

Educator Resource Guide



Part 3: Which bee is THAT?

Bee-ing a citizen scientist
(photographing & identifying bees)

Developed by:

*Michael Dawson, Nicole Miller-Struttmann, James
Faupel, Jennifer Gauble and Cheyenne Davis*



Which bee is THAT?

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Background Information

**This Bee Identification activity was intended to be used as the third lesson of the Shutterbee Activity Series. If used individually, special instruction to students should be provided beforehand to summarize the importance of pollinators (specifically bees), to lend background and value to the activity, and to tell the difference between bees and their bee and fly mimics, as these subjects were covered within the first two lessons.*

Pollinators play an intricate role in natural ecosystems by helping plant populations reproduce, a role that we rely on heavily for continuing our worldwide supply of food, as well as many of our other plant-based resources, such as medicine, clothing, building materials, etc. Research shows that around 1/3 of our global food supply is reliant on animal pollination. 80% of plants in the world rely on pollination by living beings, which is called BIOTIC pollination. Pollination by non-living factors, such as by wind or water, is called ABIOTIC pollination.

Scientific research shows declines in many native bee populations across North America. This is in part due to several factors: habitat loss, resource competition from the introduction of exotic bee species, climate change, and pests and diseases. If we were to lose some of the pollination services our native bees provide, we may end up seeing severe detrimental impacts to our production of crop plants and to our local ecosystem services that we rely on to survive.

Gathering enough widespread data for these kind of research papers can be very challenging. That is where you and citizen science can help play a bigger role in data collection. CITIZEN SCIENCE is when someone in the general public volunteers to help conduct scientific research of some kind. To help gather this kind of data, the public can participate in all kinds of activities constructed by universities and other organizations. In this activity, you will be shown how to take photos of bees for use in local citizen science projects and then identify them!

Many people will only know of a handful of types of bees prior to this series of activities, but there are over 20,000 species of bees worldwide, 4,000 in the U.S., and over 400 in Missouri! These vary a lot in their life histories. Most do not have queens and workers, and they do not make honey. Learning more about these unique creatures helps us take steps toward conserving them. For instance, 70% of bees nest in the ground. Many forage from only a few plant species (specialists), whereas others forage from many different plant species (generalists).



Background Information

Continued

With so many different types of bees living around us, and so many insects that look similar to bees, it is very important for us to learn how to identify them. Identification of a species can help better direct conservation efforts. Bees come in many different shapes, sizes, textures and colors. These physical traits are the differences that we will look at in this lesson, to learn how to tell various bee groups apart from each other. The tool we will use to look at variation in bees is a DECISION TREE. Decision trees offer a way to easily navigate multiple choices visually.



Lesson Summary and Learning Goals

This lesson consists of two related activities. During the first, students conduct scientific photographic surveys of bees similar to those conducted by citizen scientists as part of Shutterbee. In the second, students use a decision tree to identify the bees in their photographs and learn unique life history traits of those groups.

There are two optional extensions. The first is to upload the photographs to iNaturalist, a repository for data collected by citizen scientists. A community of experts, including Shutterbee researchers, will identify the photographs. The students receive feedback from experts and, by uploading their photographs, have contributed to the scientific process. The second is a Kahoot! challenge for students to test their bee ID skills.

Lesson length: 90 minutes

Learning Goals

To develop student awareness of the diversity of bees and citizen science, including:

- Use scientific methods to document and identify bees
- Knowledge of diverse bee life history strategies
- Awareness of different ways to participate in bee conservation
- Contribute to citizen science (optional extension)



Learning Standards

6-8 Science Missouri Learning Standards: Grade Level Expectations

Life Sciences 1: From Molecules to Organisms

Concept B: Growth and Development of Organisms (6-8.LS1.B.1.) Construct an explanation for how characteristic animal behaviors as well as specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

Extension

Life Sciences 2: Ecosystems: Interactions, Energy, and Dynamics

Concept C: Dynamics, Function, and Resilience (6-8.LS2.C.2) Evaluate benefits and limitations of differing design solutions for maintaining an ecosystem.

North American Association of Environmental Education Guidelines for Excellence Grades 5-8

Strand 1: Questioning, Analysis and Interpretation

C. Collecting information: Learners locate and collect quantitative and qualitative information about the environment and environmental topics, using a range of methods and sources. They explain why they used selected information collection methods.

E. Organizing and analyzing information: Learners classify, organize, and display data and information they collect in ways that help them analyze and interpret their environmental investigations.

Extension

Strand 3: Skills for Understanding and Addressing Environmental Issues

3.1 Skills for analyzing and investigating environmental issues

C. Identifying and critiquing alternative solutions and courses of action. Learners identify and develop action strategies, including design solutions, appropriate for addressing a range of environmental issues at community and regional levels. They describe how their action strategies and design solutions might impact environmental quality and other people now and in the future.



Supply List and Lesson Set-up

Supply List

- ☐ One camera per student
- ☐ One printed guide per student or student pairs
- ☐ A location with abundant flowers
- ☐ Optional: iNaturalist app
- ☐ Optional: Kahoot!

Lesson Set-up

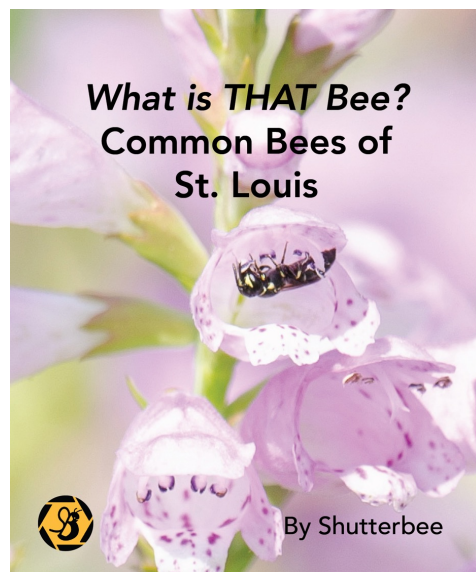
In this lesson, the students will BE the scientists – conducting their own photo surveys modeled after the Shutterbee protocol. They can upload their observation to iNaturalist, which is a repository for photographic observations of organisms found throughout the world. However, that is not necessary to meet the learning goals. The goals are for students to learn about citizen science, the importance of standardizing a scientific protocol, and local bee diversity.

Activity 1: Photographic Survey. The activity starts with a PowerPoint presentation to provide background and tips for conducting a standardized survey and photographing bees. Then, the students conduct a survey at a nearby location with flowering plants and identify them using a decision tree. Should the weather not cooperate, we have images of bees that can be used as a back-up.



We recommend using whatever camera students are familiar with. Mobile phones and small digital cameras work better than iPads, which are more challenging to navigate around flowers.

Activity 2: Identify Bees with Decision Trees. Upon return to the classroom, introduce bee anatomy and demonstrate how to effectively use a decision key. Once the students have figured out which bee they observed, they will learn more about the natural history of the bee using the information in our Bee Guide. The students share one fact they learned about their bee with the class.





Photographic Survey Activity

The first slide of the presentation is an introduction to citizen science, where professional scientists and participants who are not trained in the field work together to solve a problem. In this lesson, students will practice skills of citizen scientists. If they choose to at the end, they can become official citizen scientists by submitting their photographs to iNaturalist, an app for sharing natural history observations with professional scientists.

The next three slides introduce the students to scientific methodology and the specific photo-survey protocol that will be used during this activity. In order to compare “apples to apples”, scientists conduct **standardized surveys**, which are the same length of time and conducted at the same time of day, in the same place, and under the same weather conditions. Often, they are repeated over months or even years. For example, Shutterbee **citizen scientists** conduct standardized photo surveys every 2 weeks and share their results with professional scientists through iNaturalist, a repository for natural history observations. The scientific community then identifies the organisms in the photographs and can use the sightings to learn about the organisms. The Shutterbee team, for instance, is studying bees in neighborhood and backyard gardens of St. Louis, MO to inform conservation efforts.

Photo-survey Protocol. Bees are most active when it is warm and sunny, so Shutterbee citizen scientists conduct their surveys between 10 a.m. and 3 p.m. on sunny, warm days. Bees will forage when it is hotter than 100°F. However, that gets a bit too hot for us humans, so we recommend that our participants refrain from doing surveys when it gets that hot. During a photo survey, the surveyor walks slowly through and around a patch of flowers, carefully looking for bees, and photographing every bee that they see.

The students will emulate that process during this activity. While Shutterbee citizen scientists conduct 20 or 30-minute surveys, 10 to 20 minutes should be sufficient for this activity. If bee activity is low, we provide photographs of bees taken by Shutterbee citizen scientists for students to identify.

Tracking bees: Comparing apples to apples

To figure out which bees are in an area and compare that other areas, scientists **STANDARDIZE** their observation methods



Shutterbee's standardized survey method



10am to 3pm



Sunny or Partly
Cloudy



Temperature
60°F to 100°F



PC: moprattle.org

Walk a slow,
leisurely pace

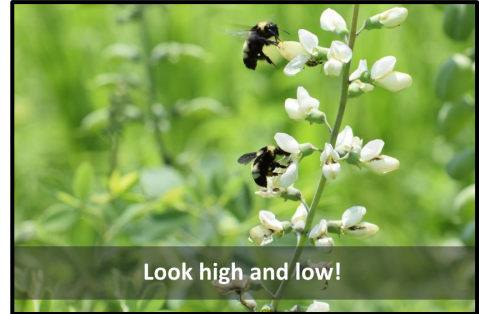
Stop at each patch
of flowers and
search for bees

Don't overlap
anyone else, if
possible



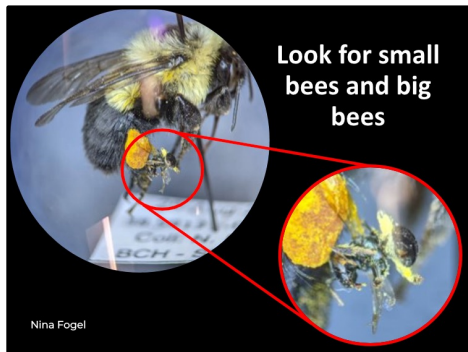
Photographic Survey Activity Continued

The next four slides provide tips on “seeing” bees. We each have a picture in our head regarding what we think a bee looks like. However, as Activity 1 demonstrates, bees come in all kinds of shapes and sizes. It takes time to train our brains to register that the small moving “gnats” or the shiny insect that looks hairless are actually bees. The first slide encourages folks to look at any flowers they see – whether they are along the ground or on flowers above their heads.

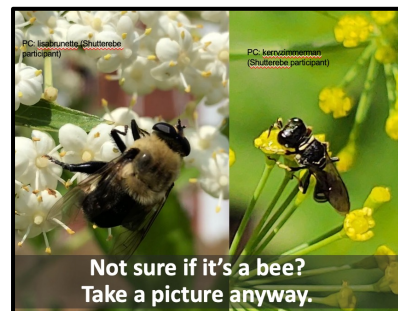


The next two slides demonstrate size variation in bees. The first provides a relative size comparison. The small bee is attached to the leg of the larger bumble bee (Note: bees do not normally hold on to each other like this in the wild. This is an artifact of how the bees were sampled – they got stuck together in a collection tube). The next slide demonstrates the sizes of common bees found in the region – from our largest, the carpenter bee, to some of the smallest bees that are less than half the length of a dime.

Our greatest diversity is found in the medium sized bees, so we recommend that participants pay particular attention to photographing the medium and smaller bees.



While this activity focuses on bees, it can be very hard to tell a bee from a mimic, such as the wasp in this image. We recommend that they take pictures of anything that looks bee-like, if they are uncertain whether or not it is a bee. After they have taken the photograph, they can zoom in and look more closely at the insect’s features to determine if it is truly a bee.





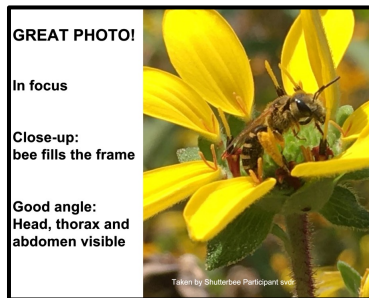
Photographic Survey Activity

Continued

How to take a “good” photograph of a bee. When scientists are taking photographs for research, we aren’t looking to take beautiful pictures – though that is often the result! The image of the bee on the purple flower below is beautiful, and you can see the head in detail. However, that is all we can see.

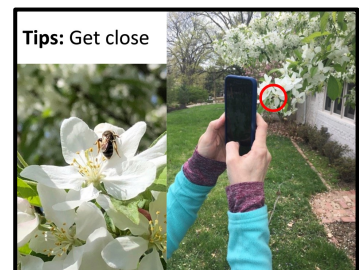
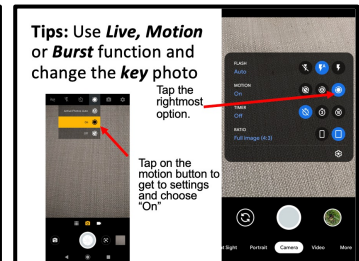
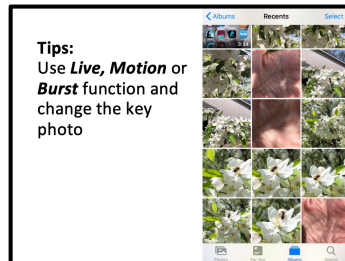
However, we can still get a lot of information about a bee visit without the picture being perfectly in focus. Being up-close and clear is certainly helpful, but we can still get great information from “imperfect” photographs! Even if they are out of focus or the bee is partially obscured, the photographs can still be “good data”.

To identify bees from photographs, it is helpful to have pictures of different parts of the body and from multiple angles (i.e., the head, thorax, and abdomen). For that reason, we recommend getting multiple photographs of each insect. Generally, some will be more in focus than others as well.



Taking photographs of moving organisms can be a challenge and it often takes practice to learn how the bees move, how light affects the pictures, and how to use one’s camera. We provide a series of tips to help the students be more successful on their first try.

1. Use Live, Motion, or Burst functions, which result in multiple photographs being taken in quick succession.
2. Get close. Many folks are uncomfortable or scared around bees. While female bees can sting (males cannot), they will only do so when they feel very threatened. Maintaining a calm presence and moving slowly will allow you to get close to the bee without spooking them. Do not touch the bees, and they will likely ignore you or fly away if they feel threatened by your presence.

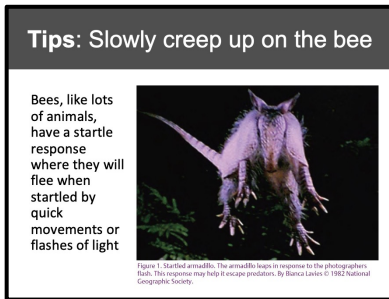




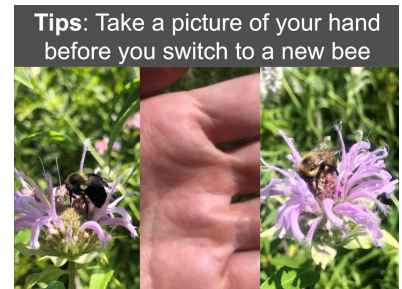
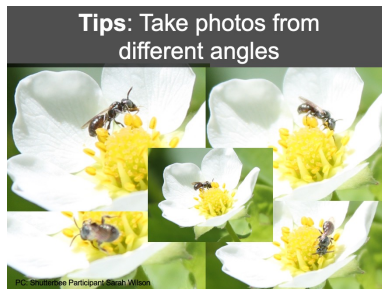
Photographic Survey Activity

Continued

3. Slowly creep up on the bee or wait until it has its head in a flower to move toward it. Like many animals, bees have a startle response (like this armadillo) and will fly away when spooked.
4. Keep the light on the bee, so the camera can pick up on the details. If shaded, the details will not be visible.



5. Try not to shade the bee with your phone. Sudden changes in lighting may also spook the bee if it perceives you as a predator.
6. Take several pictures of the bee from different angles. That will help you identify the bee later and improve your chances of getting a high-quality photograph.
7. To help keep track of which pictures are of which bees, take a picture of your hand between each bee.



8. Bees vary a lot in size! Our largest bee is roughly the size of the last digit of your thumb. Our smallest is roughly the size of the tip of your pinky nail. Keep an eye out for the small ones, because the big ones tend to catch our eye first.
9. Our final tip is to be patient! You won't get a picture of every bee that you see. That is normal! Just get what you can.



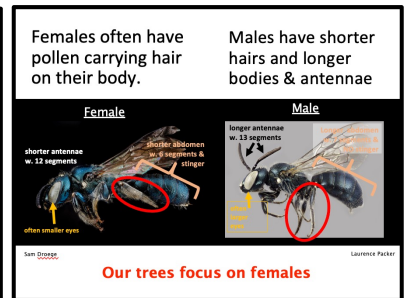
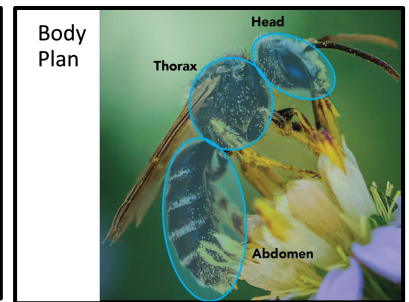
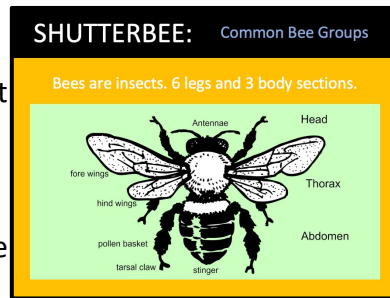


Identify Bees with Decision Trees

Once the students have photographed 3-5 bees, return to the group and provide some background on the bee body plan and how to use a decision tree. Then, have them identify the bees in their photographs using decision trees (more on these in a moment).

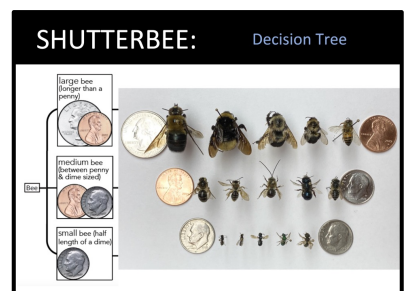
The **slides** we provide focus on traits that are used in the decisions trees. We start with a review of the general body plan. Bees have six legs, two sets of wings, five eyes and three main body parts: the head, thorax, and abdomen.

Our decision trees are most reliable for females, which are more commonly found foraging. Males generally differ from females by having longer antenna, bigger eyes and a longer abdomen.



Females also have scopa, or pollen collecting hairs on their bodies (males do not, because they do not collect pollen). Different bees carry pollen on different parts of their body. Some have dense scopal hairs on their hindlegs, others have them on underside of their abdomen (which we refer to here as their “bellies”). Bumble bees and honey bees have special scopal hairs in a ring around large hairless part of their hindlegs. Known as a corbicula, this special trait allows them to pack pollen into a tight ball and carry it far distances. Finally, there are a few bees that don’t have scopa! We do not focus on them in this activity.

While we often think first of the bigger bees (bumble bees, carpenter bees, and honeybees), most bees are much smaller than that. The next few slides help the students compare the different sizes of bees. One important thing to note is that bumble bee workers can vary a lot in size, though they would still fall within the “large bee” category.





Identify Bees with Decision Trees

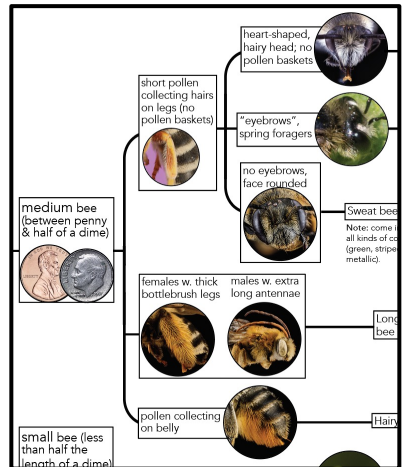
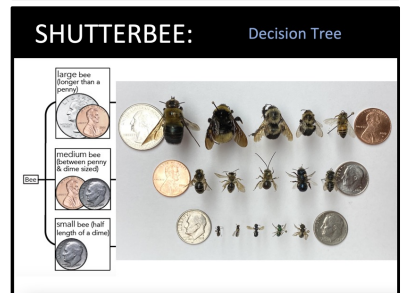
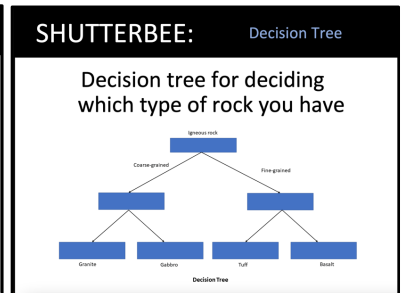
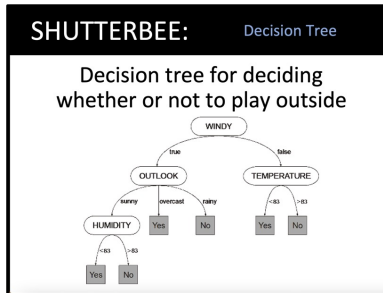
Decision trees help scientists correctly identify organisms. Many species can look very similar. If you aren't focusing on the correct traits, they can easily be mis-identified. We provide two example decision trees that aren't related to biology to help the students better understand the purpose of the trees.

Our decision trees start with **body size**. Bees that are between the size of a quarter and a penny, such as bumble bees and honeybees, are considered "large". Whereas those that are between the size of a dime and a penny are considered "medium". Finally, bees that are smaller than a dime are considered the "small" bees. Because those are the most challenging to photograph, this activity focuses on the medium and large bees.

The next decision has to do with the **location of hairs** on the body. Bees can have hairs all over their body, no hair, and everything in between. Most also have a special kind of hair: scopa which are used to collect and carry pollen. They are generally longer and densely packed. The placement of scopal hairs varies by group: some bees have scopa on their hind legs; some on their abdomens; some (like honeybees and bumble bees) have scopal hairs in ring around a concave part of their leg called pollen baskets.

The last set of decisions have to do with the **shape of the face** and whether or not there are hairs along the side of the large eyes of the bee (what we call "eyebrows"). An image of the "eyebrows" is available in the identification guide.

Next, we provide an example for the group to work through together. We provide additional slides that can be used as a back up if bee activity is low (e.g., if the weather is rainy or cloudy) OR can be used as additional practice before the students identify their own photographs.





Assessment of Student Learning

Kahoot! Quiz to check for understanding

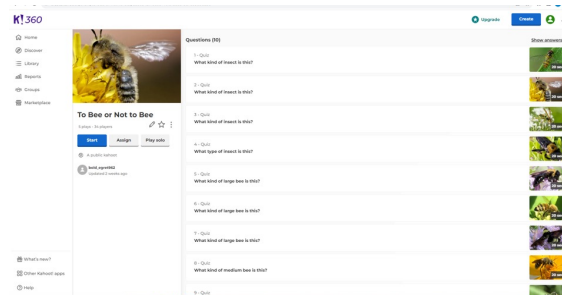


Shutterbee has created a public Kahoot quiz for your use as an assessment. When you're preparing your lesson follow these steps:

Use this link to go to the "Shutterbee To Bee or Not to Bee?" Quiz:
<https://create.kahoot.it/share/to-bee-or-not-to-bee/b3995421-3e0b-46fd-abae-be78b58bd2bb>

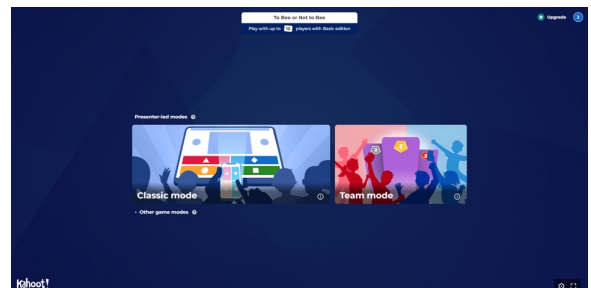
You will be prompted to log in or create a free educator account. Once logged in, the quiz should open. If not, it will be visible in your XXXX folder. There are three options to launch the quiz: Start, Play Now, and Play Solo. We recommend playing the game solo on your own as a preview before using it with the class.

To use the "Shutterbee To Bee or Not to Bee?" quiz as a class assessment, your students will need a device to connect to www.kahoot.it or the Kahoot! app. Be sure you're logged into www.kahoot.com before beginning class using the provided PowerPoint.



When you're ready to play as a class, use the link in the PowerPoint slide to access the quiz. Select Start and choose your preference of Classic (individual) or Team mode.

Kahoot! will generate a unique code for students to log in from their devices (phones, tablets and computers are all supported).



Note: with a free basic Kahoot! account, only 10 players can participate at a time, so your group may need to be divided into teams depending on number of students and your account type.



Assessment of Student Learning

Final wrap-up questions for discussion

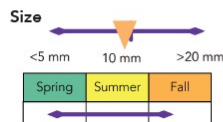
The bee guide includes natural history information about each type of bee. Have the students review that information and select something that they find most interesting to them. Then, have each student draw that bee that they observed. If time allows, have the students share out what type of bee they had and what makes it unique.



Sweat Bees
Family Halictidae



Variable in color; mostly distinguishable from other taxa by what they don't have!



Pollination: Melons, alfalfa (feed for dairy cows), eggplant, cotton

Foraging: Most are generalists.

Nesting: Ground nesters that range from solitary to highly organized (social).

Other fun facts: Some collect the water and salts in our sweat, giving them their name. Think of your sweat as a sports beverage for bees.

Break the students into 3 groups and have each group discuss the following:

1. What have you learned about bees through these activities?
2. Why does diversity matter?
3. What does photographing bees have to do with the bee crisis?

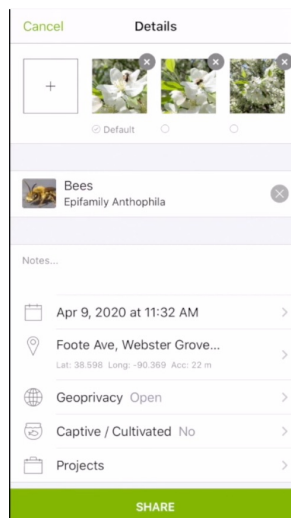
Come back together and have the students share their thoughts with the class.

For advanced students: Submit Observations to iNaturalist (Optional)

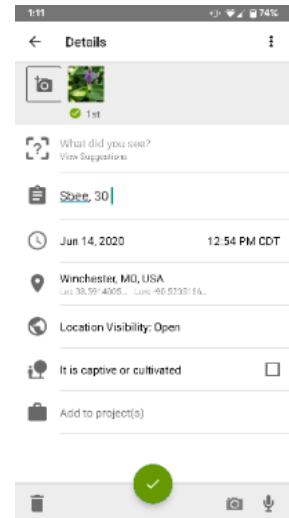
Have the students complete their role as citizen scientists by uploading their observations to iNaturalist! You will need an account (it is free!) and a phone or computer that supports the app. The app is pretty user-friendly, though each platform is a little different. Generally, you will follow these steps:

1. Open the iNaturalist App
2. Select the "Observe" button
3. Select the "Photo library"
4. Select up to 4 photographs of a single bee
5. In the "What did you see?" box type the name of the bee as you have identified it.
6. Last, select the "Share" or checkmark button, and you are all done!

Check back in a few days to see if your bees have been identified by experts. Were your identifications correct? If not, which bees were the hardest to identify?



iPhone



Android



Supply Descriptions

Cameras (we recommend that each student or each pair of students have a camera. Use whatever camera students are familiar with. Mobile phones and small digital cameras work better than iPads, which are more challenging to navigate around flowers.)

A nearby location with flowering plants and insects. The area doesn't have to be large; we supply photographs of bees as a back up if bees are not abundant.



Print outs of the Bee ID Guide



Thank you for joining!!!

