



Brought to You By... **POLLINATORS**

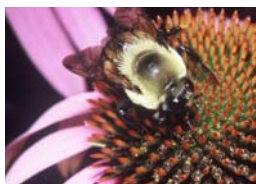
What is “Pollination” & What is a “Pollinator?”

- The act of “pollination” occurs when pollen grains are moved between two flowers of the same species by wind or animals. Successful pollination results in the production of healthy fruit and fertile seeds, allowing plants to reproduce. Without pollinator visits to tomatoes and other fruit and vegetable plants in our gardens, we would have no produce! For more information: <http://hiltonpond.org/ThisWeek031008.html>
- Almost 90% of all flowering plants rely on animal pollinators for fertilization, and about 200,000 species of animals act as pollinators. Of those, 1,000 are hummingbirds, bats, and small mammals such as mice. The rest are insects like beetles, bees, ants, wasps, butterflies and moths. See <http://www.wildaboutgardening.org/en/attracting/section1/>

Why Are Pollinators Important to Us?

- Worldwide, approximately 1,000 plants grown for food, beverages, fibers, spices, and medicines need to be pollinated by animals in order to produce the goods on which we depend.
- Foods and beverages produced with the help of pollinators include: apples, bananas, blueberries, chocolate, coffee, melons, peaches, potatoes, pumpkins, vanilla, almonds, and tequila. (Imagine a world without some of these things!)
- In the United States, pollination by honeybees and other insects produces \$40 billion worth of products annually!

Did You Know?



Bees -- can fly at about 7 miles per hour, and have to beat their wings 190 times per second to do it! Bees are constantly on the lookout for brightly-colored flowers with sweet scents. Bees tend to prefer flowers that they can walk on to sip nectar. Learn more at: <http://maarec.cas.psu.edu/infoonline.htm>.

Butterflies and Moths – Monarch butterflies in eastern North America have one of the longest migrations of any species! Their flights can last for thousands of miles, from Canada to central Mexico. Butterflies and moths need a place to land on the flowers that they visit, so they prefer broad, flat-faced flowers. Since they have long, straw-like mouth-parts, they can suck nectar from deep within the flower. Learn about butterflies at: <http://www.monarchwatch.org/htm>





Beetles – Did you know that ladybugs are natural enemies of many insects that we consider pests? A single ladybug can eat as many as 5,000 aphids in its lifetime! Many beetle species eat pollen, so the plants they visit must produce ample amounts of pollen to make sure that there is enough left to pollinate the flower after the beetles are finished eating! Beetles are attracted to spicy or fruity odors, and most of them need a wide opening in the flower, because they are clumsy fliers.

Hummingbirds – have long beaks and brush-like tongues, and they are good pollinators of many plants in the Western hemisphere. They generally look out for long, tube-shaped, flowers colored red or orange. Learn more at: <http://www.hummingbirdsociety.org/indexnew.asp>



Bats – like moths, nectar-eating bats are attracted to pale or white flowers that blossom after dark. Bats search for flowers with a large amount of nectar and that emit strong, musky or fruity odors. These flowers include the agave and many other tall, cactus species. Learn more about bats at: <http://www.batcon.org/home/default.asp>

Pollinator-Friendly Activities

Here are some simple steps you can take in your yard to create habitat and help pollinators survive and thrive!

- **Plant a pollinator garden.** Pollinator gardening is fun. Check out: <http://www.kidsgardening.com/growingideas/projects/jan03/pg1.html>. This website offers gardening instructions along with educational and curriculum resources.
- **Reduce chemical misuse.** Practice Integrated Pest Management (IPM) to reduce damage to your plants and to protect pollinators by using less chemicals. You could intersperse food plants, like tomatoes, with inedible plants like marigolds. Marigolds are known to attract pest insects away from food plants. Learn more about IPM and gardening at: <http://paipm.cas.psu.edu/homegarden/garden.html>
- **Reduce your area of lawn grass.** Grass lawns offer little food or shelter for most wildlife, including pollinators. You can replace grass with a wild meadow or prairie plants. For a neater look, make a perennial border with native plants. Plants native to your area are adapted to your soil type, climate, precipitation, and local pollinators! You can get a list of plants native to your area at: <http://www.nwf.org/backyardwildlifehabitat/nativeplants.cfm>
- **Provide water.** All wildlife, including pollinators, need water. Some butterfly species sip water from muddy puddles to quench their thirst and get important minerals. You can provide water in a birdbath or even a shallow dish placed on the ground.



For information about pollinators and to learn about other fun activities, please contact:

North American Pollinator Protection Campaign
info@nappc.org or www.nappc.org

Stennett S. Heaton © 2001 California Academy of Sciences



Gulf fritillary butterfly



5 Things Kids Can Do To Help Pollinators

1. **Be kind to your pollinator friends.** Pollinators like bugs and birds are small and fragile. It's easy for people to hurt them. Be gentle and quiet when they are near!
2. **Look, but don't touch!** When you see a butterfly, bee, beetle, or hummingbird outside, look, but don't touch! Pollinators won't hurt you if you leave them alone and are nice to them.
3. **Don't use poison sprays.** Bug your family to stop using poison sprays in your house and garden. This poison kills bad bugs, but it hurts pollinators too. Bug your family to buy ORGANIC fruit and vegetables. These are grown without poison sprays, so they keep pollinators safe and happy.
4. **Keep pollinators' homes safe.** And help make habitat for pollinators. Take care of a garden. Plant some flowers. When you find a bug in your house, gently take it outside to its natural habitat.
5. **Bug someone!** Bugs and pollinators are fun and interesting. Teach your family and friends about these important animals. Teach them to say "Thanks Bugs!" You can "bee" an expert! ★



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Jo-Ann Ordano © California Academy of Sciences

Bumblebees harvesting.



Dr. Lloyd Glenn Ingles © California Academy of Sciences

Hummingbird and thistle

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Pollinator Friendly Practices



Use native plants since they are adapted to the local climate and soils, and local pollinators are adapted to them.



Provide a variety of flower shapes and colors since different pollinators are attracted to different types of flowers.



Avoid modern hybrids, especially those with "doubled" flowers, since pollen, nectar, and scent can be lost in the cultivation process.



Plant a variety of flowers to bloom continually from early spring to early fall.



Provide bare ground or a shallow bird bath filled with soil, sprinkled with sea salt and kept moist, to create a source of water and minerals for pollinators.



Help pollinators find the plants they need by planting them in clumps rather than singly. Clustering plants also shortens the distances that pollinators need to travel.



Build a bee condo or leave dead trees or limbs to create nesting habitat for bees.



Avoid using pesticides if at all possible. If you want butterflies, you need caterpillars (and the nibbled leaves that go with them!)

Include plants for caterpillars. They are surprisingly fussy eaters and require particular "host" plants, but the average gardener won't notice the damage until at least 10% of the leaves are affected.

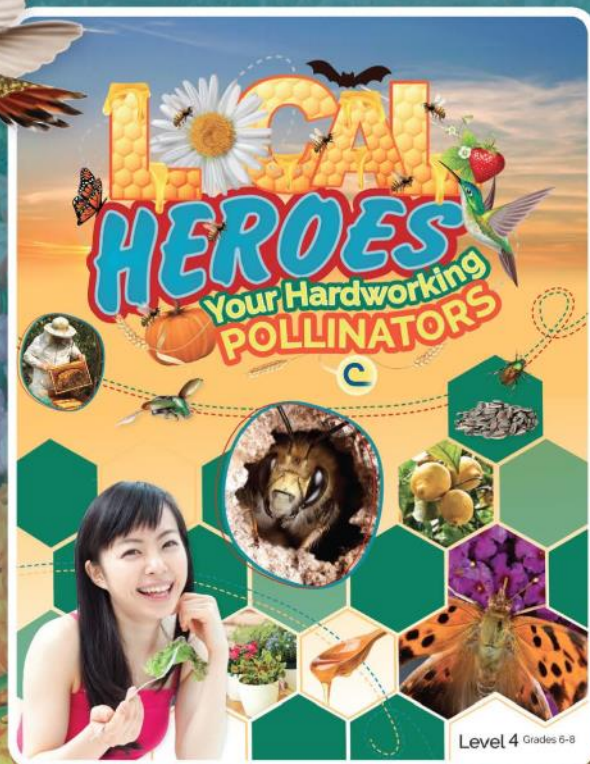
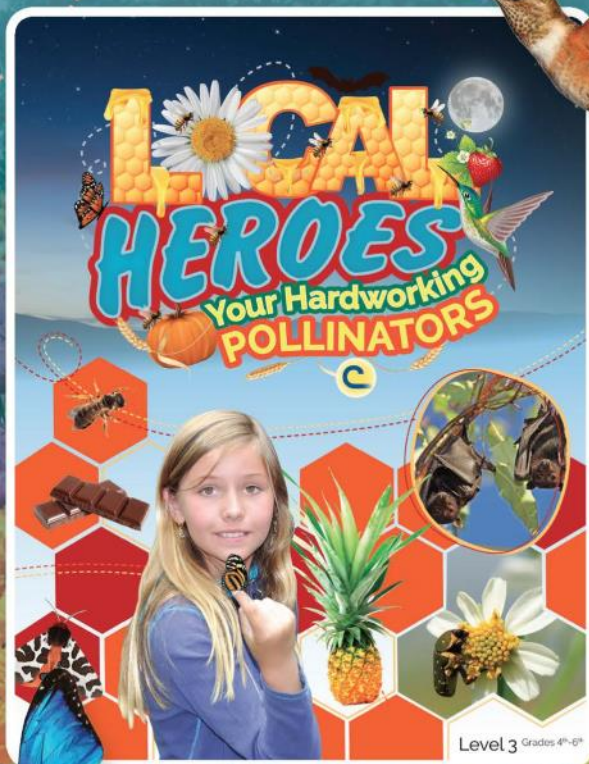
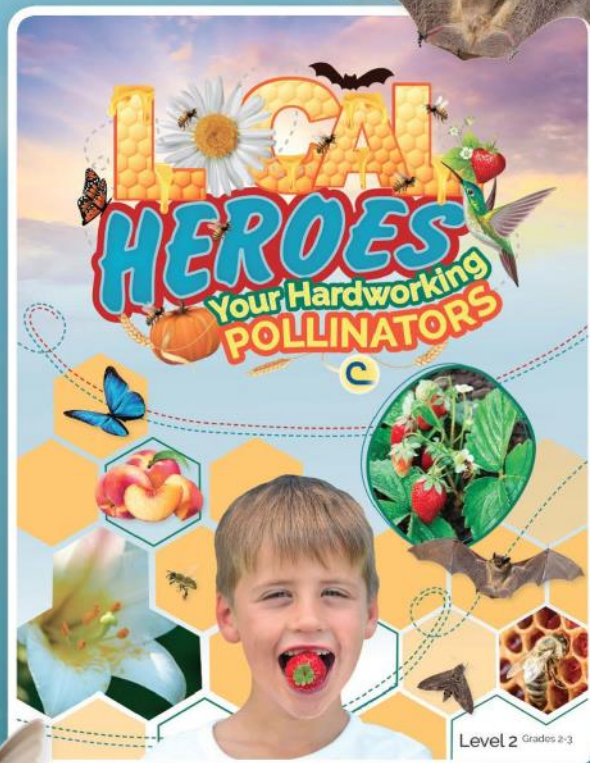


Pollinator Pathway

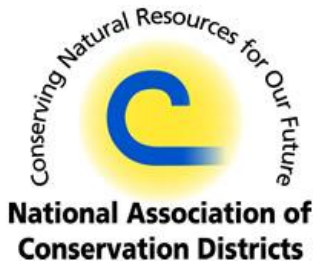
The Pollinator Pathway is a series of habitats that support the life cycle of pollinators. It includes areas where pollinators can find food, shelter, and places to lay their eggs. The pathway is made up of many different types of plants and animals that work together to support pollinators.



This strip contains logos for several partner organizations, including APIS (American Pollinator Protection Alliance), ASPI (Association to Support Pollinators), ASPHISH (Association for the Study of Pollinators and Hummingbird Interactions), and others. At the bottom of the strip is a QR code and the ASPHISH logo.



Educators Guide



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Educator’s guide information

You can download this PDF educators guide from the NACD website. You can access information by clicking on the links and it will take you directly to the web page. You may also print out a page that you need.

<http://www.nacdnet.org/education/resources/local-heroes>

This booklet will be updated as needed to bring you the most current information.

Visit the **NACD Marketplace** to purchase Local Heroes—Your Hardworking Pollinators education materials.

www.nacdstore.org

Special thanks to “Local Heroes—Your Hardworking Pollinators” education booklet reviewers and content assistance:

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Pollinator Partnership, www.pollinator.org
 San Francisco, CA

And the many educators in the development and reviewers of the materials.

Please submit information to share with others on your successful stewardship programs or conservation education activities.

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The National Association of Conservation Districts is the non-profit organization that represents the nation's nearly 3,000 conservation districts, their state associations and the 17,000 men and women who serve on their governing boards. For almost 70 years, local conservation districts have worked with cooperating landowners and managers of private working lands to help them plan and apply effective conservation practices.

Conservation districts are local units of government established under state law to carry out natural resource management programs at the local level.

NACD's mission is to serve conservation districts by providing national leadership and a unified voice for natural resource conservation. The association was founded on the philosophy that conservation decisions should be made at the local level with technical and funding assistance from federal, state and local governments and the private sector. As the national voice for all conservation districts, NACD supports voluntary, incentive-driven natural resource conservation programs that benefit all citizens.

NACD maintains relationships with organizations and government agencies; publishes information about districts; works with leaders in agriculture, conservation, environment, education, industry, religion and other fields; and provides services to its districts. NACD is financed primarily through the voluntary contributions of its member districts and state associations.

The association's philosophy is that conservation decisions should be made by local people with technical and funding assistance from federal, state and local governments and the private sector. The association's programs and activities aim to advance the resource conservation cause of local districts and the millions of cooperating landowners and land managers they serve.

Visit www.nacdnet.org for additional information.
To find your local district contact information, go to
www.nacdnet.org/about/districts/directory

STEWARDSHIP WEEK INFORMATION

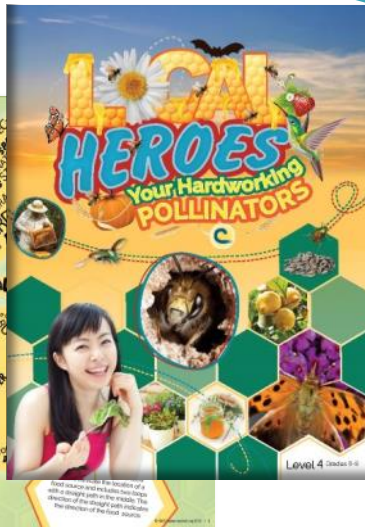
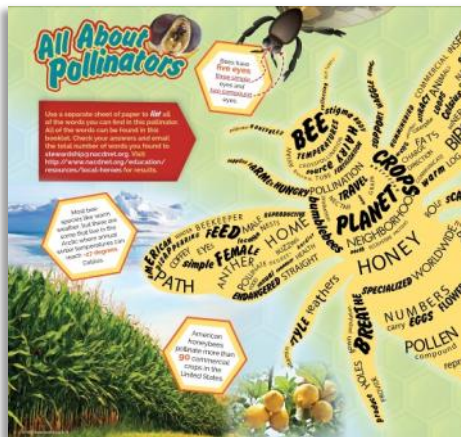
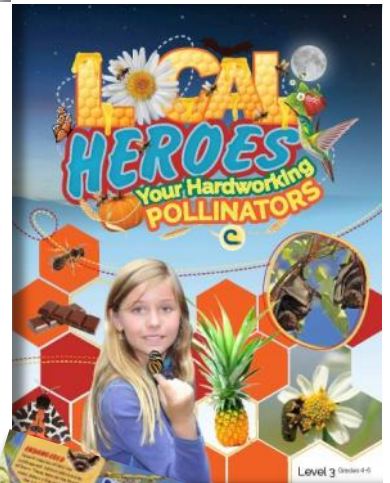
NACD has sponsored Stewardship Week since 1955. **2015 marks the 60th year** to celebrate NACD Stewardship Week.

Education is a critical element of the conservation effort at the local, state and national levels. Educating youth ensures that the next generation will be wise stewards of America's natural resources. Helping today's adults understand the need for effective conservation practices builds on the conservation legacy. Through NACD's Stewardship and Education efforts, we help districts, educators and communities extend the reach of their education programs.

Stewardship Week, celebrated annually between the last Sunday in April and the first Sunday in May, reminds us of our individual responsibilities to care for the natural resources upon which we all depend.

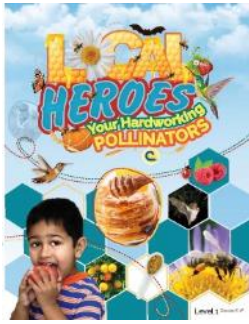


NACD Education Materials available at the
 NACD Marketplace visit www.nacdstore.org/
 Additional Resources available at
www.nacdnet.org/education/resources/local-heroes



Additional Products will be added to this page after final development.





Level 1-Grades K-1

Local Heroes: Your Hardworking Pollinators

Booklet Objectives

Students will:

- Realize that humans need food in order to live and grow and that a large portion of their food comes from plants.
- Gain an awareness of the dependence of plants upon pollination.
- Deduct which items utilized in their daily lives are dependent upon pollination.
- Explain the steps in animal pollination.
- Recognize that humans can have a positive impact their environment by making changes beneficial to pollinators.

Next Generation Science Standards

Disciplinary Core Ideas

K. Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment

LS1.C: Organization for Matter and Energy Flow in Organisms

ESS2.E: Biogeology

ESS3.A: Natural Resources

ESS3.C: Human Impacts on Earth Systems

ETS1.B: Developing Possible Solutions



1. Structure, Function, and Information Processing

LS1.A: Structure and Function

LS1.B: Growth and Development of Organisms

Vocabulary Words

Nectar—the sweet liquid that flowering plants produce as a way of attracting the insects and small birds that assist in pollination.

Pollen—a powdery substance produced by flowering plants that contains male reproductive cells. It is carried by wind and insects to other plants, which it fertilizes.

Pollination— to transfer pollen grains from the male structure of a plant anther to the female structure of a plant stigma and fertilize it.



Pollinators and Me

Activity Objectives

Students will:

- Realize the correlation between the food they eat and pollinators.
- Relate the ways in which they function to the ways in which pollinators function.

Materials

- Pollinators and Me hand out (pg 8)
- Food items that are a result of pollination (apple slices, grapes, cheese cubes, cherry tomatoes, strawberries, etc.)
- Pictures of pollinators: - page 24
 - bee eating pollen
 - butterfly using proboscis to drink nectar
 - hummingbird



Discussion

- ◆ Define pollinator for students: Pollinators are small animals like birds, bats, bees and bugs that eat the pollen or nectar found in flowers. Show picture of bee eating pollen, pg 24.
- Discuss how we eat with our mouths and pollinators eat with different body parts; mouth, beak, proboscis, etc. Show picture of butterfly drinking nectar with proboscis (the long or tubular mouthparts of some insects, worms, and spiders, used for feeding, sucking, and other purposes) pg 24.

Instructions

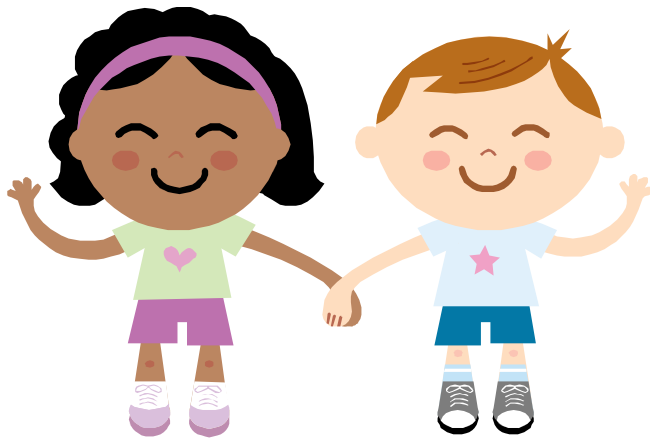
1. After discussing how pollinators eat, place the food items you have chosen around the room. Tell the students what items are available. Invite the students either individually or in small groups to go and get a food item and return to their seat.
2. While the students eat have a discussion on what body parts they used to collect their food. Discuss what body parts pollinators use to collect their food; legs, wings. Show students picture of hummingbird, pg 24
3. Explain to students how pollination occurs: pollen is moved from one flower to another. Flowers use this pollen to make seeds that grow into fruits, vegetables and grains that we can eat.
4. Distribute copies of the “**Pollinators and Me**” handout for students to complete.



Pollinators and Me

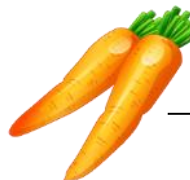
Pollinators get hungry and have to eat just like we do. Pollinators eat pollen. Draw a circle around the body part that you use to eat. Draw a circle around the body parts that the pollinators use to eat.

Pollinators have to move around to find food just like we do. Draw a square around the body parts you use to move around and find food. Draw a square around the body parts that the pollinators use to move around and find food.



Pollinators help us have many good foods to eat. Draw a circle around the foods that you like to eat. Write the name of the food on the line by the picture.









apple

cheese

carrot

banana





Level 2 Grades 2-3 Local Heroes: Your Hardworking Pollinators

Booklet Objectives

Students will:

- Understand that most plants depend on animals for pollination.
- Distinguish the connection between the physical properties of plants, pollen and pollinators and successful pollination.
- Realize the role pollination plays in plant reproduction.
- Appreciate the vital role pollinators play in their everyday lives.
- Recognize that changes made in the environment can affect the availability of resources for pollinators which in return affects the availability of resources for humans.
- Identify actions that can be taken to improve and provide habitat for pollinators.

Next Generation Science Standards

Disciplinary Core Ideas

2. Interdependent Relationships in Ecosystems

PS1A: Structure and Properties of Matter

2. Interdependent Relationships in Ecosystems

LS2.A: Interdependent Relationships in Ecosystems

3. Interdependent Relationships in Ecosystems

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

LS4.C: Adaptation

LS4.D: Biodiversity and Humans

3. Inheritance and Variation of Traits: Life Cycles and Traits



Vocabulary Words

Anther—a male flower part forming the top part of a stamen and bearing the pollen in sacs.

Migrate—to move from one habitat or environment to another in response to seasonal changes and variations in food supply.

Nectar—the sweet liquid that flowering plants produce as a way of attracting the insects and small birds that assist in pollination.

Pollen—a powdery substance produced by flowering plants that contains male reproductive cells. It is carried by wind and insects to other plants, which it fertilizes.

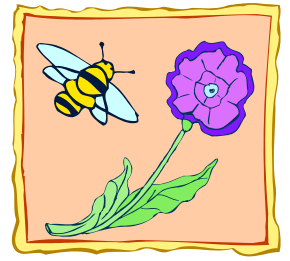
Pollination— to transfer pollen grains from the male structure of a plant anther to the female structure of a plant stigma and fertilize it.

Stigma—a flower's female reproductive organ that receives the male pollen grains. It is generally located at the tip of a the style.



Level 2 Activity

Bees, Birds, Bugs & Butterflies



Activity Objectives

Students will:

- Recognize the diversity present in pollinators.
- Understand the value of pollinators and pollination.

Materials

- One *Bee, Bird, Bug & Butterfly Catcher* activity sheet, pg 11

Discussion



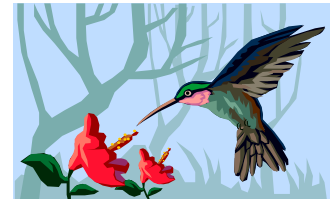
◆ Discuss with students how important pollinators and pollination is to their every day lives: one out of every three bites of food we eat has been pollinated, plants that reproduce through pollination help provide the oxygen we need to breathe, some of the clothing we wear is made from plants that were pollinated, etc.

- ◆ Allow students the opportunity to name pollinators they have observed in their neighborhoods.
- ◆ Point out the diversity of pollinators: some walk, some crawl, some fly, some are hairy, etc..

Instructions

Distribute *Bee, Bird, Bug & Butterfly Catcher* activity sheet to students and instruct them to answer the questions based on your classroom discussion.

Demonstrate how to fold the *Bee, Bird, Bug & Butterfly Catcher* .
The following on-line link provides step-by-step directions for folding:
http://www.ehow.com/how_4558938_fold-cootie-catcher.html



Divide students into pairs to play the *Bee, Bird, Bug & Butterfly Catcher* game.

1. For “round one”, one student will hold the *Bee, Bird, Bug & Butterfly Catcher* and one will be the player. With the *Bee, Bird, Bug & Butterfly Catcher* closed, have the player choose one of the four pollinators pictured.
2. Count the number of letters in the name of the pollinator. The student holding the *Bee, Bird, Bug & Butterfly Catcher* then opens and closes it once for each letter.
3. The player chooses one of the true/false questions and answers it. The student holding the *Bee, Bird, Bug & Butterfly Catcher* opens the flap and reads the answer.
4. Round two—the students switch roles.
5. Continue playing and switching roles until the facts regarding all four pollinators have been revealed.



Bee, Bird, Bug & Butterfly Catcher

What is a pollinator? _____

What is pollination? _____

Why do we need pollinators? _____

bee

True or False? Bees carry pollen in a pouch under their head.

True! Bees have hair all over their bodies. Even their eyes are covered with tiny hairs.

True or False? Bees are hairy!

False! Bees carry pollen in pollen baskets on their hind legs.

True or False? Beetles have no sense of smell.

True or False? Beetles are messy eaters.

False! Beetles like to eat the petals, pollen and nectar found in flowers with a strong smell.

True! In fact, beetles have been nicknamed the "mess and soil" pollinators!

beetle

True or False? Beetles are messy eaters.

True! Butterflies have skinny legs and pick flat shaped flowers that help give them a landing pad.

True! When hummingbirds fly, their wings often make a humming sound.

True or False? Hummingbirds get their name from their wings.

False! Many hummingbirds weigh about the same as a penny!

True or False? Hummingbirds weigh about the same as a small dog.

True! Butterflies taste nectar with a proboscis.

True or False? Butterflies taste nectar with a proboscis.

False! Butterflies taste with their FEET.

True or False? Butterflies like flat

hummingbird

True or False? Hummingbirds weigh about the same as a small dog.

True or False? Hummingbirds get their name from their wings.

False! Many hummingbirds weigh about the same as a penny!

True or False? Butterflies taste nectar with a proboscis.

True or False? Butterflies taste nectar with a proboscis.

False! Butterflies taste with their FEET.

True or False? Butterflies like flat

butterfly

True or False? Butterflies taste nectar with a proboscis.

True or False? Butterflies taste nectar with a proboscis.

False! Butterflies taste with their FEET.

True or False? Butterflies like flat

National Association of Conservation Districts (NACD)
nacdnet.org/education





Level 3 Grades 4-5 Local Heroes: Your Hardworking Pollinators

Booklet Objectives

Students will:

- Observe that plants have external structures that serve various functions in both pollination and reproduction.
- Relate the role of pollinators to plants and the supply of food for human consumption.
- Differentiate between vertebrate/invertebrate, mammal/insect pollinators.
- Investigate the necessity of pollinators to their everyday lives.
- Comprehend that pollinators can survive only in environments in which their particular needs are met.
- Identify ways in which human activities impact the environment and ways to help protect resources and habitats.

Next Generation Science Standards

Disciplinary Core Ideas

4. Structure, Function, and Information Processing

LS1.A: Structure and Function

5. Matter and Energy in Organisms and Ecosystems

LS2.A: Interdependent Relationships in Ecosystems

5. Earth's Systems



Vocabulary Words

Anther—a male flower part forming the top part of a stamen and bearing the pollen in sacs.

Ecosystem—a localized group of interdependent organisms together with the environment that they inhabit and depend on.

Hibernate—to be in a dormant state resembling sleep over the winter while living off reserves of body fat, with a decrease in body temperature and pulse rate and slower metabolism.

Insect—A six-legged, air-breathing invertebrate with a body that has well-defined segments, including a head, thorax, abdomen, two antennae, and usually two sets of wings.

Invertebrate—an animal that does not have a backbone.

Mammal—A warm-blooded vertebrate characterized by a covering of hair on some or most of the body, a four-chambered heart, and nourishment of offspring with milk from maternal mammary glands.

Nectar—the sweet liquid that flowering plants produce as a way of attracting the insects and small birds that assist in pollination.

Pollen—a powdery substance produced by flowering plants that contains male reproductive cells. It is carried by wind and insects to other plants, which it fertilizes.

Pollination—to transfer pollen grains from the male structure of a plant anther to the female structure of a plant stigma and fertilize it.

Stigma—a flower's female reproductive organ that receives the male pollen grains. It is generally located at the tip of a the style.

Vertebrate—an animal with a segmented spinal column and a well-developed brain.



Who Needs Who?

Activity Objectives

Students will:

- Realize the beneficial relationships that exist between living organisms.
- Recognize the benefits of pollinators to humans.
- Take action to benefit endangered pollinators.



Materials

- A sticky note for each student.
- “Who Needs Who?” worksheet

Discussion

- ◆ Discuss with the students the fact that most living organisms depend upon other living organisms for survival.
- ◆ Focus on the ways in which animals depend upon plants; food, oxygen, shelter, clothing, etc.
- ◆ Introduce the fact that about 80% of the world's flowering plants rely on pollinators. These plants include crop plants and need pollinators to produce seeds and fruit. One of every three bites of food consumed in the United States is dependent upon animal pollination.



Instructions

1. Give each student a sticky note to take to lunch. Assign the students the task of counting how many bites of food they eat during one meal.
2. After the students have made their counts have a class discussion on # of bites taken, average # of bites, etc. Have students complete the “Lunch Munch” chart contained in the “Who Needs Who?” worksheet. Follow with a discussion on what food they would have had to do without if there were no pollinators.
3. Using a taco as an example, have students complete Bats...Bees...Tacos? activity.

Answer Key:

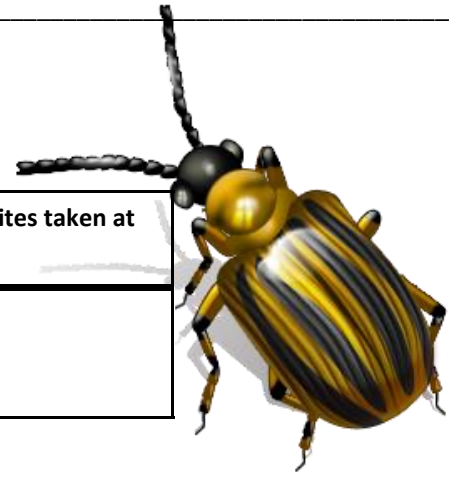
Bats...Bees...Tacos? Beef & Cheese: beef and cheese comes from cows, cows eat alfalfa hay which is pollinated by bees. Tomato: pollinated by bees. Avocado: pollinated by bees, flies and bats. Onion: pollinated by bees. Chili pepper: pollinated by bees and flies.



Who Needs Who?

The Lunch Munch

The # of bites I took at lunch:	Total # of bites taken by the class at lunch:	Average # of bites taken at lunch:



What foods would you have had to do without at lunch if there were no pollinators?



Bats...Bees...Tacos?

Draw lines connecting the taco ingredient to the pollinator or pollinators responsible for it.


- beef**
- cheese**
- tomato**
- avocado**
- onion**
- chili pepper**

bees

flies

bats

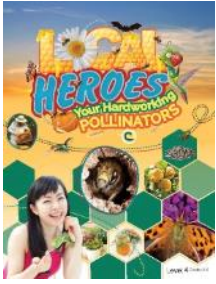


Draw a  on the map where you live. List three pollinators that are common in your state:

Many pollinators are threatened or endangered. Go to

<http://www.fws.gov/pollinators/Programs/Endangered.html> to see if pollinators in your area need help!





Level 4 Grades 6 and up

Local Heroes: Your Hardworking Pollinators

Booklet Objectives

Students will:

- Explain the connection between the specialized physical structures of both pollinators and the plants that are their food sources and successful pollination.
- Recognize the role of the sense receptors of pollinators to their choice of food.
- Grasp that pollinators are dependent on their environmental interactions both with other living organisms, including humans, and with nonliving factors that affect their access to resources.
- Identify the ways humans are dependent upon pollinators.
- Describe actions that can be taken to increase pollinator population.

Next Generation Science Standards

MS. Structure, Function, and Information Processing

LS1.A: Structure and Function

LS1.D: Information Processing

MS. Matter and Energy in Organisms and Ecosystems

LS2.A: Interdependent Relationships in Ecosystems

LS2.C: Ecosystem Dynamics, Functioning, and Resilience



Vocabulary Words

Anther—a male flower part forming the top part of a stamen and bearing the pollen in sacs.

Avian—relating to, belonging to, or characteristic of birds.

Biodiversity—the existence of a wide variety of plant and animal species in their natural environments.

Crosspollination—pollen is moved from plant to plant rather than on the same plant.

Ecosystem—a localized group of interdependent organisms together with the environment that they inhabit and depend on.

Nectar—the sweet liquid that flowering plants produce as a way of attracting the insects and small birds that assist in pollination.

Ovary—the lower part of a pistil that bears ovules and ripens into a fruit.

Pollen—a powdery substance produced by flowering plants that contains male reproductive cells. It is carried by wind and insects to other plants, which it fertilizes.

Pollination—to transfer pollen grains from the male structure of a plant anther to the female structure of a plant stigma and fertilize it.

Stigma—a flower's female reproductive organ that receives the male pollen grains. It is generally located at the tip of a the style.



I've Got Pollen WHERE?

Activity Objectives

Students will:

- Identify the location of pollen on a native flower.
- Recognize the connection between pollination and reproduction.
- Realize the correlation between their daily lives and pollinators.



Materials

- Flowers from local native flowering plants or donated “day old” flowers from a florist.
- Magnifying glasses
- Quart size plastic bags
- Flour
- Small individual candies such as M&M’s
- “I’ve Got Pollen WHERE?” student worksheets (pg. 17)

Discussion

- ◆ Discuss with students why flowering plants and pollinators/pollination are of vital importance to them. Pollinated crops make up a high percentage of our diet, flowering plants produce oxygen, some of our clothing comes from flowering plants, etc.
- ◆ Review and diagram flowering plant parts with students; anther, ovary, ovule, petal, pistil, sepal, stamen, and stigma.
- ◆ Discuss the pollination process. Pollination involves pollen grains being transferred from the male structure of the plant (anther) to the female structure of a plant (stigma) in order for fertilization to occur.
- ◆ Generate a list as a class of local pollinators.
- ◆ Discuss the fact that pollinators as a whole are threatened and how their reduction in numbers can affect our way of life.

Instructions

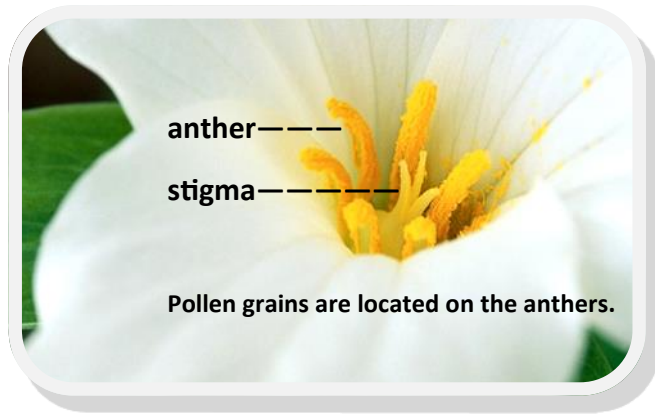
1. Divide students into groups of 3 to 4 and distribute worksheets to be completed as individuals or as a group.
2. Let each group choose a flower and assign them the task of drawing a diagram of the flower and labeling the plant parts discussed during the class discussion that they can see.
3. Instruct students to take note of where pollen is located on their flower and describe it on their worksheets. Magnifying glasses should be used to observe the pollen.
4. Distribute a baggie with flour and small candies inside it, one baggie per group. Explain to the students that they will be pretending to be pollinators foraging for food. They are to compare the flour to pollen and the candies to nectar. The students are to describe what happens with the pollen as they “forage”.
5. Students are to conclude the activity by identifying characteristics of a highly efficient pollinator and then naming any local pollinators displaying those characteristics.



I've Got Pollen WHERE?

Name: _____

Draw a diagram of your flower and label any of the following parts that you can see: anther, ovary, ovule, petal, pistil, sepal, stamen, stigma.



Describe where pollen is located on your flower:

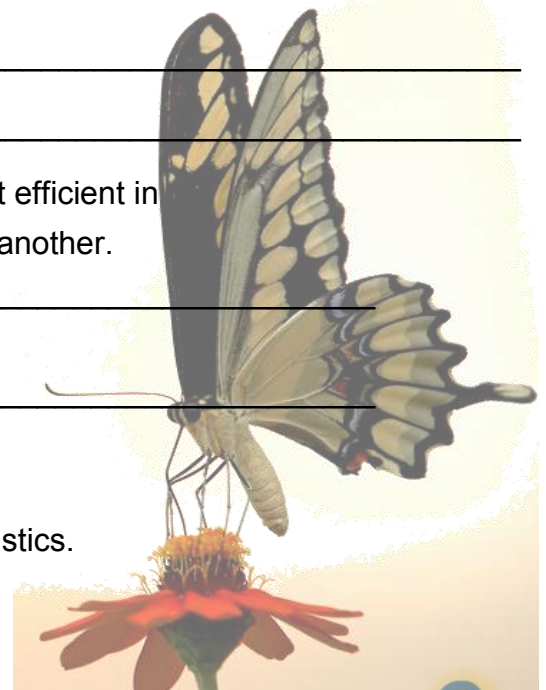


Describe what the pollen looks like, its size and texture:

What happened when you put your hand in the baggie to get the candy? How is it similar to a pollinator foraging for food?

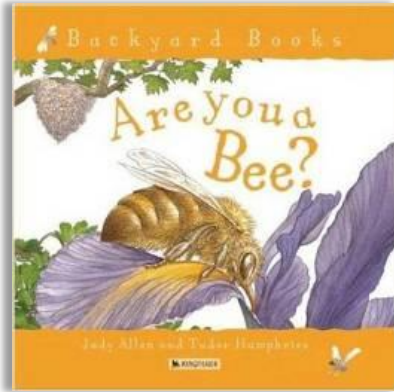
List 5 characteristics of a pollinator that would make it the most efficient in collecting and transporting pollen from one flowering plant to another.

Name a local pollinator that has some or all of these characteristics.



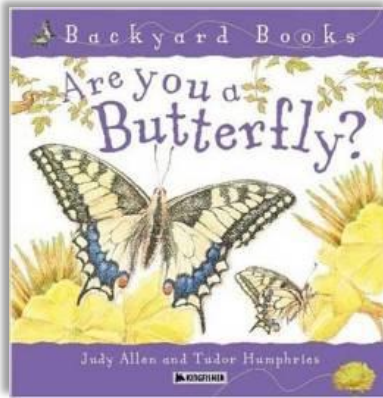


Literature Connections



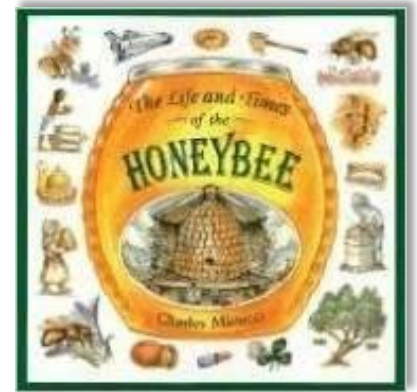
Are You a Bee?

By Judy Allen (Author)
Age 5-8
ISBN-13: 978-0753458044



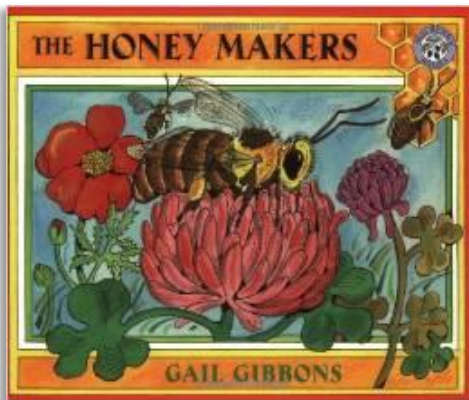
Are You a Butterfly?

By Judy Allen (Author)
Age 5-8
ISBN-13: 978-0753456088



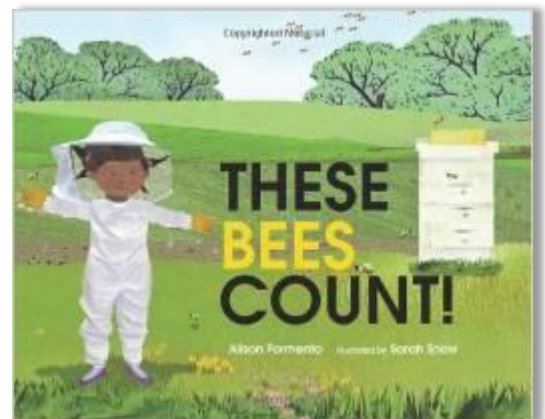
Life and times of a Honey Bee

By Charles Micucci (Author)
Age 5-8
ISBN-13: 978-0395861394



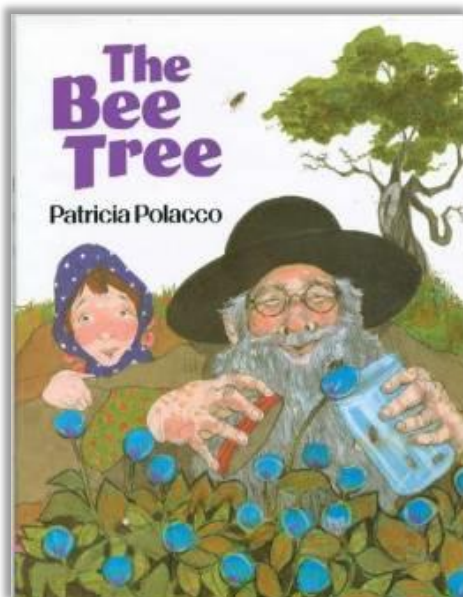
The Honey Makers

By Gail Gibbons
(Author, Illustrator)
Age 4-8
ISBN-13: 978-0688175313



These Bees Count

By Alison Formento
(Author), Sarah Snow
(Illustrator)
Age 4-7
ISBN-13: 978-0807578681



The Bee Tree

By Patricia Polacco (Author)
Age 6—10
ISBN-13: 978-0399219658

NACD BIG BOOK

Local Heroes Your Hardworking
Pollinators
Pre K-Grade 3
Purchase from the NACD
Marketplace
www.nacdstore.org

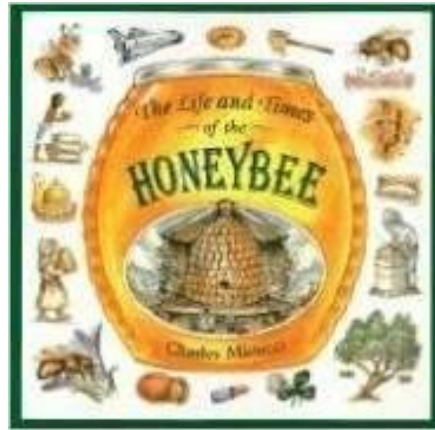


Literature Connections



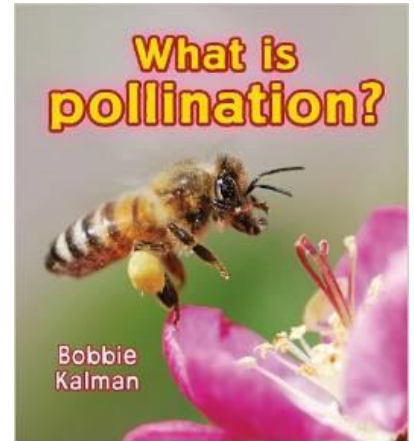
Are You a Bee?

By Judy Allen (Author)
Age 5-8
ISBN-13: 978-0753458044



The Life and Times of a Honey Bee

By Charles Micucci (Author)
Age 5-8 |
SBN-13: 978-0395861394



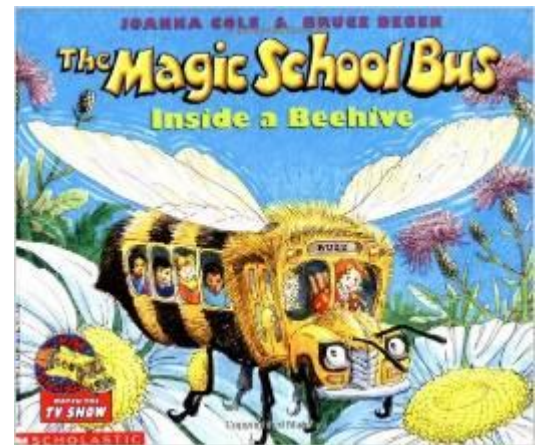
What is Pollination?

By Bobbie Kalman
Age 7 and up
ISBN-13: 978-0778732860



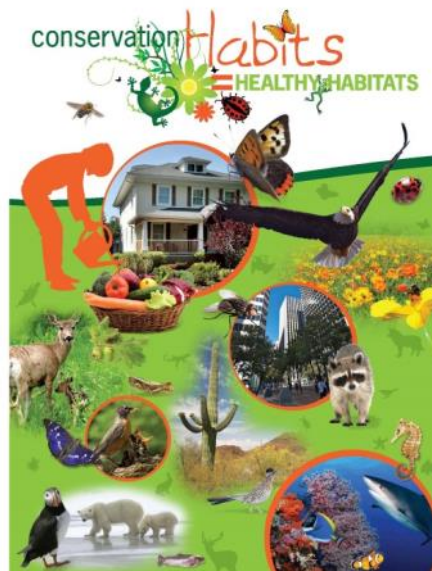
Honey in a Hive

By Anne Rockwell (Author)
Age 4-8
ISBN-13: 978-0064452045



The Magic School Bus Inside a Beehive

By Joanna Cole (Author)
Age 4-8
ISBN-13: 978-0590257213



Conservation Habits = Healthy Habitats

By NACD Pre K—Grade 3
Purchase from the NACD Marketplace www.nacdstore.org



Local Heroes—Your Hardworking Pollinators

Resources and Information

Eco-Regional

Pollinator Planting Guides

Great resource to learn about your area and what is best to plant for pollinators. From the Pollinator Partnership.

<http://www.pollinator.org/guides.htm>



Nature's Partners— Pollinators, Plants and You Curriculum for grades 3-6

<http://www.pollinator.org/nappc/PDFs/curriculum.pdf>



University of Illinois Activity Book, Coloring Pages and more

<http://www.life.illinois.edu/entomology/pollinators/docs/Pollination%20Activity%20Book.pdf>

NACD/Auxiliary POSTER CONTEST

2015 Poster Contest Theme is

Local Heroes—Your Hardworking Pollinators

You can find a Promotional PowerPoint and all the forms and rules online and ideas for the 2015 theme at:



www.nacdnet.org/education/contests/poster/

NACD/Auxiliary

PHOTOGRAPHY CONTEST

Entries are due December 1st of each year
Photo entry contest form and rules can be found online at:

www.nacdnet.org/education/contests/



Local Heroes—Your Hardworking Pollinators

Resources and Information

Photo by Susan
Henning, OK



USDA—Natural Resource Conservation Service

How Farmers Help Pollinators

<http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/pollinate/farmers/>

How Gardeners Can Help Pollinators

<http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/pollinate/gardeners/>

How NRCS is helping Pollinators

<http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/pollinate/help/>

More information on Pollinators

<http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/pollinate/info/>

Pollinator Partnership

What is pollination/pollinator?
Why are pollinators important to us?

Types of pollinators

<http://www.pollinator.org/Resources/What%20is%20a%20pollinator.pdf>

List of additional resources

<http://www.pollinator.org/resources.htm>

Xerces Society

Pollinator Conservation: <http://www.xerces.org/pollinator-conservation/>

Fact Sheets: <http://www.xerces.org/fact-sheets/>

Butterfly Conservation

<http://www.xerces.org/butterfly-conservation/>



DID YOU KNOW??

Worldwide, approximately 1,000 plants grown for food, beverages, fibers, spices, and medicines need to be pollinated by animals in order to produce the goods on which we depend.

Bee Friendly Certification for Farmers and Gardeners

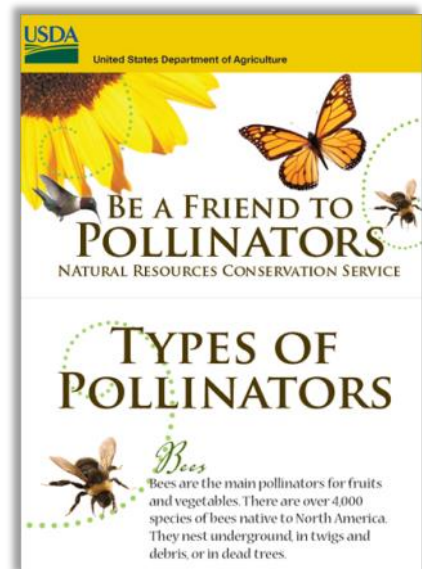
<http://pfspsbees.org/bee-friendly-farming/certification>

Crop Life

<http://www.croplifeamerica.org/pesticide-issues/protecting-our-pollinators>

America's Heartland

<http://www.americasheartland.org/pollinators/index.htm>



Local Heroes—Your Hardworking Pollinators

Resources and Information

US Forest Service Fun Facts

- ◇ More than half of the world's diet of fats and oils come from animal-pollinated plants (oil palm, canola, sunflowers, etc.).
- ◇ More than 150 food crops in the U.S. depend on pollinators, including almost all fruit and grain crops.
- ◇ The USDA estimated that crops dependent on pollination are worth more than \$10 billion per year.
- ◇ Corn is mostly a wind-pollinated crop. Native peoples were the first to recognize the role of pollination and to plant corn in such a way that they could hybridize certain types of corn for particular characteristics and purposes. Native Americans are known as the "first hybridizers" for their scientific talents in cross-pollination and hybridization.

The Power of Pollinators Ohio State University

3 downloadable Power Point's and additional resources

1) Why Pollinators Matter



2) Bee Biology & ID



3) Gardening for Pollinators

<http://ocvn.osu.edu/sites/d6-ocvn.web/files/sites/drupal-ocvn.web/files/>

Plants and Animals – Partners in Pollination—Smithsonian

4 lesson plans

http://www.smithsonianeducation.org/educators/lesson_plans/partners_in_pollination/lesson2_main.html

EPA's Pollinator Information

<http://www2.epa.gov/pollinator-protection>

USDA Forest Service

Pollinator Resources

<http://www.fs.fed.us/wildflowers/pollinators/>

Gardening for Pollinators

<http://www.fs.fed.us/wildflowers/pollinators/gardening.shtml>

Pollinator Live

Archived Webcasts, Lesson Plans and Resources

<http://pollinatorlive.pwnet.org/>

Monarch Live

Archived Webcasts, Lesson Plans and Resources

<http://monarch.pwnet.org/>

US Fish and Wildlife

PowerPoints, Fact Sheets, Articles and more

<http://www.fws.gov/pollinators/PollinatorPages/Outreach.html>



Ohio State University Bee Lab

http://osu.campusguides.com/agric_bees_pollination

Research

<http://www.pollinator.org/research.htm>

Citizen Science Sites

<http://www.xerces.org/educational-resources/#citizen>



Local Heroes—Your Hardworking Pollinators

Resources and Information

Bats Are Pollinators, Too

Bat Conservation

International

[http://batcon.org/pdfs/stories/
PollinatorBrochure2010Web.pdf](http://batcon.org/pdfs/stories/PollinatorBrochure2010Web.pdf)



Nectar Bats

Nectar bats make several hundred flower visits nightly to fuel their roaring metabolism. In the tropical forests of Central and South America, plants have found unique ways to attract bats. The flowers of these plants shape the echoes of bats' calls, providing sound cues that streamline foraging—a strategy that pays off in improved pollination for the plant

<http://ngm.nationalgeographic.com/2014/03/bat-echo/plant-interactive>

Interactive Pollinator Activity from PBS

<http://www.pbs.org/wgbh/nova/nature/pollination-game.html>

VIDEO: Dino Martins Explains the Importance of Bees and Insects

[http://
education.nationalgeographic.com/
education/media/people-plants-and-
pollinators/?ar_a=1](http://education.nationalgeographic.com/education/media/people-plants-and-pollinators/?ar_a=1)



Projects

Build Your Own Bee Hotel

[http://education.nationalgeographic.com/
education/media/build-your-own-bee-
hotel/?ar_a=1](http://education.nationalgeographic.com/education/media/build-your-own-bee-hotel/?ar_a=1)



Photo by Crouch, UT

ACTIVITIES/ CURRICULUM

Project Learning Tree (PLT) www.plt.org

PLT K-8 Guide (visit website for state coordinator and workshop listings)

Habitat Pen Pals (#7)

Trees as Habitats (#22)

Web of Life (#45)

Are Vacant Lots Vacant (#47)

Improve Your Place—[http://monarch.pwnet.org/
pdf/PLT_Activity_96.pdf](http://monarch.pwnet.org/pdf/PLT_Activity_96.pdf)

Can it Be Real? [http://monarch.pwnet.org/pdf/
PLT_Activity_11.pdf](http://monarch.pwnet.org/pdf/PLT_Activity_11.pdf)

Project WET www.projectwet.org

Project WET guide (visit website for state coordinator and workshop listings)

Project WILD www.projectwild.org

Project WILD Aquatic Guide (visit website for state coordinator and workshop listings)

Improving Habitat in the Community (page 440)

Migration Barriers (page 308)

Planning for People and Wildlife (page 436)

Shrinking Habitat (page 310)

And more

Food Land and People (FLP)

www.foodlandpeople.org

Schoolyard caretakers (page 35)

Buzzy, Buzzy Bee (page 139)

Your School Ground Through New Eyes (page 285)

And more

Ag In the Classroom

[http://www.agclassroom.org/teacher/matrix/
index.cfm](http://www.agclassroom.org/teacher/matrix/index.cfm)

[http://www.agclassroom.org/ny/programs/pdf/
literacy/additional_books.pdf](http://www.agclassroom.org/ny/programs/pdf/literacy/additional_books.pdf)

National Resource Directory—curriculum

State Contacts and more

Junior Master Gardner Program

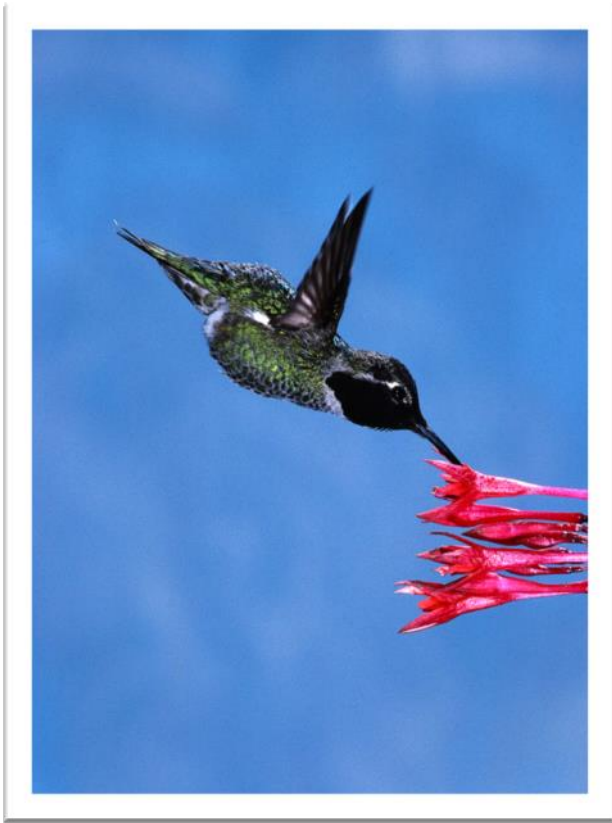
www.jmgkids.us/

Curriculum and more



Pollinators and Me

Level 1 Activity Page 7—Pollinator Cards



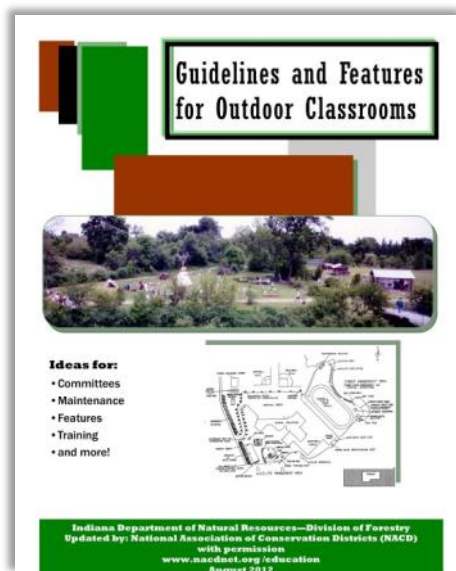
Community and Schoolyard Habitat Ideas

U.S. Fish and Wildlife Service Schoolyard Habitat Project Guide

The Schoolyard Habitat program guidebook is a tool that takes teachers and administrators through the process and outlines the steps to creating a successful project where students go outside to experience nature. The guide has everything you need to go from concept to completion, and with a successful result: creating a natural spaces on school grounds where students will observe, draw, write, think, question



<http://www.fws.gov/cno/pdf/HabitatGuideColor.pdf>



Guidelines and Features for

Interested in developing an outdoor classroom at a local school or area in your community? This guide was developed by the Indiana Department of Natural Resources - Division of Forestry and updated with permission by the National Association of Conservation Districts (NACD). It is only available in a PDF format that you can print as needed. This guide will give ideas for features in an outdoor classroom as well as setting up a community, funding ideas, curriculum resources and more.

<http://www.nacdnet.org/education/resources/outdoorclassrooms>

National Association of Conservation Districts (NACD)

509 Capitol Court, NE
Washington, DC 20002-4937
P: (202) 547-NACD (6223)

E-mail: stewardship@nacdn.net
Web: www.nacdnet.org/education
NACD Marketplace: www.nacdstore.org



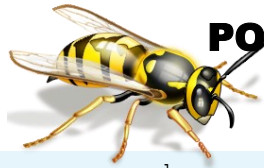
m v k c q a z g t f
 d b v p e i b b u v
 r o t a n i l l o p
 r a p o h b y g g m
 b d j f f a u w o l
 l g r j e z w r r j
 k l j k c c p m c x
 b r a u o w i i z w
 t z k r h r q g d o
 v j d z n q h t w d

Search for the word with the following meaning: An animal that moves pollen from the male part of a flower to the female part of a flower.



d i a o z e b b q v
 j q m m s q k c s q
 w o g y c x c m j v
 r w i a q e c k n o
 x r t a j b s q o h
 t p s o z u d i r t
 l e g g t f s l o o
 f g l q h n o o b a
 z x f y y w x j k k
 v m x t s g n g d I

Search for the word to fill in the blank: As a pollinator moves from flower to flower, some of the pollen on its body falls onto a flower's _____ and fertilization occurs.

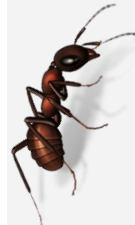


POLLINATOR SEARCH

Search out each word and write the answer on the blank below each puzzle.

z z n d w o n g j r
 l y j p c v c k w j
 h u c s k e e a f w
 u o v o p g p n g i
 g e a e e l u p j o
 n n t q x l f i p c
 w a m x c s b i r m
 l g n e h i z z p n
 h j k g p f y p z c
 g x q r h w v d e r

Search for the word to fill in the blank: Pollinators choose where to eat based on the color, scent and/or _____ shape of a flower.



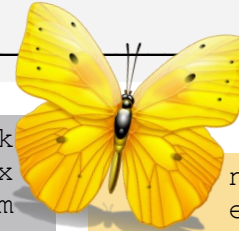
c p s p m a a h z b
 i b r b b w o u g o
 w v i y d k a a w h
 g u d y y w x d h p
 v j p o l l e n u l
 g e l q n a a u o x
 w d k b o u l x g k
 r d z y b k j s k t
 j t j u o k t t n e
 y c i s r z p g d m

Search for the word with the following meaning: Located on the flowers' anthers, it contains protein that pollinators need to grow.



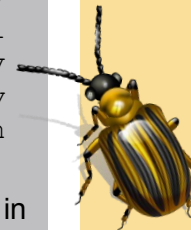
r l o o n b q u n s
 f i r h v n f t e p
 b j j r g r x u c t
 w o p l u y e u t t
 p a f u o y c n a k
 m p b e m y c w r y
 b p e a f g e k b p
 p z z d g m n v n r
 d v l r g h q n p t
 w a p n q u e h b q

Search for the word to fill in the blank: The _____ produced by flowers is packed with sugars, B-vitamins, amino acids, and lipids.



w j x l z b d h k k
 m k w o o r p e l x
 l z e r m e c w n m
 z u g i v j g b n v
 q u x g r b h t q f
 v e o g p l t w i v
 y e i c z e z l m i
 q r y o r j a a k v
 t h s y n a a z w y
 r t c q m v o s i n

Search for the word to fill in the blank: One out of every _____ bites of food we eat depends upon pollinators.



n c z a r d q x p x
 e f g u j j q s z q
 a p m i w r t x j w
 h f c z i n e g t s
 h j j l a y i x r u
 g y j l k m g v e y
 t t p k u y h s d f
 s u e v z a n s s z
 u y i m i c q n n b
 m x v d r n o d e v

Search for the word to fill in the blank: We depend upon pollinated _____ for air to breathe, homes to live in, clothes to wear and many of the medicines we use.

STREAMLINED BEE MONITORING PROTOCOL FOR ASSESSING POLLINATOR HABITAT



The Williams Lab at University of California, Davis, Isaacs Lab at Michigan State University, and Winfree Lab at Rutgers University conduct research into how habitat and habitat restoration projects support and increase the value of wild bees in crop pollination. Working to better understand the ecology of wild pollinators and the pollination services they provide, their research examines pollinator diversity, community ecology of plant-pollinator networks, the ecology and behavior of pollinators, pests and natural enemies within agricultural systems and surrounding landscapes, and the persistence of pollinator populations and communities in the face of global change. They collected and analyzed three field seasons of data on plants and bees at pollinator plantings to develop this streamlined protocol.

The Xerces Society for Invertebrate Conservation is a nonprofit organization that protects wildlife through the conservation of invertebrates and their habitat. Established in 1971, the Society is at the forefront of invertebrate protection, harnessing the knowledge of scientists and the enthusiasm of citizens to implement conservation programs worldwide. The Society uses advocacy, education, habitat restoration, consulting, and applied research to promote invertebrate conservation.

The Xerces Society for Invertebrate Conservation
628 NE Broadway, Suite 200, Portland, OR 97232
Tel (855) 232-6639 Fax (503) 233-6794 www.xerces.org

Regional offices in California, Minnesota, Nebraska, New Jersey, North Carolina, and Texas.



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The Xerces Society, University of California, Davis, Rutgers University, and Michigan State University are equal opportunity employers and providers.

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We are grateful to the many photographers who allowed us to use their wonderful photographs in this monitoring guide. The copyright for all the photographs is retained by the photographers. The photographs may not be reproduced without permission from the photographer.

Citation

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Cover Photos

Front: Clockwise from left to right: Eucerine ground-nesting bee, Mace Vaughan, The Xerces Society; Green sweat bee, Rollin Coville; and Bumble bee on red currant, Mace Vaughan, The Xerces Society.

Back: Small carpenter bee, Rollin Coville.

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Section 1

INTRODUCTION

Declines in native bee populations and increased challenges in maintaining sufficient honey bees for pollination in the United States have underscored the need for greater flowering resources in agricultural landscapes. The USDA Natural Resources Conservation Service (NRCS) and the Farm Service Agency (FSA) recognize the value in supporting pollinators and have devoted millions of dollars annually to help farmers and other landowners plant and maintain pollinator habitat on private lands.

Assessing the effectiveness of different habitat restoration practices is a key component of augmenting floral resources for bees, so that conservation strategies can be adapted and improved. A standardized monitoring protocol is presented in this document to allow agency staff, land managers, farmers, and others to evaluate the performance of individual pollinator habitat plantings. This protocol can be used to assess pollinator plantings in three ways. First, it allows users to rank multiple pollinator plantings from least to most diverse in terms of bee communities supported. This may be particularly useful when comparing different management or implementation techniques, or even different seed mixes. Second, by including samples at reference sites, such as old fields or weedy field borders that have not been planted for pollinators, it can indicate whether plantings have increased pollinator populations and species diversity. Third, it can be used to determine whether pollinator diversity and abundance change over time.

This streamlined protocol balances the time and training required to conduct a survey with the need for accurate estimates of the abundance and diversity of pollinators attracted to the pollinator habitat plantings. To develop this streamlined protocol, bee abundance and diversity were observed and recorded at flowers in pollinator habitat plantings and unrestored reference sites over a three-year period in California, Michigan, and New Jersey. These locations represent three important agricultural regions of the United States. Simultaneously, species richness of native bee communities was assessed at the same sites through more thorough sampling with nets followed by species-level identifications. Observation data and net-collection data at each site were compared to determine the sampling effort required to accurately measure the abundance and diversity of bees at pollinator plantings.

This research found that simply observing and recording the **abundance** of native bees on flowers during two site visits of 15 minutes each provide good estimates of both abundance and diversity of bees visiting that site. The best data came from counting native bees in the middle of the growing season (for example May–July in California, and July–August in New Jersey and Michigan), and separating the site visits by two to three weeks. The research also shows that a single 30-minute survey (400 ft of transect) during these same time periods is adequate for assessing bee diversity. However, two 15-minute surveys provide a much more reliable assessment.

Finally, it is important to understand that counting honey bees does not provide a good measure of the value of habitat for bees and other pollinators. The number of honey bees visiting a planting is most heavily influenced by the number of managed bee hives nearby. Seeing abundant honey bees is certainly a sign that a habitat supports bees, but it doesn't indicate how well that planting increases the abundance and diversity of bees.

Therefore, in order to assess changes in the abundance of bees that are using habitat created or enhanced for pollinators, you will need to know how to distinguish native bees from honey bees and other flower-visiting insects. You will also need to understand how to consistently implement a standardized monitoring protocol. In the following pages, we guide you through basic bee identification (Section 2), followed by instructions on the monitoring protocol (Section 3).



Bees are the most important group of pollinators in North America, responsible for pollinating crops and wildflowers.

Section 2

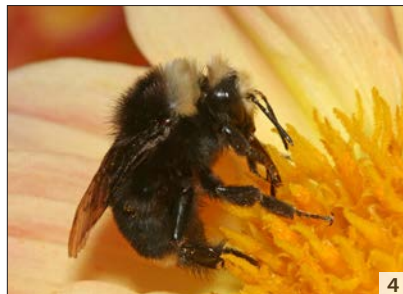
BEE IDENTIFICATION

There are approximately 4,000 species of bees native to North America, and along with that diversity comes great variation in appearance (see Box 1, p.7). One feature all bees share is their dependence on pollen for rearing young. Their adaptations for carrying pollen often make them easy to distinguish from other insects. Usually, bees are quite hairy, allowing pollen grains to stick to them, and females have special pollen carrying structures on their legs or bellies. The location of these pollen-carrying structures and the appearance of obvious pollen loads (dry powder vs. moist balls) can be helpful in identifying bees from wasps or flies, and can even help distinguish between groups of bees.

The size and location of bees' eyes and antennae also help distinguish them from other similar-looking insects, such as flower flies. Specifically, bees' eyes are positioned at the sides of their heads, giving their heads a somewhat heart-shaped appearance, and their antennae are long and straight. In contrast, bee-mimicking flies tend to have large eyes that take up most of their heads, and short, stubby antennae that are often hard to see. Bees also have four wings, whereas flies have two, but this can be hard to see unless they are at rest on a flower or leaf.

To help separate bees from wasps, it is useful to know that bee bodies tend to be rounder than many wasps. Wasps often have a more pointed abdomen and a thinner waist.

Is It a Bee?

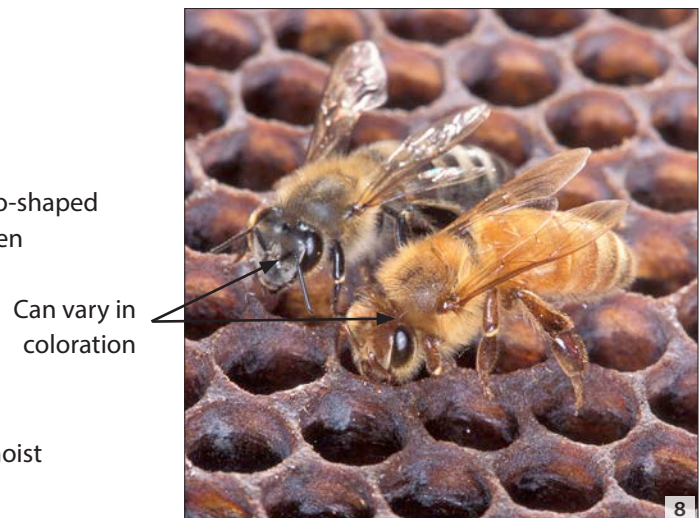
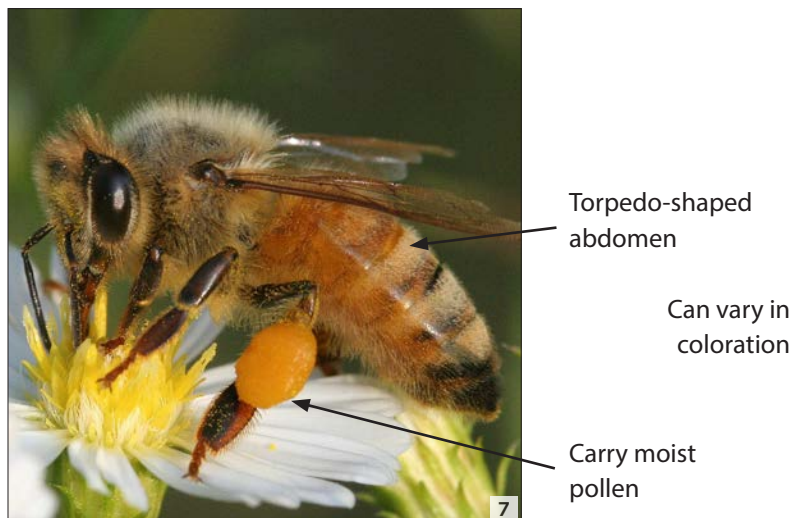


HONEY BEES

For this protocol, it is important to distinguish native bees from European honey bees. While support of honey bees is one goal of providing pollinator habitat, honey bees can be an unreliable indicator of the planting's ability to attract pollinators because their numbers depend on the location of honey bee hives or apiaries.

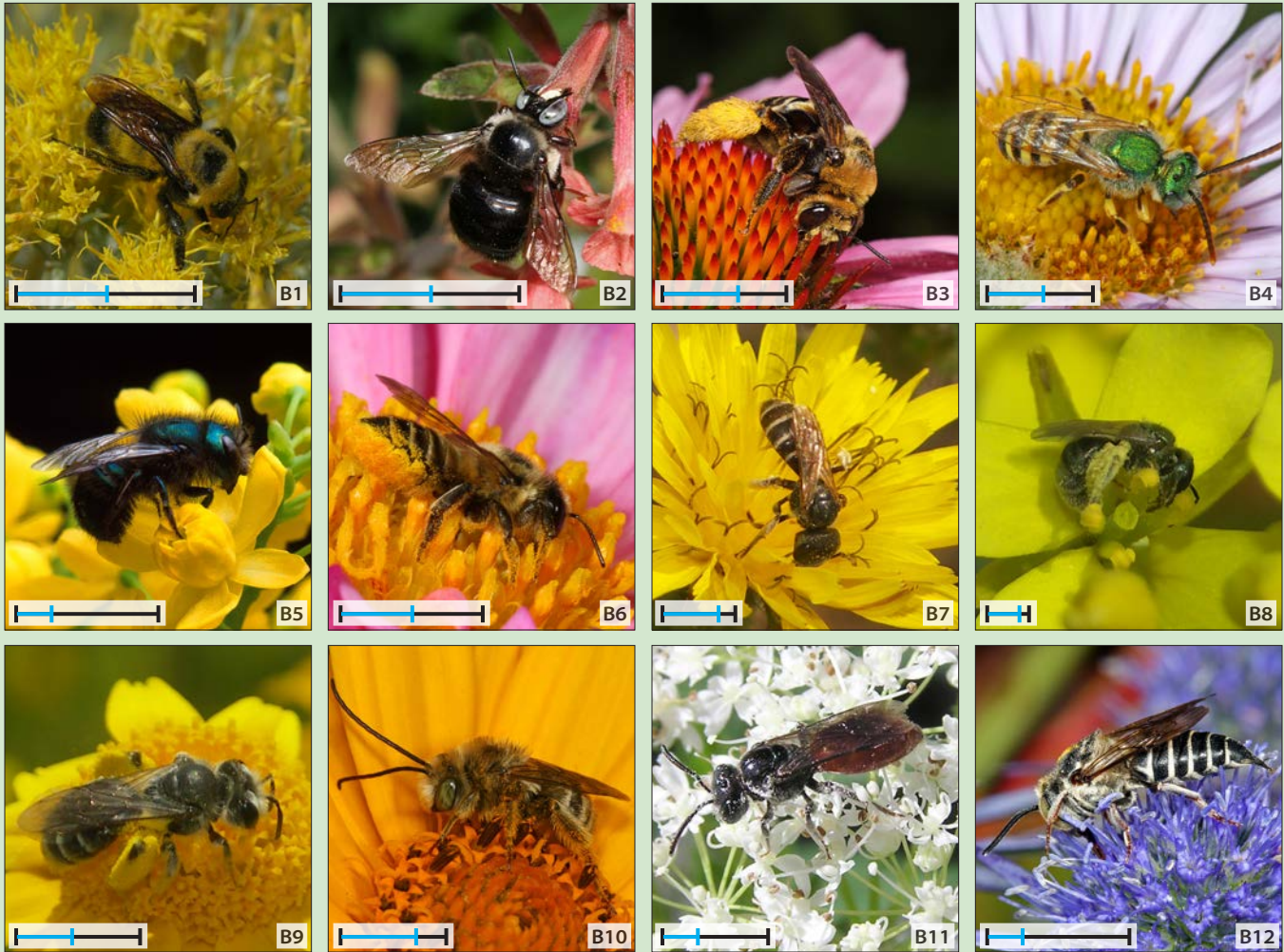
Honey bees vary in coloration from orange-brown to a very dark brown. They always have stripes on their distinctive “torpedo” shaped abdomen. They will always have a thorax covered in light brown hair. Honey bees, like bumble bees, carry pollen in baskets on their hind legs. These pollen baskets are slight indentations surrounded by long, hooked hairs. If the pollen baskets are empty you can see the flattened wide shape of the middle of the hind legs, and if they are full, you see the pollen is carried in moistened clumps, unlike the powdery dry pollen loads of many native bees.

Honey Bees



BOX 1: THE VARIETY OF NATIVE BEES

Pictured here are examples of the wide diversity of native bees you might observe on flowers. Look for some of the features described below.



Size: Native bees can range in size from tiny, dark-colored sweat and mining bees that are 1/8th to 1/4 inch long (e.g., B4, B7, B8), to bumble bees (B1) and large carpenter bees (B2) that are more than 1 inch long.

Shape: Native bees can be relatively slender, as in some of the small carpenter bees. They can be moderately wide, similar to European honey bees. Or they can be quite stocky and robust, as in the bumble bees or large carpenter bees.

Color: Bees vary greatly in color on their body surface (exoskeleton) and in the color of their hairs. Their exoskeleton can range from black, yellow, or red to metallic green and blue. Hair colors found on bees include black, grey, brown, yellow, orange, and white, and frequently create striped patterns.

Distribution of Hair: The patterns and locations of hair can make some bees look very "fuzzy" (e.g., bumble bees) while other species are hairy only in certain areas (e.g., legs) and, overall, may look quite shiny or bald.

Pollen Transport: Honey bees and bumble bees carry a mixture of pollen and nectar located on a flattened area on the hind leg called the pollen basket. Other bees carry pollen in a dense mass of stiff, branched hairs called the scopae. The scopae are often located on the hind legs, but in some species they are located on the underside of the abdomen. Note: only female bees have pollen-carrying structures.

Pollen: Bees can carry moistened pollen loads (mixture of pollen and nectar) or dry pollen. The wet pollen balls in the pollen baskets of European honey bees helps set them apart from all of the native bees in North America except bumble bees.

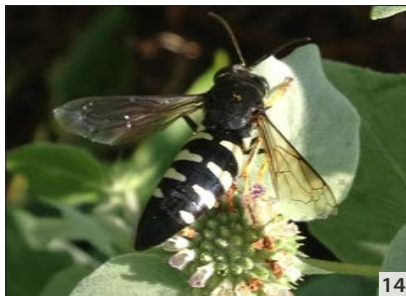
Approximate size:  smallest (blue) / largest (black)

WASPS

Wasps are close relatives of bees and share many features, including 4 wings, stripes, and heart-shaped heads with the eyes on the sides. However, wasps are carnivores and do not have adaptations to collect and carry pollen. They are not very hairy and have little or no pollen on their bodies when visiting flowers. Wasp coloration results from patterns in their exoskeleton, giving them a shiny appearance compared to bees, which usually—but not always—get their stripes from colored hairs. Wasps have been described as having a “tough” or “mean” look with their more slender pointed bodies compared to the more rounded shape of bees. One very common family of wasps folds their forewings lengthwise when at rest, making them look more narrow.

DO NOT COUNT WASPS WHEN USING THIS BEE PROTOCOL.

Wasps

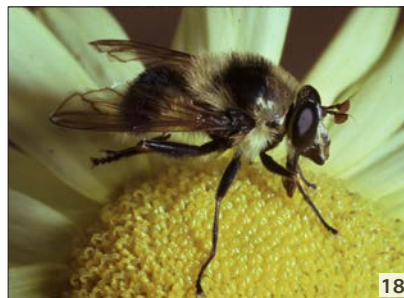


FLIES

Although many flies look very similar to bees, several features make them easy to distinguish. First, the flies that look like bees have eyes that are large and round, often making up the bulk of their head and sometimes giving the head a helmet-like appearance. Their antennae are short and thick, coming out like a 'V' from the middle of their face. Although they may be visiting flowers for nectar, they are not carrying pollen back to their young, so in general they are not as hairy as bees (although some species mimic bumble bees), and they never have hairy pollen-carrying structures on their legs. Flies also have two wings, rather than four wings like bees and wasps. However, it is often difficult to see this feature unless the insects are at rest.

DO NOT COUNT FLIES WHEN USING THIS BEE PROTOCOL.

Flies



Section 3

MONITORING PROTOCOL

The goal of this streamlined bee monitoring protocol is to efficiently document bee diversity and abundance on pollinator habitat plantings in order to measure their success in supporting pollinators, or to document changes in the bee community over the years after seeding. Plantings can include meadows, hedgerows, cover crops, or field trials of pollinator plant seed mixes.

During two separate site visits per year, you will conduct timed assessments, observing and counting bees visiting flowers along transects. Your two site visits should be separated by two to three weeks. In California, you can survey bees anytime between May and July. In the Great Lakes or Mid-Atlantic regions you should survey between early July and late August.

Bees are most active when weather conditions are good, so you must survey your site when it is warm, sunny, and calm. Ambient temperatures should be greater than 60°F, wind speeds ideally should be less than 8 mph, and skies should be mostly clear (partly cloudy or overcast skies are OK if you can still see your shadow). You will get the best data during an afternoon visit, so conduct surveys between noon and 4 pm. For each site or planting that you survey, allow enough time to mark or find the transects, collect two 7.5-minute samples, and walk between transects. We estimate about 30 minutes per site will be needed for each visit.

Each time you visit a site, you will survey two 100 ft transects (or the equivalent length split into smaller sections). Keep the transects in full sun because bee activity declines in the shade. Each 100 ft transect should be sampled for 7.5 minutes, and only count bees on flowers in a 3 ft wide strip. If you are sampling a relatively large meadow or cover crop that will easily fit a 100 ft transect, one of the transects should be 10–20 ft from the planting edge (running parallel with the edge) and the other should be either 250 ft from the edge, or in the center of the habitat, whichever is shorter (Figure 1). If sampling a small planting, do your best to set up 200 ft of transects through each plot. For example, this may be four 50 ft transects (Figure 2). If you are sampling a hedgerow, then run one transect along each side of the hedgerow, only counting bees in a 3 ft wide strip (Figure 3).

Select and photocopy the appropriate data sheet for your site (p.12–14). Record the site name, the date and your name at the top of the data sheet, as well as whether this is your first or second visit to the site. Note the weather conditions to show that the sample was conducted during optimal conditions for bees. Also note the type of planting (e.g., hedgerow, meadow, cover crop, etc.).

When sampling each transect, record the time of day you start, then start the timer and begin walking down the transect. Plan your transect walk so that your shadow does not move in front of you or across where you are counting bees. As you slowly walk, survey three feet to one side of the line you are walking, trying to watch all the open flowers. Record each bee you see visiting a flower (visiting = landing on the reproductive structures of a flower for more than 0.5 seconds). Pause the timer if you need time to record an insect or to shift over to another subsection of the transect you are surveying. Then start the timer again when you are ready to resume observations. Tally native bees and honey bees separately on your data sheet.

- ⇒ Try to pace yourself so you reach the end of the 100 ft transect when the 7.5 minutes are up.
- ⇒ If the timer goes off before you have reached the end of the transect, quickly walk to the end of the transect and take a rough count of the native bees and honey bees visiting flowers.
- ⇒ Don't count the same bee twice even if it visits several flowers—the goal is to count the number of bees using the site, not the rate of flower visitation.

SUPPLIES NEEDED FOR MONITORING

During your site visit you will need:

- A stopwatch, wristwatch, or timer on your phone
- Thermometer
- Data sheets
- Monitoring protocol
- Clipboard
- Pencils/ pens
- Long measuring tape (eg. 100–150 ft)
- Flags or stakes to mark transect start and end
- Permits (if necessary)
- Optional: camera or phone with high quality camera
- Suggested: sunscreen, hat, water, first aid kit, and plant list/ identification guide

In the notes section of the data sheet, record important site information, such as the dominant flowers in bloom and which species seem to be attracting the most native bees or honey bees.

Interpretation of results: The number of native bees counted by this streamlined survey protocol is positively correlated with the diversity of bees at a site. If multiple sites are surveyed, the differences in diversity of the bee community likely will reflect differences in habitat quality among sites. Thus, native bee counts can be used to rank the quality of sites or the quality of a pollinator seed mix. If data are collected over several years, these bee counts can also assess the change in the bee community at a site over time.

LAYOUT OF SAMPLING TRANSECTS



Figure 1. For larger habitat plantings, survey bees on two 100 ft transects parallel to the edge of the habitat. One transect should be 10–20 ft from the edge, and the other should be 250 ft from the edge or at the center of the habitat, whichever is shorter.

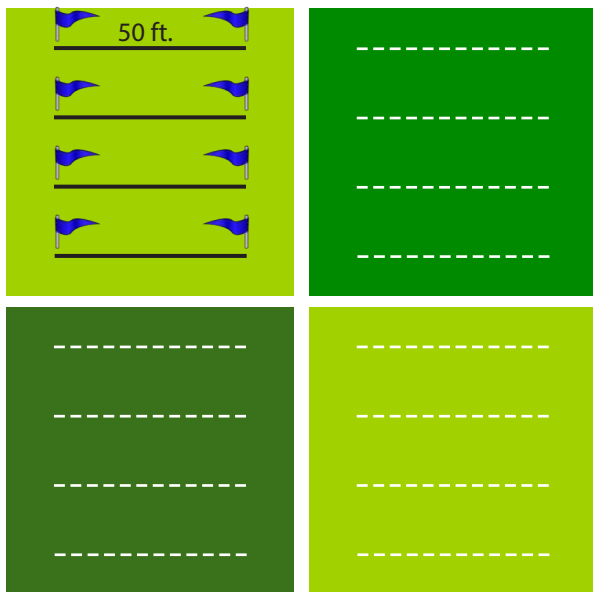


Figure 2. For smaller habitat plantings, such as field trials of pollinator seed mixes, you can work to fit 200 ft of transect into each block. For example, the upper left block demonstrates establishing four parallel 50-foot-long transects. When walking each transect, you are only observing bees in a 3 ft wide strip along the transect path. The dotted lines in the other blocks in this figure indicate similar sampling efforts.

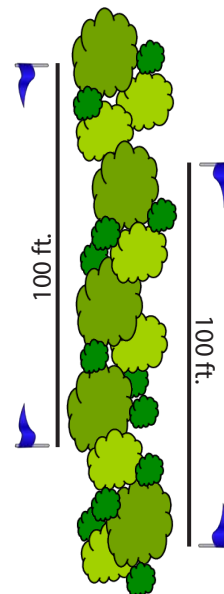


Figure 3. For hedgerows, survey bees on two 100 ft transects on opposite sides of the hedgerow. If the two sides are difficult to access, sample a single transect that is 200 ft long. You will observe bees in a 3 ft wide strip along each transect.

Bee Monitoring Data Sheet: Large Habitat (See Figure 1)

please remember
to photocopy

Site Name: _____ Date: ____ / ____ / ____ Observer: _____

Visit #: ____ of 2 Skies (circle): Clear / Partly Cloudy / Bright Overcast Temp: ____ °F

Type of planting (circle): Meadow / Range / Cover Crop / Other (describe): _____

Conduct observations in the afternoon (noon–4 pm), when temperatures are over 60°F, skies are clear (partly cloudy or bright overcast is OK as long as you can see your shadow) and wind speed is low (a gentle breeze or less). **Conduct observations on two 100 ft transects in open areas of the planting.** One transect should be 10–20 ft from the edge, and the other should be 250 ft from the edge or at the center of the habitat, whichever is shorter. Observe plants in each transect for 7.5 minutes. For each transect, record the number of native bees and honey bees visiting flowers (touching reproductive structures of flowers) within 3 ft of one side of your transect line. You can note flies, wasps, or other floral visitors in the notes.

Transect	Start Time	End Time	# Native Bees	# Honey Bees	Notes
Transect 1 (10–20 feet from edge of planting)					
Transect 2 (center of planting)					

Site notes (e.g. details of the planting, dominant plants in bloom, proximity of honey bee hives, etc.): _____

Bee Monitoring Data Sheet: Small Planting Blocks (See Figure 2)

please remember
to photocopy

Site Name: _____ Date: ____ / ____ / ____ Observer: _____

Visit #: ____ of 2 Skies (circle): Clear / Partly Cloudy / Bright Overcast Temp: _____ °F

Type of planting (circle): Field Trials / Meadow / Cover Crop / Other (describe): _____

Conduct observations in the afternoon (noon–4 pm), when temperatures are over 60°F, skies are clear (partly cloudy or bright overcast is OK as long as you can see your shadow) and wind speed is low (a gentle breeze or less). **Conduct observations on 200 ft of transects, evenly spaced through the planting.** Observe plants in all combined transects for a total of 15 minutes. For each transect, record the number of native bees and honey bees visiting flowers (touching reproductive structures of flowers) within 3 ft of one side of your transect line. You can note flies, wasps, or other floral visitors in the notes.

Transect	Start Time	End Time	# Native Bees	# Honey Bees	Notes
Transect 1 length: _____					
Transect 2 length: _____					
Transect 3 length: _____					
Transect 4 length: _____					

Site notes (e.g. details of the planting, dominant plants in bloom, proximity of honey bee hives, etc.): _____

Bee Monitoring Data Sheet: Linear Planting (See Figure 3)

please remember to photocopy

Site Name: _____ Date: ____ / ____ / ____ Observer: _____

Visit #: ____ of 2 Skies (circle): Clear / Partly Cloudy / Bright Overcast Temp: ____ °F

Type of planting (circle): Hedgerow / Windbreak / Insectary Strip / Other (describe): _____

Conduct observations in the afternoon (noon–4 pm), when temperatures are over 60°F, skies are clear (partly cloudy or bright overcast is OK as long as you can see your shadow) and wind speed is low (a gentle breeze or less). **Conduct observations on two 100 ft transects along either side of the planting.** Observe plants in each 100 ft transect for 7.5 minutes. For each transect, record the number of native bees and honey bees visiting flowers (touching reproductive structures of flowers) within 3 ft of one side of your transect line. You can note flies, wasps, or other floral visitors in the notes. If it is less than 6 ft wide, consider using a single 200 ft transect.

Transect	Start Time	End Time	# Native Bees	# Honey Bees	Notes (Describe where transect is located)
Transect 1 (side A) length: _____					
Transect 2 (side B) length: _____					

Site notes (e.g. details of the planting, dominant plants in bloom, proximity of honey bee hives, etc.): _____

Appendix A

ADDITIONAL RESOURCES

Bee Conservation Publications

Buchmann, S. L. and G. P. Nabhan. 1996. *The Forgotten Pollinators*. 292 pp. Washington, D.C.: Island Press.

National Research Council. 2006. *Status of Pollinators in North America*. 307 pp. Washington, D.C.: National Academies Press. (Available at: <http://www.nap.edu/catalog/11761.html>.)

Mader, E., M. Shepherd, M. Vaughan, S. H. Black, and G. LeBuhn. 2011. *Attracting Native Pollinators. Protecting North America's Bees and Butterflies*. 384 pp. North Adams, MA: Storey Publishing.

Bee Biology and Identification Publications

Michener, C. D., R. J. McGinley, and B. N. Danforth. 1994. *The Bee Genera of North and Central America*. 209 pp. Washington, D.C.: Smithsonian Institution Press.

Michener, C. D. 2000. *The Bees of the World*. 913 pp. Baltimore, MD: The Johns Hopkins University Press.

O'Toole, C., and A. Raw. 1999. *Bees of the World*. 192 pp. London, UK: Blandford Press.

Williams, P. H., R. W. Thorp, L. L. Richardson, and S. R. Colla. 2014. *Bumble Bees of North America: An Identification Guide*. 208 pp. Princeton, NJ: Princeton University Press.

Plant Lists & Conservation Resources

Fiedler, A., J. T. Tuell, R. Isaacs, and D. Landis, 2007. *Attracting Beneficial Insects with Native Plants*. 6 pp. Michigan State University Extension Bulletin E-2973.

Rutgers University Outreach:

<http://winfreelab.rutgers.edu/outreach>

<http://winfreelab.rutgers.edu/documents/NativeBeeBenefits2009.pdf>

Michigan State University, Native Plants and Ecosystem Services: www.nativeplants.msu.edu

The Xerces Society Pollinator Plant Lists: <http://www.xerces.org/pollinator-conservation/plant-lists/>

The Xerces Society Pollinator Conservation Resource Center: <http://www.xerces.org/pollinator-resource-center/>

Citizen Science Opportunities

Bumble Bee Watch (www.bumblebeewatch.org): Citizen science database for collecting bumble bee observations in North America.

The Great Sunflower Project (www.greatsunflower.org): A citizen science project that identifies bees visiting flowers.

Bug Guide (www.bugguide.net): An online resource devoted to North American insects, spiders, and their kin, offering identification, images, and information.

Partner Websites

University of California, Davis: <http://polleneaters.wordpress.com/>

Rutgers University Outreach: <http://winfreelab.rutgers.edu/>

Michigan State University: www.isaacslab.ent.msu.edu

The Xerces Society: www.xerces.org/pollinator



Some native bees, such as this small carpenter bee, can be tiny and wasp-like.



The Xerces Society's Bring Back the Pollinators campaign is based on four principles: grow pollinator-friendly flowers, protect bee nests and butterfly host plants, avoid pesticides, and spread the word. You can participate by taking the Pollinator Protection Pledge and registering your habitat on our nationwide map of pollinator corridors.

www.bringbackthepollinators.org