Activity Guide to Minnesota’s Native Pollinators

Pre-K through 6

by

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Project Overview

The question that I answered was how can I develop a pollinator activity guide for preK-6 formal and non-formal educators? I utilized curriculum development to answer my question, as I was interested in creating and adapting various pollinator lessons and activities that were hands-on, place-based and engaging for students. These activities are written to be used by both formal and non-formal educators in urban, suburban and rural settings and are age appropriate for preK-6 students. In order to achieve my goal of increasing awareness and understanding of the importance of native pollinators, I used the backward design theory proposed by Wiggins and McTighe and environmental education philosophy of David Sobel and Rachel Carson to frame my thinking and throughout the creation of this guide as a whole (Wiggins & McTighe, 2005; Sobel, 2003; Carson, 1956).

Project Description

The goals of this pollinator activity guide are to raise awareness of the diversity and importance, to both ecosystems and humans, of native pollinators in Minnesota. The activities within are designed to not only raise awareness and increase knowledge, but to foster appreciation and move students and teachers alike to action. This guide is meant to supplement and provide resources and lessons for educators who are incorporating pollinators, insects and animal-plant interactions into their units in a similar format to the Project WILD and Project Learning Tree activity guides (Project WILD, & Council for Environmental Education, 2013; American Forest Foundation, 2012).

The activities included within the guide provide educators with creative and engaging methods to introduce pollinators to their students, as well as activities that drive investigations and creative thought processes. Introductory activities are often filled with surprising facts about pollinators themselves or their direct connection to our daily lives and are meant to intrigue students. As well, many of the investigative activities are highly
student-guided. When students complete activities that are guided by their own questions and hypotheses, they are that much more interesting and meaningful to a particular student.

Following the backward design theory, this activity guide is meant to provide lessons and activities to students that ultimately lead to a larger priority and understanding. If teachers utilize multiple lessons, they are constructivist and the concepts build on each other in order to increase overall knowledge and understanding as a whole.

**Intended Audience**

The intended audience for the pollinator activity guide are preK-6th grade students in urban, suburban and rural settings. These activities are meant to be used both by formal educators in preschool, elementary and middle school settings, as well as outreach programming in communities and field trip based programming at nature centers.

Formal educators can use this activity guide both in the classroom and outside in the schoolyard. They can use it to introduce or reinforce multidisciplinary lessons centering on animals, insects, morphology, taxonomy, pollinators, the link between pollinators and the food we eat, plant life cycles or a myriad of other topics. These experiential lessons can be used to introduce and reinforce newly learned skills and knowledge, including measuring using a ruler, writing sentences using descriptive words and labeling body parts on sketches. In addition, they can use the literature connections suggested to create extensions and encourage inquiry based reading.

Informal educators conducting outreach programming can use this activity guide to help plan place-based lessons at the variety of facilities that they visit. The age-appropriate, hands-on activities and games provide great outlines and additions to after school, library or drop-in programs with a variety of age ranges. They can choose to use these activities for a one-time program or combine a series of them for weekly or monthly programs.
Informal educators conducting field trip programming at nature centers or similar facilities can utilize these activities to enhance their established lessons or as a basis for creating new curricula. Educators can use these activities on site at the nature center or as a pre-lesson in the teacher’s classroom.

I designed this activity guide to be versatile and easily adaptable to a wide variety of educational programming. As insects can be found in the most urban and the most rural of settings, I believe that these activities can be conducted regardless of the setting of the facility. While this guide focuses on pollinators native to Minnesota, it can be utilized and slightly modified for formal and non-formal educations in neighboring Midwest states that have similar habitats, including Wisconsin, Michigan, Iowa and Illinois.

This activity guide will be a living document, please contact Alaina Larkin (alaina.larkin17@gmail.com) for the most current version.
Introduction to Insects

Age Range: PreK-2

Ideal Setting: Indoors

Materials:
- Paper, one sheet per participant
- Crayons or colored pencils
- OR a whiteboard or flip chart
- Frame or cardboard rectangular frame, one per participant

Goals:
- Students understand that insects share similar characteristics
- Students can name four of the parts of an insect

Background Information:

Animals are grouped or organized into different categories, based upon common characteristics and are often placed on a pictorial branching tree of life. The biggest initial divide is between vertebrates and invertebrates. Mammals, birds, fish, reptiles and amphibians are all vertebrates, while snails, slugs, worms, spiders, crustaceans and insects all lack a backbone and are invertebrates.

Insects are one “leaf” on the tree of life and have many characteristics that define this category. Though there are some exceptions, in general insects have three body parts, six legs, two antennae, compound eyes, two pairs of wings, and mouth parts. The three body parts are the head, where the compound eyes and two antennae can be found, the thorax, the middle body part where the six legs are attached, and the abdomen. Insects also have a hard exoskeleton. Since they lack a backbone and are invertebrates, they need a different way to keep their body upright and together. Their hard shell protects the insect and helps maintain their shape.

Some insects lack some of these characteristics depending on their current life stage or role within a colony. For example, many insect larvae lacks wings, including caterpillars, dragonfly larvae, and mosquito larva. They go through a transformation to become adults, and as an adult, they have wings. As well, many worker ants in a colony will not have wings, even in their adult stage. Even so, ants are still insects.

Butterflies, moths, dragonflies and damselflies all have three pairs of legs, even though you can only easily count four legs when you observe them. One pair is smaller and is closest to the head. They are often tucked in and are vestigial, or no longer used.

Using these defining characteristics, spiders are not insects. Instead, they have two body parts, eight legs, simple eyes and no wings or antennae.
Lesson Prep:

Review the parts of an insect and practice the song and accompanying motions. If you’re completing the outdoor exploration connection, cut out cardboard frames.

Activity:

Ask students what they know about insects or bugs. Have them close their eyes and think or imagine for thirty seconds about insects. What are some insects that they have seen? Does anyone have a story about insects? Have a discussion with your students.

Have students draw an insect independently or have them help you draw an insect on a white board or flip chart. Ask them what they think that this insect needs or what it is missing. Talk about and act out different body parts as you add them.

Body parts & characteristics of (most) insects*:

- Head: eyes, antennae and mouth parts are found on the head
- Thorax: legs are attached to the thorax
- Abdomen
- Compound eyes
- Antennae
- Mouth parts
- Legs: 3 pairs of legs, 6 in total, attached to the thorax
- Exoskeleton: they have a protective outer layer instead of bones

*There are always exceptions, so not all insects have all of these characteristics. Flies, for example, only have two wings (one pair), instead of four in total.

Following this brainstorm, have them list more insects that they know. Common insects include grasshoppers, katydids, ants, beetles, true bugs, dragonflies, damselflies, butterflies, moths, bees, wasps, flies and the praying mantis. Do they have any favorites?

Next have students learn the Insect Song! This song can reinforce the parts of an insect and is fun for students to learn and practice. Incorporate body movements while singing it by putting your hands on your head, shoulders, and stomach for the first verse. Hold up your fingers for numbers in the fourth verse and wiggle your arms for the legs, flap your arms for the wings and press your two pointer fingers up from your temples.

Insect Song (sung to head, shoulders, knees and toes):

Head, Thorax, Abdomen, Abdomen

Head, Thorax, Abdomen, Abdomen

6 legs, 4 wings, 2 antennae
To finish this activity have students think of animals that they like or brainstorm your own list of animals that they’re familiar with. Possible animals to discuss include spiders, butterflies, dogs, or cats. For each one, have students think about and figure out if it’s an insect or not. If it isn’t an insect, what are the parts that it is missing? It might have too many or too few legs, might not have an exoskeleton or it might not have three body parts, etc.

Outdoor exploration connection: Go outside and use small frames or rectangular frames cut out of cardboard or cardstock to focus your student’s attention in smaller spaces. Have them look at the insects crawling within the frame or have them pick up leaves or move aside the grass within their window.
Introduction to Pollinators

Age Range: PreK-2

Goals:
- Understand how pollinators and flowers are connected
- Be able to name three native pollinators

Ideal Setting: Indoors then Outdoors

Materials:
- Examples of pollinators
  - Can be photos, printed from Page 56
  - Can be images, search online
  - Can be stuffed animals, beanie babies, finger puppets
- Crayons or colored pencils

Background Information:
Pollinators encompass a large group of animals that transfer pollen from one flower to another. Pollinators include bumblebees, solitary bees, honey bees, moths, beetles, ants, hummingbirds and bats. Honey bees are originally from Europe and are not native to Minnesota. They are heavily managed for use in commercial agriculture. Pollinating bats are not found in Minnesota, but can be found in the southwest United States and more tropical countries.

Some pollinators are more efficient than others, with bumblebees being particularly efficient. Beetles are the most numerous pollinators with more than 350,000 species worldwide, but they are a less efficient pollinator, due to their smooth exoskeleton. In contrast, bumblebees have a furry thorax and abdomen and the pollen baskets on their hind legs that help with pollen collection and transference.

Plants need to be pollinated in order to produce their fruit, which can be anything from a literal fruit, to an acorn or a seed. Pollination can require an animal, or a plant can be self-pollinated or require wind. Plants that are wind pollinated can cause allergies, as these plants release large amounts of pollen into the air during certain times of the year.

Plants that require animals or the wind to assist with the process produce pollen in their male anthers and pollinators come into contact with the pollen when they are in search of nectar (and collecting pollen for their own uses). When these pollinators travel from plant to plant, they transfer some of the pollen to the sticky stigma, the top of the female pistil. The pollen enters the style through a pollen tube and initiates the development of the fruit. The pollen is plant specific, so pollinators need to have visited a different plant of the same species.
Lesson Prep:

Familiarize yourself with the variety of pollinators. If using printed photos, print them out. If using images from the internet, have images of solitary bees, bumble bees, wasps, butterflies, moths, flies, beetles and hummingbirds pulled up in different tabs. You can also have a tab for bats, even though they aren’t found in Minnesota.

Check the weather. The outdoor exploration portion of this activity works best on sunny days above 55°F. Insects are cold-blooded and will be more active on warmer days.

Activity:

Today we are going to talk about the animals that visit flowers! These animals go from flower to flower, most of them drinking the sweet sugar-water nectar from the plants. Have students close their eyes and think about flowers. Without saying anything have them imagine some of the animals and bugs that you have seen on or visiting flowers. How are these animals getting from one flower to another?

Have students share the different types of animals and how they get from one flower to another. As you talk about different pollinators you can have students act out that pollinator and show photos or the stuffed version of that pollinator. They can buzz like bees and wasps, uncurl and re-curl their pointer finger to pretend drink through a proboscis straw like a butterfly or moth, clean or groom their head like flies, flap their wings really fast like hummingbird, and open and fold their wings on their back like beetles.

These animals all visit flowers and they help out plants. Because of this, they have a special name, pollinators! Can they say that word? Who are the different pollinators again? Have them list them again by raising their hands. If they are struggling to remember certain ones, you can complete the action or sound and see if they remember.

Let students know that they are going to go on a hunt for pollinators! The quieter they are and the more they sneak up on the flowers, the better chance they have of seeing these animals. Have them practice “sneaking” as you head outside. Define boundaries and let students explore for several minutes.

Finish up the activity by having them draw their favorite insect or pollinator using crayons or colored pencils. If doing this from memory is too hard, have the printed or internet images available for them to reference.
Pollinator Observation

**Age Range:** 3-6

**Goals:**
- Understand how pollinators and flowers are connected
- Be able to name three native pollinators

**Ideal Setting:** Indoors then Outdoors

**Materials:**
- Examples of pollinators
  - Can be photos, printed from Page 56
  - Can be images, search online
  - Can be stuffed animals, beanie babies, finger puppets
- Data Sheet, printed from Page 14
- Pencils and/or colored pencils

**Background Information:**

Pollinators encompass a large group of animals that transfer pollen from one flower to another. Pollinators include bumblebees, solitary bees, honey bees, moths, beetles, ants, hummingbirds and bats. Honey bees are originally from Europe and are not native to Minnesota. They are heavily managed for use in commercial agriculture. Pollinating bats are not found in Minnesota, but can be found in the southwest United States and more tropical countries.

Some pollinators are more efficient than others, with bumblebees being particularly efficient. Beetles are the most numerous pollinators with more than 350,000 species worldwide, but they are a less efficient pollinator, due to their smooth exoskeleton. In contrast, bumblebees have a furry thorax and abdomen and the pollen baskets on their hind legs that help with pollen collection and transference.

Plants need to be pollinated in order to produce their fruit, which can be anything from a literal fruit, to an acorn or a seed. Pollination can require an animal, or a plant can be self-pollinated or require wind. Plants that are wind pollinated can cause allergies, as these plants release large amounts of pollen into the air during certain times of the year.

Plants that require animals or the wind to assist with the process produce pollen in their male anthers and pollinators come into contact with the pollen when they are in search of nectar (and collecting pollen for their own uses). When these pollinators travel from plant to plant, they transfer some of the pollen to the sticky stigma, the top of the female pistil. The pollen enters the style through a pollen tube and initiates the development of the fruit. The pollen is plant specific, so pollinators need to have visited a different plant of the same species.
Lesson Prep:

Familiarize yourself with the variety of pollinators. If you’re using printed photos, print them out. If you’re using images from the internet, have images of solitary bees, bumble bees, wasps, butterflies, moths, flies, beetles and hummingbirds pulled up in different tabs. You can also have a tab for bats, even though they aren’t found in Minnesota. Print out the Pollinator Observation Data Sheet.

Check the weather. The outdoor exploration portion of this activity works best on sunny days above 55°F. Insects are cold-blooded and will be more active on warmer days.

Activity:

Pollinators are animals that visit flowers and spread tiny, sticky grains of pollen from one flower to another. How do you think they got their name?

Why do you think pollinators are visiting flowers? Many pollinators are visiting flowers in order to eat nectar, a sugar-water that plants produce. Plants produce this nectar in order to attract these animal pollinators. As well, some pollinators visit flowers in order to collect their pollen, as it is a good source of protein. As they visit flowers, pollen can stick to their bodies, especially if they have a fuzzy thorax and abdomen. When they visit a flower of the same species, that pollen might rub off on that plant.

Who are these pollinators? Have students brainstorm a list and help them fill in the gaps. Pollinators native to Minnesota include bumble bees, solitary bees, wasps, butterflies, moths, flies, beetles and hummingbirds. Other pollinators they might’ve heard of are honey bees (native to Europe, heavily utilized in commercial agriculture) and bats (pollinators in the southwestern United States and in tropical countries).

How can they tell these pollinators apart? As students bring up the different pollinators, write them on the board or on a flip chart. Next to each pollinator, have them come up with a couple of ways to distinguish that particular pollinator. Listed below are the pollinators and some of the ways to tell them apart.

Bumble Bee: a larger and fuzzy bee with mainly yellow and black markings

Solitary Bees: typically smaller than a bumble bee, can be a variety of colors, including metallic blue and green

Wasp: typically has yellow and/or black markings, narrow waist between thorax and abdomen, not fuzzy

Fly: can mimic bees, but the only have one pair of wings, where bees have two

Butterfly: colorful, large wings, wings closed while perching
Moth: more active at night, less colorful than butterflies, feathered antennae, wings spread while perching

Beetles: their wings are hidden within a protective layer when resting, they have a straight line down their thorax and abdomen, they have a smooth exoskeleton

Hummingbirds: not an insect, they don’t perch while feeding from flowers, Ruby-throated Hummingbirds are the only hummingbirds native to Minnesota

There are plentiful pollinators to be found outside, in any type of landscape. All it requires is looking closely and using observation skills. And PATIENCE! The more patient you are, the more fruitful and successful your observations will be.

Practice using a magnifying glass in the classroom and then go outside and go on a pollinator hunt! Pollinators are usually occupied while feeding on flowers, giving students the opportunity to observe them. It’s more effective and efficient to wait at a flower in order to observe a pollinator, than it is to chase one down. Insects are just too fast and agile for us to follow sometimes!

Have students look for pollinators and tally the different types that they find on their data sheet. They can also draw or sketch one example of each type of pollinator.

Come back together as a group and have students count up their tallies. Which type of pollinator was the most plentiful? Were there any pollinators that they didn’t see? Do they have any guesses as to why some pollinators weren’t found or were harder to find? Was it hard to tell what kind of pollinator it was? Many pollinators prefer certain types of flowers and some pollinators are more active in different parts of the day.

Citizen Science Connection: If your students take photos of the pollinators that they find, students or the educator can add them as observations to iNaturalist or Bumble Bee Watch. Reference the Citizen Science section (p. 41) for more information.
Pollinator Observation Data Sheet

<table>
<thead>
<tr>
<th>Name: ___________________________</th>
<th>Date: __________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bumble Bee</td>
<td></td>
</tr>
<tr>
<td>Solitary Bee</td>
<td></td>
</tr>
<tr>
<td>Wasp</td>
<td></td>
</tr>
<tr>
<td>Fly</td>
<td></td>
</tr>
<tr>
<td>Butterfly</td>
<td></td>
</tr>
<tr>
<td>Moth</td>
<td></td>
</tr>
<tr>
<td>Beetle</td>
<td></td>
</tr>
<tr>
<td>Hummingbird</td>
<td></td>
</tr>
</tbody>
</table>
What is Pollination?

**Age Range:** PreK-1

**Ideal Setting:** Indoors

**Materials:**
- Bean bags or tossable items, one per participant
- Two medium or large hula hoops
- 1-2 bags of Cheetos
- Napkins, one per participant

**Goals:**
- Students understand that plants create pollen
- Students can name two of the ways pollen is transported

**Background Information:**

Plants need to be pollinated in order to produce their fruit, which can be anything from a literal fruit, to an acorn or a seed. Pollination can require an animal, or a plant can be self-pollinated or require wind. Plants that are wind pollinated can cause allergies, as these plants release large amounts of pollen into the air during certain times of the year.

Plants that require animals or the wind to assist with the process produce pollen in their male anthers and pollinators come into contact with the pollen when they are in search of nectar (and collecting pollen for their own uses). When these pollinators travel from plant to plant, they transfer some of the pollen to the sticky stigma, the top of the female pistil. The pollen enters the style through a pollen tube and initiates the development of the fruit. The pollen is plant specific, so pollinators need to have visited a different plant of the same species.

Pollen is a small grain that plants produce. It is microscopic, but in large amounts, we can see it. Each plant species has a unique pollen grain and the structure of pollen grains differs depending on how the pollen is transported for pollination. Pollen that is transported by the wind is more aerodynamic and can also include air pockets. Pollen that is transported by animals is more spherical and might include spikes so that it can better attach to visiting animals.

Pollen that is transported by the wind is the type of pollen that causes seasonal allergies. Plants that use wind pollination are the reason for pollen that can coat our cars and bodies of water. Pollen that is transported by animals is carried from flower to flower on an animal and, thus, isn’t the reason for our sneezing. Blame the wind pollinators!

Some pollinators, such as bumble bees and honey bees, do intentionally collect pollen to bring back to their colony or hive. But other animals don’t always intend to...
carry pollen, instead many pollinators visit flowers for the nectar, or sugar water, that they produce. The pollen sticks to their bodies and when they visit other plants, some of the pollen rubs off.

Lesson Prep:

Clear an area for the animal and wind pollination demonstrations. Students can be seated on the floor in this area until that part of the activity.

Activity:

Write the word pollinator on a whiteboard and underline the first portion of the word. What do they think the word pollinator means? Has anyone heard of pollen?

Ask them if any of them have allergies. Do they get worse during certain times of the year? Pollen is what makes so many of us sneeze in the spring and summer! Pollen is a small circular or ball shaped yellow grain. Plants make this powdery product in order to make fruit and seeds. The majority of plants produce pollen, but they differ on how they distribute it. Some plants throw their pollen to the wind, some self-pollinate and some require animals to move the pollen between the flowers.

Tell students that they’re going to pretend to be the wind and animal pollinators. They are going to be responsible for getting the pollen from one flower to another! They will work together to get the pollen bean bags from one flower (hula hoop) to the other (another hula hoop).

First complete the wind pollination demonstration. Students will pick up a pollen bean bag from the hula hoop in front of them and gently toss it towards the other hula hoop. Everyone will get a chance to toss at least one bean bag. To ensure more students are actively involved at a time, you can have several sets of this demonstration occurring simultaneously.

Next complete the animal pollination demonstration. During the animal pollination iteration, you can have students pick an animal pollinator that they want to pretend to be. Students can pick between being a hummingbird, bee, butterfly, moth, fly or beetle. For the animal pollinated flowers, students can carry or fly the pollen bean bag from the original flower hula hoop to the other flower hula hoop. Specify whether students can run or speed walk, and encourage them to flap their wings and pretend to be their pollinator.

After both demonstrations, ask students several follow up questions. Which type of pollination, wind or animal, was harder? Which was easier? Did more pollen make it into the hula hoop flower when you carried or tossed the pollen? What were you pretending to be when you tossed the pollen? When you carried the pollen?

End this activity with a snack. Give students a handful of Cheetos on a napkin. Have them use their Cheetos to make marks on their napkin and allow them to eat the Cheetos. After they’ve finished their snack, have them look at their fingers and their
napkin. What do they notice? At this point have students clean their fingers using their napkin and collect the napkins.

Why were their fingers orange? Did they mean to make their fingers that color? Just like flowers, Cheetos have a powdery substance covering them and it spreads without us even trying! Bees and other pollinators visit flowers looking for nectar, or sugar-water and pick up pollen on accident. Just like you accidentally got orange fingers while eating Cheetos!
Pollination Exploration

Age Range: 2-6

Ideal Setting: Outdoors

Materials:
- Bean bags or tossable items, one per participant
- 2-4 small or medium hula hoops
- Scotch tape
- Hand lenses, one per participant
- Note cards or Data Sheet from Page 22, one per participant
- Pencils or colored pencils
- Optional: tennis balls and Velcro mitts

Goals:
- Students understand that plants create pollen
- Students can name two of the ways pollen is transported

Background Information:

Plants need to be pollinated in order to produce their fruit, which can be anything from a literal fruit, to an acorn or a seed. Pollination can require an animal, or a plant can be self-pollinated or require wind. Plants that are wind pollinated can cause allergies, as these plants release large amounts of pollen into the air during certain times of the year.

Plants that require animals or the wind to assist with the process produce pollen in their male anthers and pollinators come into contact with the pollen when they are in search of nectar (and collecting pollen for their own uses). When these pollinators travel from plant to plant, they transfer some of the pollen to the sticky stigma, the top of the female pistil. The pollen enters the style through a pollen tube and initiates the development of the fruit. The pollen is plant specific, so pollinators need to have visited a different plant of the same species.

Pollen is a small grain that plants produce. It is microscopic, but in large amounts, we can see it with the human eye. Otherwise, scientists need an electron microscope in order to view an individual grain. Each plant species has a unique pollen grain and the structure of pollen grains differs depending on how the pollen is transported for pollination. Pollen that is transported by the wind is more aerodynamic and can also include air pockets. Pollen that is transported by animals is more spherical and might include spikes so that it can better attach to visiting animals.

Pollen that is transported by the wind is the type of pollen that causes seasonal allergies. Plants that use wind pollination are the reason for pollen that can coat our cars and bodies of water. Pollen that is transported by animals is carried from flower
to flower on an animal and, thus, isn’t the reason for our sneezing. Blame the wind pollinators!

Some pollinators, such as bumble bees and honey bees, do intentionally collect pollen to bring back to their colony or hive. But other animals don’t always intend to carry pollen, instead many pollinators visit flowers for the nectar, or sugar water, that they produce. The pollen sticks to their bodies and when they visit other plants, some of the pollen rubs off.

Lesson Prep:

Scout out areas outdoors where students can find flowering plants and print out data sheets for students.

Activity:

Write the word pollinator on a whiteboard and underline the first portion of the word. What do they think the word pollinator means? Has anyone heard of pollen?

Ask them if any of them have allergies. Do they get worse during certain times of the year? Pollen is what makes so many of us sneeze in the spring and summer! Pollen is a small circular or ball shaped grain. Plants make this powdery product in order to make fruit and seeds. The majority of plants produce pollen, but they differ on how they distribute it. Some plants throw their pollen to the wind, some self-pollinate and some require animals to move the pollen between the flowers.

Tell students that they’re going to pretend to be the wind and animal pollinators. They are going to be responsible for getting the pollen from one flower to another! They will work together to get the pollen bean bags from one flower (hula hoop) to the other (another hula hoop). For the animal pollinated flowers, students can carry or fly the pollen ball from the original flower hula hoop to the other flower hula hoop. Specify whether students can run or speed walk, and encourage them to flap their wings and pretend to be their pollinator. For the wind pollinated flowers, students have to toss the pollen ball to the other flower hula hoop.

During the animal pollination iteration, you can have students pick an animal pollinator that they want to be. Students can pick between being a hummingbird, bee, butterfly, moth, fly or beetle.

Depending on the group, you can choose to make this a relay contest by completing both wind and animal pollination at the same time, doing two rounds of the same iteration simultaneously, or you can complete the wind and the animal pollinator activities separately. After each iteration, write down how many grains of pollen made it into the other flower (success rate).

Additional challenges:

You can vary the distance between the hula hoops in different rounds to demonstrate the benefits of having groups of like plants in similar areas and the
increased probability of pollination. Does the distance between flowers matter? Do you think distance matters more for animal or wind pollinated flowers?

Have students transfer the pollen balls using Velcro disc paddles during the animal pollination iteration in order to mimic how bees and other pollinators transport pollen on their bodies.

Follow up questions: Which type of pollination, wind or animal, was harder, or required more effort? Which type of pollination was most successful? Can we figure out the success rates?

Math connection: have students figure out the percent success rate of each type of pollination. How would they figure that out? What numbers do they need to know? They need to know the total number of pollen grains and the number that made it into the second hula hoop. How do they use those two numbers? Have students complete the long division independently or as a class and then convert the decimal into a percentage.

Inform students that they are going to be collecting actual pollen samples. Instead of brushing up against the flowers like bees and other pollinators do, they are going to be using scotch tape to collect grains of pollen. They will also be using a hand lens as an observation tool. They can use it to look at the pollen samples, the flowers and the insects that visit the flowers they are observing. Students can tape their scotch tape onto note cards and make observations on the other side or they can fill out the data sheet on Page 22.

Students should pick a flower and sit and observe it for several minutes. They should look closely using their hand lens and gently touch the petals, stems and leaves. While they are observing, they can draw the flower, using a pencil or colored pencils. Students can also use adjectives to describe the flower and can tally the number of insects that visit while they watch or write down the types that they observe. After making their observations about a flower, they can come to the educator or raise their hand for a piece of tape. After taping their pollen to their data sheet, they can use their hand lens to look at it up close.

After students collect the pollen and fill out their data sheet, have them share their discoveries. Did different flowers have different colors of pollen? Did certain flowers have more insect visitors than others? What were the insects doing when they were on the flower? Did anything surprise them?

Different plants have different types of pollen grains, depending on whom and how they are pollinated. They can be compared to fingerprints, with each type of pollen being distinctly different. And pollen grains are tiny! In order to look at their structures, scientists use special microscopes. If you have access to the internet, search for images of “pollen grains under electron microscope” in order to show students a wide variety of pollen grains.
Have students write two sentences about their observations and discoveries surrounding pollen and the flowers they observed. This can be written on the back of their data sheet or on a separate piece of paper. You can start them with “Today I discovered”, “Today I learned”, “I was surprised to see”, “I noticed” or other short phrases.

Research Project: have students pick a favorite flower or food product and research how it is pollinated – wind, self or animal. If it is animal pollinated, what types of animals are most efficient for that plant?
## Pollen Collection Data Sheet

Name: ____________________________ Date: __________________

<table>
<thead>
<tr>
<th>Draw or sketch the flower</th>
<th>Draw or sketch the flower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe the flower:</td>
<td>Describe the flower:</td>
</tr>
<tr>
<td>Insects:</td>
<td>Insects:</td>
</tr>
<tr>
<td>Pollen Sample</td>
<td>Pollen Sample</td>
</tr>
</tbody>
</table>

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<td>Insects:</td>
</tr>
<tr>
<td>Pollen Sample</td>
<td>Pollen Sample</td>
</tr>
</tbody>
</table>
What do Bees (and other Pollinators) Need?

**Age Range:** 4 - 6

**Ideal Setting:** Indoors then Outdoors

**Materials:**
- Solitary Bee Box materials – varies depending on what you build

**Goals:**
- Students can name the four components of habitat
- Students understand the components of a bee-friendly yard

**Background Information:**

One of the major reasons for declines in some bee populations is the degradation or loss of quality habitat. The two biggest components of habitat (food, water, shelter, space) that is critical for native pollinators are typically food and shelter.

Native solitary bees, bumble bees and other pollinators require areas that have flowers with good nectar sources, which are typically native flowers. The majority of flowers in the typical garden are cultivated flowers, bred to be showy and beautiful and aren’t usually great sources of nectar for pollinators. As well, they need flowers that bloom throughout the spring, summer and fall. Just like humans, as long as they’re alive, they need to eat. If an area only has flowers that bloom in the summer, it won’t provide adequate habitat for bees.

Some pollinators are also specific to certain types of flowers, so quality habitats will include multiple clumps of the same species of flower throughout. And, as a general rule, flowers need to be free of pesticides and herbicides, as those products are harmful or deadly to pollinators.

Native bumble bees nest socially in colonies underground or in small clumps of grass (Evans, 2017). In contrast, native solitary bees don’t nest socially and nest in cavities underground or in the pithy stems of plants. They need open ground available to dig in or plant matter left behind in gardens. Thus, messier yards are more bee-friendly.

Along those lines, it’s better to not rake leaves in the fall and to leave dead stems in your garden until spring. Certain butterfly and moth species overwinter as pupae under the leaves. The leaves provide them with a protective and insulator layer. In your garden, thick-stemmed plants provide solitary bees with a place to hibernate overwinter. They can be trimmed in late spring, once all bees and other insects have emerged.

One way to provide additional shelter for native bees is to build a bee box either for solitary bees or bumble bees. Instructions are on the Bee Kind MN website at https://www.beekindmn.org/build-your-own (Bee Kind MN, 2017).
Lesson Prep:

Review habitat needs for native pollinators. If you’re making a bee house, prep the materials.

Activity:

Bees and other pollinators need habitat in order to survive, and need four of the same basic things that you need to survive. Any guesses as to what they could be?

Shelter: pollinators need somewhere to be able to lay their eggs, raise their babies, hide from rain and storms. Examples: honey bees have hives, bumble bees have colonies, cavity-nesting bees make tunnels, bees that hibernate overwinter shelter under leaves on your lawn or in thick plant stems in gardens

Water: all living things need clean water, though they don’t all get it the same way. Pollinators usually get their water by drinking nectar, but might also drink from droplets of water on leaves.

Food: pollinators need to eat! Examples: nectar from flowers (similar to sugar water), pollen (used to feed babies). They need flowers that aren’t sprayed with pesticide and they prefer flowers that are native to the area (versus showy garden flowers).

Space: all animals need space and a territory. Pollinators tend to be small, so they require less space than a moose, deer or eagle, but they still need their food, water and shelter in a similar area.

How can we provide habitat for bees? We can help bees out by providing bee-friendly yards! By raking less in the fall and waiting to clean up gardens until the spring, we can provide butterflies, moths and bees with increased shelter. If we let dandelions bloom in our yards and plant native flowers, we can give bees more food sources, especially earlier in the year when they’re really hungry. What else do they think they can do to provide bees with better habitat?

Tell your students that they are now bees! Have them one or both of the following activities while considering the habitat requirements of a bee.

Indoor activity: Have students think about the different components of habitat and, as a bee, think about what they need to survive. Have them or describe their ideal habitat.

Outdoor activity: Define the boundaries for your students and have them explore their territory in order to identify the other three habitat components. What does their territory offer a bee? Do they think a bee has enough to survive? How could they make this area more bee-friendly?

Habitat extension: Create a solitary or bumble bee bee house with your participants and register it with Bee Kind MN. Instructions can be found on their website at https://www.beekindmn.org/build-your-own (Bee Kind MN, 2017).
Buzzing Bumble Bees

Age Range: PreK-2

Ideal Setting: Outside

Materials:

- Bee Hand Puppet Templates, one per participant
- Crayons or colored pencils
- Kid’s scissors
- Glue sticks or scotch tape
- Optional: crown for the Queen bumble bee

Goals:

- Students understand that bumble bees live in colonies
- Students can name three different jobs

Background Information:

Bumble bees live socially in small colonies and there are eighteen different bumble bee species native to Minnesota. Bumble bees are typically fuzzy bees and are known for their buzz pollination and ability to collect pollen. While they do make honey, they don’t produce as much honey as a honey bee hive will.

A bumble bee colony consists of 50 – 500 bees and is typically found underground or in clumps of grass (Evans, 2017). In contrast, honey bee hives have between 10,000 to 30,000 bees (Evans, 2017). In a bumble bee colony, there is one queen bumble bee and she’s the only bee that lays eggs. The majority of the rest of the bees are female worker bees and a handful of male drones. Female workers will help with raising the bumble bee larvae, cleaning and guarding the colony and foraging, or collecting nectar and pollen from plants outside of the colony. Male drones are the only male bumble bees in the colony and their role is to find unmated female queens (from other colonies) and fertilize them. Drones are typically significantly larger than female workers and can have different markings.

The queen bumble bee does raise several queens and they leave the colony at different times of the year, depending on the particular species. Bumble bee queens don’t live as long as honey bee queens and typically live around one year. Bumble bee workers don’t live nearly as long and can live up to 6 weeks.

Only queen bumble bees survive the winter. Worker bumble bees will continue to forage and work well into the fall, until temperatures get low enough to freeze the bees. Queen bumble bees overwinter pregnant, having mated with a drone prior to hibernating. They hibernate under the ground and, like other insects and amphibians, produce glycerol, or an anti-freeze, in order to prevent freezing.
In the spring, the queen bumble bee wakes up from hibernation and sets out to establish her colony and to gather nectar and pollen. This is a critical time of year, as there aren’t many flowering plants early in the season and the queen bumble bee desperately needs food. Dandelions, considered a weed by many, are an essential early bloomer for queen bumble bees in Minnesota. The queen bumble bee raises the first set of young and from then on workers assist with the rearing process, along with the other worker roles.

In contrast, honey bee hives survive the winter. They kick out the drones from the hive and the honey bee queen and workers all gather together in what is called a winter cluster. The honey bee workers rotate positions throughout the clump, with the honey bee queen always being in the middle, and beat their wings to generate heat. They eat honey that they’ve built up throughout the season and wait out the season until spring comes again.

Lesson Prep:


Activity:

Introduce your student to bumble bees. Unlike the majority of native bees in Minnesota they are social and live in a colony. They live with 50 – 500 of their favorite friends and most of them are hard workers. What does a bumble bee look like? If you’ve taught “Introduction to Insects” review the body parts of an insect by drawing them onto a bumble bee. Bumble bees have three body parts (head, thorax, abdomen), compound eyes, antennae, 6 legs, 4 wings and have yellow and black fuzzy bodies. While bumble bees do have a stinger, they only sting if they feel that their life is in danger or the colony is under attack (protecting their “family”). Bumble bees can only sting once in their life and they die after stinging.

In each bumble bee colony there’s one queen who rules the colony, kind of like a principal makes the rules for the school. The rest of the bumble bees are workers! What kind of jobs do you think they might have? Some workers help the queen raise the larvae, or bumble bee babies. Some help clean the colony – why might that be important? Some bees guard and protect the colony. Other bumble bee workers collect food from flowers! What job would you like to have?

Students are going to get to make their own bumble bee! They are going to make hand puppets. The first step is to color their template with crayons or colored pencils. It’s easiest to color before cutting out, that way they don’t lose any pieces. While realistic colors for these bumble bees would be yellow and black for the head and body, black for the legs and stinger and blue for the wings, students can choose to make their bumble bee whatever color they want. After they’ve finished coloring,
students (or adults can help students) can cut out the different parts of their bee and then use a glue stick or scotch tape to attach the different body parts.

Bee Hand Puppet Instructions: https://www.easypeasyandfun.com/bee-paper-hand-puppet-template/


After making their bumble bee hand puppet, students can use it for imaginative play! They are going to all be members of a bumble bee colony in the summer, with the educator or leader being the queen bee. Have the students help to figure out how to act out the different roles of the bumble bee workers. If someone helped take care of the babies or clean the colony, where would they be? How would they act? What would a guard worker bee act like? What would a forager (a worker bee that collects food) be doing?

In addition to acting out their worker bee roles, all worker bumble bees can play act by buzzing and flapping their wings while they move. Bumble bees can walk, but it’s much faster to fly! And flying requires flapping their wings.

In order to start the imaginative play, all bees, including the queen bumble bee, start in the colony. The colony area will stay constant, as that’s where the queen bee will stay. Once play starts, forager worker bees leave the colony, while the rest act around the colony. If this is outside, define the boundary where students can fly to, they will get too tired if they go farther than that!

One additional factor to add in to the imaginative play would be for the colony to go through the seasons. You can end the play by the queen bumble bee declaring that it is winter and all of the students (worker bumble bees) have to dramatically pretend to die.

End this activity by having students share what their favorite role was. Is one role more important than the other? Can the colony survive without any of the roles? While some roles are more fun to play than others, all roles are needed for the colony to survive!
Bumble Bees versus Honey Bees

Age Range: 3 - 6

Ideal Setting: Indoors then Outdoors

Materials:

- White board or flip chart, markers
- Pipe cleaners, one of each color per participant
  - Black, yellow
- Silver or white pipe cleaner, ½ per participant

Goals:

- Students understand the life cycle of a bumble bee
- Students can name two differences between bumble bees and honey bees

Background Information:

Bumble bees:

Bumble bees live socially in small colonies and there are eighteen different bumble bee species native to Minnesota. Bumble bees are typically fuzzy bees and are known for their buzz pollination and ability to collect pollen. While they do make honey, they don’t produce as much honey as a honey bee hive will.

A bumble bee colony consists of 50 – 500 bees and is typically found underground or in clumps of grass (Evans, 2017). In a bumble bee colony, there is one queen bumble bee and she’s the only bee that lays eggs. The majority of the rest of the bees are female worker bees and a handful of male drones. Female workers will help with raising the bumble bee larvae, cleaning and guarding the colony and foraging, or collecting nectar and pollen from plants outside of the colony. Male drones are the only male bumble bees in the colony and their role is to find unmated female queens (from other colonies) and fertilize them. Drones are typically significantly larger than female workers and can have different markings.

The queen bumble bee does raise several queens and they leave the colony at different times of the year, depending on the particular species. Bumble bee queens don’t live as long as honey bee queens and typically live around one year. Bumble bee workers don’t live nearly as long and can live up to 6 weeks.

Only queen bumble bees survive the winter. Worker bumble bees will continue to forage and work well into the fall, until temperatures get low enough to freeze the bees. Queen bumble bees overwinter pregnant, having mated with a drone prior to hibernating. They hibernate under the ground and, like other insects and amphibians, produce glycerol, or an anti-freeze, in order to prevent freezing.
In the spring, the queen bumble bee wakes up from hibernation and sets out to establish her colony and to gather nectar and pollen. This is a critical time of year, as there aren’t many flowering plants early in the season and the queen bumble bee desperately needs food. Dandelions, considered a weed by many, are an essential early bloomer for queen bumble bees in Minnesota. The queen bumble bee raises the first set of young and from then on workers assist with the rearing process, along with the other worker roles.

Honey bees:

Honey bees are not native to Minnesota and are originally from Europe. They are less effective and efficient pollinators and pollen collectors than bumble bees, but the sheer size of their hives makes up for it. Honey bee hives have between 10,000 to 30,000 bees (Evans, 2017). Honey bees are known for making honey, but they are also known for being commercial pollinators. They are commercially managed and rented to farmers and commercial agriculture. While some crops that farmers plant are self-pollinated or wind-pollinated (corn, grain, wheat, rice, rye, barley and oats), the rest of their produce requires animal pollination (NSERC-CANPOLIN Canadian Pollinator Initiative, 2012). Since farming has moved toward monoculture crops, native bees aren’t as effective for pollinating. They pollinate the fringes of the fields, but don’t reach the interior as there isn’t adequate habitat and shelter for them. Instead, farmers rent and place honey bee hives throughout their fields to ensure that their crops get pollinated.

Honey bees have a similar hive structure to bumble bees, except it’s called a hive, not a colony. They have female workers and male drones that fulfill similar roles. The biggest difference is that honey bee hives survive the winter. They kick out the drones from the hive and the honey bee queen and workers all gather together in what is called a winter cluster. The honey bee workers rotate positions throughout the clump, with the honey bee queen always being in the middle, and beat their wings to generate heat. They eat honey that they’ve built up throughout the season and wait out the season until spring comes again.

Throughout the warmer months, honey bee worker bees have a similar lifespan to bumble bee worker bees, as they live about six weeks. But the honey bee worker bees that survive the winter can live several months. Honey bee queens also live longer, and have an average life span of 3-4 years.

Though honey bee colonies can survive the winter, they weren’t built for such cold temperatures. In order to increase their hive’s survival rate and decrease stress, many honey beekeepers truck their bee hives down south for the winter.
Lesson Prep:

Practice making the pipe cleaner bumble bee and familiarize yourself with the life cycles of a bumble bee colony and a honey bee hive. Fold over the ends of the pipe cleaners to prevent any injuries.

Activity:

Let students know that today they are going to be learning about the similarities and differences between bumble bees and honey bees. Start by having students brainstorm what they already know about bumble bees and then what they know about honey bees and record these on a whiteboard or a flip chart. It’s fine if their knowledge is limited or wrong, at the end of the lesson you’ll review these first statements.

Next, have students guess the answers to the following questions. Make a t-chart on the board and write their guesses there. Below is the t-chart with the answers under the correct type of bee. After students guess all of the answers, go over the questions one at a time and correct any misconceptions.

<table>
<thead>
<tr>
<th>Bumble bee</th>
<th>Honey bee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collecting Pollen</td>
<td>Honey</td>
</tr>
<tr>
<td>Colony</td>
<td>Larger Hive</td>
</tr>
<tr>
<td>Queen survives</td>
<td>Hive</td>
</tr>
<tr>
<td>Native</td>
<td>Whole hive survives</td>
</tr>
<tr>
<td></td>
<td>Rented by farmers</td>
</tr>
</tbody>
</table>

Who produces more honey? Honey bees produce more honey

Which one is better at collecting pollen from flowers? Bumble bees are much more effective at collecting pollen.

Which one has a larger hive/colony? Honey bees hives can have between 10,000 to 30,000 bees, while bumble bee colonies have 50 to 500 bees.

Which one has a hive and which one has a colony? Honey bees live socially in a hive and bumble bees live in a colony

For each, who survives the winter? Bumble bee queens are the only individuals of a colony to survive the winter, she overwinters pregnant and a new colony is started every spring. Honey bee hives survive the winter, with the majority of the hive surviving.
Which one is native to Minnesota? Bumble bees are native to Minnesota and there are eighteen different species. Honey bees are non-native and they were brought to the United States from Europe.

Which one is rented by farmers to pollinate their crops? Honey bees are commercially managed and are rented to farmers throughout the state of Minnesota to pollinate their large fields of crops. The hives are transported in boxes and are placed throughout a field.

What surprised your students? What other questions do they have about bumble bees and honey bees?

Students are going to make their own pipe cleaner bee! You can choose to have students create their bee on a pencil or on their finger. Have students first twist the silver/white pipe cleaner into a figure eight to create the wings for their bee. They can then twist the yellow and black pipe cleaners middle portion of the wings to make the body of their bee and secure the wings in place. Have them start and end their black pipe cleaner at the head of their bee, leaving a bit extra on each end to create their antennae.

Finish this activity with two demonstrations. Students are going to pretend be a bumble bee colony and then a honey bee hive!

The bumble bee colony starts with just the queen (educator) in the spring. The queen yawns and wakes up from the winter hibernation. The queen practices using her wings and finds flowers. Then the queen taps several students on the head and they join the queen. They help raise the rest of the workers by tapping them on the head. The workers help raise the bee larvae, clean the colony, guard the colony and go fly out to flowers to find food. The season flies by! Summer is hot and fall is upon us. The leaves start changing and the temperature starts dropping. Brrrr! WINTER! All of the bee workers tragically die and the queen finds a spot underground to spend the winter. THE END.

The honey bee hive starts with everyone in the spring. The queen (educator) is in the middle with the worker bees in a clump around the queen. It’s getting warmer! The bees wake up from their winter sluggishness and resume their jobs. The workers help to raise new bee larvae, clean the hive, guard the hive and go fly out to flowers to make food. The season flies by! Summer is hot and fall is upon us. The leaves start changing and the temperature starts dropping. Brrrr! WINTER! All of the bees come together and form the winter clump once again with the queen in the middle. Throughout the winter the workers switch places and beat their wings in order to generate heat. The winter clump winds its way through the hive, with the bees consuming the honey stores as they go, waiting for warmer days in the spring. THE END.
Diversity of Bees

Age Range: 3 - 6

Goals:
- Name two unique bee adaptations
- Understand that there are over 300 different species of bees native to Minnesota

Ideal Setting: Indoors

Materials:
- One cup per participant, ideally clear or translucent
  - Cups can be of the same height or varied heights
- One plastic straw per participant
  - Cut to a variety of lengths
- Water or juice
- One flower per participant
  - Print and cut out from Page 35
- Guides to MN Bumble Bees
  - Print from Page 57 - 58
- Native Bee Guides
  - Print from Page 59 - 61
- Cameras, iPads or Tablets
  - With the iNaturalist App

Background Information:
There is an incredible variety of native bees in Minnesota, more than meets the eye! There is estimated to be 18 native species of bumblebees and 300 - 400 native species of bees.

Bumble bees live socially in small colonies and there are eighteen different bumble bee species native to Minnesota. Bumble bees are typically fuzzy bees and are known for their buzz pollination and ability to collect pollen. While they do make honey, they don’t produce as much honey as a honey bee hive will.

A bumble bee colony consists of 50 – 500 bees and is typically found underground or in clumps of grass (Evans, 2017). In contrast, non-native honey bee hives have between 10,000 to 30,000 bees (Evans, 2017).

The majority of bee species in Minnesota are solitary bees, meaning that they don’t live in colonies. They either live on their own or with up to five other individuals. They create their own shelter, raise their own young and find their own food. This means that these bees are much more docile than honey bees, bumble bees or social wasps, as they have less to protect.
Solitary bees have an amazing diversity – reference the Native Bee Guides on pages 59 - 61 to see the variety of species. The majority of these solitary bees help with pollination and all are incredibly valuable to the ecosystem. Some bees are specialists, pollinating one or a few species of plants, while others are generalists and pollinate many species.

We don’t even have a grasp of the diversity of bees in Minnesota, currently we can only estimate. The Minnesota Bee Atlas, a four year project funded by Minnesota Environment and Natural Resources Trust Fund and coordinated by University of Minnesota Extension, is looking to change that (University of Minnesota Extension, 2017). Their goal is to complete a census of native bee species found within the state, as the last survey was in 1919 and they only documented 67 species (University of Minnesota Extension, 2017). Citizen science observations combined with the Minnesota Department of Natural Resources historical records and insect collection from the University of Minnesota will help researchers understand the diversity and range of bees within Minnesota.

Lesson Prep:

Print and cut out the flower templates. If you will be completing this activity more than once, it is advantageous to laminate the flowers. These flowers will be set on top of the cups that are filled with water or juice and will help students visualize that they are pollinators sipping nectar out of flowers. Cut the plastic straws into 1/2, 2/3 and full length. If you are using cups that are all the same size, pour different amounts of water or juice into them. If you are using cups of different heights, pour the same amount of water or juice into them. Place the paper flowers on top of the cups. Also print the Guides to MN Bumble Bees and Native Bee Guides.

If you want to complete the Citizen Science Connection using an iPad or tablet, create a free account, download the iNaturalist App to all devices and log all devices into that account. For more information about how to use iNaturalist, reference the Educator’s Guide to iNaturalist on Page 43.

Activity:

Explain that students are going to be learning about all the different types of bees and to start they are going to pretend to be bees! Bees drink nectar, or sugar water, from flowers and they are going to drink the nectar, or water/juice, from the cups in the room. The two rules are that they have to use their own straw and that they can’t remove the flower from the top of their cup. You can also encourage them to buzz on the way to their “flower” and flap their wings as they “fly” across the room.

Pass out the cut plastic straws randomly and either assign students to a cup or let them choose. They can then drink their “nectar”. Students might start complaining, they can’t get to their “nectar”! They are a bee with a shorter tongue and are specialized to pollinate and drink nectar from specific flowers that don’t require long tongues. This particular flower is not one that they can drink from. You can have a
discussion with your students about who was able to get to their “nectar” and who
wasn’t. It might be helpful to group students that had the same straw lengths and
see if there is a trend between straw length and success of drinking nectar. The
students with the longest straws should have the highest rate of success.

Discuss these results with your students. What do they think? Bees have different
tongue lengths and have different unique characteristics that make them better
suited to harvest nectar and pollen from certain flowers.

Have them guess how many different types of bumble bees there are in Minnesota.
They can do this verbally or you can have them write the number down. Tell them
that there are eighteen different types of bumble bees and show them the Guides
to MN Bumble Bees. Have them look at the different markings of the different bees
and how pretty minor differences separate species. These bumble bees live in
colonies of 50 – 500 bees, with one queen and female worker bees.

Not all bees live in colonies like bumble bees, some bees are solitary. What might
that mean? These bees gather their own nectar and pollen, raise their own young,
find their own shelter and fend for themselves. How many species of solitary bees do
they think are there in Minnesota? Again, they can guess verbally or write down this
number. There are over 300 bees native to Minnesota and scientists are just learning
about the diversity through a project called the Minnesota Bee Atlas.

Citizen Science Connection: One way to help these scientists is to submit photos
through iNaturalist, a citizen science project. Citizen science is a way that students
and adults can help scientists by collecting data! It’s crowd-sourcing the data
collection. This particular project doesn’t require that you identify the bee species,
other experts can help with that. Once you submit a photo, they have the ability to
suggest identifications and you can always go back and see their comments.

Let students know that they are going to be scientists today, helping to collect
valuable data. The photos that they take will help scientists complete their census of
bees in Minnesota, so it’s important that they take quality photos. Use the Bumble
Bee Watch Tips for Photographing Bees on Page 42 to discuss how to go about
taking quality photos. Use the Educator’s Guide to iNaturalist to help with submitting
the observations (students or the educator can submit them).

Have students share their experiences. Was it hard or easy to take pictures of bees?
Did they notice different types of bees visiting the flowers? Did anything surprise
them?

Research Extension: Have students pick a solitary bee from the guide and look up
the flowers and plants that it pollinates, its life cycle and what type of habitat it
requires.
Who Pollinated your Apple?

Age Range: 3 - 6

Ideal Setting: Indoors

Materials:

- Apples, enough for ½ of your participants
  - Get two of each type of apple, or get all of the same type of apple
- Knife
- Paper towels, one per apple
- Toothpicks, one per participant

Goals:

- Students understand that apples require pollination
- Students understand that pollinators vary in efficiency

Background Information:

Fruit can form without successful pollination, often at the cost of flavor and size. The fruit will lack seeds if there was no successful pollination and will have a variable amount of seeds depending on the overall pollination of the flower. One way to investigate this topic is to look at apples.

Apples have five seed pockets and can have up to two seeds per pocket, with up to 10 seed in total. In theory, the more seeds that an apple has, the larger and more flavorful that fruit is. Counting the seeds can give you an idea!

Bees are the most effective and efficient pollinator for apples and if you have 6-10 robust seeds in your apples pockets, you know that particular apple was pollinated by a bee. If there are small seeds, it was pollinated by a wasp or less effective pollinator. If there are no seeds, it was most likely pollinated by a human.

Lesson Prep:

Cut the apples in half, across the “equator”, so that the star seed pockets are exposed. Keep the pairs of apples together, as groups of four will receive two apples of the same type.

Activity:

Some jobs are best completed with a specialized and trained person. What are some jobs that require someone special? Who is better at making dinner – you or your parent/adult? Packing lunch? You can certainly do it, but you might make something simpler or eat dessert!

Our job is to figure out who pollinated our apple. It turns out apples produce different types and numbers of seeds depending on the type of pollinator that
visited its flower! In groups, we are going to investigate our apples, count our seeds and make an educated guess about who pollinated it.

The animals that typically pollinate apples include bees, wasps/other, and humans. Who do you think might be the best pollinator? The worst?

Time to find out! In groups of four, they are going to investigate two apples. Students need to count the number of seeds found and determine if they are large or small. Hand out the apples on a plate or paper towel and the toothpicks. Your apple is already cut in half, so open it up and look at the seeds inside. Sometimes the seeds are hard to get out of the seed pockets, have them use their toothpick as a tool. Go around to each pair and help them look at their apples. Do their two apples have similar or different seeds?

Once they write down their observations, they can try one slice from each apple and see if one apple tastes better than the other. Does one apple have more flavor than the other? Does the group agree?

The three categories that we are looking at are 6-10 large seeds, 8 or more small seeds or no seeds. How many seeds do they think are produced by human pollination? Bee? Wasp/other? Apples pollinated by bees produce 6-10 large seeds, apples pollinated by wasps/other pollinators produce 8 or more tiny seeds or and apples pollinated by humans produce no seeds.

If their two apples had different seeds and tasted different, did a bee, wasp or human pollinate the more flavorful apple? In theory, apples pollinated by bees are pollinated more efficiently and have more flavor. Wasps and other pollinators aren’t as efficient at pollinating and humans come in last. While humans can pollinate plants using a cotton swab, we are nowhere near as qualified as other pollinators. Is there any advantage to preventing an apple from having seeds?
Grocery Store Quiz

Age Range: 4 to 6

Goals:
- Students gain awareness of the connection between pollinators and humans
- Students understand that the majority of the food we eat on a daily basis is dependent on animals pollinating it

Ideal Setting: Indoors or Outdoors

Materials:
- Photos of pollinators
  - Can print from Page 56
- One food product per participant
  - Plastic/wooden renditions OR
  - Have students draw their favorite type of food
- 2 baskets or containers to separate food products

Background Information:
Pollinators encompass a large group of animals that transfer pollen from one flower to another. Pollinators include bumblebees, solitary bees, honey bees, moths, beetles, ants, hummingbirds and bats. Some pollinators are more efficient than others, with bumblebees being particularly efficient. Beetles are the most numerous pollinators with more than 350,000 species worldwide, but they are a less efficient pollinator, due to their smooth exoskeleton. In contrast, bumblebees have a furry thorax and abdomen and the pollen baskets on their hind legs that help with pollen collection and transference.

Pollinators are intricately connected with the daily lives of an average Minnesotan, especially with the food we eat. One out of three bites of every meal is connected to pollinators. Many of the foods that we eat are pollinated by local or tropical pollinators (see table below). This list is not all encompassing, but covers a common assortment that students can relate to. If you want to include other options or are curious if other food items that you want to utilize are pollinated by animals, more thorough lists are available online.

<table>
<thead>
<tr>
<th>Food Product</th>
<th>Pollinator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almond</td>
<td>Honey bees</td>
</tr>
<tr>
<td>Apple</td>
<td>Honey bees, blue mason orchard bees</td>
</tr>
<tr>
<td>Apricot</td>
<td>Bees</td>
</tr>
<tr>
<td>Apricot</td>
<td>Bees, flies, bats</td>
</tr>
<tr>
<td>Banana</td>
<td>Birds, fruit bats</td>
</tr>
<tr>
<td>Blackberry</td>
<td>Bees</td>
</tr>
<tr>
<td>Blueberry</td>
<td>Over 115 species of bees</td>
</tr>
<tr>
<td>Food Product</td>
<td>Pollinators</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Broccoli</td>
<td>Bees</td>
</tr>
<tr>
<td>Brussels Sprouts</td>
<td>Bees</td>
</tr>
<tr>
<td>Cacao (Chocolate)</td>
<td>Midge (flies), stingless bees</td>
</tr>
<tr>
<td>Cantaloupe</td>
<td>Bees</td>
</tr>
<tr>
<td>Cashew</td>
<td>Bees, moths, fruit bats</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>Bees</td>
</tr>
<tr>
<td>Celery</td>
<td>Bees</td>
</tr>
<tr>
<td>Cherry</td>
<td>Honey bees, bumblebees, solitary bees, flies</td>
</tr>
<tr>
<td>Chestnut</td>
<td>Bees</td>
</tr>
<tr>
<td>Coconut</td>
<td>Insects, fruit bats</td>
</tr>
<tr>
<td>Coffee</td>
<td>Stingless bees, other bees, flies</td>
</tr>
<tr>
<td>Cranberry</td>
<td>Over 40 native species of bees</td>
</tr>
<tr>
<td>Cucumber</td>
<td>Bees</td>
</tr>
<tr>
<td>Eggplant</td>
<td>Bees</td>
</tr>
<tr>
<td>Grape</td>
<td>Bees</td>
</tr>
<tr>
<td>Grapefruit</td>
<td>Bees</td>
</tr>
<tr>
<td>Honeydew Melon</td>
<td>Bees</td>
</tr>
<tr>
<td>Kiwi</td>
<td>Honey bees, bumblebees, solitary bees</td>
</tr>
<tr>
<td>Lemon</td>
<td>Bees</td>
</tr>
<tr>
<td>Lima Beans</td>
<td>Bees</td>
</tr>
<tr>
<td>Macadamia Nuts</td>
<td>Bees, beetles, wasps</td>
</tr>
<tr>
<td>Mango</td>
<td>Bees</td>
</tr>
<tr>
<td>Mustard</td>
<td>Bees</td>
</tr>
<tr>
<td>Papaya</td>
<td>Moths, birds, bees</td>
</tr>
<tr>
<td>Peach</td>
<td>Bees</td>
</tr>
<tr>
<td>Pear</td>
<td>Honey bees, flies, mason bees</td>
</tr>
<tr>
<td>Pepper (Bell)</td>
<td>Bees</td>
</tr>
<tr>
<td>Plum</td>
<td>Bees</td>
</tr>
<tr>
<td>Pumpkin</td>
<td>Squash and gourd bees, bumblebees</td>
</tr>
<tr>
<td>Raspberry</td>
<td>Honey bees, bumblebees, solitary bees, hoverflies</td>
</tr>
<tr>
<td>Strawberry</td>
<td>Bees</td>
</tr>
<tr>
<td>Vanilla</td>
<td>Bees</td>
</tr>
<tr>
<td>Watermelon</td>
<td>Bees</td>
</tr>
</tbody>
</table>

(Pollinator Partnership, n.d.; Sarich, 2013; University of Nebraska Entomology, n.d.)

Food crops that are wind pollinated (and aren’t pollinated by animals) include wheat, rice, corn, rye, barley, oats, carrots and onions (NSERC-CANPOLIN Canadian Pollinator Initiative, 2012). Food crops that are self-pollinated include beans and peas.

**Lesson Prep:**

Print and cut photos of pollinators. Label the two baskets, one with Yes and one with No. Familiarize yourself with the list of food products that are and aren’t pollinated by animals and/or have the table accessible as a resource.
Activity:

Ask students what they think the word pollinator means? What types of animals could be pollinators? Why do they think they are important? Have students brainstorm answers to these questions and remind them that there is no wrong answer. You can write these answers on a white board or a flip chart that you can refer to after the activity.

Pass out one food product to each student and explain to them that they just went grocery shopping and picked out this item. As a class they picked out a wide variety of items! It is their job to think about this type of food and to come up with an educated guess about whether or not it required animal pollinators. Have them share with their neighbor about the food product that they have and whether or not it required bees or other pollinators to form. Go around and talk with students and let them know if their food product is pollinated by animals and if so, what types of pollinators.

Have students come back as a group. They are now going to share their food product and pollination information with the whole class. Have students come up one at a time to the front, present their food product and say whether it goes into the “yes” basket or the “no” basket. If it goes into the “yes” basket, students can name the pollinators (with the educator’s assistance). Once all students are done, have them look at the two baskets.

Ask those same questions again. What are pollinators? Why are pollinators important? What surprised them? If pollinators were to disappear, what foods would they miss? Pollinators are directly connected to the food that we eat on a daily basis, as they spread pollen from plant to plant. This process is necessary for plants to form seeds and fruit, which is something that we need to live.
Citizen Science Projects

Citizen science is an excellent way for your students to connect to insects and contribute research in an understudied field. Citizen science is a mechanism for research to be crowd sourced and conducted by the public. These projects can range in complexity and commitment.

There are two citizen science projects that are related to pollinators outlined in the following pages, iNaturalist and Bumble Bee Watch. They both involve the collection and submission of data by citizen participants. This information that they collect will help these research projects understand more about these insects.

Both of these citizen science projects require an account login, but they are simple and free to create. With that account, all of the submitted observations are stored and easy to access at any point. You can go back and reference all of the different observations and see the identifications suggested by the experts and scientists reviewing the observation submissions.

Both projects require photos of the observations, so on the next page are Bumble Bee Watch’s Tips for Photographing Bees (Tips for Photographing Bees, 2017). These tips apply for most insects in order to aid researchers in identification. As well, if your class or program is utilizing smartphones or tablets, a camera lens kit for smartphones or tablets can really increase the quality of your camera.
Bumble Bee Watch: Tips for Photographing Bees

What makes a good bumble bee photo?

There are many strategies for snapping photos of fast moving insects, but sometimes a helpful tip can be to wait at an open flower of a species attractive to bumble bees instead of trying to follow a bee around. This is especially true if you are using a smartphone, or point and shoot camera that is slow to respond after the shutter button is pressed.

While some species can be identified from almost any photograph, there are some characters that are helpful to try and include in your photographs. In general, it is helpful to include multiple photos from different angles to give the best chance of a positive ID.

Here are some helpful tips:

1. Don’t be afraid to get close to bumble bees when they are visiting flowers. As long as you don’t touch them, you are very unlikely to get stung. Close-ups are the best photos as they allow the observer to see more detail!
2. If your camera has one, use the macro setting (usually an icon of a flower)! This usually lets you focus on objects closer to the camera.
3. Include photos from a few different angles. These will help you to see all of the characters on the bee.
4. Try to include a shot that includes the face of the bumble bee. The coloration of the face can be important, but the structure of the face is often an essential character to verify submitted records.
5. Cropping your photos before uploading them can also be an effective way to illuminate more detail.
6. Putting a bee in a vial (they can often be captured directly into the vial from a flower) can be an effective way to snap some clear photos.
7. If you are using a smart phone, another option is to take a video of the bumble bee and then extract images from the video file. There are numerous ways to do this, and a quick web search should lead you in the right direction.
8. Don’t worry if you can’t ID the bee in your photo! Bumble bees can be tricky. Your photo submission will still help us keep track of bumble bee populations and it is quite possible that our experts may be able to ID your bumble bee. We carefully verify all of our photo submissions.

Developed by Bumble Bee Watch: https://www.bumblebeewatch.org/photo-tips/
Educator’s Guide to iNaturalist and the Minnesota Bee Atlas

Age Range: 2nd grade and up

What you can submit: Photos of any observation, ranging from insects to plants to birds

Available Platforms to submit sightings: iOS, Android, Web

Information needed for a “research grade” observation: Date, approximate location, photo and guess at the species

Overview:

Students love taking photos! This project compiles those photos and they can be accessed by relevant research projects nationwide. Students can participate by taking the photos and having an adult enter the observation, or they can assist with the submission process.

iNaturalist is a citizen science project that allows individuals of all levels to participate in. This project allows users to submit observations of a wide variety, so students can submit photos of pollinators that they find, but also of the trees, plants, lichen, birds, amphibians, reptiles and mammals and their signs (tracks, scat, nests) that they encounter while outdoors.

The most notable aspect of this project is that it doesn’t require identification, meaning that individuals can submit their observation and other users will help identify it. You can submit a picture of a bee and other users have the ability to see the observation and suggest an identification.

Minnesota Bee Atlas:

While you can post observations in general, you can also add your observations to a specific project. This is a way of grouping observations and data together that is relevant to a specific research project. Projects can also independently add your observations to their project.

One project of interest is the Minnesota Bee Atlas. This is a four year project funded by Minnesota Environment and Natural Resources Trust Fund and coordinated by University of Minnesota Extension (University of Minnesota Extension, 2017).

The goal is to complete a census of native bee species found within the state, the last survey was in 1919 and they only documented 67 species (University of Minnesota Extension, 2017). Citizen science observations combined with the Minnesota Department of Natural Resources historical records and insect collection from the University of Minnesota will help researchers understand the diversity and range of bees within Minnesota.
Submitting an observation:

You can submit your observations using an iOS or Android based phone or tablet or on their website. I’ve outlined the three ways to submit your observations below:

iOS

Once you open the iNaturalist App and log in, this is the home page. In order to add an observation, push the Observe camera icon.

Either take a photo by pushing the green button or select a photo from your library.

Once you take or select a photo, push Next.

After pushing Next, you will be directed to this screen. You can add more photos by pushing the square with the + in the upper left hand corner. Next, push What did you see?

The app will load suggestions or you can look up a species.

If you don’t know, you can leave this blank or you can select a general category (in this case, fungi and lichens).
The next step is to confirm that the date and location are correct. If you don’t have your GPS linked, you will have to input the location.

**Joining a project**

To add a project, you push the More icon. Within the More menu, push Projects.

In the Projects menu, you’ll be able to view all of the projects that you have joined. In order to add a project, click the magnifying glass in the upper right hand corner and type in the name of the project.

After selecting a project, you’ll see their home page. Push Join to add the project!
Once you open the iNaturalist App and log in, this is the home page. Push the green + icon in the lower right hand corner to make an observation.

Either select Take Photo or Choose Image.

If you Choose Image, select what application to complete the action.

You can add more photos by pushing the square with the camera icon in the upper left hand corner. Next push What did you see?

The app will load suggestions or you can look up a species. If you don’t know, you can leave this blank or you can select a general category (in this case, Plants).

The next step is to confirm that the date and location are correct. If you don’t have your GPS linked, you will have to input the location.
Joining a project

To join a project, you push the hamburger icon (top left hand corner).

Within this menu, push Projects.

In the Projects menu, you’ll be able to view all of the projects that you have joined. In order to join a new project, click the magnifying glass in the upper right hand corner and type in the name of the project.

After selecting a project, you’ll see their home page. Push Join to add the project!
Web-based Platform (https://www.inaturalist.org/home)

If you’re logged in, this is the initial page you will see. To add an observation, hover over your profile in the upper right hand corner and under Observation, select Add.

Choose photos to add. If you want to add multiple photos to one observation, you can upload them at the same time.

In order to use multiple photos for one observation, you need to combine them. Click on one observation, press the control key and select the other photos. They should all be outlined in green. Then click on the Combine option found in the bar above the photos.
The two photos are now in one observation! Next, click on the Species name to see suggestions and select your description. Since I’m not sure what type of bumble bee this is, I’ll just select Bumble Bee for the species name. If I wasn’t sure what type of insect it was, I could go as general as insect.

Click on Location on the left hand menu to add your location. In the Search for a location box you can type in an address or name and the map will zoom to that area. Move the red circle to the location where you made your observation and make the circle bigger or smaller depending on how accurate the location is.

Next, add a Project (if applicable). Click on the Projects tab on the left hand menu, click within the Add to a project box and select one of the options. You have to have already joined the Project under your profile in order for it to populate in this menu. See below for how to join projects.
Now you’re ready to submit your observation! Click on the Submit 1 observation in the upper right hand corner of the page.

Joining a Project

Go back to the main page (https://www.inaturalist.org/) and hover over the Projects tab across the top bar. In the Search projects box search for Minnesota Bee Atlas (or a different project that you want to join).

Click on the Minnesota Bee Atlas (or the project that you want to join).

Click on Join this Project above Add observations to this project in the right hand side of the page. You can also explore the different observations that are part of this project.
Educator’s Guide to Bumble bee Watch

Age Range: 4th grade and up

What you can submit: Photos of bumble bees

Available Platforms to submit sightings: iOS, Web

Information needed for a submission: Date, location, photo and guess at bumble bee species

Overview:

Bumble Bee Watch is a citizen science project that was designed to collect data about bumble bees in North America. Elaine Evans from the University of Minnesota is a collaborator on this project and The Xerces Society for Insect Conservation is a partner. The main goals of this project are to start a virtual bumble bee collection, to help researchers determine the status and conservation needs of bumble bees and to help locate rare or endangered populations of bumble bees.

Students and adults can submit photos of bumble bees that they find and researchers help verify and identify the species. Submissions through the app require an identification of the bumble bees, whereas the web-based platform does not. I recommend submitting observations through the web-based platform and using the app as a tool to look up information about local native bumble bees. After submitting an observation, you can an email notification when someone identifies it!

iOS

Once you open the Bumble Bee Watch App, this is the home page. The first time you log in, it jumps right to the tutorial page, but don’t worry you’ll be able to access this tutorial again by pressing settings!

Within the settings menu, press Tutorial.

The tutorial goes through how to use the app and submit an observation step by step and you can watch it as many times as you need! Swipe to the left to go through the steps.
Push the globe icon to filter for species found in Minnesota. Click Nearby or scroll down to Minneapolis area.

Choose a specific bumble bee in the menu to see detailed information and photos about that species.

Press the Range icon to see where this bumble bee species can be found (green) and has been sighted (red dots).

Press the Photos icon to see several pictures of this bumble bee species.

To submit an observation, you have to identify the bumble bee species, choose that specific bumble bee in the home menu, and push the plus sign in the upper right hand corner. Upload your photos and fill in the location, accuracy and date/time.
Web-based Platform (https://www.bumblebeewatch.org/)

When you are on the Bumble Bee Watch website, hover over the Record a Sighting tab and click on Bumble Bee Sighting. Then upload up to three photos of the same bumble bee.

You’ll need to enter the location. The easiest way is to search for an address or location in the Enter a Location box and then click on the map to drop a pin. Give it a Site Name, estimate your location’s accuracy and record the date of the sighting.

Add any additional details into the floral host and observation notes, check the photo permission box and select the Bumble Bee Watch project. Then hit Next.
They’ll ask you to define certain categories (head, thorax, abdomen) to help with the identification, but for each, you can select Not Sure.

Though it says you must select one of the choices below (the bumble bees) before submitting your sighting, it lets you submit without identifying the bumble bee. Click Next to submit your sighting!
Pollinator and Insect Videos

Pollination

Like Fruit? Thank a Bee!, SciShow Kids: https://www.youtube.com/watch?v=txv2k7OoY7U

- Discusses how bees and our food are connected – through pollination! This video explains the pollination in an easy to understand manner.

The World’s Smelliest Flower, SciShow Kids: https://www.youtube.com/watch?v=OyClEw5GCMA

- The beginning of the video discusses the corpse flower and how it attracts pollinators. It also discusses how seeds become plants and then how pollination creates new seeds.

Pollination Lesson with Stop Motion Science Animation for Kids, Science Up with the Singing Zoologist: https://www.youtube.com/watch?v=zy3r1zlC_IU

- This video provides a comedic interpretation of animal pollination in a manner that’s easy to understand.

Pollen Collection

Bee Pollen Slow Motion Flow Hive, FlowHive: https://www.youtube.com/watch?v=Tk0rj0-npTl

- This video provides a close up look at honey bees collecting pollen and their pollen baskets. Watch until 1:07, after that point the narrator talks about more abstract concepts.

Pollinators

The Beauty of Pollination – Moving Art, Louie Schwartzberg: https://www.youtube.com/watch?v=MQiszdkOwuU

- This video gives students a good opportunity to see a variety of pollinators, including hummingbirds, butterflies, flies, bumble bees, honey bees, and bats.
Meet the Pollinators

From near-microscopic thrips to the lemurs of Madagascar, pollinators come in all shapes, colors, and sizes. In addition to their contribution to plant reproduction, pollinators worldwide play a crucial role in ecological food webs, the human food supply, and the global economy. Here’s a quick look at some common groups of pollinators and the plants they visit:

**Beetles**
Beetles were probably some of the first animal pollinators. They feed on pollen and flower parts. Flowers that rely on beetle pollination are white to green, produce lots of pollen, and have large bowl-like petals.

**Flies**
Adult flies typically visit flowers to drink nectar. Many types of flowers attract flies, but those that specialize in fly pollination are often brown to dark purple, rotten-smelling, and shaped like a shallow funnel or trap.

**Butterflies**
Larvae eat plant vegetation. Adults have strawlike mouthparts to drink nectar. Flowers attractive to butterflies are bright red or purple, make lots of nectar, and have long tubular petals with large landing areas.

**Wasps**
Wasps are related to bees, but the larvae are typically carnivorous and fed insects by their mothers. Adult wasps often still visit flowers for nectar.

**Birds**
Hummingbirds rely on flower nectar. Other birds consume nectar and fruit. Flowers attractive to birds are red, orange, or white. Hummingbird pollinated flowers have long tubes to match their long tongue and beak.

**Bats**
More than 300 species of fruit are bat pollinated, including bananas, mangos and guava. Bat-pollinated flowers open only at night, are white or light green, emit a strong scent, and produce both pollen and nectar.

**Bees**
Bees are the most common pollinators. They are likely responsible for the diversity of flowering plants found today, while bees in turn would not have evolved without flowering plants. They completely rely on flowers for food during all life stages. Flowers attractive to bees are usually white, blue, or yellow, sometimes with ultraviolet patterns humans cannot see. Females have structures for carrying pollen, and often have an electrostatic charge that attracts pollen to their bodies. There are more than 20,000 species of bee worldwide—more than the number of bird and mammal species combined.
This guide is only for females (12 antennal segments, 6 abdominal segments, most bumble bees, most with pollen baskets, no beards on their mandibles). First determine which yellow highlighted section your bee is in, then go through numbered characters to find a match. See if your bee matches the color patterns shown and the description in the text. Color patterns can vary. Most workers and queens have similar color patterns, but queens are much larger. More detailed keys are available at discoverlife.org. Join the search for bumble bees with www.bumblebeewatch.org.

Yellow hairs between wings, 1st abdominal band yellow (may have black spot in center of thorax)

1. Black on sides of 2nd ab, yellow or rusty in center
   - Bombus bimaculatus: two-spotted bumble bee
   - Bombus griseocollis: brown-belted bumble bee

2. All other ab segments black
   - Bombus impatiens: common eastern bumble bee
   - Bombus affinis: rusty patched bumble bee

3. 2nd ab brownish centrally surrounded by yellow
   - Bombus rufocinctus: red-belted bumble bee
   - Bombus perplexus: confusing bumble bee

4. 2nd ab entirely yellow and ab 3-6 black
   - Bombus vagans: half-black bumble bee
   - Bombus sandersoni: Sanderson’s bumble bee

5. Yellow on front edge of 2nd ab
   - Bombus rufocinctus: red-belted bumble bee

6. No obvious spot on thorax.
   - Bombus perplexus: confusing bumble bee

Black stripe between wings

1. Yellow on ab 1-4
   - Bombus fervidus: yellow bumble bee
   - Bombus borealis: boreal bumble bee

2. Orange/red on ab 2-3
   - Bombus temarius: tricolored bumble bee
   - Bombus huntii: Hunt’s bumble bee

Back half of thorax is predominantly black

1. Yellow on top of head
   - Bombus auricomus: black and gold bumble bee

2. Black on top of head
   - Bombus pensylvanicus: American bumble bee
   - Bombus terricola: yellowbanded bumble bee

Much of abdomen lacking hair, no pollen baskets

- Bombus citrinus: lemon cuckoo bumble bee
- Bombus bohemicus: indiscriminate cuckoo bumble bee
- Bombus flavivus: Fernald’s cuckoo bumble bee

Common
This guide is only for **males** (13 antennal segments, 7 abdominal segments, mostly common late in the season, no pollen baskets, beards on their mandibles). **First determine which yellow highlighted section your bee is in, then go through numbered characters to find a match.** See if your bee matches the color patterns shown and the description in the text. Color patterns can vary. More detailed keys are available at discoverlife.org. Join the search for bumble bees with [www.bumblebeewatch.org](http://www.bumblebeewatch.org)  
Ab=Abdominal band  
Ant= Antennal segment  
by Elaine Evans, University of Minnesota  
[www.beelab.umn.edu](http://www.beelab.umn.edu)  
[www.befriendingbumblebees.com](http://www.befriendingbumblebees.com)

### Thorax with yellow near wing base AND 3rd abdominal segment black or orange

<table>
<thead>
<tr>
<th>Character</th>
<th>Bee</th>
<th>Color Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Black on sides of 2nd Ab, yellow or rusty in center</td>
<td>Bombus bimaculatus</td>
<td><img src="image1" alt="Bombus bimaculatus" /></td>
</tr>
<tr>
<td>2nd Ab with yellow in middle, black on sides. Yellow often in a “W” shape. Eyes not large.</td>
<td>Bombus griseocollis</td>
<td><img src="image2" alt="Bombus griseocollis" /></td>
</tr>
<tr>
<td>2nd Ab with yellow in middle bordered by rusty brown in a swooping shape. Large eyes.</td>
<td>Bombus impatiens</td>
<td><img src="image3" alt="Bombus impatiens" /></td>
</tr>
<tr>
<td>3. 3rd Ab orange</td>
<td>Bombus rufocinctus</td>
<td><img src="image4" alt="Bombus rufocinctus" /></td>
</tr>
<tr>
<td>Eyes slightly enlarged. Color pattern variable.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Thorax with yellow near wing base AND abdomen segments 1-3 yellow

<table>
<thead>
<tr>
<th>Character</th>
<th>Bee</th>
<th>Color Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Black spot in center of thorax</td>
<td>Bombus citrinus</td>
<td><img src="image5" alt="Bombus citrinus" /></td>
</tr>
<tr>
<td>Not large eyes. Very short cheek.</td>
<td>Bombus auricomus</td>
<td><img src="image6" alt="Bombus auricomus" /></td>
</tr>
<tr>
<td>Large eyes</td>
<td>Bombus perplexus</td>
<td><img src="image7" alt="Bombus perplexus" /></td>
</tr>
</tbody>
</table>

### Thorax with black stripe between wings

<table>
<thead>
<tr>
<th>Character</th>
<th>Bee</th>
<th>Color Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ab 1-4 yellow</td>
<td>Bombus fervidus</td>
<td><img src="image8" alt="Bombus fervidus" /></td>
</tr>
<tr>
<td>Black on top and front of head. Sides of thorax yellow.</td>
<td>Bombus borealis</td>
<td><img src="image9" alt="Bombus borealis" /></td>
</tr>
<tr>
<td>Yellow on top and front of head. Sides of thorax with brown hairs. 5th Ab may be black.</td>
<td>Bombus pensylvanicus</td>
<td><img src="image10" alt="Bombus pensylvanicus" /></td>
</tr>
<tr>
<td>Often with orange on 7th Ab. Sides of thorax with dark hair.</td>
<td>Bombus ternarius</td>
<td><img src="image11" alt="Bombus ternarius" /></td>
</tr>
<tr>
<td>Rear 1/2 of thorax yellow. Common in northern MN.</td>
<td>Bombus huntii</td>
<td><img src="image12" alt="Bombus huntii" /></td>
</tr>
</tbody>
</table>

### Rear half thorax is black

<table>
<thead>
<tr>
<th>Character</th>
<th>Bee</th>
<th>Color Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 1st Ab black</td>
<td>Bombus terricola</td>
<td><img src="image13" alt="Bombus terricola" /></td>
</tr>
<tr>
<td>Smaller and stouter than many other humble bees. Fringe of yellow hairs near end of abdomen.</td>
<td>Bombus insularis</td>
<td><img src="image14" alt="Bombus insularis" /></td>
</tr>
<tr>
<td>Ab seg 1-3 black.</td>
<td>Bombus bohemicus</td>
<td><img src="image15" alt="Bombus bohemicus" /></td>
</tr>
<tr>
<td>Ab seg 1 yellow.</td>
<td>Bombus flavicus</td>
<td><img src="image16" alt="Bombus flavicus" /></td>
</tr>
<tr>
<td>Ab seg 6-7 with orange. Variable color. Often with yellow on rear half of thorax. Sometimes Ab 2-3 yellow</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Guide to MN Bumble Bees II**  
by Elaine Evans, University of Minnesota  
[www.beelab.umn.edu](http://www.beelab.umn.edu)  
[www.befriendingbumblebees.com](http://www.befriendingbumblebees.com)
GROUND-NESTING NATIVE BEES

Mining Bees, *Andrena* spp.

Cellophane Bees, *Colletes* spp.

GROUND NEST

BEE BREAD

EGG

Green Sweat Bees, *Agapostemon* spp.

Sweat Bees, *Halictus* spp.


Digger Bees, *Anthophora* spp.


Shown: *A. terminalis* nests in rotting wood
All other *Anthophora* nest in the ground

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SUPPORT NATIVE BEES

Fragrant Hyssop
Agastache foeniculum

Stiff Goldenrod
Solidago rigida

Purple Prairie Clover
Dalea purpurea

Pale Purple Coneflower
Echinacea pallida

Golden Alexanders
Zizia aurea

Hoary Vervain
Verbena stricta

Black Eyed Susan
Rudbeckia hirta

Meadow Blazingstar
Liatris ligulistylis

Sunflowers
Helianthus spp.

Smooth Beardtongue
Penstemon digitalis

Wild Bergamot
Monarda fistulosa

Yellow Coneflower
Ratibida pinnata

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PLANT NATIVE PLANTS
SUPPORT NATIVE BEES

Fragrant Hyssop
Agastache foeniculum

Butterfly Milkweed
Asclepias tuberosa

Prairie Onion
Allium stellatum

Wild Lupine
Lupinus perennis

White Upland Aster
Aster ptarmicoides

Spotted Bee Balm
Monarda punctata

Black Eyed Susan
Rudbeckia hirta

Harebell
Campanula rotundifolia

Prairie Smoke
Geum triflorum

American Pasqueflower
Anemone patens

Wild Petunia
Ruellia humilis

Prairie Cinquefoil
Potentilla arguta

Sandy Soil

PLANT NATIVE PLANTS

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<table>
<thead>
<tr>
<th>Support Native Bees</th>
<th>Moist Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culver’s Root</td>
<td>Ironweed</td>
</tr>
<tr>
<td><em>Veronicastrum virginicum</em></td>
<td><em>Vernonia fasciculata</em></td>
</tr>
<tr>
<td>Swamp Milkweed</td>
<td>Obedient Plant</td>
</tr>
<tr>
<td><em>Asclepias incarnata</em></td>
<td><em>Physostegia virginiana</em></td>
</tr>
<tr>
<td>White Turtlehead</td>
<td>Fringed Loosestrife</td>
</tr>
<tr>
<td><em>Chelone glabra</em></td>
<td><em>Lysimachia ciliata</em></td>
</tr>
<tr>
<td>Blue Lobelia</td>
<td>Joe Pye Weed</td>
</tr>
<tr>
<td><em>Lobelia siphilitica</em></td>
<td><em>Eutrochium maculatum</em></td>
</tr>
<tr>
<td>New England Aster</td>
<td>Blue Vervain</td>
</tr>
<tr>
<td><em>Symphyotrichum novae-angliae</em></td>
<td><em>Verbena hastata</em></td>
</tr>
<tr>
<td>Common Boneset</td>
<td>Mountain Mint</td>
</tr>
<tr>
<td><em>Eupatorium perfoliatum</em></td>
<td><em>Pycnanthemum virginianum</em></td>
</tr>
</tbody>
</table>

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PLANT NATIVE PLANTS
SUPPORT NATIVE BEES

Jacob’s Ladder
*Polemonium reptans*

Cicely
*Osmorhiza spp.*

Virginia Waterleaf
*Hydrophyllum virginianum*

Bishop’s Cap
*Mitella diphyllo*

Violets
*Viola spp.*

Solomon’s Seal
*Polygonatum spp.*

Zigzag Goldenrod
*Solidago flexicaulis*

Wild Geranium
*Geranium maculatum*

Large-Leaved Aster
*Eurybia macrophylla*

Bellworts
*Uvularia spp.*

Dutchman’s Breeches
*Dicentra cucullaria*

Bloodroot
*Sanguinaria canadensis*

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Association for Supervision and Curriculum Development.