bee nest is a wooden block with many holes drilled in it. The holes are usually  $\frac{3}{16}$  of an inch in diameter. It is very easy to make a block yourself and one that will accommodate the needs of many species.

Use preservative-free dimensional lumber: a 4" x 4" for blocks with holes smaller than  $\frac{3}{16}$  inch, or a 4" x 6" for blocks with holes greater than  $\frac{3}{16}$  inch. You can also use a rough block of wood, a piece of firewood, or a log that is at least these dimensions in cross-section. The height of the block is less important but most are constructed at least eight inches high.



In one side of your block drill a series of nest holes (see table below). Providing a range of hole sizes and depths will help to meet the needs of different species of bees. Drilled holes should be about  $\frac{3}{4}$  inch from center to center and from any edge. Bees will not use a hole that is open at both ends so if you drill all the way through your block, attach a backing board. Bees will also avoid holes with rough interiors so use a very sharp drill bit and have your drill set at the highest speed to ensure a smooth hole. Holes can also be lined with regular drinking straws which are easy to maintain and provide smooth edges. The exterior of the block can be rustic or fancy, and any color you like. Nest blocks are best hung from a tree, a fence post or any structure.

Table 1: Dimensions for wooden block nest construction:

<i>Recommended diameter 3/16"</i>	<i>Less than or equal to 3/ 16"</i>	<i>Greater than or equal to 3/16"</i>
4" x 4" blocks	3-5 inches deep	5-6 inches deep
4" x 6" blocks	3-5 inches deep	5-6 inches deep

*Stem and straw bundles:* Another easy option is to make nests from bundles of hollow stems or straws. Joe-pye weed and common reeds are good choices, but any hollow stem will do. Manufactured plastic straws can also be used. Create a handful of tubes with only one open end. Strap the hollow stems together into a tight bundle with wire, string, or tape, making certain that the closed ends of the stems are all at the same end of the bundle. You can also pack the stems into a tin can, paper milk carton or short section of PVC pipe. The bundles should be placed in a sheltered location with the stems horizontal to the ground.

*Location and orientation:* Whether erecting nest blocks or bundles of tubes or stems, the nest should be mounted in a location that receives morning sun, but has some protection from the extremes of midday sun and heat in the summer. Generally, nests should be at least four feet above the ground.

*Maintaining your nests:* Cleaning will help to reduce parasites, fungi, and diseases that might affect the developing bees in their brood cells. It's best to erect new nest blocks each year, rotating the older blocks for cleaning and re-drilling. First make sure the bees have emerged from their nests by looking for emergence holes. Empty blocks can be cleaned with a mild bleach (5%) solution and the holes re-drilled.

If you used lined nesting blocks with straws pull out the straws containing brood cells and dormant pupae at the end of the season and carefully store them in a cool place (36-39 F) over the winter. The straws need to be ventilated to prevent mold. Be gentle with occupied straws and keep them horizontal. The empty blocks can then be washed with a mild bleach solution, dried and stored for the winter. In the spring, take your occupied straws from storage, bundle them and place them in a box with a single exit hole, one inch in diameter. Place the box beneath new/clean nest blocks with new straws inserted. When the bees emerge they will not return to the old straws.

2. Nesting sites for ground-nesting bees (such as bumble bees, digger bees, and sweat and mining bees)

Start with the simplest approach and look for nest sites that already exist. Protect these sites for future populations of native bees.

Bare ground	Clear vegetation from a gently sloping or flat area that is not under cultivation, leave small clumps of grass and stems for cover, provide rocks for bee basking
Sand or sandy loam piles	Create a pile of sand or sandy-loam (with a 35 % sand component) about 2 feet high at different locations on the property

In general, it is important for ground-nesting sites to receive direct sunlight. Patches of bare soil interspersed among plants is ideal. The site should also be well drained. Avoid walking or driving across the site when bees are active to avoid compacting the soil.

**Pupation and over wintering habits**

For most bees, pupation and over wintering needs are both served by the nest. Solitary bees spend most of the year in their brood cells, passing through the stages of egg, larva and pupa. They emerge in the spring or summer and spend only a few active weeks (approximately 2-4) as adults. Some species of solitary bees, such as small carpenter bees, emerge at the end of the summer and over winter as adults, usually in their original nests. Bumble bee workers die at the end of summer, leaving only a newly reared and subsequently mated, fertilized queen to hibernate. These individual queen bumble bees will need to establish a new nest next year. They will survive the winter by burrowing into soil or finding shelter in protected sites such as leaf litter or under bark. Queen bumble bees will not hibernate (over-winter) in the nest they were reared in.



# MEET THE POLLINATORS



## **BUMBLE BEES** (Apidae, Apinae, Bombini)

*Bombus bimaculatus, B. impatiens, B. pensylvanicus, B. griseocollis, B. fervidus*

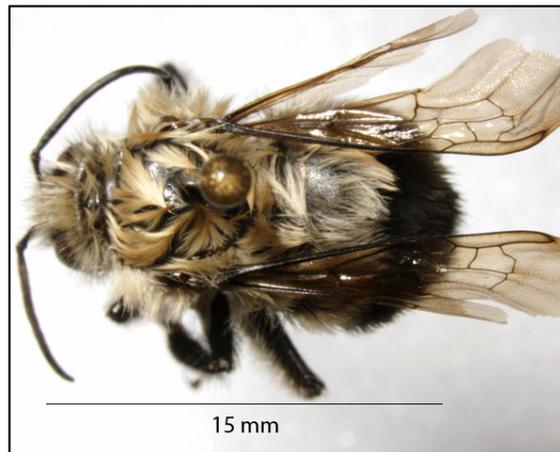
Bumble bees are highly social, like honey bees, but with smaller, less structured nests, consisting of one to five hundred bees. Bumble bees work harder, faster and at cooler temperatures than honey bees. They are medium-sized as workers and drones, approximately 1/2 inch and queens are larger, approximately 1 inch. Bumble bees are quite hairy, black and yellow (sometimes orange to white) bees. They prefer to nest under ground in abandoned rodent burrows, undisturbed meadows, old barns and in wood lots. A single queen emerges in the spring and produces several generations of workers through the season to build her nest. Bumble bee colonies are annual; the entire colony dies each year, usually between August and October. In late summer, new queens and males (drones) are produced; they mate and the new queens over-winter. The queen will start a new colony in the spring. Unlike honey bee queens, bumble bee queens must gather nectar and pollen during early spring until their first offspring emerge. After she raises the first workers, queens concentrate on laying eggs. She can produce as many as 20 per day for the rest of her life. Bumble bee queens live for approximately 20 weeks. Bumble bees are very effective at pollinating many crops including cucumbers, melons, pumpkins, cantaloupes, tomatoes, peppers, eggplants and many kinds of berries.

*Note: Artificial nests can be made out of old Styrofoam coolers or wooden boxes. To make a nest, drill drainage holes in the bottom and stuff the box with upholsterer's cotton. Make a hole in one side and place the box 6-12 inches under ground. Connect the box to the soil surface with a piece of old garden hose or other tubing fitted into the hole in the box. Hay bales left in the field may also provide cavities for bumble bee queen nests.*

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## BUMBLE BEES

**Photo 1:** Dorsal view of *B. bimaculatus*, notice how hairy and robust the body is with both yellow and black coloring (a mounting pin is visible in the middle of this photo).



**Photo 2:** Head of *B. bimaculatus*, notice the sticky hairs also covering the head.



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## DIGGER BEES (Apidae, Apinae, Eucerini)

*Melissodes bimaculata*, *Peponapis pruinosa*

Digger bees excavate nests in the ground, leaving small mounds of soil above ground. They often hide their nest entrances beneath leaf litter or in the grass. Nests are long tunnels, lined with salivary gland secretions to keep them from collapsing, with brood cells as terminal branches. All digger bees are solitary nesters but some species nest in dense aggregations. Digger bees pollinate a variety of plants and crops including cucumber, watermelon and cantaloupe. They are drab, solitary and rarely noticed yet they may be the most abundant wild pollinators in the field.



*Peponapis pruinosa* also called **squash bees**, are medium-sized bees that specialize in collecting pollen and nectar from the flowers of cucurbits, especially squash, pumpkin and gourds. Females become active at or before dawn, visiting cucurbit flowers until midday when the flowers close. Males sleep in closed blossoms overnight. They typically will pollinate flowers before honey bees are fully active, which is closer to mid-day. They have a life span of about 2 months, or until the food source is gone.



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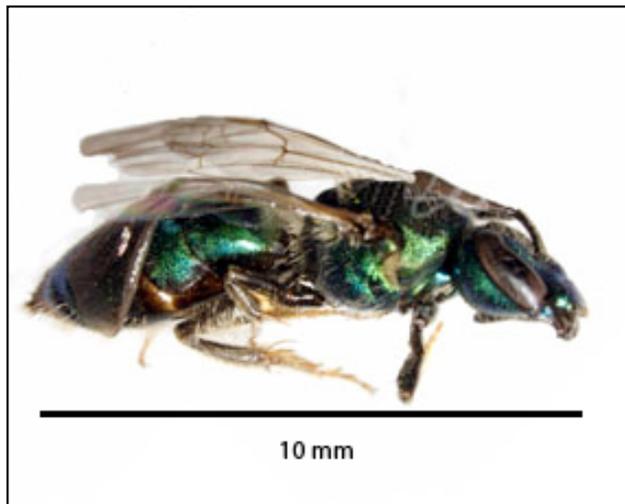
## SWEAT BEES (Halictidae, Halictinae, Halictini)

*Augochlora pura*, *Agapostemon splendens*, *A. sericeus*, *A. virescens*, *Lasioglossum vierecki*, *L. bruneri*, *L. versatum*

An abundant group of bees around farms, sweat bees tend to be small and bright metallic green/blue (*Augochlora pura*) or a dull metallic brown on head/thorax with bands of hair on the abdomen (*Lasioglossum vierecki*). All carry pollen on special long hairs on their hind legs and nest in both cavities and in the ground. Some sweat bees are solitary, and often quite small in size. There is usually only a single generation per year. A few species are social and have one to a few queens, supported by a number of female workers and produce multiple generations per year. Halictid bees are common and are good pollinators of crops and wildflowers.

*Note: The common name 'sweat bee' derives from some species having an affinity for the salt in human sweat.*

**Photo 5:** *Augochlora pura*, a bright green and metallic adult bee. This bee likes to nest in sandy soils.



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## SWEAT BEES

**Photo 6:** *Agapostemon virescens*, another sand specialist, exhibits a blue-green head and thorax with a striped abdomen.



**Photo 7:** *Lasioglossum vierecki*, a sweat bee with a golden abdomen and lacking the metallic blue/green of the other species.



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## LEAF-CUTTING BEES (Megachilidae, Megachilinae, Megachilini)

*Megachile brevis*, *M. mendica*, *M. pugnata*, *M. sculpturalis*

'Leaf-cutting bee' is a common name for bees that use pieces of leaves or flowers to construct their nests. Leaf-cutting bees are closely related to 'Mason bees.' They are black bees with white or silvery hairs and a striped abdomen. Their heads are large relative to their body size, with large mouth-parts used to cut leaf pieces. Uniquely, the underside of the female's abdomen has a dense brush of hairs that is used for carrying pollen which is unlike other bees that carry pollen on their hind legs. Most leaf-cutting bees nest in pre-existing cavities, such as hollow plant stems, hollow trees and holes created by wood boring insects. Most species are solitary but have communal nesting habits. Leaf-cutting bees are first observed in late spring, and some species continue collecting pollen until the first frost. These bees have a single generation per year. Leaf-cutting bees are most active in midsummer, when the temperatures rise above 70 F.



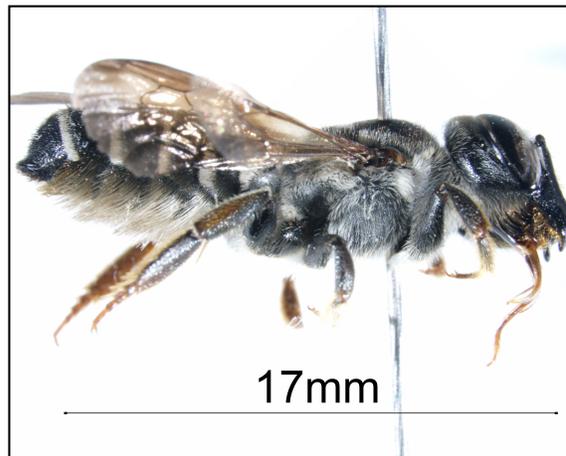
*Megachile mendica*

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## LEAF-CUTTING BEES

**Photo 8:** *Megachile pugnata*, a leaf-cutting bee, notice pollen carrying hairs on the underside of its abdomen.



**Photo 9:** A lateral view of the abdomen of *M. mendica* showing the special hairs (scopa) that collect and carry pollen on the underside of the abdomen.



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## CARPENTER BEES (Apidae, Xylocopinae, Xylocopini and Ceratininia)

*Xylocopa virginica*

*Ceratina calcarata*, *C. dupla*, *C. strenua*

These two groups of bees do not look much alike. The large carpenter bee is robust and often confused for a bumble bee. It lacks the hairy abdomen associated with bumble bees, its abdomen is metallic bluish-black and males have a prominent yellow patch in the middle of the face. The large carpenter bee also lacks the hind leg pollen baskets which bumble bees possess. The small carpenter bee is tiny, bluish black and is less hairy. Both small and large carpenter bees may be common on cucurbits but we do not know their value as pollinators. Both nest in wood; the large carpenter bee drills nickel-sized holes in wooden structures, including barns; the small carpenter bee also nests in wood but prefers pre-made holes often made by wood boring beetles or in dead trees or other wooden structures with pre-existing holes.

*Note: Large carpenter bees bite blossoms and rob nectar without pollinating the flower and thus are not effective pollinators, especially on tubular-shaped flowers.*



*Xylocopa* nest in an agave stem (AZ) by Heather Harmon

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## CARPENTER BEES

**Photo 10:** *Xylocopa virginica*, large carpenter bees resemble bumble bees but are not social insects. The yellow patch on the face signifies a male which neither pollinates nor stings.



**Photo 11:** *Ceratina calcarata*, a small bee that is a generalist pollinator that collects pollen from flowers and crops.





## MASON BEES (Megachilidae, Megachilinae, Osmiini)

*Osmia lignaria*, *O. atriventris*

'Mason bee' is a general term for certain species of bees in the family Megachilidae, also called leaf-cutting bees. Mason bees are solitary nesting bees and small to medium in size. They are typically metallic blue or green but sometimes black in color and often have white hair bands on the thorax. They do not excavate their own nests but build their nests in ready-made, above ground cavities; in hollow plant stems; and in drilled wood nesting blocks. They need mud near their nests which the females use to line their brood cells. Males emerge from nests before females in the spring. They remain near the nesting site waiting for the females. When the females emerge, the first thing they do is mate. Males die shortly thereafter and the females begin building and provisioning their nests. Females visit flowers to gather pollen and nectar, and make multiple trips to complete a pollen/nectar provision into which she will lay an egg. There will be several eggs laid in each nest cavity, in compartments. Eggs destined to become females are laid in the back of the cavity while male eggs are laid towards the front. Once a female has finished with a nest, she plugs the entrance to the cavity tube, and then may seek out another nest location. Mason bees are increasingly cultivated to improve pollination for early spring fruit flowers.

*Note: The most significant native species is Osmia lignaria, the orchard mason bee or blue orchard bee, which is managed for crop pollination similar to the honey bee. Osmia spp. can be attracted to nest in wooden blocks with holes drilled in them.*

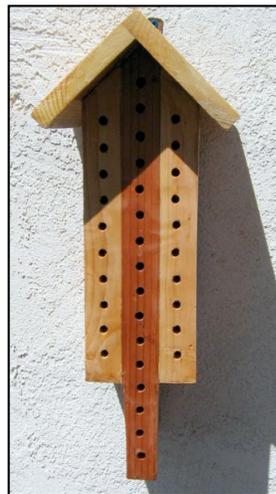
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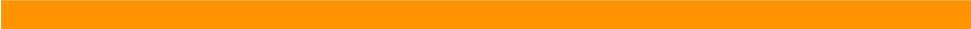
## MASON BEES

**Photo 12:** *Osmia lignaria*, the common orchard mason bee.



**Photo 13:** Mason bees are attracted to wooden nest blocks and easily cultivated for pollination services.





## HONEY BEE (Apidae, Apinae, Apini)

*Apis mellifera*

The honey bee is not native to North America. It is a Eurasian and African species originally brought to this continent by European settlers as a source of honey. Honey bees successfully spread throughout North America after their introduction and were once common in tree hollows and the sides of farm buildings but mites have reduced these wild or feral populations. Today, most of the honey bee colonies live in man-made hives. The honey bee is an important pollinator in modern agriculture.

The honey bee is a cavity nester. Colonies are perennial, with the queen and workers over-wintering in the hive. A queen may live several years. Unlike the bumble bee queen, a honey bee queen is unable to start a colony by herself. The sex of a bee is in large part controlled by the fertilization of the egg: fertilized eggs develop into females, and unfertilized eggs develop into males. Whether a larval honey bee, destined to become a female, becomes a worker or queen depends on the sort of food it is fed. There is normally only one queen in a colony. When a new one is produced, it may be killed by the old queen, or one of the queens (usually the old one) may leave the hive in a swarm, along with a group of workers, and build a nest elsewhere. The new queen mates during one or possibly several mating flights, with a male drone bee and thereafter never leaves the nest except to swarm. The drones serve only to fertilize the queen. Drones may be present in a normal, healthy hive during the peak of the season (July-August) but are kicked out of the hive by the workers at the onset of cold weather and at times of nectar dearth.

Honey bees are generalist pollinators and a colony will visit well over 100 different flowering plants during the active season. They store honey reserves for the winter when they cluster inside the nest. They pollinate over 100 crops including all of the cucurbits.

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## HONEY BEE

**Photo 14:** *Apis mellifera*, the honey bee is managed commercially and can be found at farms of all sizes helping to pollinate hundreds of species of both flowers and crops.



**Photo 15:** Honey bees range in size from 14-20 mm or 1/2 to 3/4 inches





## A QUICK GUIDE TO NATIVE BEES

1. Bumble bees – *Bombus spp.*

A social bee, 1/2 to 1 inch in size, with hairy black and yellow bodies. Form small, social colonies, usually underground. Found from spring to fall.

2. Digger bees– *Peponapis pruinosa* and *Melissodes bimaculata*

Similar in size to honey bees, digger bees are solitary but will construct nests in groups. Nests are built under ground. Major pollinators of cucurbit crops such as squash, gourds and pumpkins.

3. Sweat bees – family Halictidae

Small and medium sized bees that can vary in color from metallic green or blue to brown often with hair bands on the abdomen and hairy hind legs. These bees can be solitary or social and nest in the ground.

4. Carpenter bees – *Ceratina spp* and *Xylocopa virginica*

The large carpenter bee is robust and often confused for a bumble bee. Large carpenter bees can be distinguished by a hairless, shiny black abdomen. The small carpenter bee is tiny, distinctly bluish-black with a prominent white stripe in the middle of the face. Both species nest in wood.

5. Leafcutting and Mason bees – family Megachilidae

Solitary, medium sized bees, gray to black in color often with a striped abdomen. Carry pollen beneath their abdomens, not on their legs like other bees. Nest in ready-made, and hollow cavities. Active from early spring to after the first frost.

6. Honey bees – *Apis mellifera*

Non-native bees usually brought in to pollinate crops in managed hives. Effective pollinators for a variety of crops.

## SUGGESTED PLANTS

To attract a diverse group of pollinators, plant a variety of flowering plants along field edges, in hedgerows, and alongside structures to provide additional resources of pollen and nectar. The plants listed below are arranged according to bloom time and color.

<b>Genus species</b>	<b>Common name</b>	<b>Color</b>	<b>Bloom time</b>
<i>Daucus carota</i>	Queen Anne's lace	white	May-Oct
<i>Penstemon digitalis</i>	tall white beardtongue	white	May-July
<i>Hypericum perforatum</i>	common St. John's wort	yellow	June-Sept
<i>Verbena urticifolia</i>	white vervain	white	June-Oct
<i>Rudbeckia hirta</i>	black-eyed susan	yellow	June-Oct
<i>Asclepias tuberosa</i>	butterfly milkweed	orange-yellow	June-Aug
<i>Asclepias syrica</i>	common milkweed	pale purple	June-Aug
<i>Oenotehra biennis</i>	evening primrose	yellow	June-Aug
<i>Eupatorium fistulosum</i>	Joe pye weed	pink	July-Sept
<i>Liatris spicata</i>	marsh blazing star	purple	July-Sept
<i>Veronia noveboracensis</i>	New York ironweed	purple	July-Sept
<i>Chamaecrista fasciculata</i>	partridge pea	yellow	July-Sept
<i>Elymus villosus</i>	silky wild rye		July-Sept
<i>Panicum virgatum</i>	switch grass		July-Sept
<i>Solidago canadensis</i>	Canada goldenrod	yellow	July-Oct
<i>Silene armeria</i>	catchfly	magenta	July-Aug
<i>Monarda punctata</i>	horsemint	yellow or purple	July

<b>Genus species</b>	<b>Common name</b>	<b>Color</b>	<b>Bloom time</b>
<i>Aster novae-angliae</i>	New England Aster	purple	Aug-Sept
<i>Helianthus microcephalus</i>	small headed sunflower	yellow	Aug-Sept
<i>Solidago nemoralis</i>	gray goldenrod	yellow	Aug-Sept
<i>Aster prenanthoides</i>	zigzag aster	pale purple	Aug-Oct
<i>Andropogon scoparius</i>	Camper little blue stem		Aug-Oct
<i>Sorghastrum nutans</i>	Rumsey Indian yellow grass		Aug-Oct
<i>Senna hebecarpa</i>	wild senna	yellow	Aug
<i>Solidago speciosa</i>	showy goldenrod	yellow	Sept-Oct
<i>Lespedeza capitata</i>	round-head bush clover		



## RESOURCES AND REFERENCES

### Photography

BugGuide: <http://bugguide.net/node/view/15740>: Identification, images and information for insects, spiders and their kin for the United States and Canada.

Cover page art provided by: Kelly M. Sverduk

Bee Nesting Blocks by: Faith Kuehn, Delaware Department of Agriculture

Photographs 1, 2, 4-9,11, 15 and *Rudbeckia hirta* by Heather Harmon; 3 by Jimmy Kroon, Delaware Department of Agriculture, Plant Industries.

*Peponapis pruinosa* on squash flower, and photo 14: Dewey Caron, University of Delaware.

*Megachile medica*: © Copyright John Ascher, 2006-2007 / [www.discoverlife.org](http://www.discoverlife.org)

Photo 10, Steve Jacobs, Sr. Extension Associate. Pennsylvania State University, Department of Entomology, Cooperative Extension, Entomological Notes; Carpenter Bees, *Xylocopa virginica*.

Photo 12 and 13: Robert Engelhardt

### Publications

Isaacs, R. and J. Tuell. 2007. *Conserving Native Bees on Farmland*. Michigan State University Extension Bulletin E-2985. (Available online at <http://www.maes.msu.edu/extension/bulletin/E-2985/>)

Shepherd, M., S. L. Buchmann, M. Vaughan, and S. Hoffman Black. 2003. *Pollinator Conservation Handbook*. The Xerces Society in Association with The Bee Works, Portland, OR. 145 pp.

Vaughan, M., M. Shepherd, C. Kremen, S. Hoffman Black. 2006. *Farming for Bees: Guidelines for Providing Native Bee Habitat on Farms*. The Xerces Society. Portland, OR. 34 pp.



## Internet Sites

North American Pollinator Protection Campaign

<http://www.nappc.org/>

The Pollinator Partnership

<http://pollinator.org/index.html>

The Xerces Society for Invertebrate Conservation

<http://www.xerces.org>

USDA-Agriculture Research Service

[http://www.ars.usda.gov/main/site\\_main.htm?modecode=54-28-05-00](http://www.ars.usda.gov/main/site_main.htm?modecode=54-28-05-00)

USDA Forest Service

<http://www.fe.fed.us/wildflowers/pollinators/index.shtml>

USDA Natural Resource Conservation Service (NRCS)

<http://www.nrcs.usda.gov>

## Local Resources

Mid-Atlantic Apiculture Research and Extension Consortium, Dewey Caron, Department of Entomology and Applied Ecology, 250 TNS, University of Delaware, Newark, DE 19717. (302) 831-8883.

<http://maarec.cas.psu.edu/>

**Farming for Pollinators in Delaware.** A Delaware Department of Agriculture and NRCS publication.

**Delaware Native Plants for Native Bees.** A Delaware Department of Agriculture and NRCS publication.

Both publications available by contacting:

DE Department of Agriculture

Dr. Faith Kuehn

Plant Industries Administrator

2320 S. Dupont Hwy.

Dover, DE 19901

Phone: (302) 698-4500



*To obtain information about cost-share and technical assistance programs:*

**Department of Natural Resources and Environmental Control:**

Shelley Tovell  
Private Lands Biologist  
DNREC Division of Fish and Wildlife  
6180 Hay Point Landing Road  
Smyrna, DE 19977  
Phone: 302-735-3600  
Email: [Shelley.Tovell@state.de.us](mailto:Shelley.Tovell@state.de.us)

**USDA Natural Resource Conservation Service:**

Kent County Agriculture Center  
800 Bay Road, Suite #2  
Dover, Delaware 19901-4667  
Phone: 302-741-2600  
Fax: 302-741-0341

Georgetown Agriculture Center  
21315 Berlin Road, Unit #3  
Georgetown, Delaware 19947  
Phone: 302-856-3990  
Fax: 302-856-4381

New Castle Agriculture Center  
2430 Old County Road  
Newark, DE 19791  
Phone: 302-832-3100  
Fax: 302-834-0783