H1811

(Photo by E. McGinnis, NDSU)

Bee-utiful Landscapes:

Building a Pollinator Garden

Esther McGinnis, Extension Horticulturist
Janet Knodel, Extension Entomologist
Todd Weinmann, Extension Agent – Cass County

Bees are in trouble in the U.S. Native bee species are declining in numbers due to habitat loss and other factors. Approximately one-fourth to one-third of European honey bee colonies in the U.S. also die each year despite the best efforts of their attentive beekeepers.

A continued decrease in pollinator numbers will affect our food supply because insect pollination is necessary or beneficial for many fruit, nut and vegetable crops. However, the news need not be dire.

You can have a major impact by providing suitable habitat and nutrition for bees. By planting a pollinator garden, you can turn your yard or farm into an oasis for bees.

This publication will help you identify major pollinators, choose plants that will provide a continuous source of nectar and pollen during the growing season, and safely use pesticides.

NDSU EXTENSION SERVICE
North Dakota State University
Fargo, North Dakota

JULY 2016

The Importance of Pollinators

Many of our nuts, fruits and vegetables are pollinated by bees.
Nearly one out of every three mouthfuls of food comes from a bee-pollinated crop.

In a world without bees, we wouldn't have apples, blueberries, avocados, almonds, squash, melons, and many more fruits and vegetables. See Table 1. Our diet would be bland, less nutritious and definitely less colorful.

How Pollination Occurs

Pollination is the transfer of pollen grains from the anther (male) to a receptive pistil (female). Once deposited on the tip of the pistil (stigma), the pollen grain germinates and a pollen tube grows down the length of the pistil (style) to the ovary. The pollen tube transports two male gametes that fertilize an egg (ovule) and another cell to produce an embryo and endosperm to nourish the embryo (Figure 1). The embryo, endosperm and a portion of the ovule become a seed.

Pollen transfer can occur within the same flower (self-pollination), between two separate flowers on the same plant (still considered self-pollination) or between two separate flowers on two different plants of the same species (cross-pollination), depending on the pollination mechanism.

The purpose of pollination is to ensure the next generation by producing seeds. After pollination and fertilization occur, seeds are produced in what we call a botanical fruit. A botanical fruit is simply a seed-bearing structure and can include fresh produce that we normally consider to be vegetables. Apples, peppers and cucumbers are common products of pollination and are derived from the plant's ovary tissue.

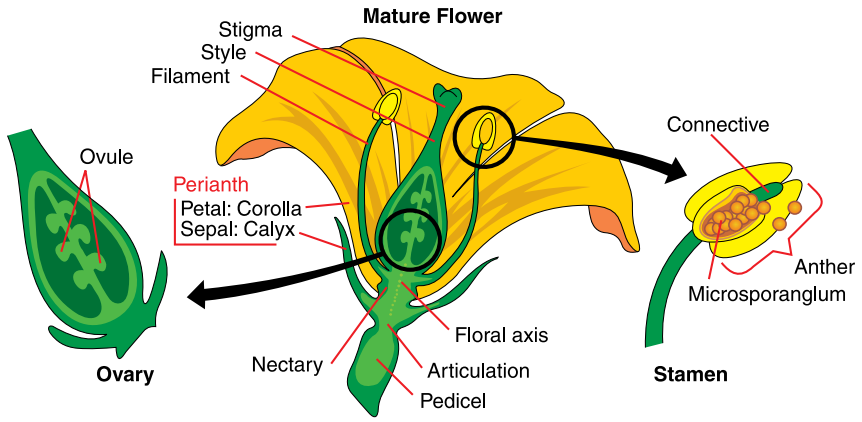


Figure 1. Flower anatomy. (Illustration by Mariana Ruiz, Wikipedia)

Table 1. Common backyard fruit and vegetable crops and whether they require bee pollination.

Information derived from the 2015 U.S. Department of Agriculture document titled "Attractiveness of Agricultural Crops to Pollinating Bees for the Collection of Nectar and/or Pollen."

Backyard Crops	Honey Bees	Bumble Bees	Other Native Bees	Bee pollination required?
Apples	✔	✔	Mining bees, Sweat bees, Mason bees	Yes
Beans (string)	✔	✔	Unknown	Not required
Cucumbers	✔	✔	Long-horned bees, Mining bees	Yes, for many varieties
Eggplant	No	✔		Not required
Muskmelon	✔	✔	Small carpenter bees, Long-horned bees, Green sweat bees	Yes
Peas	✔	✔	Large carpenter bees	Not required
Pears	✔	✔	Mason bees, Mining bees	Yes
Peppers	✔	✔		Not required
Plums	✔	✔	Mason bees, Digger bees	Yes
Pumpkins, squash, zucchini	✔	✔	Green sweat bees, Long-horned bees	Yes
Sour cherry	✔	✔	Mason bees	Yes
Raspberries	✔	✔	Mason bees, Mining bees, Cellophane bees, Sweat bees	No, but beneficial
Strawberries	✔	✔	Mining bees, Sweat bees, Mason bees	No, but beneficial
Tomatoes	No	✔		No, but beneficial

Pollinator Decline

Generally, pollination occurs in two ways: wind and animal. Agronomic crops such as wheat, soybeans and corn are wind-pollinated. No insects are required for an ear of corn to develop. The wind simply blows the pollen from one plant to another. Showy flowers are unnecessary in wind-pollinated plants because they have no need to attract an insect pollinator.

Animal pollination requires an insect, bird or mammal to carry pollen from one flower to another. This publication will focus on insect pollination, but hummingbird plant preferences will be mentioned in Tables 3-5.

Cucurbits such as melons, squash, zucchini, pumpkins and most cucumbers depend on bees for pollination because they have separate male and female flowers on the same plant. For pollination to occur, a bee must visit a male flower and then deliver the sticky pollen to a female flower.

Cross-pollination

Plants have different pollination mechanisms. Some plants require cross-pollination, meaning that they require pollen from a plant that is genetically different. Fruit trees such as apples, pears and American plums require pollen from a different variety of tree.

For example, a Honeycrisp apple flower must receive pollen from another apple variety, such as Haralson or Cortland. A Honeycrisp tree will not produce fruit if only Honeycrisp pollen is available. Bees are an important means of ensuring cross-pollination in fruit trees.

Self-pollination

Other plants such as tomatoes, are self-pollinated. This means that pollen from another plant is not necessary. When the wind vibrates the anther at the right frequency, pollen is released and lands on the pistil, resulting in self-pollination.

However, new research shows that bumble bees improve fruit production even in self-pollinated species. Bumble bees engage in a practice of buzz pollination. They grasp the flower and rapidly vibrate their flight muscles at the right frequency to release tomato pollen.

In a recent study, researchers discovered that bumble bees increased the number of tomatoes by 45 percent, compared with wind pollination. Honey bees are unable to pollinate tomatoes because they are unable to do buzz pollination.

European Honey Bees

North Dakota is the nation's leader in honey production. In 2014, North Dakota beekeepers produced 42 million pounds of honey worth $84 million. The state's 500,000 colonies of European honey bees are distributed throughout the state and spend their summers foraging for nectar and pollen on clover, alfalfa and other flowering plants (Figure 2).

Honey bees were brought to North America first by European colonists in the 1600s. Unlike native bees, honey bees have a hard time wintering in North Dakota unless their hives are well-insulated. During the winter, the majority of honey bees are shipped to California and other warm states to overwinter and then pollinate almond, vegetable and fruit crops in late winter (Figure 3).

Figure 2. Honey bee on dandelion.
(Photo by Phil Sloderbeck, Kansas State University, Bugwood.org)

Figure 3. Honey bee colonies. (Photo by Gerald Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org)

Colony collapse disorder (CCD) frequently has been covered by the news media. This disorder is manifested by the sudden disappearance of adult worker bees with no dead bodies in the colony. The queen and her larvae are the only inhabitants left in the colony.

While CCD is alarming, winter die-off is an even bigger concern for the honey bee industry. Approximately 30 percent of colonies die each winter.

The cause of CCD and winter die-off still are being studied, but a multitude of factors appear to play a role. Varroa mites are parasites that feed on the blood of honey bees. Fungal, bacterial and viral diseases further weaken the bees.

Other potential factors include migratory stress as colonies are shipped between North Dakota and other states, as well as poor nutrition. Honey bees may feed on a single crop such as almond flowers for two or more weeks when they are shipped to California and other southern states. Diverse sources of forage are better for their health than a single source.

In addition, pesticides may play a contributing role in the decline of honey bees. Bee kills from lethal exposure to insecticides have been featured on the news. Less is known about sublethal exposures to insecticides such as neonicotinoids. Neonicotinoids are a class of insecticides that are taken up systemically by plants and may appear in pollen and nectar.

The U.S. Environmental Protection Agency (EPA) is conducting risk assessments to determine the effect of five neonicotinoid insecticides on honey bees.

Bumble Bees

Bumble bees (*Bombus* spp.) are the most well-known of the native bee species (Figure 4). Their wide, fuzzy bodies seem to defy the laws of physics as they fly through the air. Of the 46 species that are native to North America, approximately 20 species call North Dakota home. A complete survey of bumble bee species has not been conducted in North Dakota.

They live in social colonies with a single queen. Depending on their species, each colony can house 50 to 1,000 individuals. Unlike honey bees, many bumble bee species live underground in abandoned rodent burrows, and they do not store honey.

Bumble bees are better adapted to cold weather than their European cousins and can fly on cold, cloudy days when honey bees are confined to the hive. Consequently, bumble bees can be better pollinators of early spring fruit trees such as apple and plum in North Dakota (Table 1).

Bumble bee colonies are annual. Each spring, a single, pregnant queen emerges from her underground burrow, feeds on nectar and pollen from early spring flowers, and then begins constructing her nest. The nest can be above-ground or underground, depending on the bumble bee species.

Figure 4. Bumble bee *(Bombus impatiens)* on cone flower.
(Photo by David Cappaert, Michigan State University, Bugwood, org)

The queen proceeds to lay eggs that will hatch into female worker bees that will forage for food, take care of the larvae and defend the colony. In late summer, the queen produces male bees that will mate with young, large females that will become next year's queens. The whole colony, with the exception of the newly fertilized queens, dies as fall progresses.

Although bumble bees are not susceptible to CCD and winter die-off, many species are in decline. Of the approximately 20 species that are native to North Dakota, three and possibly more species appear to have decreasing populations.

A parasitic fungus called *Nosema bombi* appears to be undermining the health of a few native species. Researchers hypothesize that commercial bumble bees that were sold to pollinate greenhouse crops may have escaped and introduced this fungal parasite into the native bumble bee population in the U.S.

Loss of habitat and suitable forage also may impact native bumble bee populations. As native prairie and Conservation Reserve Program lands are converted to cropland, native wildflowers and flowering weeds that provide much-needed nectar and pollen become less abundant.

The life cycle of bumble bees shows the need for a continuous supply of nectar and pollen from early spring through late fall. As native flowering plants give way to corn, wheat and soybean fields, suitable bumble bee habitat is eliminated or fragmented.

Most bumble bee species can travel only one-third to one mile in search of flowers,

while honey bees can travel 2½ miles. Therefore, bumble bees are more limited in their foraging ability.

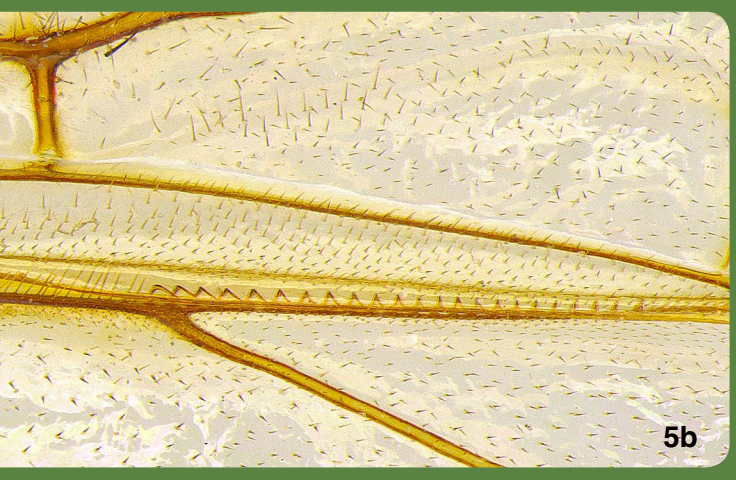
Our towns and cities also may be inhospitable places for bumble bees. Vast expanses of weed-free lawns provide no food or nesting habitat for bees. Overuse of pesticides, such as insecticides and fungicides, also may have a detrimental effect on bumble bees.

Solitary Bees

Most bee species do not live in social colonies like honey bees and bumble bees. Solitary bee species have short lives and produce a single generation of bees. They have no worker bees; each bee outfits her own nest and lays eggs in cells.

Most solitary bees, such as cellophane bees and green sweat bees, live in underground nests that they have excavated. About one-third of solitary bees, such as mason bees, leafcutter bees and masked bees, nest in dead plant stems or small holes in trees that have been drilled by woodpeckers or wood-boring insects.

Less is known about the status of solitary bee species in North Dakota. However, solitary bees such as mason bees can be important pollinators of backyard orchards and vegetable gardens.



Figures 5a and b. Two pairs of wings of bees with shadowed submarginal cells and close-up of small hooks (hamuli).
(Photos by Patrick Beauzay, NDSU)

Bee Identification

Bees belong to the Order Hymenoptera, which includes wasps, ants and bees. Bees are very diverse in color, shape, size and nesting habits, but they generally are easy to recognize as "bees."

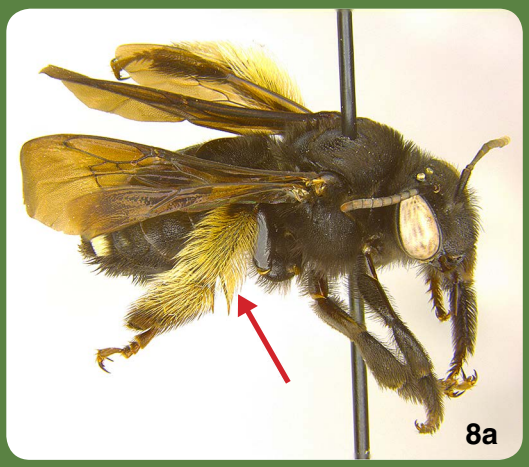
Color can range from black-brown with yellow-white hair markings to metallic green-blue, and size ranges from as small as 5 millimeters (mm) to as large as 25 mm. They can be found anywhere, especially where flowers are available for food (nectar and pollen).

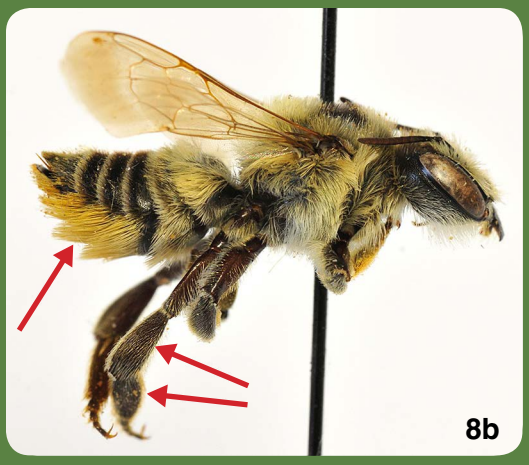
Some general characteristics of bees are:

- **Head:** The head of the bee is round to heart-shaped, and has long, narrow eyes on the side.
- **Thorax:** Two pairs of wings are found on the thorax (Figure 5a). The front and hind wings are connected by small hooks called hamuli (Figure 5b). The front wing has one to three closed cells along the leading edge of the wing called submarginal cells that are used in identification (Figure 5a).
- **Abdomen:** The abdomen of female bees has a stinger that is used primarily for defense of the nest. Most stings of native bees are weak and more annoying than painful. Their behavior is usually nonaggressive toward people unless defending their nest.
- **Special Characteristics:**
  - Most bees have **hairy bodies**, giving them a fuzzy appearance (Figure 6). Hairs are branched but must be viewed under a microscope or magnifying lens (10x) to see the branches (Figure 7).

Figure 6. Bumble bee on thistle showing typically hairy body of bees.
(Photo by Patrick Beauzay, NDSU)

Figure 7. Close-up of branched hairs of bees.
(Photo by Patrick Beauzay, NDSU)





Figures 8a and b. Arrows show pollen-collecting hairs (scopae) on rear legs of long-horned bee (top) or underneath abdomen of leaf-cutting bee (bottom). (Photo by Patrick Beauzay, NDSU)

- For carrying pollen, most species have areas of **pollen-collecting** hairs (scopae) on the rear legs or underneath the abdomen (Figures 8a and b) or long, stiff, inward-curving hairs surrounding a flat area on the rear legs forming a **pollen-collecting basket** (corbicula, Figure 9).

About 250 species of bees live in North Dakota, and more than 4,000 species live in North America. Key features used to identify the major families of bees in North Dakota are listed in Table 2. Nesting locations and common bee behavior also can be used to help with identification (Table 2).

Bee identification can seem overwhelming at first; however, learning what to look for and how to distinguish a bee from other bees is important. You will be amazed at the diversity of bees that you can find in your flower garden!

Bees can be divided into two groups: short-tongued bees and long-tongued bees. The short-tongued bees (Figure 10a) also have three bee families: Andrenidae, Colletidae and Halictidae. The long-tongued bees (Figure 10b) are in three families: Apidae, Megachilidae and Melittidae (not discussed here due to limited species in North Dakota).

Figure 9. Circle shows pollen-collecting basket (corbicula) on rear leg of bumble bee. (Photo by Patrick Beauzay, NDSU)

Figures 10a and b. Example of short-tongued bee, cellophane bee (on left) and long-tongued bee, long-horned bee (on right). (Photo by Patrick Beauzay, NDSU)

Bee Mimics

Other insects look and even sound like bees, but they are not bees. These bee mimics include some flies and wasps.

Flies

Flies are easy to distinguish from bees because they have only two wings; in contrast, a bee has four wings. Second, flies usually have short antennae with only three segments; bees have long, segmented antennae, with 12 segments for females and 13 segments for males.

The compound eye of flies is large and takes up most of the head, whereas bee eyes are limited to the sides of the head. The hoverfly or flower fly (Family Syrphidae) looks like a bee with yellow and black markings on the body and even buzzes like a bee when pollinating flowering plants (Figures 11a and b).

Another fly group that mimics bees is called the bee fly (Family Bombyllidae), which feeds on nectar and pollen as valuable pollinators (Figures 12a and b).

Wasps

Wasps belong to the Order Hymenoptera, like bees, and hence have some of the characteristics of bees, such as four wings, a stinger and long antennae. However, wasps have sparse and simple hairs, while bees are hairy on most of the body, with branched hairs.

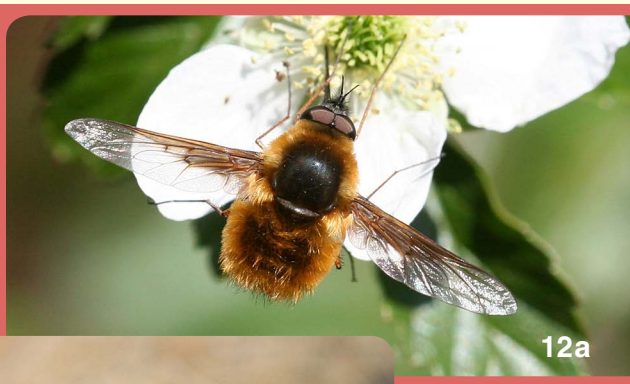
Second, wasps have narrow, round hind legs in cross section, compared with bees, which have wide, flat hind legs that are modified with pollen-collecting hairs, or pollen basket.

The body of a wasp has a narrow "waist" between the thorax and abdomen, while bees do not. The yellow and black markings of wasps are more brightly colored than bees and indicate "warning" to any predator or person who disturbs them.

Wasps can sting more than once because their stinger is not barbed like it is on bees and it stays with the insect. A good example is yellow-jackets or hornets (Family Vespidae), which are more aggressive and likely to sting people during late summer (Figure 13). Yellow-jackets are predators of bees and other insects and also feed on flower nectar.

Nests of some wasps are made of mud or paper that hangs from trees or buildings, such as the bald-faced hornet's nest. Bees do not construct these types of nests.

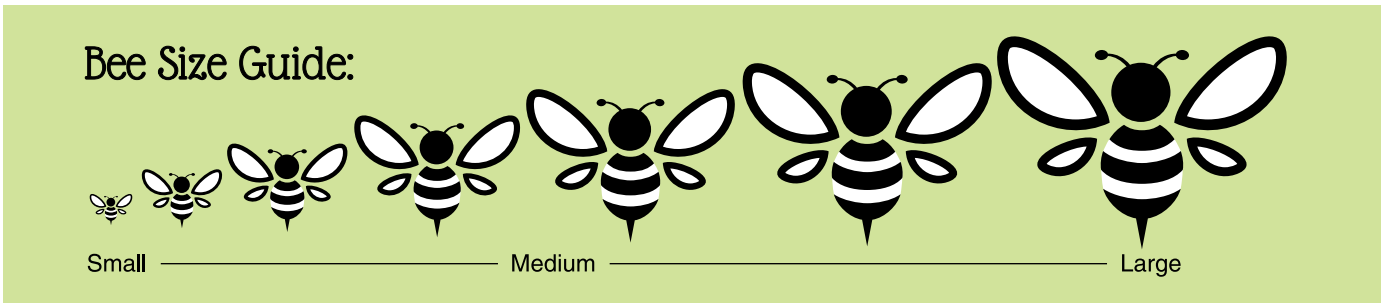
Figures 11a and b. Hoverfly or flower fly (Syrphidae), a bee mimic. (Photo by Patrick Beauzay, NDSU)



Figures 12a and b. Bee fly (Bombyliidae), a bee mimic. (Photos by Johnny N. Dell, Bugwood.org, David Cappaert, Michigan State University, Bugwood.org)

Figure 13. Yellow-jacket wasp or hornet (Vespidae), a bee mimic. (Photo by Patrick Beauzay, NDSU)

Table 2. Key Identification Characteristics and Nesting Sites of the Major Bee Families in North Dakota.



Common Name Family	Size	Key Identification Characteristics	Nesting Sites
Mining bee Andrenidae	Small to medium (6-18 mm)	Front of face of females has large, shallow depressions (called facial fovea) with short velvety hairs (sometimes white) between eyes and antennae. Looks like eyebrows (Figure 14a). Short-tongued. Second submarginal cell is smaller than third submarginal cell (Figure 14b). Generally black with pale hair stripes on abdomen. Pollen-collecting hairs on rear legs and side of thorax; looks like pollen collected in "armpits."	Nest solitary in ground, often in large aggregations. Prefers to build nests in lawns with sandy soils near or under shrubs.
Cellophane bee Colletidae	Small to medium (7-15 mm)	Slender body with light bands of hair on their abdomens. When viewed from the front, heads appear heart-shaped and eyes are slanted toward each other (Figure 10a). Short-tongued (unique two-lobed tongue). Second submarginal cell is the same size as third submarginal cell (Figure 15). Pollen-collecting hairs on the upper part of hind legs and thorax. Many *Colletes* spp. are specialists and will collect pollen only from specific plants, such as prairie clover.	Nest solitary in ground, but some in large aggregations. Line their nests with a waterproof secretion that dries to a cellophane or polyester-like substance and protects it from fungal infections.
Masked bee Colletidae	Small (<7 mm)	Bodies are shiny, slender, hairless and wasplike (Figure 16a). Females lack pollen-collecting hairs, store pollen and nectar in their crops (honey stomach). They regurgitate it for young in nest. Most have some facial markings, yellow to white (Figure16b). Markings variable, even within a species. Short-tongued.	Nest solitary in hollow branches and cavities, some in the ground.

(Photo by Patrick Beauzay, NDSU)

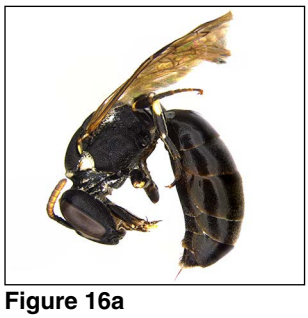
Figure 14a

(Photo by Patrick Beauzay, NDSU)

Figure 14b

(Photo by Patrick Beauzay, NDSU)

Figure 15



(Photo by Patrick Beauzay, NDSU)

Figure 16a

(Photo by Patrick Beauzay, NDSU)

Figure 16b

(Photo by Patrick Beauzay, NDSU)

Figure 17a

(Photo by Patrick Beauzay, NDSU)

Figure 17b

(Photo by Patrick Beauzay, NDSU)

Figure 17c

(Photo by Patrick Beauzay, NDSU)

Figure 17d

Table 2. Key Identification Characteristics and Nesting Sites (continued)

Common Name Family	Size	Key Identification Characteristics	Nesting Sites
Sweat bees Halictidae	Small to medium (5-15 mm)	Bright metallic green, dull metallic green or black/brown with light bands of hair on the abdomen (Figures 17a-c). Basal wing vein strongly arched (Figures 17d). Pollen-carrying hairs on rear legs. Short-tongued. Attracted to the salt when you sweat.	Nest in soil, solitary to semisocial to some communal nesters.
Leaf-cutting bees Megachilidae	Medium to large (7-20 mm)	Pollen-collecting hairs on ventral surface of abdomen (Figure18a). Stout, dark body with light bands of hair on pointy abdomens. Head as broad as thorax with large mouthparts to cut leaves. Cut round pieces of leaves to line nests (Figure 18b). This small amount of leaf removal is not harmful to the plant. Long-tongued.	Nest solitary in holes or cavities (natural or man-made).
Mason bees Megachilidae	Small to medium (5-15 mm)	Pollen-collecting hairs on ventral surface of abdomen (Figure 19a). Robust round body, two color types: 1) metallic green-blue with less hairs and 2) black body covered with light hairs. Some species are used commercially for pollination services. Efficient pollinators of many crops; for example, *Megachile rotundata* (alfalfa leaf-cutter bee) is essential for alfalfa seed production and *Osmia lignaria* (blue orchard bee) is used for pollinating almonds, cherries and apples. Long-tongued.	Solitary or nest in groups in artificial nesting structures (Figure 19b) (widely available at garden supply stores or build your own).

(Photo by Patrick Beauzay, NDSU)

Figure 18a

(Photo by K. Steinmann, University of California, Bugwood.org)

Figure 18b

(Photo by J. Dykinga, U.S. Department of Agriculture-Agricultural Research Service, Bugwood.org)

Figure 19a

(Photo by J. Knodel, NDSU)

Figure 19b

Table 2. Key Identification Characteristics and Nesting Sites (continued)

Common Name Family	Size	Key Identification Characteristics	Nesting Sites
European honey bee *(Apis mellifera)* Apidae	Medium (10-15 mm)	Hairy body, golden brown with dark brown legs, hairy eyes (Figure 20). Hind tibia with pollen basket (or corbicula). Hind tibia without spurs. Long-tongued. Swarm to find new nesting sites.	Nest in man-made hives and in open cavities, such as stumps or hollow tree cavities. Social bees.
Bumble bees (*Bombus* spp.) Apidae	Medium to large (10-23 mm)	Robust, very hairy (fuzzy), often black body with yellow, white, red or orange bands of hairs (Figure 21a). Long-tongued. Hind tibia with pollen basket (or corbicula) (Figure 21b). Hind tibia with spurs. Pollinates in cool, cloudy weather. Makes low buzzing sound when flying and uses buzz pollination for some flowers, such as tomatoes. Many species are in decline due to introduced diseases.	Nest underground, commonly in old rodent burrows or grass tussocks. Social bees.
Long-horned bees and Digger bees Apidae	Small to large (7-18 mm)	**Long-horned bees:** Black body with dense pale hairs on thorax and abdomen. Long-tongued. Males have long antennae (Figure 22a). Females have pollen-collecting hairs on lower half of the hind legs. **Digger bees:** (Figure 22b) Robust, round, hairy bees. Long-tongued. Females have pollen-collecting hairs on hairy hind legs. Fast-flying bees.	Most species are solitary to communal ground nesters. Digger bees prefer to nest gregariously in lawns with dry, sandy soil.

(Photo by D. Cappaert, Michigan State University, Bugwood.org)

Figure 20

(Photo by Patrick Beauzay, NDSU)

Figure 21a

(Photo by Patrick Beauzay, NDSU)

Figure 21b

(Photo by Patrick Beauzay, NDSU)

Figure 22a

(Photo by Patrick Beauzay, NDSU)

Figure 22b

Planting a Pollinator Garden

We can help pollinators by designing our yards to become a hospitable haven for pollinators such as honey bees and native bees. The first step is to incorporate a variety of flowering plants into the landscape. You can beautify your yard and help the bees at the same time. Additional steps include providing a water source, creating a suitable habitat or shelter, and limiting use of detrimental pesticides.

Plants for Bees

While flowers dazzle us with their color and beauty, honey bees and native bees see flowers as a food source. Sugary nectar provides carbohydrates to help power the bees as they go about their daily foraging.

Nectar usually is produced deep within the flower, which increases the chances for bees to come in contact with the pollen-coated anthers. Bees also deliberately collect pollen as an important source of protein. They combine pollen and nectar to make bee bread, a nourishing food source for bee larvae.

With the diversity of native bees in North Dakota, many species are active at any given time throughout the entire growing season. In addition, some species produce multiple generations of bees throughout the year. Therefore, providing a continuous supply of blooming plants from early spring through fall is important.

To satisfy short-tongued and long-tongued bee species, plant flowers in a variety of colors and shapes. Generally, bees prefer flowers that are white, yellow, purple, violet or blue. Butterflies are attracted to the same colors, plus red and pink.

Native plants are extremely important to bees because these plants co-evolved with our native pollinators. Therefore, they are more likely to provide larger quantities of nectar and pollen and bees may be more attracted to them.

Native plants should make up the majority of species in a pollinator garden. Many beautiful native plants are listed in Tables 3 and 5. If you select native plants that are well-suited to your soil type and precipitation levels, your pollinator garden will be low-maintenance, too.

Some non-native ornamentals, such as catmint and salvia, also may provide valuable pollinator services. If you decide to plant a non-native species in a pollinator garden, choose one that is not double-flowered.

A plant that is double-flowered is bred to have an extra set of petals that replaces important reproductive parts such as stamens or pistils (Figure 23). These types of "improved" cultivars may not produce pollen or nectar. Alternatively, the extra petals may block the pollinator from reaching the pollen or nectar.

A quick and easy perennial pollinator garden can be designed from the choices offered in Table 3. By choosing two or more plant species from each seasonal category, you can ensure many weeks of beautiful blooms in your garden. Please note that these plant choices are for a full sun exposure.

Spring

- Spring-flowering perennials such as crocus, grape hyacinth, prairie smoke and wild columbine provide important early sources of nectar for hungry bumble bee queens. Not all spring flowers are equally beneficial. Most tulips and daffodils have been heavily hybridized and will not attract bees.

June

- Golden Alexander, a North Dakota prairie native, is an important June-blooming perennial. Its flat clusters of yellow flowers resemble dill. In addition to providing abundant nectar for bees, this plant is an important host plant for caterpillars that will later transform into black swallowtail butterflies.
- Orange-flowered butterfly weed provides cheerful flowers that begin to bloom in June and continue for an extended period of time (Figure 24). Although butterfly weed is a milkweed, it provides benefits for more than just butterflies. Many milkweeds are rich sources of nectar for bees. Although butterfly weed is not native to North Dakota, it is native to South Dakota and Minnesota. This plant grows best in drier soils, so it is a good choice for the western half of North Dakota.

Figure 23. This Echinacea is double-flowered and fails to provide adequate pollinator services. The reproductive parts have been replaced with an extra set of petals.
(Photo by Esther McGinnis, NDSU)

Summer

The summer-flowering category (Table 3) lists many choices to adorn your garden and feed the bees.

- Culver's root is an underutilized plant that looks equally at home in formal botanical gardens as it does on the prairie (Figure 25). The plant's candlelike inflorescences provide a focal point for the back of the garden.
- *Echinacea,* otherwise known as purple coneflower, is a popular pollinator garden choice. The flower's spiny brown cone offers a convenient place for insects to land, sip nectar and gather pollen (Figure 26). A wide variety of insects congregate around *Echinacea* plants. The only downside to these plants is that they are rather short-lived.
- Native blazing stars are all-stars of pollinator gardens. Natives such prairie blazing star and meadow blazing star (Figure 27) draw many more visitors than cultivated varieties, such as 'Kobold.' Prairie blazing star blooms in July and is better adapted to clay soils, while meadow blazing star blooms in August and can take drier soils.

Fall

Fall-blooming flowers are especially important to allow new bumble bee queens to grow and mate with males to ensure the next generation.

- Tall sedums, although not native, are a staple of the fall pollinator garden. They are especially useful in well-drained soils.
- Stiff golden rod is one of the better native golden rods for garden use. Unlike other species, it does not spread by rhizomes.
- New England aster (Figure 28) is probably the most important of the fall perennials because it is one of the last perennials to bloom in the garden and provides nectar and pollen when food is scarce.

Figure 24. Butterfly weed is a good choice for western North Dakota. (Photo by Esther McGinnis, NDSU)

Figure 25. Culver's root is a 4- to 5-foot plant that provides an attractive focal point in the garden. (Photo by Esther McGinnis, NDSU)

Figure 26. Native and ornamental coneflowers attract many insect pollinators. (Photo by Esther McGinnis, NDSU)

Figure 27. Meadow blazing star is a favorite of monarchs and bees. (Photo by Esther McGinnis, NDSU)

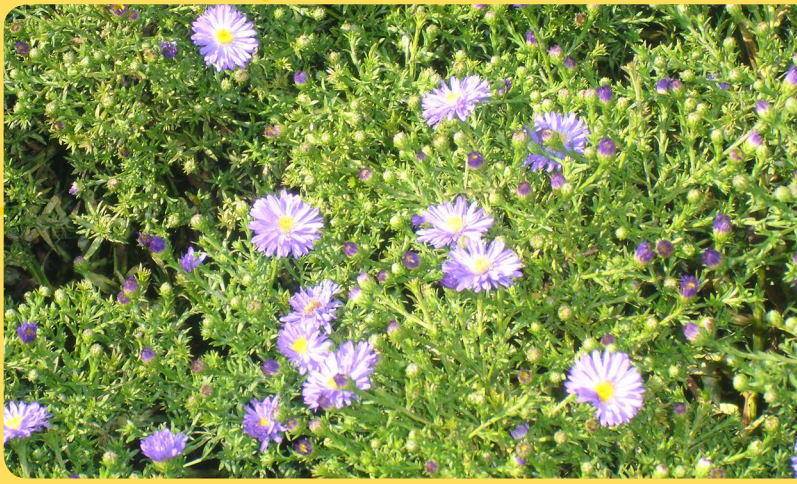


Figure 28. Asters are some of the latest-blooming plants in the garden. (Photo by Esther McGinnis, NDSU)

To ensure that bees will find your pollinator garden, plant at least three plants of each flowering perennial species. Not only will the bees be more likely to find a grouping of the same flowering plants, they also will be able to gather a substantial amount of nectar and pollen in one place. Joe Pye weed would be the exception because that plant is relatively large and three plants of this species would overwhelm the average garden.

If you discover that you have gaps in flowering in your perennial pollinator garden, incorporating a few annual bedding plants can help (Table 4). Many annuals are sold while flowering and will continue to produce flowers for most of the summer. Common bedding plants such as lantana (Figure 29) and zinnia (Figure 30) not only will draw bees, they also may attract butterflies and hummingbirds.

Other Beneficial Plantings

Herbs also can be beneficial to bees (Table 4). Borage is an underutilized herb that is an absolute bee magnet. Its purplish-blue flowers are extremely attractive to bees (Figure 31). Borage is a good herb to incorporate in and around vegetable gardens to ensure a steady supply of pollinators. However, beware of its propensity to self-seed vigorously.

When selecting trees and shrubs for your landscape, don't forget that they can be great sources of nectar and pollen, particularly in spring. May-flowering fruit trees and shrubs, such as apples, chokecherries, plums, tart cherries, honeyberries and Juneberries, provide a very important food source when very little is blooming in perennial gardens (Table 5).

Boulevard trees can be beneficial to bees, too. The wonderfully fragrant blossoms of linden (basswood) trees seem to draw every bee on the block when the trees bloom in late June into early July. Honey produced from linden trees is prized because of its golden brown color and its depth of flavor.

Other beneficial boulevard trees include honeylocust, Kentucky coffeetree and Ohio buckeye (Table 5). Common wind-pollinated trees, such as ash, are not very attractive to bees and do not produce nectar.

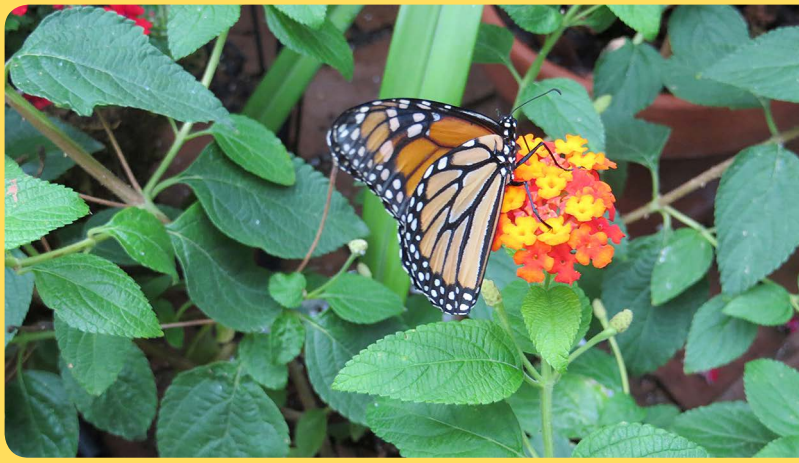


Figure 29. Lantanas will attract bees and butterflies. (Photo by Esther McGinnis, NDSU)

Figure 30. Zinnia, a common annual bedding plant. (Photo by Esther McGinnis, NDSU)

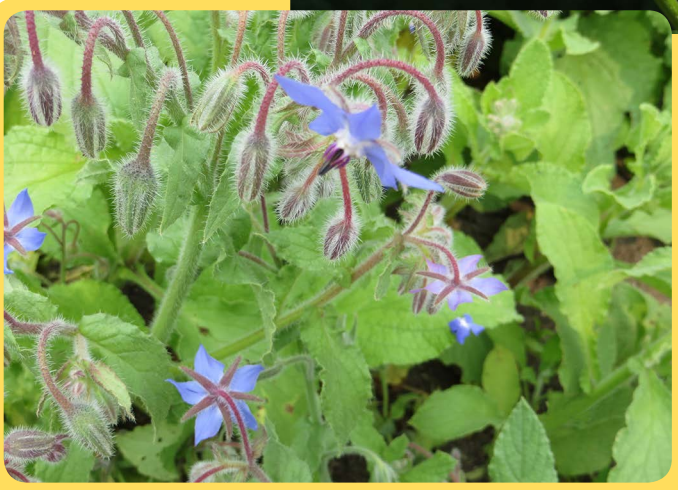


Figure 31. The bright blue flowers of borage attract bees. (Photo by Esther McGinnis, NDSU)

Table 3. Perennials by Bloom Time

Common Name	Scientific Name	Perennial or Annual	Native	Pollinators	Bloom Time	Comments
SPRING FLOWERING PERENNIALS						
Spring crocus	*Crocus* spp.	Perennial		B	March-April	The first spring bulb to bloom in North Dakota; great source of pollen and nectar for hungry bumble bee queens; bulbs must be planted in the fall.
Grape hyacinth	*Muscari* spp.	Perennial		B	April	Bulbs must be planted in the fall.
Siberian squill	*Scilla siberica*	Perennial		B	April	Bright blue flowers; caution - will spread very vigorously; goes dormant by May.
American pasqueflower	*Pulsatilla patens*	Perennial	X	B	April-May	One of the first native plants in bloom. Grows throughout North Dakota.
Prairie smoke	*Geum triflorum*	Perennial	X	B	April-May	Grows well throughout North Dakota; has great, feathery seedheads that resemble smoke.
Red columbine	*Aquilegia canadensis*	Perennial	X	B, BF, H	May-early June	Best planted in shade; red color attracts hummingbirds.
JUNE FLOWERING PERENNIALS						
Golden Alexander	*Zizia aurea*	Perennial	X	B, BF	May-June	Yellow clusters of flowers resemble dill. Butterfly host plant.
Butterfly milkweed	*Asclepias tuberosa*	Perennial		B, BF, H	June-July	Native to South Dakota and Minnesota but not North Dakota; great orange flowers; best grown in western North Dakota on well-drained soils.
False indigo	*Baptisia* spp.	Perennial		B, BF	June	Great choice for June-blooming plant.
Catmint	*Nepeta* x faassenii	Perennial		B	June	'Walkers Low' is popular in the trade; cut back after blooming for a second flush of blooms later in the season.
Salvia	*Salvia nemorosa*	Perennial		B, BF	June	'May Night' is the old standby; will rebloom if they are cut back after blooming.
SUMMER FLOWERING PERENNIALS						
Purple prairie clover	*Dalea purpurea*	Perennial	X	B, BF	July-Aug.	Grows well throughout North Dakota; has a great "landing pad" for butterflies.
Swamp milkweed	*Asclepias incarnata*	Perennial	X	B, BF	July	Best grown in the eastern half of North Dakota; grows well in a garden setting.
Black-eyed Susan	*Rudbeckia* spp. (*R. hirta* is native)	Perennial	X	B, BF	July-Sept.	Great all-around pollinator plant; seedheads will feed the birds in winter.
Prairie blazing star	*Liatris pycnostachya*	Perennial	X	B, BF, H	July-Aug.	Best grown in loamy to clay soils.
Purple coneflower	*Echinacea* spp. (*E. angustifolium* is native)	Perennial	X	B, BF, H	July-Aug.	If choosing an ornamental cultivar, do not choose one that is double-flowered.
Bee balm	*Monarda fistulosa*	Perennial	X	B, BF, H	July-Aug.	Native species can spread aggressively; cultivars may be better behaved in a garden setting; red cultivars will attract hummingbirds.
Anise hyssop	*Agastache foeniculum*	Perennial (short-lived)	X	B, BF, H	July-Aug.	Grows best in sandier soils; smells like a cross between licorice and mint.
Culver's root	*Veronicastrum virginicum*	Perennial	X	B, BF	July-Aug.	Great architectural plant; provides tall, vertical accent.
Joe Pye weed	*Eutrochium maculatum* (recent name change)	Perennial	X	B, BF	July-Aug.	Grows best in moist soils; many ornamental cultivars are available in different heights.

Table 3. Perennials by Bloom Time (continued)

Common Name	Scientific Name	Perennial or Annual	Native	Pollinators	Bloom Time	Comments
SUMMER FLOWERING PERENNIALS (continued)						
Fireworks goldenrod	*Solidago rugosa* 'Fireworks'	Perennial		B, BF	Aug.	More ornamental than stiff golden rod.
Meadow blazing star	*Liatris ligulistylis*	Perennial	X	B, BF, H	Aug.	Will grow in all parts of North Dakota with the exception of the southwestern quarter of the state; one of the best plants for monarchs.
FALL FLOWERING PERENNIALS						
Stiff goldenrod	*Solidago rigida*	Perennial	X	B, BF	Aug.-Sept.	One of the better native golden rods because it doesn't spread by rhizomes.
Sneezeweed	*Helenium autumnale*	Perennial	X	B, BF	Aug.-Sept.	Doesn't actually cause sneezing. Likes moist soils.
Tall sedum	*Hylotelephium telephium* (formerly in the *Sedum* genus)	Perennial		B, BF	Sept.-Oct.	'Autumn Joy' or any of the tall, fall-blooming sedums are great pollinator plants. Grows best in drier soils.
New England Aster	*Symphyotrichum novae-angliae*	Perennial	X	B, BF, H	Sept.- Oct.	One of the last blooming plants in the garden. Absolutely covered in bees.

B is for bee; BF is for butterfly and H is for hummingbird.
Please note that bloom times are approximate. Bloom times may vary, depending upon weather and other factors.

Table 4. Annuals and Herbs That Nourish Pollinators

Common Name	Scientific Name	Perennial or Annual	Pollinators	Comments
ANNUALS				
Alyssum	*Lobularia maritima*	Annual	B, BF	Very fragrant.
Cleome	*Cleome hassleriana*	Annual	B, BF, H	Great for a cottage garden.
Cosmos	*Cosmos* spp.	Annual	B, BF	Easy to grow from seed.
Egyptian starcluster	*Pentas lanceolata*	Annual	B, BF	Underutilized annual; butterfly magnet.
Lantana	*Lantana camara*	Annual	B, BF, H	Very drought-tolerant; butterfly magnet.
Marigold	*Tagetes* spp.	Annual	B, BF	Very common garden annual.
Sunflower	*Helianthus annuus*	Annual	B, BF	Many varieties are available.
Verbena	*Verbena* spp.	Annual	B, BF	*Verbena bonariensis* (tall verbena) is beautiful but may self-seed vigorously.
Zinnia	*Zinnia* spp.	Annual	B, BF, H	Avoid double-flowered varieties.
HERBS				
Basil	*Ocimum basilicum*	Annual	B	Let your basil flower.
Borage	*Borago officinalis*	Annual	B	Will reseed very readily; absolute bee magnet.
Chives	*Allium schoenoprasum*	Perennial	B, BF	A perennial herb that blooms in late spring when flowering plants are scarce.
Dill	*Anethum graveolens*	Annual	B, BF	Important caterpillar host plant.
Lavender	*Lavandula angustifolia*	Annual	B, BF, H	All-around good pollinator plant.
Oregano	*Origanum vulgare*	Annual	B, BF	Let your oregano flower.

B is for bee; BF is for butterfly and H is for hummingbird.
Please note that bloom times are approximate. Bloom times may vary, depending upon weather and other factors.

Table 5. Pollinator Trees and Shrubs

Common Name	Scientific Name	Tree or Shrub	Native	Pollinators	Bloom Time	Maximum Height (ft.)	Light Exposure	Hardiness Zone
BOULEVARD TREES								
Honey locust	*Gleditsia triacanthos*	Tree	X	B	May-June	50	Full sun	4*
Kentucky coffeetree	*Gymnocladus dioicus*	Tree	X	B, BF, H	May-June	60	Full sun	Plant only south of I-94 in North Dakota
Linden	*Tilia americana*	Tree	X	B, M	June-July	70	Full sun	3-4
Ohio buckeye	*Aesculus glabra*	Tree		B, H	May	35	Full sun	3
SMALL TREES/LARGE SHRUBS								
Apple	*Malus* spp.	Tree		B	May	**	Full sun	**
Chokecherry	*Prunus virginiana*	Tree	X	B	May	25	Full sun to light shade	2
Crabapple	*Malus* spp.	Tree		B	May	**	Full sun	**
False indigo	*Amorpha fruticosa*	Shrub	X	B	June	12	Full sun to light shade	2
Gray dogwood	*Cornus racemosa*	Tree or shrub	X	B, BF	June	25	Full sun to shade	3
Hawthorn	*Crataegus mollis* and other spp.	Tree	X	B, BF	May	**	Full sun	4
Nannyberry	*Viburnum lentago*	Shrub	X	B, BF	May-June	14	Full sun to partial shade	2
Pagoda dogwood	*Cornus alternifolia*	Tree		B	June	20	Full sun to partial shade	4
Plum	*Prunus americana* and other spp.	Tree	X	B, BF, M	May	20	Full sun	3
Smooth sumac	*Rhus glabra*	Shrub	X	B, BF	July	15	Full sun to partial shade	3
SHRUBS								
American cranberrybush	*Viburnum trilobum*	Shrub	X	B	May	12	Full sun to partial shade	3
Black chokeberry	*Aronia melanocarpa*	Shrub		B	May-June	6	Full sun to light shade	3
Common snowberry	*Symphoricarpos albus*	Shrub	X	B, BF, M	June-July	6	Full sun to partial shade	3
Dwarf bush honeysuckle	*Diervilla lonicera*	Shrub	X	B, M	June-Aug.	4	Full sun to partial shade	3
Golden currant	*Ribes aureum*	Shrub	X	B, BF, M	May	6	Full sun to partial shade	2
Honeyberry	*Lonicera caerulea*	Shrub		B	May	8	Full sun	2
Juneberry (Saskatoon)	*Amelanchier alnifolia*	Tree	X	B	May-June	6	Full sun	2
Leadplant	*Amorpha canescens*	Shrub	X	B, BF, M	June-Aug.	3	Full sun to partial shade	2
Ninebark	*Physocarpus opulifolius*	Shrub	X	B, BF	June-July	10	Full sun to partial shade	3
Prairie rose	*Rosa arkansana*	Shrub	X	B	June-July	3	Full sun	2
Redosier dogwood	*Cornus sericea*	Shrub	X	B, BF	May-June	10	Full sun to partial shade	2

B is for bees, BF is for butterflies, M is for moth, H is for hummingbird
*NDSU's release, Northern Acclaim® Honeylocust is hardy to zone 3.
**Varies with cultivar

Provide a Water Source

Bees require a water source because they need to supplement the liquid found in nectar. If you don't have a pond or creek on your property, you can provide a small water source. A bird bath or fountain certainly is attractive, but simpler water sources are acceptable.

Adding water to a plant saucer with rocks or glass beads is easy and quick. The rocks or beads provide a place for the bees to land because they cannot land on water. To prevent mosquitoes from breeding, change the water at least twice a week.

Provide Suitable Habitat

Nearly 70 percent of bees live in nests below the ground. To accommodate these ground-nesting bees, leave some dry, bare ground on your property where they can nest.

Bees usually prefer to nest in sandy slopes. Native bunch grasses such as prairie dropseed *(Sporobolus heterolepis)* and little bluestem *(Schizachyrium scoparium)* also provide shelter for ground-nesting bumble bees.

The other 30 percent of bees live in cavities, such as plant stems or holes bored in trees by woodpeckers and beetle larvae. Some bees nest in hollow stems while others have the ability to excavate the core of stems to facilitate egg-laying.

The easiest way to provide habitat for these cavity nesters is to postpone cleaning up your perennial flower beds until the following spring. Leave the dead stalks until the spring daytime temperatures are consistently in the 50s. If you wish to clean up your garden early in the spring, leave the dead debris on top of your compost pile so the bees can hatch and fly away.

Another option is to purchase or build a bee house for cavity-nesting bees. Two common bee houses are on the market. One type features a block of untreated wood that is 5 by 8 inches with 0.1- to 0.4 inch-diameter holes drilled in it (Figure 33).

The depth of the holes is critical. Small holes (less than ¼ inch diameter) should be 3 to 4 inches deep, and large holes (more than ¼ inch diameter) should be 5 to 6 inches deep.

The second type features 15 to 20 hollow canes or reeds with one end closed. The hollow tubes are cut to 6 to 8 inches and tied together. Make sure the hollow tubes have a closed end and stay dry.

Nesting boxes should be located in a sheltered spot about 3 to 6 feet high with entrances facing east or southeast for the morning sun. Your best option is to fix the nesting boxes to a post, building or tree so they don't move in the wind.

Building bee houses is a great summer activity for kids. Directions for building nests for native bees are available at The Xerces Society website listed in Other Resources.

Figure 32. Flowering crabapples provide much needed nectar and pollen when little else is blooming in the landscape. (Photo by Esther McGinnis, NDSU)

Figure 33. Mason bee nesting box showing plugged holes that are occupied by bees. (Photo by Janet Knodel, NDSU)

Wise Pesticide Use

Besides having food and nesting sites, protection from pesticides is critical if native bees are to survive in your flower garden. Insecticide spraying on blooming flowers is especially deadly for all bee species. In addition, spraying herbicides to kill weeds in gardens or lawns removes the diversity and abundance of flowering plants needed by bees throughout the growing season.

An integrated pest management approach should be used to promote judicious use of pesticides for pest control only when needed and to implement scouting and nonpesticide pest management strategies, such as cultural control, biological control or host plant resistance.

When an insecticide is necessary, select a product that is designated as "least toxic" to bees but still reduces pest levels on plants. Some examples of common organic pesticides that have low toxicity to bees are Bt *(Bacillus thuringiensis)*, garlic, kaolin clay and neem.

Remember, any broad-spectrum insecticide can kill "all" insects, including bees and natural enemies of the target pest. Choose the least hazardous formulation of an insecticide product for bee safety (Table 6).

Application is recommended in the late evening or when temperatures are below 55 F, when most bees are not foraging. Remember, some bees such as bumble bees forage in cooler temperatures (up to 50 F) and are actively foraging in the early morning and late evening, much longer than honey bees.

Use short-residual insecticides. "Spot" treat instead of broadcast spraying to minimize the area treated with insecticide. Remember to use all pesticides in a manner consistent with the label. Read, understand and follow the pesticide's label directions.

If the bee hazard icon is on the label, this indicates that this product is highly toxic to bees and specific application restrictions apply to protect pollinators. An example of a highly toxic substance to bees is the active ingredient imidacloprid or clothianidin in the neonicotinoid insecticide class (systemic). Avoid buying garden plants that are treated with these bee-killing systemic insecticides from garden centers.

Table 6. Different pesticide formulations and general toxicity to bees.

Granular Solution	Least toxic
Soluble powder	
Emulsifiable concentrate	
Flowable	
Wettable powder	
Dust	Most toxic

Pollinator Garden Summary

- ☑ Choose two or more perennial species from each seasonal flowering category (spring, June, summer and fall) for a minimum of eight plant species in the pollinator garden.
- ☑ Plant multiples of each species.
- ☑ Select predominantly native species for your pollinator garden.
- ☑ Avoid planting cultivars with extra petals (double-flowered).
- ☑ Create a water source.
- ☑ Provide habitat for ground-nesting and cavity-nesting bees.
- ☑ Be wise in your use of pesticides and avoid spraying blooming plants.

Honey Bee Swarms

Honey bees will swarm at times. This means that more than half of the bees will leave with a new queen to find a new place to live. This can be alarming for people the first time they see it. Swarming bees should be left alone and usually will not bother people.

The swarm will gather in a cluster approximately 150 yards from the hive and bee scouts will go out looking for a new place for the colony to live. They prefer dark holes, such as hollow tree trunks, meat smokers, grills (Figure 34), attic spaces and other man-made items/spaces.

When the bee scouts find a suitable location, they return to the swarm and perform a waggle dance to relay the information to the rest of the swarm. They will begin to build combs, gather honey and pollen, and the queen will start laying eggs in the new location.

If a colony decides to establish itself in an undesirable place (Figure 35), we recommend you have a beekeeping professional remove the bees (Figure 36). Any honey left after the bees are removed will ferment with a bad odor, attract dermestid beetles such as larder beetles, and potentially cause structural damage.

If you have questions on honey bee swarms or removal, please contact the state apiary inspector for North Dakota at www.nd.gov/ndda/program/apiary-program-honey-bees.

Figure 34. A grill that was infested with swarming honey bees. (Photo by Janet Knodel, NDSU)

Figure 35. Honey bee swarm. (Photo by Esther McGinnis, NDSU)

Figure 36. Consult a professional when removing bee swarms. (Photo by Esther McGinnis, NDSU)

Sources of Plants and Other Materials

Sources for pollinator garden plants and other materials are provided on this NDSU Master Gardener Program website: **www.ag.ndsu.edu/mastergardener**.

Other Resources

Holm, Heather. 2014. Pollinators of Native Plants. Pollination Press LLC: Minnetonka, Minn.

Minnesota Department of Agriculture. Pollinators and Their Habitat. 2016. www.mda.state.mn.us/protecting/bmps/pollinators.aspx

North Dakota Department of Agriculture. 2016. North Dakota Pollinator Plan. www.nd.gov/ndda/files/resource/ND%20Pollinator%20Plan%202016.pdf

The Xerxes Society. 2016. Pollinator Conservation. www.xerces.org/pollinator-conservation/

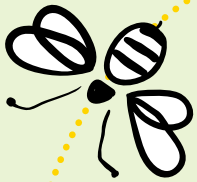
Bee Identification Resources

www.xerces.org/bumble-bee-identification/

http://bugguide.net/node/view/475348

http://articles.extension.org/pages/26310/identification-of-native-bees

http://articles.extension.org/pages/29761/collecting-and-identifying-bees



Pollinator Garden Summary

- ☑ Choose two or more perennial species from each seasonal flowering category (spring, June, summer and fall) for a minimum of eight plant species in the pollinator garden.
- ☑ Plant multiples of each species.
- ☑ Select predominantly native species for your pollinator garden.
- ☑ Avoid planting cultivars with extra petals (double-flowered).
- ☑ Create a water source.
- ☑ Provide habitat for ground-nesting and cavity-nesting bees.
- ☑ Be wise in your use of pesticides and avoid spraying blooming plants.

For more information on this and other topics, see www.ag.ndsu.edu

553-7-16