Note to instructor: The tables below provide general information about the nesting habits and distribution of the six bee families found in North America. They are intended to aid in preparation for the activities described below. As an instructor, you can identify the species students would be most likely to see in your area and familiarize yourself with their general appearance and nesting habits. The second table notes the most widespread genera within each of those families: genera that are found throughout North America. The activities below will help bring the importance of pollination and a recognition of native bee species into the classroom.

Nesting habits, timing and distribution of North American native bees

Native bee families:	Colletidae polyester bees	Andrenidae mining bees	Halictidae sweat bees	Megachelidae leafcutter and mason bees	Apidae bumble, carpenter, and other bees	Mellitidae
Nest location*						
Ground	X	X	X	X	X	X
Mason				X		
Cavities				X		
Stems	X			X	X	
Wood			X	X	X	
Rodent burrows					X	
Time of year†						
Spring	X	X	X	X	X	
Summer	X	X	X	X	X	X
Fall	X	X	X		X	
Distribution						
Northeastern US	X	X	X	X	X	X
Southeastern US	X	X	X	X	X	X
Midwestern US	X	X	X	X	X	X
Mountain states	X	X	X	X	X	X
Northwestern US	X	X	X	X	X	X
Southwestern US	X	X	X	X	X	X
Canada: BC-AB	X	X	X	X	X	
Canada: SK-MB	X	X	X	X	X	
Canada: ON-QC	X	X	X	X	X	
Canada: eastern territories	X	X	X	X	X	

*** Ground**: bees burrow into soil to make nests. **Mason**: bees make nests using resin or mud. **Cavities**: bees use natural cavities (snail shells, beetle borings). **Wood**: bees excavate nests in wood. **Stems**: bees excavate nests in stems. **Rodent burrows**: bees use abandoned rodent burrows, underground or in hollow trees.
† Approximate timing: **Spring:** March-May. **Summer:** June-mid-August. **Fall:** late-August-October.

Common genera within each family

The genera listed below are found throughout North America (both the United States and Canada) and will be the bees most likely encountered during observational activities.

Family	Genus (common name)
Andrenidae	*Andrena* (sand/mining bees)
	Calliopsis (miner bees)
	Perdita (miner bees)
Apidae	*Bombus* (bumble bees)
	Ceratina (small carpenter bees)
	Epeolus (cuckoo bees—lay eggs in other bees' nests)
	Melissodes (long horned bees)
	Nomada (cuckoo bees—lay eggs in other bees' nests)
Colletidae	*Colletes* (polyester bees)
	Hylaeus (yellow-faced bees)
Halictidae	*Agapostemon* (sweat bees)
	Dufourea (sweat bees)
	Halictus (sweat bees)
	Lasioglossum (sweat bees)
Megachelidae	*Coelioxys* (cuckoo bees—lay eggs in the nests of leafcutter bees)
	Hoplitis (mason bees)
	Megachile (leaf-cutter bees)
	Osmia (mason bees)

(Supplement for "Discovering Native Bees" from Green Teacher *#93, Summer 2011)*

Activities *(The following activities can be done with children ages 9 and up)*

Pollination Exploration

Materials: at least 4 potted flowering plants (e.g., bell peppers), unused paintbrushes, tags and pen to label flowers, twist-ties or string to attach tags to plants

Preparation: There are two possibilities for this activity, depending on educational goals and time availability. The short version requires several weeks and illustrates the role of pollen transfer in fruit development. The long version requires several months and not only illustrates the outcome of pollination, but also takes students through the full life-cycle of a flowering plant.

If you plan to use the longer version of this activity, students will need to plant seeds and raise them into plants for the activity detailed below. If starting with seed, fill eight 20 cm (8 inch) pots with high-quality potting soil and provide seeds to students (individually or in groups) to plant. (Doubling the number of pots will help to ensure that at least four plants bloom.)

Students can watch the seeds grow into mature plants. A classroom with a window would provide an ideal environment; in the absence of a window, plants can be housed under a grow-light. Keep the soil moist but not overly wet and fertilize with compost tea (tomato feed) every other week. Bell pepper seeds can require 2-3 months to reach full size. Once plants are blooming, follow the procedure below.

Procedure:

1. Introduce the activity by asking the students where fruit comes from. Do they know that flowers grow into fruit? How does that happen, and why don't all flowers become fruit?
2. Designate one plant as an unpollinated plant. This one will not be used for pollen transfer; it serves as a control in this experiment. Label the plant "control" and keep in an area where it is unlikely to be jostled or otherwise disturbed. (Bell pepper plants are capable of self-pollinating; bumping the plant may cause unwanted pollination of flowers; see step 8 if this happens.)
3. Designate a second plant "self-pollinator" and label it as such. Place tags marked "pollinated" on branches near flowers that will receive pollen. Have students use paint brushes to gently pick up pollen from untagged flowers on the same plant then transfer the pollen to the tagged flowers.
4. Choose at least two remaining plants to use for cross-fertilization. Label each plant "cross-pollinated" and give each a letter or number to distinguish between them. On each of the cross-pollinated plants, tag several flowers with "pollinated" tags. Have students (using clean paint brushes) transfer pollen from the untagged flowers of one plant to the tagged flowers of the other. Be sure that this cross-pollination goes in both directions. Record the date of pollen transfer.
5. Each day, have the students check the status of the tagged flowers on each plant, and

Self-pollinated plant	Date:	Date:	Date:
Number of tagged flowers that:			
• are in bloom			
• have fading petals			
• are growing into fruit			

track the changes they observe in a table like the one below (use one table per plant; increase the number of columns to record data for as long as needed).

6. Look at overall trends at the end of the fruiting season: how many cross-pollinated flowers bore fruit? How many self-pollinated? How many on the unpollinated plant? (This can be a nice activity for graphing, as well: create a line graph that illustrates the change in number of fruiting flowers over time for each of the plants.)
7. If the activity began with students planting seeds, wait until some of the fruit is mature, then cut it open to look at the seeds inside. This will help to reinforce the role of pollination in the life cycle of flowering plants.
8. If the control (unpollinated) plant produces fruit, measure and record the weight and diameter of each fruit in a table like the one below. The fruit from the plants visited by "pollinators" should be larger and more robust. This will be most easily seen by graphing the data. This particular activity is also ideal for calculating the average weight and diameter of each category.

Plant	**Fruit 1**		**Fruit 2**		**Fruit 3**		…
	Weight	Diameter	Weight	Diameter	Weight	Diameter	
Control							
Self-pollinated							
Cross-pollinated A							
Cross-pollinated B							

Nest Search

Materials: magnifying glasses, tweezers, Petri dishes

Preparation: This activity will work best in colder climates, where bees overwinter below ground rather than inside hollow sticks; if you live in a temperate climate, see the variation below.

Procedure:

1. Take students to search for abandoned insect nests in a location with an abundance of hollow sticks.
2. Break the sticks to see if anything is inside; collect those that contain used nests and bring them back to the classroom.
3. Using tweezers, gently break open the sticks to reveal the contents.
4. Students examine the nests inside the sticks, using magnifying glasses. Try to identify what they see.
5. Carefully remove the contents of the sticks and place them in Petri dishes for more thorough examination.
6. Armed with the information from the previous steps, students research what they find: what kinds of insects would make a nest inside hollow sticks?
7. Can students identify the type of wasp or bee (or other insect) that built the nest?

Variation:

1. In warmer climates, the above activity may be less destructive if the teacher brings a small number of hollow sticks into the classroom; children again dissect what is found inside (they will be more likely to find overwintering prepupae).

2. If they find prepupae, the students can do research to see if they can identify the species, or at least whether they can identify wasp vs. bee (this will be evident based on the type of food present: insect or plant).

Building a nesting block

Materials: untreated 4" x 6" block of wood; drill with a variety of drill bits ranging from 2.375 mm (3/32 inch) to 9.5 mm (3/8 inch) diameter; ruler; pencil; shingle or other flat piece of wood for a roof; safety goggles for anyone involved in drilling; hammer; nails

Preparation: Cut the block of wood into one or more smaller pieces 20-30 cm (8-12 inches) in length.

Procedure:

1. Using the ruler and pencil, measure and mark the location of the holes on the shorter side of the wood. Each pencil mark will be the center of a hole; marks should be 2 cm (3/4 inch) apart. Leave at least 2.5 cm (1 inch) on all outer edges.
2. Wearing goggles for safety, attach one of the drill bits to the drill and drill holes into the wood. Space out the holes made by this particular drill bit to allow for other diameter holes to be interspersed between them. The holes should be deep without penetrating the back side of the block. Ideally, the holes will end 1.5 cm (1/2 inch) from the back wall. To encourage a variety of bee and wasp species, use different drill bits to make slightly larger and smaller holes. Small holes (up to 63 mm [1/4 inch] diameter) should be 7-12 cm (3 to 5 inches) deep. Holes larger than 63 mm (1/4 inch) should be 12 cm (5 inches) to just under 15 cm (6 inches) deep.
3. If the drill goes all the way through the wood, back the wood block with a thin sheet of untreated wood after drilling, as the bees will not use holes that go all the way through.
4. On the back side, drill a hole for hanging the block. This hole should be drilled at a slight angle towards the top of the block.
5. Nail the roof onto the top of the block.
6. Hang the block in a location where it will face southeast to catch morning sunlight. Also ensure that it will not sway with a strong wind (a second nail at the base may be needed).
7. Watch to see what kinds of insects make use of the nesting block. What do they do when they first arrive? Do some species stay, but others not? Why might this be?

Behavioral observations

Materials: Nesting block (already in use); notebooks, pencils

Preparation: None, provided the block is already in place; if not, see previous activity. Check that the block is actively in use (bees and wasps regularly coming and going) before beginning the activity.

Procedure:

1. Take students out to observe the nest block. They should record their observations in their notebooks. Things to watch for:
    a. What kinds of insects use the block? (Students may not recognize all species that land on the block, but they should record as much information about the insects as possible and do research to identify them.)

b. If insects are just arriving to the block, what do they do when they inspect the holes?
c. What do the insects do when they leave? (Bees and wasps fly in a circular pattern to familiarize themselves with nearby landmarks that allow them to locate their burrow upon return.)
d. What kinds of nesting materials do the insects bring to their burrows? (Mud and leaves are commonly used nesting material.)
e. What kinds of food do they place inside the cells for their larvae to eat? (Students should watch for wasps carrying caterpillars or other insects and for the bright yellow pollen baskets on bees' legs and abdomens.)

Busy Bees

Materials: notebook and pencil for each student, stopwatches (one for each pair of students)

Preparation: Find a patch of flowers (e.g., school or local garden) with sufficient space for all students to sit nearby. Discourage use of perfumes or scented lotions on the day this activity takes place, as these may attract the bees.

Procedure:

1. Seat students in pairs around the flowers, close enough that they can observe the insects that visit.
2. Assign each pair of students a different type of flowers to observe (choose a variety of shapes, colors, and sizes, if possible).
3. The student with the stopwatch should start the timer when they begin observations. The other student should take notes. Working together, the members of the pair should record the number and type of insects that visit their assigned flower(s), noting when they arrive, how long they stay, and any other behavior of interest.

Discussions that tie into the above activities:

1. How do we recognize bees?
    - Many bees are yellow and black, but not all.
    - Bees have lots of little hairs that help them collect pollen.
    - Bees are usually found near flowers because they eat pollen and nectar.
2. How can we tell a bee from a wasp?
    - Most "bee stings" are actually from yellow jacket wasps, not bees.
    - Bees are unlikely to sting unless threatened or defending their hive.
    - Wasps tend to have brighter colors and lack "hair".
3. Why are bees important? Why do we need them?
    - This is a good opportunity to discuss the types of foods children like to eat; most—including fruits, nuts, and, indirectly, meat and dairy products—depend on pollination by bees.
4. Where do bees live?
    - Only honey bees live in a hive, all other species make their nests in hollow spaces in trees or buildings or underground.
    - Only honey bees live in large colonies. There can be as many as 60,000 honey bees in a colony; in contrast, bumble bee nests typically have 16-30 individuals.

Other species of bees may be semi-social: females nest together, but each female rears her own young.

- Most native bees are solitary—they live alone, females make and provision nests for their young. Adults will often sleep in a burrow at night.

5. What can children do to encourage native bees?
    - Plant a variety of blooming plants, particularly native plant species.
    - Provide ideal nesting sites (dry woody areas, or a nesting block).
    - Avoid using pesticides or insecticides, which kill beneficial insects as well as harmful ones.
    - Help protect natural habitats from development.
    - Encourage use of native flowering plants in open spaces, parks, and in the landscaping of public buildings.

