

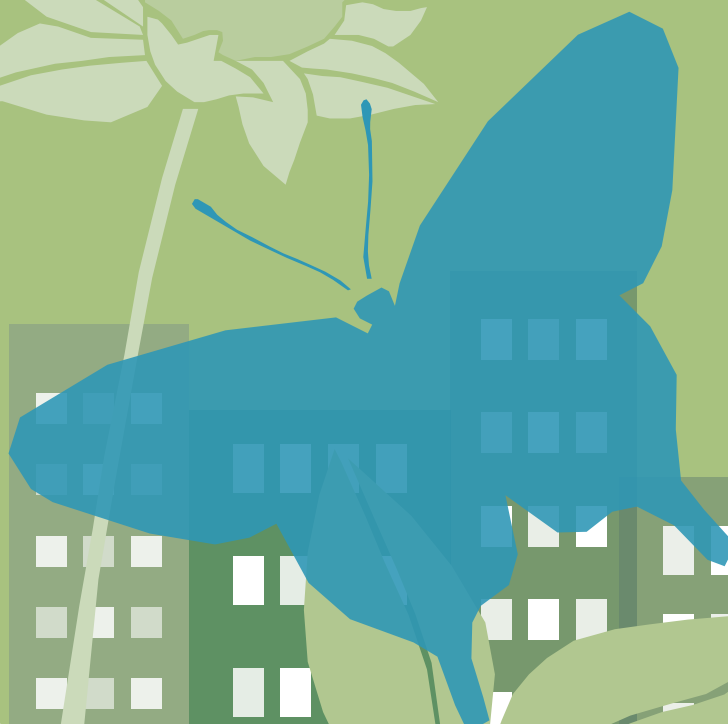
A K-5 URBAN POLLINATOR CURRICULUM



Growing

a Wild

NYC





The National Wildlife Federation

Uniting all Americans to ensure wildlife thrive in a rapidly changing world

Through educational programs focused on conservation and environmental knowledge, the National Wildlife Federation provides ways to create a lasting base of environmental literacy, stewardship, and problem-solving skills for today's youth.

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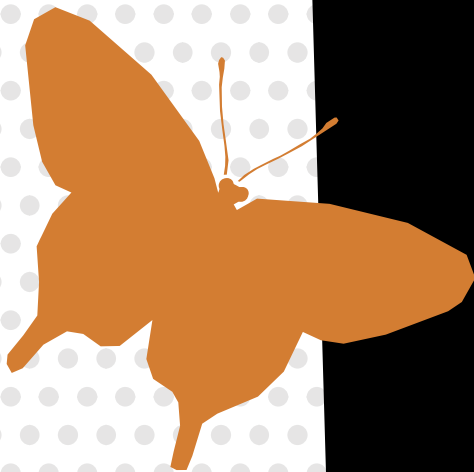
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The National Wildlife Federation works to instill a love of nature and wildlife in teachers and students across New York City. Our place based education programs foster whole-school sustainability, promote climate resilience, and inspire people to create and conserve habitat. We invite you to discover and celebrate urban pollinators with Growing a Wild NYC: A K-5 Urban Pollinator Curriculum.

We dedicate this curriculum to current and future generations of children so they may understand that the planet's smallest creatures are also the most important.



A Message from a National Wildlife Federation Naturalist

Without pollinators, life on this planet would not exist as we know it.



By visiting flowering plants to feed on nectar and pollen, the diverse group of wildlife collectively known as pollinators fertilize

flowers, allowing plants to form seeds and to reproduce. These plant species would disappear without their pollinating wildlife partners. Over 85 percent of flowering plants rely on wildlife to pollinate them so they can produce the seeds that will grow into the next generation of plants and keep their species going.

Beyond ensuring plant communities across the planet continue to thrive, pollinators are responsible for the formation of the seeds, fruits, berries and nuts that plants produce to house their seeds, which in turn feed wildlife across the food web. Without pollinators, wild plant communities would fail, and so would the animals that depend on them for food. That includes us humans. If pollinators disappeared, so would one-third of our food supply.

Honey bees are the most familiar pollinators. Yet the world of pollinating animals is so much more diverse than that one domesticated bee species. Did you know that there are over 20,000 wild bee species on the planet, with around 4,000 native bee species found here in North America alone? Collectively, bees are the most efficient and effective pollinators, but wasps, moths, butterflies, beetles, flies, hummingbirds and bats are all pollinators too. Yet many people are completely unaware of the critically important ecological role these animals play.

This *Growing a Wild NYC: A K-5 Urban Pollinator Curriculum* will help you change that. The twenty lessons feature place-based projects, games, field guides, and data collection activities that will introduce students to wild bees, butterflies, flies and other pollinators, as well as pollination ecology. The curriculum includes field lessons so students will have the opportunity to spend time outdoors and directly observe, compare, and make inferences about the pollinators and other wildlife that depend on the urban habitat.

This curriculum will help your school community reach the ultimate goal of creating a Schoolyard Habitat that will not only provide habitat for urban pollinators but also serve as an outdoor classroom to connect the next generation to nature.

At the National Wildlife Federation, our goal is to help pollinators and other wildlife, but equally important is to foster curiosity in children about the natural world, sharpen observation and scientific inquiry skills and encourage an appreciation and understanding of all life on our planet—including the urban environment. Educators are the front line in both reversing the Nature Deficit problem and creating an environmentally literate citizenry. By empowering and equipping you with the tools to share the wonders of the natural world with your students, we hope to help you do just that. Nothing less than the future of both wildlife and people is at stake.

David Mizejewski

Naturalist,
National Wildlife Federation

At the National Wildlife Federation, our goal is to help pollinators and other wildlife, but equally important is to foster curiosity in children about the natural world, sharpen observation and scientific inquiry skills and encourage an appreciation and understanding of all life on our planet—including the urban environment.

Introduction

This curriculum was designed to engage students in learning about pollinator habitats, the connections between plants and animals, and our role in the environment.

Purpose of the Growing a Wild NYC: A K-5 Urban Pollinator Curriculum

Did you know that there are over 20,000 species of bees worldwide, and more than 230 species in New York City alone?¹ Bees, butterflies and other pollinators play an essential role in our ecosystem. They enable plant reproduction by pollinating plants through the transfer of pollen from flower to flower. One out of every three bites of food that we eat, and over 75% of all flowering plants, depend on the pollination services of bees. Pollinators are also the foundation of our food web. For example, a pair of chickadees needs 6,000 to 9,000 caterpillars just to feed one brood of hatchlings.²

Yet pollinators face serious threats due to several human factors, most significantly from the loss and fragmentation of habitat in growing towns and cities across the country. For example, monarch butterfly populations have declined by as much as 90% in recent decades. Other species have become extinct entirely. It is time for us to pay attention to what biologist E.O Wilson called, “the little things that run the world.”

By the year 2050, there will be a 72% increase in the global demand for food based on population growth,³ while by that time 68% of the world’s population will be living in cities.⁴ In other words, there will be more demand for food and less habitat available for the insects that pollinate those crops, unless we make a difference.

With increasing urbanization, our city

parks, gardens, and schoolyards can play a key role in restoring habitat connectivity for pollinators, thus ensuring greater biodiversity not just in our neighborhoods, but also the surrounding agricultural lands.⁵ Cities play an increasing role in protecting biodiversity. Significantly, several American cities support a higher diversity of native bee species than do adjacent rural areas.⁶

This curriculum was designed to engage students in learning about pollinator habitats, the connections between plants and animals, and our role in the environment. It is a place-based curriculum which allows students to learn about biodiversity, ecosystems and habitats through direct experience and observation. By extending the classroom to the city’s parks and gardens, students learn directly from nature, awakening their senses, thinking, and curiosity. **The culmination is the creation of their own schoolyard pollinator habitat**, in which they are able to apply all they have learned to help solve a real problem and contribute to the restoration of habitat connectivity in our urban environment. Once the schoolyard habitat is created, the learning only really just begins. It is a living laboratory right on the school grounds, which will continue to foster opportunities for interdisciplinary study. By engaging with nature directly, students will not only be more engaged with environmental study, but they will have the opportunity to become lifelong stewards of the environment, which is so essential for our times.

1 greatpollinatorproject.org/

2 Tallamy, Douglas W. *Bringing Nature Home: How You Can Sustain Wildlife with Native Plants*. Timber Press, 2009.

3 Food and Agriculture Organization of the United Nations, 2017. *The future of food and agriculture – Trends and challenges*. Rome.

4 “News”, United Nations, Dept. of Economic and Social Affairs, 2018, un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html Accessed 23 August, 2019.

5 Hall, Damon M. et al. 2016. The City as a Refuge for Insect Pollinators. *Conservation Biology*. 31, No. 1: 24–29.

6 *ibid*



How to Use the Growing a Wild NYC: A K-5 Urban Pollinator Curriculum

The curriculum is organized by season, beginning in September. The lessons reflect what is happening in nature and take advantage of opportunities for field observation. Although the lessons build sequentially, teachers may wish to pick and choose lessons.

The curriculum begins broadly by exploring habitat and comparing the built and natural environments in the city. It then hones in on pollinators, their significance in ecosystems, and their symbiotic relationships with flowers. Students are then introduced to the diversity of bees and butterflies and compare their life cycles, adaptations and habitat needs. After developing an appreciation of pollinators and biodiversity in general, the students then become aware of the threats to pollinators and how we can play a role in supporting them. In the final part of the curriculum the students begin to apply all that they have learned to assessing and planning their own urban schoolyard habitat for pollinators.

Each lesson is designed for students in K-5 and has an estimated run time of 90 minutes. Some lessons have an indoor introductory activity and an outdoor field activity. Teachers may choose to conduct the lesson in two parts by dividing the activities. Because the emphasis is on learning in the field, you should find a nearby park or garden where pollinators may be found, assuming the school does not yet have its own schoolyard pollinator habitat. Even a small community garden can be surprisingly full of pollinators. The appendix offers a list of local field trip sites where pollinators abound. The lessons can be aligned to the Next Generation Science Standards suggested at the end of each lesson.

This curriculum lends itself well to keeping a **field journal** where students can record observations through the seasons. Students can keep journals separate from the lesson worksheets, or the worksheets can be saved and bound with other pages into a field journal at the end of the year. Many of the lessons build upon the previous lessons, so it is important to keep a record of students' worksheets and other material in the form of a journal, or simply a binder or folder. Please see the Appendix for a suggested journal entry template as well as many other great resources that will help you make the most of the curriculum.

Creating an Urban Schoolyard Habitat

As mentioned, the culmination of the curriculum is the creation of the urban schoolyard (pollinator) habitat. We have designated that final lesson at the end of the school year to coincide with the National Pollinator Week, which takes place in the third week of June. Understandably, the process of creating a schoolyard habitat takes time and may not always follow your ideal timeline. Whether you can manage to create the habitat by June, or whether the process extends beyond one academic year, we hope that this curriculum paves the way for your school to create an urban schoolyard habitat for all the reasons mentioned above. Knowing that it is a process, it is wise to plan ahead. Read through the *NWF Schoolyard Habitat How-to-Guide* at nwf.org as soon as you begin the curriculum. Form a habitat team as close as possible to the beginning of the school year and develop a timeline, budget, and fundraising plan so that you will have everything ready for the opening date of the urban schoolyard habitat.

With this curriculum, students will:

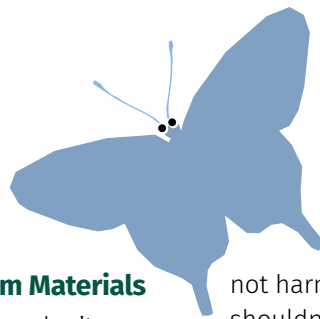
Explore habitat and compare the built and natural environments in the city.

Hone in on pollinators, their significance in the ecosystem, and their symbiotic relationship with flowers.

Understand the diversity of bees and butterflies and compare their life cycles, adaptations and habitat needs.

Become aware of the threats to pollinators and how we can play a role in supporting them.

Assess and plan their own urban schoolyard habitat for pollinators.



The materials that we do provide for each lesson such as worksheets can be adapted to suit your class.

Color Key for Lessons

- **Habitat**
- **Bee**
- **Butterfly**
- **Pollinator**

Preparation of Curriculum Materials

We understand that teachers don't always have a lot of time to gather and prepare materials for lessons, which is why we have tried to keep that work at a minimum. The materials that we do provide for each lesson such as worksheets can be adapted to suit your class. Many lessons also share the same materials. It would be helpful to have a few field guides and hand lenses to take with you outdoors. A recommended list of such resources is found in the Appendix and most titles can be found in your local library. Some lessons require additional materials which need to be ordered in advance. For example, the free plant catalogues for Lesson 19 need to be ordered about two months in advance, so plan ahead (see Lesson 19 for details).

Working with the Fear of Bees

Bees sadly have earned a bad reputation, mainly because they are often mistaken for their more aggressive cousins, the wasps. Furthermore, over 90% of bees are solitary species, meaning that they have no reason to defend a colony and naturally are not aggressive. Even the European honey bee, a social species, will rarely sting unless they feel threatened. Their barbed stinger means they can sting only once because it leads to their death. So while female bees do have stingers, they rarely use them.

Unfortunately, the fear of bees is deeply ingrained. Some children (and even some adults) may think a bee flying in the garden is after them, when really they are just heading to the nearest flower for pollen. It would be helpful to allow students to calmly observe the bees at work and make observations in order for them to see that they really are

not harmful. Tell the children that they shouldn't be offended if the bees completely ignore them, which they are apt to do unless their nest is being attacked. Our hope is that through the education that this curriculum provides, students will lose their preconceived fears as they gain an appreciation for bees and other pollinators, their fascinating behaviors and adaptations, and their essential roles in the ecosystem.

Rearing Monarchs

Bringing insects such as monarch butterflies indoors for closer study can be a wonderful gift for your students, but it's also important to be mindful that we are removing an animal from its natural habitat and handle this responsibly. The National Wildlife Federation stands with other environmental organizations in strongly discouraging the rearing of captive bred monarchs. These insects ordered by mail can harbor disease, are no longer adapted to their natural habitat, and can impact the genetic diversity of the wild populations. You can find out more by visiting: xerces.org/monarchs/joint-statement-regarding-captive-breeding-and-releasing-monarchs.

If you are interested in observing the monarch life cycle responsibly, it's best to find them locally in the wild and place a screen enclosure over the milkweed plant outdoors, which will protect the caterpillars from predators and allow students to observe the life cycle without having to bring them indoors. You can find out more on raising wild monarchs by visiting:

monarchjointventure.org/images/uploads/documents/monarch_rearing_instructions.pdf

monarchwatch.org/rear/index.htm



September - January



← HABITAT HUNT

Habitat Hunt

Background

In order for an animal to survive, it must be able to find an adequate habitat that provides food, water, cover, and a safe place to raise young.

Each species' habitat has a characteristic physical environment, including climate, and often a characteristic type of vegetation. Eastern temperate forests tend to have cold winters and wet, hot summers. Broadleaf trees like oaks and maples live well in these conditions. These trees create a canopy that shades the forest floor and provides habitat for many creatures, such as gray squirrels, white-footed mice, white-tailed deer, blue jays, and more. Deserts, on the other hand, receive little rain throughout the year and can only support plants able to tolerate dry conditions such as cacti and sagebrush, which in turn characterize the habitat for many other plants and animals.

(From NWF Schoolyard Habitats® How to Guide)

The city of New York, which is renowned for its cultural diversity was once a place of great biodiversity as well. The Lenape, Manhattan's original inhabitants, called the island Manahatta, which means "hilly island." The landscapes of Manahatta were comprised of diverse natural

habitats of salt marshes, freshwater wetlands, estuaries, temperate forests, fields, ocean beaches, and springs and streams that supported many species of wildlife. Though they grew some crops, the Lenape moved seasonally and devoted much of their time to hunting, fishing, and gathering wild plant foods, as well as oysters, clams, and other shellfish which were abundant in the waters surrounding Manahatta. The Wildlife Conservation Society's Mannahatta Project estimated that, when Henry Hudson arrived in 1609, the area now known as New York City might have been home to as many as 1,850 plant and vertebrate animal species including large carnivores. Adding invertebrates—all insects, oysters, clams, and other organisms without a backbone— contributes thousands more species. As the city's built environment and human activity increased, much of that biodiversity was lost.

Although we may no longer have gray wolves, deer, and mountain lions roaming as they did in previous time periods, wildlife can still be found in the green

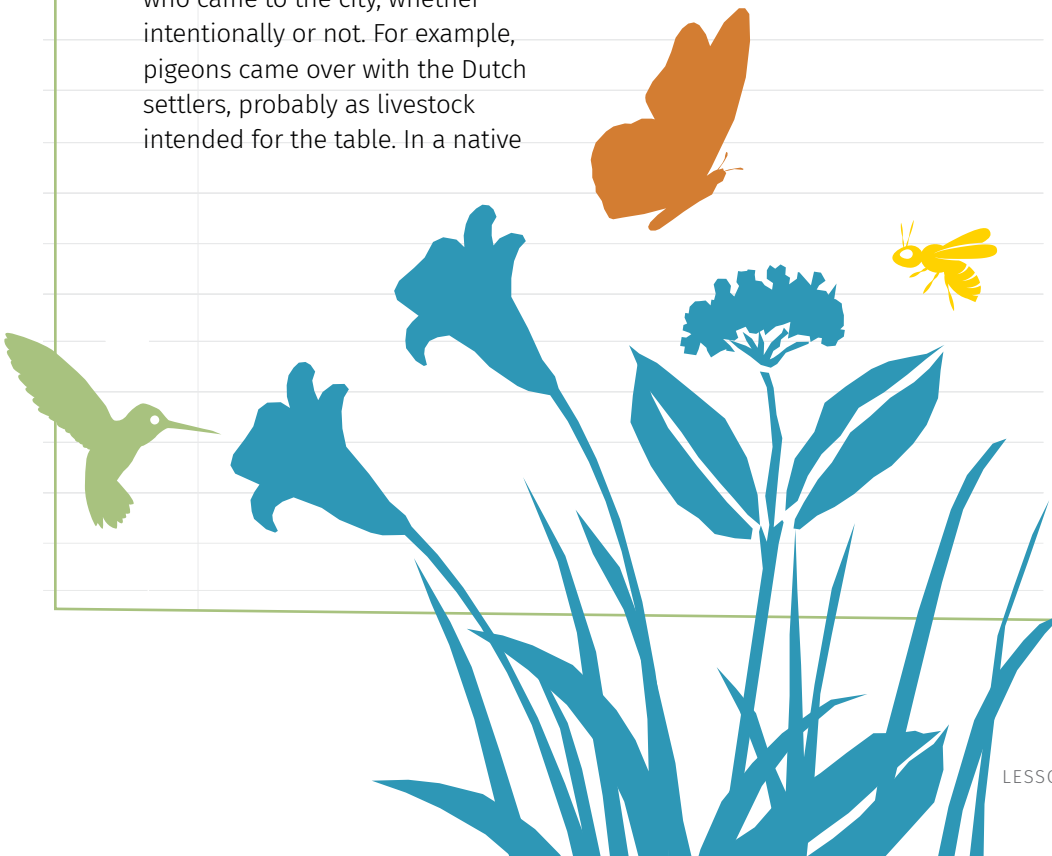
BACKGROUND

Habitat Hunt (Continued)

spaces across the city. Many of the plants and animals that are found in an urban setting live here because it offers some remnant of their natural habitat. For example, squirrels, red-tailed hawks, and chipmunks are native animals still seen in our parks. Even humpback whales, dolphins, and harbor seals can be seen off the coast; and oysters, which once piled up on the beaches, are now making a comeback thanks to restoration efforts. Other native animals have learned to adapt to their changing habitat. Raccoons are highly adaptable native animals that have learned to pry open garbage cans in search of food. Other plants and animals are non-native transplants, which typically migrated with the people who came to the city, whether intentionally or not. For example, pigeons came over with the Dutch settlers, probably as livestock intended for the table. In a native

habitat, these “rock doves” would nest on rock ledges but learned to use city buildings for that purpose and also learned how to depend on people for food. Another species that likely arrived by ship from Europe is the highly adaptable Norway (Brown) rat, which has found an ideal habitat in the city, and much to our aggravation, has thrived.

New York City will never return to the ecological Eden that it once was, but by educating the next generation about the nature that can be and once was found here, we can begin the work of conserving and restoring our natural spaces and learning to live in ways that respect the wildlife that supports people and the planet.



ACTIVITY



Lesson 1

Summary

Students are introduced to the concept of habitat by making personal connections. They explore local gardens or parks to look for evidence of animals in their habitats and compare observations between the built and natural environments.

Objectives

Students will:

- understand the concept of habitat by making personal connections.
- understand that animals have adapted to a certain habitat or habitats.
- understand how the urban environment and human activity influence biodiversity.

Materials

- **1.1 Habitat Web Animals**
- **1.2 Habitat Web Worksheet**
- **1.3 Habitat Hunt Worksheet**, clipboards, pencils, poster board, scissors, glue, rulers, drawing tools

Preparation

Introduction

- Print one copy each of 4 different habitats (ex. desert, arctic, ocean, forest) or use digital images.

Activity 1

- Print and cut out images from **1.1 Habitat Web Animals** (two per group of 6 students)
- Print **1.2 Habitat Web Worksheet** (one per student)

Activity 1

- Print **1.3 Habitat Hunt Worksheet** (one per student)

Introduction

Ask students to focus on the natural features of their neighborhood. What animals have they seen in their neighborhood? Were they pets or wild animals? Can they think of any wild animals they have seen in the neighborhood? Squirrels, birds, etc.? Where did they see them? What were they doing? What are

some wild animals that we rarely find in the street, but are more likely to find in a garden or park in the city? Why don't they venture outside those green spaces? Perhaps they are not able to travel far or maybe the park provides them with everything they need. Think of a turtle as an example. We rarely see turtles walking down the street. Where do we most

ACTIVITY

often find them? The pond is the turtle's habitat. A habitat is where an animal lives, just like our neighborhood is where we live. And just like our neighborhood provides us with everything we need, a habitat provides an animal with everything it needs. A habitat must provide an animal's four basic needs. What might those be? Does an animal need gas stations or coffee shops? Those four basic things that a habitat must provide for an animal's survival are: **food, water, cover, and a place to raise young**. When you think about it, these are the essential needs of people as well. Is there anything else that people might need to survive that animals might not need? (Maybe heat or clothing for protection). Why don't animals need clothing? Discuss the difference between needs and wants.

Show students an image of different habitats: desert, arctic, ocean, forest, etc. Can they think of an animal that lives in each habitat? How does that habitat meet that particular animal's needs and why not another habitat? What might happen if we moved one of these animals to another habitat? Why might it not survive?

Activity 1: Habitat Web

1. Can our city parks be a habitat? What are some animals that we find in our city parks? Explain that the plants and animals that share the same habitat form a community and depend on each other for survival. For example, in the forest, a hawk depends on a squirrel which depends on the oak tree.

2. Divide students into groups of six. Pass out the [1.2 Habitat Web Worksheet](#) to each child in the group.
3. Cut out and distribute to each child an animal from the [1.1 Habitat Web Animals](#); they should not share their animal with the group.
4. Each child will complete [1.2 Habitat Web Worksheet](#) by selecting food, water, and cover resources from the list under the habitat web and copying the ones that they think apply to their animal in the bubbles. Instruct them to leave the center animal bubble blank.
5. Ask them to share with a partner and see if the partner can identify the animal based on its food, water, and cover resources. If students need clues, you can provide the list of animals that were cut out from [1.1 Habitat Web Animals](#). Once their partners have guessed, students can label the animal in the center bubble.
6. Students can work with their group to answer the questions on the second page of the worksheet.

Extension

1. Groups can create a larger habitat food web on poster board or chart paper. Ask students to copy their food web bubbles from their [1.1 Habitat Web Worksheet](#) onto a clean sheet of paper. Students then cut out the bubbles, place them on the poster board, and work their with their group to connect the animals with their food sources using a ruler, marker, or string (see example on page 12). They can also add visuals to the poster and display them in the classroom when complete.

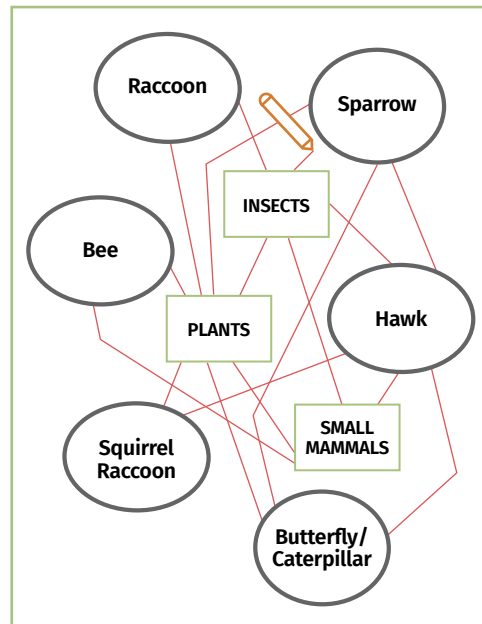


Activity 1 Discussion

1. Discuss the questions on [1.2 Habitat Web Worksheet](#).
2. Which animals eat only plants? Which animals eat both plants and other animals, and which only eat other animals? This might be a good time to introduce the terms herbivore, omnivore, and carnivore.
3. Why is it important to have trees and parks in a city?

ACTIVITY

Habitat Food Web Example (Gr. 3-5)



Activity 2: Habitat Hunt (outdoors)

1. Take a walk around the school and then to a local park or garden. Ask students to look closely for animals both on the street and in the park or garden; students can look for animals of all sizes—tiny critters in the soil or birds flying overhead.
2. Students can record their observations on the **1.3 Habitat Hunt Worksheet**. Remind them to count any animal no matter how big or small and include animals that they hear but cannot see. They will also indicate where they observed the animal (on the street, in a tree, on a flower) and what it was doing. They will also record observations that relate to the animals' habitat needs for food, water, and shelter. For example they may see seeds fallen from a tree that might make a good lunch for a bird or squirrel or a puddle for water. They may see holes or cracks that might be an entry for a burrow, or birds nests in trees.
3. Before they return indoors, ask them to tally the number of each animal they observed on their walk.
4. Create a folder where students can hold on to this worksheet as it will be referred to in upcoming lessons.

Discussion

1. Which animals did you observe and what were they doing? How might that relate to their habitat?
2. Which animal did you observe the most? Why do you think that is?
3. Did you see evidence of animal homes, but not the animals themselves? For example, burrows or nests?
4. Did you see any animals eating? Did you see any food sources—seeds, nuts, or flowers? What animals might these attract?
5. When may be a better time to observe the animals that we didn't see today? How might seasons or the time of day affect observations?
6. Compare observations between the street and the natural environment. Were there any animals that are found in both the street and the park or garden? Which ones were different? Why?
7. Can our neighborhoods also be habitats for animals? How? Would they use the neighborhood the same way? Would they visit the library?
8. How biodiverse is the garden (bio "life," diversity "variety")? In other words, how many different kinds of animals

ACTIVITY



Did you know?

There are an estimated 2,373 Eastern Gray squirrels and 58 different species of bees found in Central Park, NYC.

(and plants) did we observe? How does this compare to observations on the street? Did we see more or less variety of animals there? Why do you think so? How might we make our neighborhood more biodiverse?

9. Before the city and neighborhoods were built, what do you think was here? Think about the animals you see in the city. Which ones do you think had their habitat here before we created our neighborhoods?
10. Why are parks and gardens good for us and the environment?

Extensions

1. Choose one of the animals on the [1.3 Habitat Hunt Worksheet](#). Individually or in groups, students can research one of the animal's habitat needs for food, water, shelter, and places it raises its young. How does the city provide these needs? How has it adapted to city life? Can it be found outside the city as well?
2. How might we keep a record of our observations of local wildlife and habitats (e.g. nature journal, photography, sketches, community science, iNaturalist)?
3. Visit a NYC Forever Wild nature preserve (nycgovparks.org/greening/nature-preserves) to see examples of various

native habitats within our own city. If possible, schedule a tour with a NYC Park Ranger. Make a field guide to record observations. Read about the type of habitat before you go. What do we already know about this habitat, what did we learn?

4. Visit welikia.org for maps of what Manhattan looked like in 1609 and lists of plants and animals. What is significant about the year 1609? What has changed since then? What was lost, what was gained? See bit.ly/WildflowersNYC for images of wildflowers once found in NYC. Why did some remain and some disappear from the city?
5. Visit oasisnyc.net/map.aspx to see historical land uses in your neighborhood. How do you think these changes affected wildlife?
6. Find more NWF lessons on habitat at bit.ly/LessonsNWF.

Resources

- The Welikia Project: welikia.org
- The Lenape Center: thelenapecenter.com
- AMNH Biodiversity Assessment of NYC: bit.ly/NYCBiodiversity
- What is Biodiversity?: bit.ly/biodiversityAMNH
- When NYC Bloomed: bit.ly/WildflowersNYC
- Audubon Resources: bit.ly/NaturalistsAudubon

RESOURCES

Books

About Habitats (series)**Cathryn Sill**

Ages 6–11

Beautifully illustrated overview of the ecosystems in different habitats.

When the Shadbush Blooms**Carla J. Messinger with Susan Katz**

Ages 6–11

A Lenape story told by Traditional Sister and Contemporary Sister, each from her own time, this is a book about the cycle of seasons, tradition and change.

The Kid's Guide to Exploring Nature**Brooklyn Botanic Garden**

Ages 6–11

Teaches children how to observe environments as a naturalist and reveals complex ecosystems of plants and animals in the woods, at the beach, and in a city park.

Hidden City: Poems of Urban Wildlife**Sarah Grace Tuttle**

Ages 6–11

Poems with colorful illustrations about the nature often unnoticed in the city.

Field Guide to Urban Wildlife**Julie Feinstein**

Ages 12+

The habits of 135 common North American animals adapted to urban life.

Wild New York: A Guide to the Wildlife, Wild Places, and Natural Phenomenon of New York City**Margaret Mittlebach**

Ages 12+

A beautifully illustrated, natural history of New York City and a guidebook for the urban explorer.

Vocabulary

Adapt (v): to change a behavior, feature, or characteristic so that it is easier to live in a particular place or situation.**Biodiversity** (n): biological diversity in an environment as indicated by numbers of different species of plants and animals.**Community** (n): a group of plants or animals that live in the same place, usually interacting with each other and their environment.**Carnivore** (n): an animal that eats other animals.**Habitat** (n): the place or type of place where a plant or animal naturally or normally lives or grows. The place that provides the animal with food, water, shelter, and a safe place to raise young.**Herbivore** (n): an animal that only eats plants.**Omnivore** (n): an animal that eats both plants and other animals

Source: Merriam-Webster Learner's Dictionary

RESOURCES

Standards

K-LS1-1 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment. Use observations to describe patterns of what plants and animals (including humans) need to survive.

K-ESS2-2 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.

K-ESS3-1 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment. Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.

1-LS1-2 Structure, Function, and Information Processing. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.

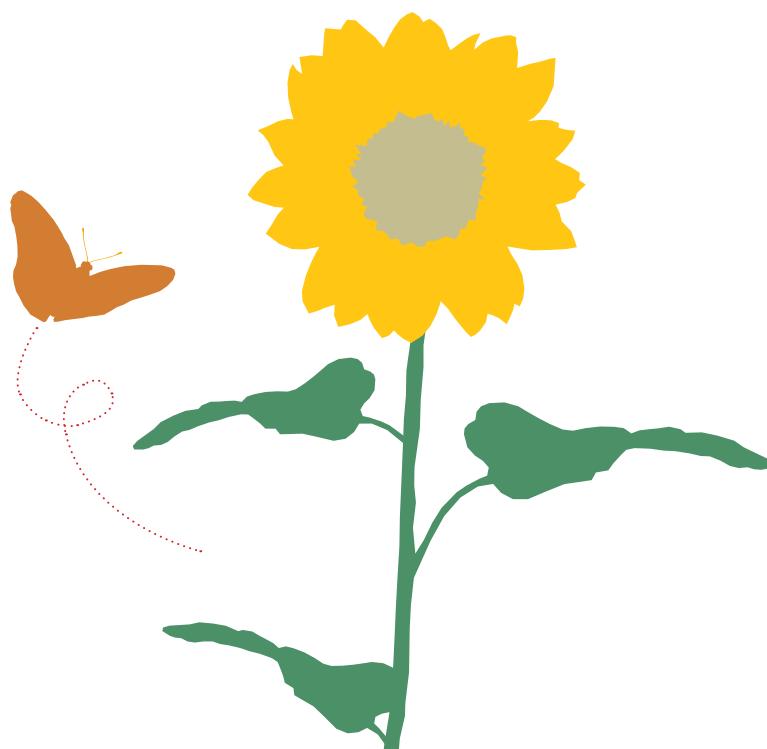
2-LS4-1 Interdependent Relationships in Ecosystems. Make observations of plants and animals to compare the diversity of life in different habitats.

3-LS3-2 Inheritance and Variation of Traits: Life Cycles and Traits. Use evidence to support the explanation that traits can be influenced by the environment.

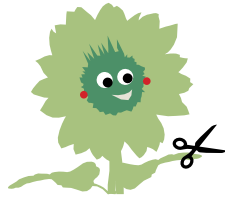
3-LS4-3 Interdependent Relationships in Ecosystems. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

3-LS4-4 Interdependent Relationships in Ecosystems. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

4-LS1-1 Structure, Function, and Information Processing. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.



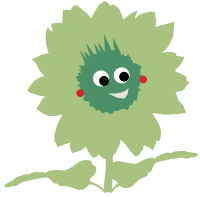
HABITAT WEB ANIMALS



Teacher Instructions: Cut out the animal cards and give one to each student. Tell them not to show their cards to anyone else! Students will use their card to complete the [1.2 Habitat Web Worksheet](#).

Raccoon**Bee****Butterfly****Squirrel****Hawk****Sparrow**

Name: _____ Date: _____



1. Look at your animal – don't let anyone else see it yet! What does your animal eat? Where does it get water? Where does it find cover? Use the list below and write the habitat needs of your animal in the appropriate food, water, and cover circles (food-green circle; water-blue circle; cover-red circle). Don't write the name of the animal in the center circle, your partner will try to guess it based on its habitat needs.

2. Turn and talk with a partner. Share the food, water, and cover needs of your animal and see if they can guess it. Once they've had a chance to guess, write down the name of your animal in the center circle.

HABITAT WEB

What **food** does your animal eat?

Where does it find **cover**?

What is your animal?

?

Where does it get **water**?

Food
▪ insects
▪ plants/trees (includes leaves, fruit, pollen, seeds, nuts, etc.)
▪ small mammals or birds

Water
▪ raindrop on leaf
▪ puddle
▪ fountains
▪ streams or ponds

Cover
▪ nest on a tree branch
▪ tall grasses
▪ chimney
▪ underground burrow
▪ hollow of a tree

HABITAT WEB

Name: _____ Date: _____



Discuss these questions with your group and write your answers in the space provided.

1. Which animals shared the same food resource?

Food:	Animals:

2. Which animals shared the same water resource?

Water:	Animals:

3. Which animals shared the same cover resource?

Cover:	Animals:

4. Which food resources also serve as cover resources?

5. Do you share any food, water, or cover resources with these animals? Which ones?

Name: _____ Date: _____



Look closely for animals during your walk, they can be tiny or large—insects, birds, mammals, and more. What animals do you see or hear? Complete the chart for all the animals you observe.

HABITAT HUNT

Animal	Tally	Total	Where is it?	What is it doing?

Do you see evidence of food, water, or cover for wildlife?
For example, fallen seeds, puddles, nests, or burrows?

Food	Water	Cover or places to raise young	Animal it may serve
		Example: Bird's Nest	Bird 

2 WHAT IS A POLLINATOR?

What is a Pollinator?

Background

Over 85% of flowering plants depend upon pollinators for reproduction.¹

The relationship between plants and animals can be best understood by looking at the symbiotic relationship between flowers and pollinators. Pollinators, those animals that visit flowers for nectar and pollen, inadvertently aid the plant in reproduction by transferring pollen from flower to flower on the hairs of their body. The color, shape, and fragrance of flowers are adapted just for this purpose—luring pollinators to ensure the plant's reproduction. Pollinators sustain our ecosystems and form the base of the natural food web, as well as our food supply. Below are profiles of some of the most common pollinators.

Bees

Bees are by far the most eminent of all the pollinators. There are over 20,000 species of bees in the world, over 4,000 in the United States, and 230 in New York City alone.² The majority of flowers are pollinated by bees. They may visit thousands of flowers each day, foraging for pollen to bring back to their nests. Although honey bees are the most famous bees, they are native to Europe, not North America, and were

imported for their honey. More than 90% of our native bee species are solitary species; they do not live in colonies but make their nests in soil, hollow plant stems, or in wood. As explained in later lessons, our agriculture systems and ecosystems depend upon the pollination services of these remarkable insects.

Wasps

Bees are often confused with their infamous look-alike cousins, the wasps. Bees and wasps are closely related and both occupy the same order, Hymenoptera. Upon close inspection, you will see that the two are quite different and have different adaptations and behaviors. One way to easily distinguish the two is that wasps are not fuzzy like bees. They visit flowers for a quick sip of nectar but do not collect pollen for their offspring like bees and thus have no need for the pollen collecting hairs. Rather, wasps are carnivorous and sting and drag other insects, including other members of their same order, back to their nests to feed their young. Because of their varied diet, wasps can be a nuisance at picnics in search of an easy

¹ xerces.org/pollinator-conservation/

² greatpollinatorproject.org/

BACKGROUND

What is a Pollinator? (Continued)

meal, especially at the beginning or end of a season when nectar is scarce. Another way to distinguish wasps from bees is that wasps tend to have a more elongated abdomen and narrower waist than bees. You can think of them as a slender race car rather than a buggy.

Like bees, the majority of wasps are solitary. Some don't even bother making nests, but will smuggle their eggs in the nests of other bees and wasps where, upon hatching, they will devour their hosts. Others are social and live in colonies, including hornets, yellow-jackets, and paper wasps. Wasp hives are usually constructed out of a paper-like material created out of regurgitated wood fibers and may be exposed on trees and under the eaves of houses.

Butterflies and Moths

Butterflies and moths belong to the insect order Lepidoptera. With about 180,000 different species, this insect order is second only to the beetles (Coleoptera). These insects are less efficient than bees at transferring pollen between plants; they lack the specialized structures to do so and have long thin legs that keep them perched above the flower. But they are a marvel to children and adults alike and are more approachable than bees. Many

people wonder at the difference between butterflies and moths. The following points are generally true for most species:

- Butterflies have knobbed antennae; those of moths range from straight filaments to feathery or branched.
- Butterflies have smooth, slender bodies; moths tend to be plump and fuzzy.
- Most butterflies fly during the day; most moths fly at night.
- Butterflies generally rest with their wings held upright; moths spread them out.
- The majority of fuzzy caterpillars become moths.
- Most of the brightly colored Lepidoptera are butterflies.³

Flies

Flies are often seen on flowers in late summer. Many can easily be mistaken for bees or wasps due to their adaptation for mimicry. Yet there are several ways to distinguish them. Flies belong to the order Diptera, meaning "two-winged." Bees and wasps have four wings, a pair of fore wings, and hind wings. Flies also have a more triangular shaped body and head when viewed from above. They have shorter antennae and don't have dense hairs because they do not carry pollen. Syrphid flies (hover flies), which closely

³ archive.fieldmuseum.org/butterfly/bvsm_basic.htm

BACKGROUND

What is a Pollinator? (Continued)

mimic bees and wasps, eat pollen and nectar. Tachinid flies visit flowers for nectar and parasitize caterpillars with their eggs. Smaller flies may lay their eggs inside flower heads or puncture the flower head to feed on the nectar.

Beetles

There are more species of beetles than any other kind of insect; fossil records show that beetles were the first insect pollinators. Common floral visitors include soldier beetles, long-horned beetles, leaf beetles, and snout beetles. Beetles visit flowers for both pollen and nectar, but they also have an appetite for other parts of the flower and can sometimes be destructive. The micro-hairs on their bodies trap and transport pollen; but because they spend a long time on a flower, their effectiveness at pollination is diminished. Beetles have certain adaptations to protect them from predators. For example, the soldier beetle demonstrates a good example of wasp mimicry.

Ants

Ants are great lovers of nectar. They are often attracted to flowers that contain extra floral nectaries, (nectar that is found on the outer part of the flower) or shallow flowers since they don't have the tongues to feed on the deep inner nectaries. Though ants are not effective pollinators, there is still

a symbiotic relationship between them and the plant. When surrounding the flower to feed on the extra floral nectaries, the ants deter other insects that may feed on the flower buds or try to steal nectar from the outside, thus forcing other insects like bees to enter the flower in a way that is more conducive to pollination.

Ants are highly social and nest in colonies underground or in hollow cavities. Like honey bees, they send a scout out in search of nectar. When the scout finds the nectar, she emits a pheromone odor trail on the way back to the nest, which leads the other ants to the food source. A trail of ants can be seen all the way up the plant stem to the nectar source.

Hummingbirds

In the eastern United States there is only one kind of hummingbird: the ruby-throated hummingbird. It has good eyes and is especially attracted to red flowers. It can reach deep nectaries with its long slender beak. When it does, its head becomes dusted with the pollen. "Although a hummingbird weighs between 2-8 grams (a penny weighs 2.5 grams), they eat frequently in order to power hearts that pump 1,200 times per minute and wings that beat seventy times each second. To survive, they must eat several times their weight in nectar every day!"⁴

⁴ fs.fed.us/wildflowers/pollinators/animals/birds.shtml

ACTIVITY



Lesson 2

Summary

Students brainstorm which animals they have seen on flowers and learn why they are called pollinators. To become familiar with different pollinators, the class plays “pollinator bingo.” They then observe and collect data about pollinators outdoors and discuss their observations.

Materials

- 2.1 Pollinator Bingo Cards
- 2.2 Pollinator Observation Worksheet
- Pencils
- Clipboards

Objectives

Students will:

- become familiar with the term pollinator and the animals that pollinate flowers.
- compare and contrast various pollinators.
- observe pollinators and make inferences about their behavior and characteristics.
- observe flowers and make inferences about their characteristics.
- represent data in chart.

Preparation

Activity 1

- Print **2.1 Pollinator Bingo Cards** (one per pair of students. Pre-cut images, or let students cut them out).
- Bingo markers (optional)

Activity 2 (outdoors)

- Print **2.2 Pollinator Observation Worksheet** (one per student)

Introduction

Review the previous lesson, **Habitat Hunt**. Ask students to recall which animals they observed. Were any of the animals visiting the flowers? If they didn't see any, you might take them out where they can observe the activity on flowers or let them just recall from experience which animals they have seen visiting flowers

(bee, butterfly, wasp, hummingbird, etc.). Why do they think they visit flowers? Explain that these animals are called pollinators because they transfer pollen from flower to flower. They will be learning more about this in the next lesson, but you may mention that the reason they are so important is that by transferring the pollen from flower to flower, they

ACTIVITY



allow the plant to develop seeds so that it can reproduce, or make more plants. The plants and animals support each other: the plant provides the animal with nectar and pollen and the animal transfers the pollen to another flower, which helps the plant produce seeds.

Activity 1: Getting to Know Pollinators

1. Divide students into pairs. Give each group a copy of [2.1 Pollinator Bingo Cards](#). Students will cut out the bingo cards and arrange them in a 3 X 3 grid in any random order.
2. Call out the names of the pollinators (hummingbird, ant, bat, butterfly, fly, moth, bee, wasp, and beetle). Students can either mark the cards or flip them over as the pollinators are called. If they turn over three cards in a row (horizontally, vertically, or diagonally), they call out, "BINGO."
3. Working in the same pairs, ask students to compare and contrast the pollinators and think of different ways to classify them (e.g., insects vs. non-insects, or winged animals vs. non-winged). Encourage them to be creative in their classifications. If time allows, students can share their classifications with the class.

Discussion

1. How many of these animals did you think were pollinators? Which ones surprised you?
2. Which ones have you seen visiting flowers? Why might that be?
3. How are they similar and how are they different from each other?

[5 fs.fed.us/wildflowers/pollinators/animals/flyes.shtml](https://fs.fed.us/wildflowers/pollinators/animals/flyes.shtml)



Did you know?

Flies don't usually come to mind when eating chocolate, but they are an important pollinator of this sweet treat. Chocolate comes from the cacao tree which is pollinated by the tiny midge fly (1-3 mm.). The tiny white flower of the cacao tree smells like mushrooms, and since midge flies are attracted to mushrooms, they also are attracted to the flowers.⁵

4. What additional questions do you have about these pollinators?

Activity 2: Pollinator Field Observation (outdoors)

1. Take students outside to a place that has a variety of flowers, or ideally a pollinator garden (see Appendix).
2. Give each student a copy of [2.2 Pollinator Observation Worksheet](#). Students will spend time observing flowers on two different plants and record their observations. They will also spend time observing one pollinator and record their observations.
3. When you return to the classroom, students can create graphs or charts from the data. For example, one graph could illustrate the types and number of pollinators observed; another could illustrate flower colors and number of pollinator visits, etc.

ACTIVITY

Extensions

- Let students work individually or in groups to conduct research on one of the pollinators. Some of the information they could research includes:
 - Habitat (feeding, nesting, resting, overwintering)
 - Anatomy
 - Life cycle
 - Range (where it is found)
 - Behavior and adaptations
 - Fun facts
- Look at iNaturalist.com to find the peak time for observations of each of these pollinators. Find the peak time to observe them at different stages of their life cycles (egg, larva, pupa, adult).
- Look at iNaturalist.com for ruby throated hummingbird observations in New York. How does that compare with certain bees? Are ruby throated hummingbirds more common or more rare? Look at a map of the range of the ruby-throated hummingbird. Is that reflected in the observations on iNaturalist? What might determine its range? When is the peak time for observations? How might we attract more ruby-throated hummingbirds to the garden?

Standards

K-LS1-1 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment. Use observations to describe patterns of what plants and animals (including humans) need to survive.

1-LS1-2 Structure, Function, and Information Processing. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.

1-LS3-1 Structure, Function, and Information Processing. Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

2-LS4-1 Interdependent Relationships in Ecosystems. Make observations of plants and animals to compare the diversity of life in different habitats.

K-2-ETS1-1 Engineering Design

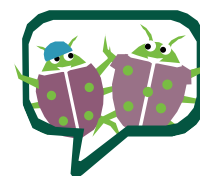
Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

3-LS1-1 Inheritance and Variation of Traits: Life Cycles and Traits. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

3-LS3-1 Inheritance and Variation of Traits: Life Cycles and Traits. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.

3-LS2-1 Interdependent Relationships in Ecosystems. Construct an argument that some animals form groups that help members survive.

4-LS1-1 Structure, Function, and Information Processing. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

**Activity 2 Discussion**

- What insects did you observe visiting the flowers?
- What part of the flowers did they prefer?
- What do you think they were doing there?
- How many different flowers did the pollinator visit?
- Did any pollinators prefer certain flower colors?
- Why are flowers so attractive?

RESOURCES

Books

The Bees in Your Backyard
Joseph Wilson and Olivia Messinger Carril

Adult

A comprehensive and clear guide to the native bees of North America with many visuals.

The Life and Times of the Ant
Charles Micucci

Ages 4–8

This picture book explores everything about this other amazing social insect.

Are you an Ant?
Judy Allen

Ages 4–8

A picture book takes readers through the life of an ant.

Tiny Bird: A Hummingbird's Amazing Journey
Robert Burleigh

Ages 5–9

The story of the life cycle and migration of the ruby-throated hummingbird.

A Wasp Builds a Nest: See Inside a Paper Wasp's Nest and Watch It Grow
Kate Scarborough

Ages 5–9

This picture book explains stage by stage how paper wasps build their nests.

Bees and Wasps: Secrets of Their Busy Colonies
Sara Lynn Latta

Ages 8–10

Discover how bees and wasps build their homes, communicate, and depend on one another to survive in their colonies.

Field Guide to the Flower Flies of Northeastern North America (Princeton Field Guides)

Jeffery H. Skevington

Adult

The first comprehensive field guide of flower flies (also known as hover flies) of northeastern North America.

Vocabulary

Pollen (n): the very fine, usually yellow, dust that is produced by [a flower] and that is carried to other [flowers] of the same kind, usually by wind or insects, so that the plants can produce seeds.

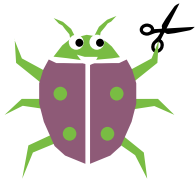
Pollinate (v): to give [a plant] pollen from another plant of the same kind so that seeds will be produced.

Pollinator (n): an animal that moves pollen from one plant to another of the same kind so that seeds will be produced.

Reproduce (v): to produce babies, young animals, new plants, etc.

Source: Merriam-Webster Learner's Dictionary

Name: _____ Date: _____



Cut out each pollinator image; arrange the images on your desk in three rows, in any order. Each row should have three pictures. When your teacher calls the name of one of your pollinators, flip over the picture. Once you flip over all three pictures in one row—horizontally, vertically, diagonally—raise your hand and say, “BINGO!”



POLLINATOR BINGO CARDS

POLLINATOR OBSERVATION

Name: _____

Date: _____



Observe flowers on two different plants for 3 minutes each.
What do you notice?

Flower #1

Describe the flower:

Sketch the flower:

What insect(s) did you observe on the flower?

Observations (How long did it stay?
What part of the flower seems the most interesting?)

Flower #2

Describe the flower:

Sketch the flower:

What insect(s) did you observe on the flower?

Observations (How long did it stay?
What part of the flower seems the most interesting?)

Name: _____ Date: _____



Next, quietly follow one pollinator around for 3 minutes
and answer the questions below.

1. Can you identify the name of the pollinator?

- a. About how many flowers did it visit in those three minutes?
- b. How many different kinds of flowers did it visit?
- c. What colors were the flowers?
- d. Did it visit any other part of the plant beside the flower?
If so, which part?

2. Describe the general behavior of the pollinator. What was it doing?

3. Why do you think pollinators visit flowers?

4. Why do you think flowers are so attractive?

POLLINATOR OBSERVATION

3 WHAT IS POLLINATION?

What is Pollination?

Background

Each part of the plant has an important function that contributes to its growth and life cycle.

The **roots** anchor the plant and absorb water and nutrients from the soil. The **stem** gives the plant structure and allows for the circulation and transport of water and nutrients throughout the plant. The leaves produce food for the plant through the process of **photosynthesis**—the leaves absorb sunlight and carbon dioxide which combines with water to produce sugars (food) for the plant. The byproduct of photosynthesis is oxygen, which sustains life on Earth.

Finally, the plant puts all of its energy into producing the **flower**, its reproductive organ. **Pollination** is the transfer of pollen from the male part of the flower (**stamen**) to the female part (**pistil**) so that fertilization can occur. Pollen is located on the **anther**, at the tip of the stamen. After a grain of pollen from the anther lands on the sticky **stigma**, the receptive part at the tip of the pistil, it germinates and a pollen tube opens and carries the sperm cell down the **style** to the **ovary**. The ovary contains the **ovules**, the female egg cells. Fertilization occurs once the sperm cell fuses with the ovule. Slowly the ovary

will begin to swell while the flower petals, having achieved their purpose, will fade and fall off. The swollen ovary, now a **fruit**, contains the fertilized **seeds** that will begin a new life cycle.

There is a symbiotic relationship between plants and animals. Over 85% of flowering plants depend on insects, birds, and even bats for pollination. The flower is the plant's lure for attracting these pollinators. The pollinators, attracted by the color and fragrance of the flower, come to drink the nectar, a sugary liquid containing nutrients and amino acids. Usually the nectar is secreted deep inside the flower at the base of the pistil so that tiny insects, like bees, must brush against the stamens—picking up pollen—to reach their sweet reward. Emerging with tiny hairs now covered in pollen, the bee will visit another flower and inadvertently transfer those pollen grains when it brushes against the pistil. Some pollinators, like bees, also carry the pollen back to the nest as food.

BACKGROUND

What is a Pollination? (Continued)

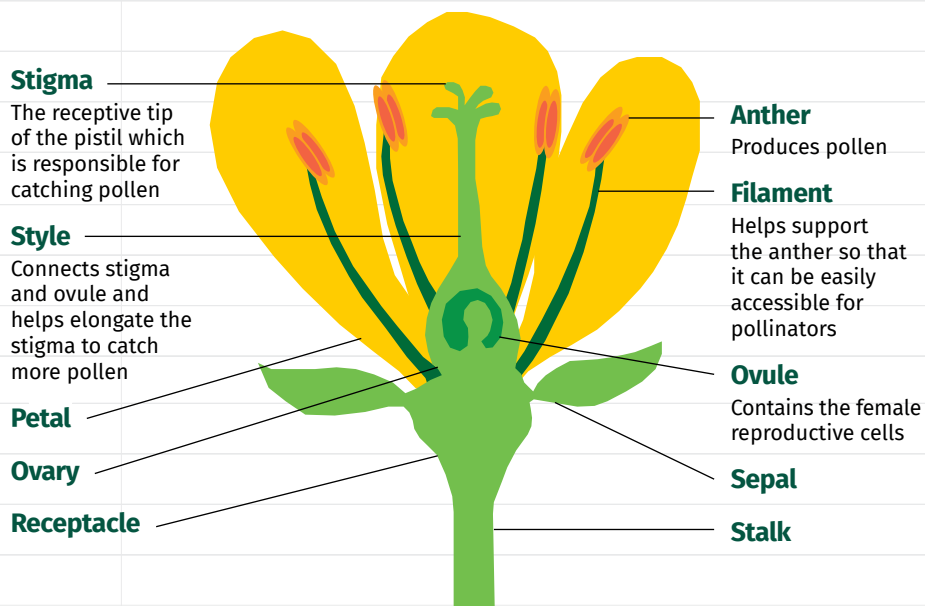
There are two main kinds of pollination: self-pollination and cross-pollination. **Self-pollination** is the transfer of pollen from a stamen to a pistil on the same plant. This can happen within one flower or between different flowers on a single plant. **Cross-pollination** is the transfer of pollen from a flower on one plant to a flower on another plant. Some plants are specifically adapted for one type or the other. For example in cross-pollinating

flowers, the pistil is usually higher than the stamens to prevent self-pollination; some plants even contain only male flowers, while others of the same species contain only female flowers. This adaptation ensures that cross-pollination will occur and leads to a greater mixing of genes and thus a variety of traits. However, self-pollination serves its own evolutionary advantage, ensuring that pollination will occur regardless of external conditions.

Parts of a Flower

The male part of a flower is known as the **Stamen** and is made up of the anther and filament.

The female part of a flower is the **Pistil** and is made up of the stigma, style and ovule.



ACTIVITY



Lesson 3

Summary

Students review the parts of a flower and their functions and understand the role that insects play in pollination. They simulate the process of pollination through a role-playing game.

Objectives

Students will:

- learn the basic anatomy of a flower.
- become familiar with the role of the flower and fruit in plant reproduction.
- understand how pollinators—like bees—aid in plant reproduction.

Materials

- **3.1 The Parts of a Flower**
- **3.2 Bees With Pollen**
- Art materials for activity outlined below

Preparation

Introduction

- Print **3.1 The Parts of a Flower**, one per group (or show digital image)
- Print **3.2 Bees With Pollen**, one per group (or show digital image)

Activity 1

- 20 pipe cleaners—10 yellow, 10 black, cut into 3–4 inch sections
- Gauze cut into 2 inch strips (optional)
- Double sided tape or velcro tape
- Small paper bags (one per student)
- About 100 assorted colored small pom poms or felt balls with 6 different colors
- Crayons or markers for each table

Introduction

Review the class's observations of pollinators. Which animals did we see visiting flowers and what were they doing? Pollinators sip nectar from flowers which gives them the energy they need. Why do we call them pollinators? While they sip the sweet nectar from the flower, they brush against the pollen and some of it sticks to

the hairs on their bodies. Without knowing it, they transfer the **pollen** from flower to flower. This pollen contains special cells which allow the flowers to produce seeds.

Show students **3.1 The Parts of a Flower** and explain that they are looking inside the flower. Have they ever looked this closely at a flower to see these parts?

ACTIVITY

Discuss the parts of the flower and how a seed is produced, using the **Background** as your reference. Adjust your explanation according to the age of your students.

Show students [3.2 Bees With Pollen](#). Explain that bees are messy eaters and they get covered in pollen as they sip nectar, which is exactly what nature intended. The pollen will travel with the bee to the next flower where it may be transferred to the pistil of that flower so that pollination can occur and the fruit can grow. Some female bees groom themselves with the mid-legs so that the pollen is combed to their back legs and stored in “pollen baskets.” When full, they carry these sacs back to their nests and prepare a pollen ball on which to lay an egg.

Activity 1: Busy Bees

1. Divide the class into two groups. One group is the **flowers**. The other group is the **pollinators** (bees).
2. The **flowers**:
 - a. Take a **paper bag** and draw a flower on one side and a fruit on the other side (remind them that a fruit is the part of the plant that contains seeds, so even a cucumber is a fruit).
 - b. Fill the bag with six pollen grains (small felt balls or pom poms) all of the same color. They can mark the color of the pollen with a circle on the front of the bag so they remember.
3. The **bees**:
 - a. Wind a black and a yellow pipe cleaner around their index finger to represent a bee.
 - b. Attach a strip of double sided tape or velcro tape to the pipe cleaner on the underside of their finger.
 - c. Take a paper bag and carry it in their other hand; the bag represents the bee’s pollen sac. (They can label the bag “baby food” since bees feed their young with pollen).
 - d. The bees fill their bags with six pollen grains (small felt balls or pom poms) which can be different colors.
4. Gather food!
 - a. The flowers stand on one side of the room holding their bags open. The bees stand on the other side.
 - b. The teacher calls, “The flowers have opened in the sun; gather food before the day is done!”
 - c. The bees buzz around and visit the flowers; they fly down to the bottom of a flower (bag) to drink nectar. While they drink **nectar**, they let one pollen grain stick to the bee.
 - d. The bee deposits the pollen grain in her pollen sac (bag) and then randomly chooses a different pollen grain from her sac to deposit in the flower’s bag; (they collect one for the pollen sac and give a different one back to the flower). It doesn’t matter which color is returned to the flower. In fact, it should be done randomly.
5. Allow the game to continue for five minutes.

ACTIVITY

6. The flowers and bees check their bags. Everyone should have no more than six pollen grains. If not, redistribute until everyone does.
7. Now the flowers can check their bags: if they have at least three pollen grains in their bag that match their original color, then their flower has been pollinated! Remember they can check the dot on their bags for reference. If it matches, they inflate their bags by blowing into them like a balloon. Their flowers have been pollinated and will become a fruit!
8. At this point, choose to end the game or continue to play with the remaining flowers until all the flowers have been pollinated and become fruits.

Discussion

1. What are some ways that flowers attract insects? Why do flowers look different than the leaves? What are some ways that the inside of the flower helps pollination to occur?
2. When a flower becomes a fruit, we say it has been fertilized. Why did the flower have to receive the same kind of pollen grain before developing into a fruit? Can two unrelated flowers fertilize each other? Say a rose and a lily? (This is why bees naturally spend their time visiting one kind of flower or even are adapted to visit only one kind of flower to ensure that fertilization occurs.)
3. How was this game similar or different to the way you think pollination actually occurs in nature?

**Did you know?**

Do you get allergies in the spring? They may be caused by pollen grains flying in the wind. Some trees and plants don't rely on animals to pollinate their flowers but instead depend on the wind to carry pollen to their flowers for pollination. Even though you may be sneezing, you probably didn't even notice the flowers on these wind-pollinated trees and plants because they are not the showy kind meant to attract the attention of pollinators.

Activity 2:
Pollination Field Observation
(outdoors)

1. Investigate flowers outdoors. Students can use [3.1 The Parts of a Flower](#) as reference. Using hand lenses, ask students to closely examine and identify the parts of the flower. Can they take a cotton swab and gather some pollen on a paper towel or petri dish? Take samples back to the classroom and observe under the microscope. How do pollen grains from different flowers compare? Note: this activity can take place indoors if flowers are purchased and distributed to groups (lilies or alstroemeria are

ACTIVITY

- commonly sold at markets and have visible plant parts and pollen).
- If they find bees outdoors, can they see the pollen on the bees or even the pollen sacs? If not, students can discuss [3.2 Bees With Pollen](#) with their groups.
 - Discuss: why are pollinators so important?
- Extensions**
- Review the plant life cycle. At what stage of the life cycle does the pollinator play a role? Plant a seed and observe the life cycle unfold. Can students predict what will happen next?
 - Look at some images of flowers including those from plants that are wind pollinated such as oaks, ashes, elms, walnut, and corn. Ask students to identify and compare flowers that they think are wind-pollinated with those that are pollinated by birds or insects. Ask them to explain their inferences. What differences do you notice between wind and animal-pollinated flowers?
 - Look at the anatomy of bee and butterfly. Which one do you think is the more effective pollinator and why? Why might bees need to carry more pollen? In Lesson 10, they will learn why.
 - Next snack time, cut an apple horizontally to see the seeds. If the apple was properly pollinated there should be 10 seeds (2 in each pocket). If not, then we say the apple was improperly pollinated meaning some ovules were not fertilized. You can also show students an image of an apple blossom so they can see how the 5 petals are mirrored in the shape of the star inside the apple.
 - Dissect a flower to look for its various reproductive organs. A store-bought lily is a good one to use for this.



Vocabulary

Fertilize (v): to make (a plant or flower) able to produce seeds.

Nectar (n): a sweet liquid produced by flowers and consumed by pollinators.

Pollen (n): the very fine, usually yellow, dust that is produced by a flower and that is carried to other flowers of the same kind, usually by wind or insects, so that the plants can produce seeds.

Pollinate (v): to give a plant pollen from another plant of the same kind so that seeds will be produced.

Pollinator (n): an animal that moves pollen from one plant to another of the same kind so that seeds will be produced.

Source: Merriam-Webster Learner's Dictionary

RESOURCES

Books

The Reason for a Flower**Ruth Heller**

Ages 4–9

The reason for a flower is to manufacture seeds, but Ruth Heller shares a lot more about parts of plants and their functions in this book.

Flowers**Gail Gibbons**

Ages 4–9

Covers flower anatomy and pollination as well as plant care with colorful illustrations and diagrams for young readers.

Flowers are Calling**Rita Gray**

Ages 4–8

In rhyming poetic form and with luminous artwork, this book shows us the marvel of natural cooperation between plants, animals, and insects as they each play their part in the forest's cycle of life.

The Clover & the Bee: A Book of Pollination**Anne Ophelia Dowden**

Ages 9+

Explains the process of pollination, describing the reproductive parts of a flower and the role that insects, birds, mammals, wind, and water play in the process.

Standards

1-LS1-2 Structure, Function, and Information Processing. Read texts and use media to determine patterns in the behavior of parents and offspring that help offspring survive.

2-LS2-2 Interdependent Relationships in Ecosystems. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.

4-LS1-1 Structure, Function, and

Information Processing. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Name: _____ Date: _____

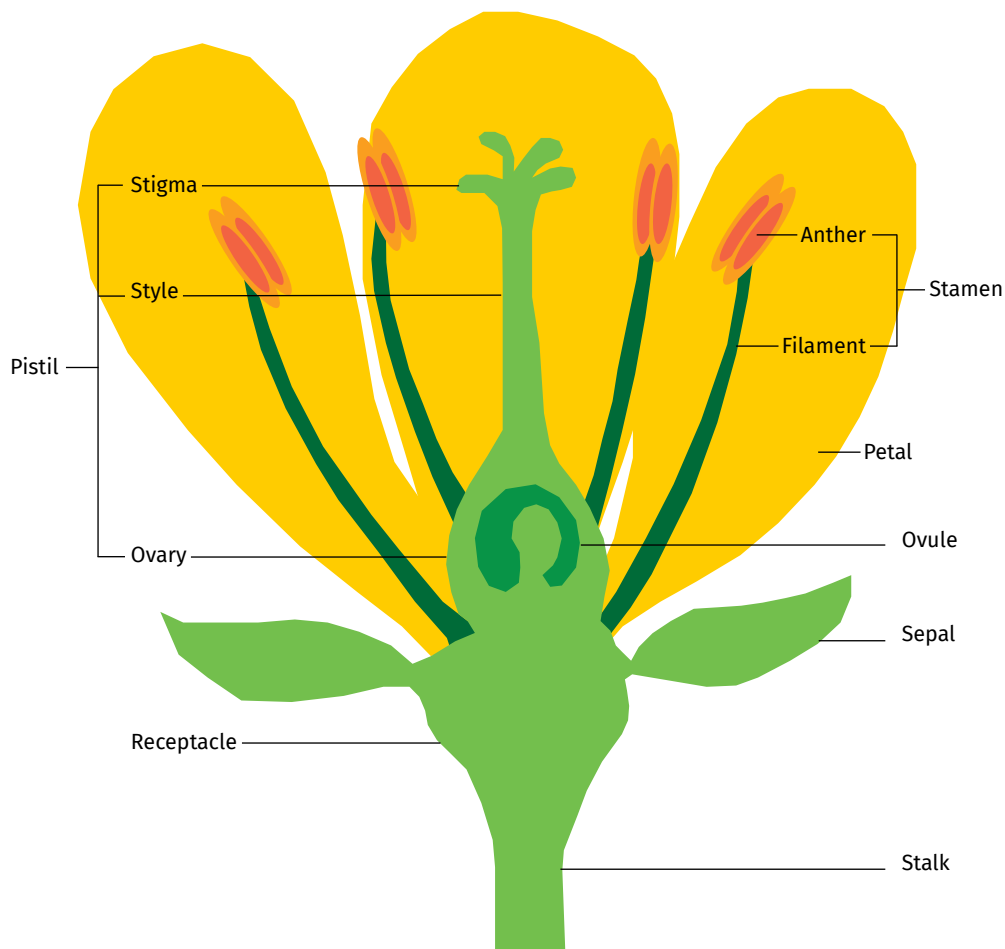


Review the parts of the flower with your group.

Parts of a flower

The male part of a flower is known as the **Stamen** and is made up of the anther and filament.

The female part of a flower is the **Pistil** and is made up of the stigma, style and ovule.



PARTS OF A FLOWER

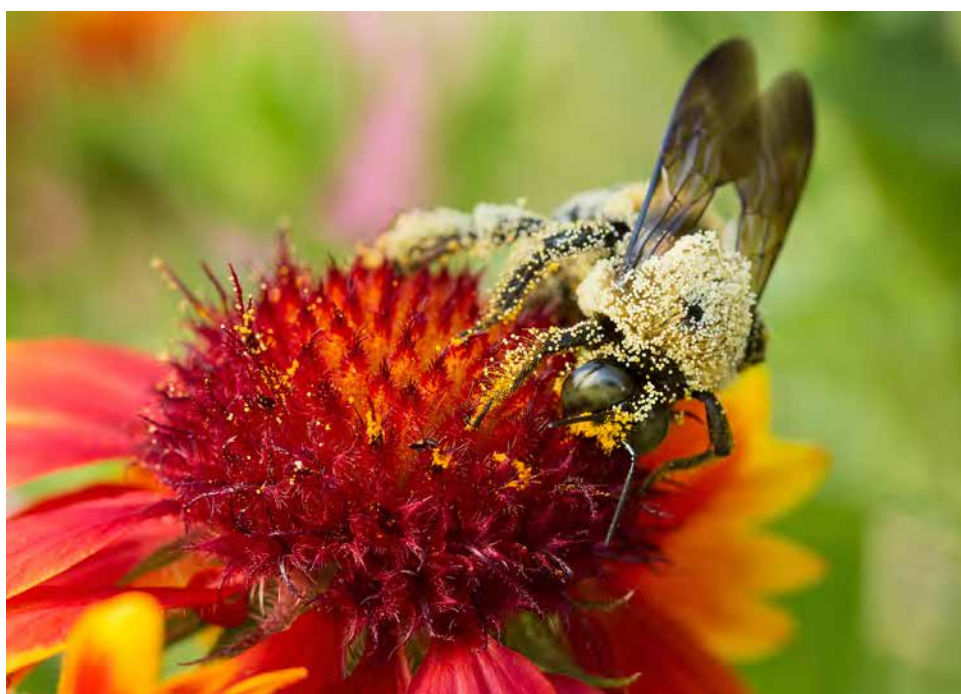
BEEES WITH POLLEN

Name: _____

Date: _____



Look closely at the images of bees, notice the tiny grains of pollen on the bees.



4 WHY POLLINATORS?

Why Pollinators?

Background

Pollinators play a critical role in our ecosystems and agriculture systems.

Over 85% of flowering plants depend on pollinators to reproduce.¹ Bees play an especially important role as they visit thousands of flowers each day, collecting nectar and pollen, loaded with proteins and vitamins, for their young. We often think of bees providing us with honey, but their real impact in agriculture lies in the fact that bees—including wild bees and pollinators in general—contribute to one in every three bites of food we eat; in other words, they pollinate about one third of our crops. Crop yields are enhanced by up to 75% through insect pollination. The estimated global economic value of insect pollination is \$217 billion.²

Melons, apples, and peaches are just a few of the crops that are produced thanks to bees (see 7.1 for more examples). Alfalfa and clover, important feed for livestock, require animal pollination as well as important fibers like cotton and flax. The unseen work of bees is so embedded in our food system that it is hard to imagine what would happen without them.

Farmers, aware of the value of bees to their crop yields, have adopted managed honey bees during the flowering season. The widespread use of honey bees, a species not native to North America, has led to a host of problems such as the introduction of pathogens and competition in addition to the problems already faced by native bee populations. Scientists have discovered that many native bee species are actually more efficient pollinators than the honey bee and farmers are beginning to find ways to support those native species.³

The dramatic decline in bee populations and pollinator species worldwide in recent decades is especially alarming given the crucial role they play in our ecosystem and economy.

¹ xerces.org/pollinator-conservation/

² pollinator.org/pollinators

³ entomology.cals.cornell.edu/extension/wild-pollinators/

ACTIVITY



Lesson 4

Summary

Students learn why bees are essential to agriculture and explore the connections between pollinators and the food we eat.

Materials

- **3.1 The Parts of a Flower**
- **3.2 Bees With Pollen**
- Art materials for activity outlined below

Preparation

Activity 1

- Print **4.1 Animal and Wind Pollinated Crops** (two per group of 4–6 students)

Activity 2

- Print **4.1 Animal and Wind Pollinated Crops** (two per group of 4–6 students)
- Print **4.2 Pollinators and Our Food Worksheet** (one per group of 4–6 students)

Objectives

Students will:

- understand the role of bees in agriculture and natural systems.
- learn which food crops depend on bees or wind for pollination.
- infer the consequences of declines in bee populations.

Introduction

Review previous lesson. Why do pollinators visit flowers; what do the flowers provide them? What does the pollinator do for the flower/plant? Ask class to stand up and imagine they were flowers in a field. Now ask $\frac{3}{4}$ of them to sit down (if they have been introduced to fractions, if not just tell them how many). Explain that if pollinators disappeared,

this is how many plants would also disappear. What happens once the flower is pollinated (it produces a fruit that contains seeds)? Can anyone think of an example of a fruit? Ask class to stand up again. Now ask $\frac{1}{3}$ of them to sit down. That is how many food crops would disappear if pollinators also disappeared.

ACTIVITY

Activity 1: The Empty Basket

1. Divide the class into groups of 4–6. Ask students to draw five fruits that they might find at the farmer’s market or supermarket. Remind them that fruit is the part of the plant that contains seeds, so a cucumber is a fruit. Ask them to cut out their fruit drawings and label the back with the fruit names.
2. Give each group one copy of [4.1 Animal and Wind Pollinated Crops](#). Together, with the others in their group, ask them to place any of their fruits that are on the list into the center of the table. Let them see what remains. Explain that this is what you would be able to find at the market if there were no pollinators.
3. How many did you start with as a group? How many fruits were left that did not require a pollinator? Can you work it out as a fraction?
4. If time allows, make a poster using their drawings of fruits, grouping or graphing those that are dependent on pollinators and those that are not. Display it publicly, possibly in the school cafeteria. How can they get the information across in a clear and interesting way?

Activity 2: Pass the Ketchup

1. Divide class into groups of 4–6 students. Give each group [4.2 Pollinators and Our Food](#).
2. Ask groups to review the food images and discuss the ingredients that make up each dish. Using the images and [4.1 Animal and Wind Pollinated Crops](#)



Did you know?

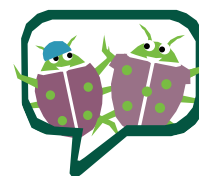
90% of apple crops, as well as many other orchard fruits, are dependent on bees for pollination. Almond trees are entirely dependent on bees.

as a reference, ask them to figure out which of the ingredients in each dish are pollinator-dependent and which are not.

3. Share back as a class. Without pollinators, what would each dish be reduced to? Would that make for a tasty dining experience?
4. If time allows, make this into a poster that can be displayed publicly, possibly in the school cafeteria. How can they get the information across in a clear and interesting way?

Extensions

1. Ask students to record all the food they eat in one day. Using 4.1 as reference, ask them to list all the foods that are dependent on pollinators and those that are not. How do the lists compare? Is one list longer than the other?
2. Research family recipes or the culinary traditions of the community. How many dishes feature ingredients pollinated by animals? Share the dishes as part of a community event.
3. Challenge: try to make a dish only with ingredients that are wind or self-pollinated.



Activity 2 Discussion

1. Review. Why are so many of our foods dependent on pollinators?
2. What did you learn? Did anything surprise you?
3. What would the world be like without pollinators? Aside from pollinating our crops, what other benefits do they think pollinators like bees and insects might provide?
4. Ask them if they changed their perspective of bees after this lesson.

RESOURCES

Books

What If There Were No Bees?**Suzanne Slade**

Ages 6–9

Grassland ecosystems can be found on nearly every continent. What difference could the loss of one animal species make? Follow the chain reaction, and discover the importance of honey bees.

Next Time You See a Bee**Emily Morgan**

Ages 10+

Visual reference book that reveals the big impact these little insects have on the world. It shows how the physical features of bees make them pros at collecting and spreading pollen.

You Wouldn't Want to Live Without Bees!**Alex Woolf**

Ages 8–12

Entertaining picture book that explains the importance of bees.

It's a Good Thing There Are Bees**Lisa M. Herrington**

Ages 6–8

A book for the beginning reader.

Harvesting Friends/Cosechando Amigos**Kathleen Contreras**

Ages 4–8

Neighbors come together to grow fruit and vegetables for salsa. This bilingual picture book includes easy-to-make recipes.

Standards

3-LS4-3 Interdependent Relationships in Ecosystems. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

3-LS4-4 Interdependent Relationships in Ecosystems. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

4-LS1-1 Structure, Function, and Information Processing. Construct an argument that plants and animals have internal and external structures that

function to support survival, growth, behavior, and reproduction.

5-ESS3-1 Earth's Systems. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Vocabulary

Crop (n): a plant or plant product that is grown by farmers.

Name: _____ Date: _____



The foods we eat are dependent on pollination. Review the lists of **Animal-Pollinated Crops** and **Wind-Pollinated Crops** and use them as a reference to complete the worksheet [Pollinators](#) and [Our Food](#).

Animal-Pollinated Crops

A

Agave: bats

Alfalfa: leafcutter bees, honey bees

Almond: honey bees

Anise: honey bees

Apple: honey bees, blue mason orchard bees

Apricot: bees

Avocado: bees, flies, bats

B

Banana: birds, fruit bats

Blackberry: honey bees, bumble bees, solitary bees, hover flies

Blueberry: over 115 kinds of bees, including honey bees, mason bees, mining bees, and leafcutter bees

Buckwheat: honey bees, solitary bees

C

Canola: honey bees, solitary bees

Cardamom: honey bees, solitary bees

Cashew: bees, moths, fruit bats

Cherry: honey bees, bumble bees, flies

Chocolate: midges (flies), stingless bees

Coconut: insects and fruit bats

Coffee: stingless bees, other bees, flies

Coriander: honey bees, solitary bees

Cranberry: over 40 native bees, including bumble bees

Cucumber: honey bees, squash bees, bumble bees, solitary bees

D

Dairy products: cows eat alfalfa which is pollinated by leafcutter and honey bees

F

Fennel: honey bees, solitary bees, flies

Fig: 800 kinds of fig wasps

G

Grape: bees

Grapefruit: bees

K

Kiwi: honey bees, bumble bees, solitary bees

M

Macadamia nut: bees, beetles, wasps

Mango: bees, flies, wasps

Melon: bees

N

Nutmeg: honey bees, birds

P

Papaya: moths, birds, bees

Passion fruit: solitary bees, bumble bees, hummingbirds

Peach: bees

Pear: honey bees, flies, mason bees

Peppermint: flies, bees

Plum: honey bees, bumble bees, solitary bees, flies

Pumpkin: squash bees, bumble bees

R

Raspberry: honey bees, bumble bees, solitary bees, hover flies

S

Sesame: bees, flies, wasps

Squash: honey bees, squash bees, bumble bees, solitary bees

Strawberry: bees

Sugarcane: bees, thrips

Sunflower: bumble bees, solitary bees, honey bees

T

Tea plants: flies, bees, other insects

Tomato: bumble bees

V

Vanilla: bees

Wind-Pollinated Crops

Barley

Corn

Maize

Millet

Rice

Rye

Wheat

ANIMAL & WIND POLLINATED CROPS

Source: Pollinator.org

POLLINATORS AND OUR FOOD

Name: _____ Date: _____



Review the images of food dishes with your group. Discuss the ingredients that make up each dish. Which dishes do you like to eat? Which ingredients come from plants that were pollinated by pollinators? Record your answers on the chart on the back.

	Ingredients produced with the help of pollinators	Ingredients that remain
Chips, Salsa & Guacamole 		
Pizza 		
Fruit Salad 		
Apple Pie 		
Ice Cream Sundae 		

5 BEE SURVEY

Bee Survey

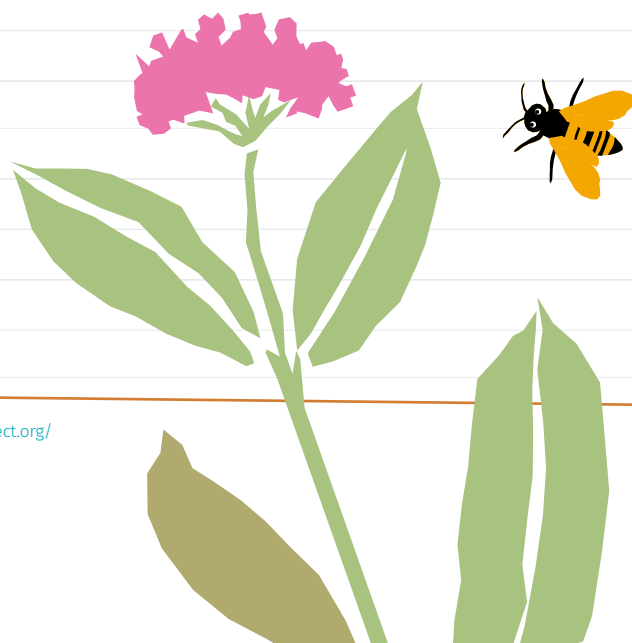
Background

New York City is home to over 230 species of bees.¹

Several common species are found in the [5.1 NYC Bee Guide](#) along with tips for identification. It can be difficult even for adults to identify bee species, so we have chosen only a few representative species that are common and easy to distinguish. If you prefer a more extensive list for your own reference, you might use a more comprehensive guide listed in the resource section of the lesson.

We have also included common **wasps** and **flies** that visit flowers and sometimes are mistaken for bees. Distinguishing between the three will develop the students' powers of observation and the guide will help sort them out.

It can take practice to develop an eye for the different types of bees; the introductory activity will help the class warm-up before going out for observations. Photography can also be a useful tool, as bees don't always stay still long enough to get a good ID. You can also upload your photos for identification using iNaturalist or some of the community science resources listed in the appendix. Once students become comfortable with identifying bees and are able to keep accurate records, you can create a class account and upload your data to these community science platforms. It's a great way for students to become motivated in keeping accurate records and to engage them in a purposeful scientific study.



¹ greatpollinatorproject.org/

ACTIVITY



Lesson 5

Summary

Students learn how to identify common bee species and conduct field observations.

Preparation

Activity 1

- Print color copies of **5.1 NYC Bee Guide** (one per group of 3–4 students)
- Print color copies of **5.2 Sorting Out the Bees Worksheet** (one per group of 3–4 students)

Activity 2

- Print **5.3 Bee Survey** (one per student)

Objectives

Students will:

- appreciate and develop an awareness of the diversity of different bee species in our city.
- become adept at identifying various bee species.
- develop their observation skills.
- analyze and interpret data.

Materials

- **5.1 NYC Bee Guide**
- **5.2 Sorting Out the Bees Worksheet**
- **5.3 Bee Survey**

Introduction

We learned that there are several kinds or species of bees besides the honey bee. Can anyone remember the name of one of them or a fact about them? Does anyone remember how many species of bees have been identified in NYC (230 different species)? Today we're going to take a look at some common bees and learn how to tell them apart.

Activity 1: Sorting Out the Bees

1. As a warm-up, divide students into groups of 3–4 and give each group **5.1 NYC Bee Guide** and **5.2 Sorting Out the Bees Worksheet**. Let each group try to identify the different bees on the worksheet using the NYC Bee Guide as a reference and record their answers on the worksheet.
2. When everyone is finished, give them the answers and let them give themselves a score. Note: answer key is on page 49.

ACTIVITY

Activity 2: Bee Survey (outdoors)

1. Bring the class outdoors, preferably to a sunny site with plants in bloom. Hand out [5.3 Bee Survey](#) to each student and ask them to observe one or more bees and record their observations.
2. Before going outside, remind students how to observe bees safely. Remind them that bees will not sting unless they feel threatened. They are most interested in feeding and collecting pollen and probably won't even notice that they are being observed. They are often confused with their more aggressive cousins, the wasps, who are less frequent flower visitors and prefer your sugary soda can. They can avoid disturbing the bees by not running, shouting or brushing against the plants.
3. Depending on the age of the students, you may approach the field observation differently. You may simply have the students walk around and record the bees that they observe, even if it means they may record the same bee more than once. The purpose here is simply for them to begin to observe and distinguish bees in the field. You may choose to have younger students only use the [5.1 NYC Bee Guide](#) as a reference and not record observations. If you want the older students to take more accurate records, have them station themselves at a certain plant in the garden for the duration of an observation period of about 5–10 minutes. Let them record all the bees they see on that plant during that period.



Did you know?

Bees have various ways to carry pollen. Some bees carry pollen in their **pollen sacs**. The bees comb the pollen to their backs legs where it sticks together in an orange ball. When the pollen sacs get full they bring it to their nest. Keep an eye out for the bumble bees carrying pollen in their sac.

Extensions

1. Compare your data with that of another NYC bee survey on iNaturalist. Which species are most commonly observed? Is that reflected in our data as well?
2. Compare bee observations in New York City with other New York counties using iNaturalist. How do the species compare? Why are some species less common in NYC than elsewhere?
3. Collect and upload data to a community science project using their protocols.
4. Can students find any bee look-alikes in the field observation? Use [5.1 NYC Bee Guide](#) or a field guide to check their work.



Activity 2 Discussion

1. What bees did we see today? Which one did you observe the most? The least?
2. Which flowers seemed to be the most popular?
3. Was it difficult to observe the bees? Do you feel you know some of the bees better now? Did the bees seem to mind you watching them?
4. How do you think the weather may have affected our observations?

RESOURCES

Books

The Bees in Your Backyard

Joseph Wilson and
Olivia Messinger Carril

Adult

A comprehensive and clear guide to the native bees of North America with many visuals.

Bees: An Identification and Native Plant Forage Guide

Heather Holm

Adult

Our Native Bees

Paige Embry

Adult

Explores the importance of native bees and focuses on why they play a key role in gardening and agriculture.

Bees & Other Pollinators: A Folding Pocket Guide to Familiar Species (Wildlife and Nature Identification)

James Kavanagh

The Life and Times of the Honeybee

Charles Micucci

Ages 4–8

Picture book that will satisfy curiosity about honey bees and beekeeping.

The Honey Makers

Gail Gibbons

Ages 4–8

Nonfiction picture book with detailed diagrams and illustrations.

The Bee Book

Charlotte Milner

Ages 4–8

Covers everything from bee anatomy to what we can do to help bees.

Mason Meets a Mason Bee: An Educational Encounter with a Pollinator

Dawn V. Pape and Heather Holm

Ages 6–12

A boy is afraid of bees but meets a native bee and finds a new appreciation.

Next Time You See a Bee

Emily Morgan

Ages 10+

Visual reference book full of information. It shows how the physical features of bees make them pros at collecting and spreading pollen.

Online Resources:

- northeastpollinatorpartnership.org/count-bees/
- greatsunflower.org/homepage
- xerces.org/citizen-science/
- bumblebeewatch.org/
- inaturalist.org/
- nyphenologyproject.org/
- usanpn.org/natures_notebook

RESOURCES

Standards

2-LS4-1 Interdependent Relationships in Ecosystems. Make observations of plants and animals to compare the diversity of life in different habitats.

3-LS3-1 Inheritance and Variation of Traits: Life Cycles and Traits. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.

3-LS4-3 Interdependent Relationships in Ecosystems. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

4-LS1-1 Structure, Function, and Information Processing. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

3-5-ETS1-3 Engineering Design. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

5.2 Sorting Out the Bees Answer Key

Bee No.	Bee Name
1	Common Eastern Bumble Bee
2	Wool Carder Bee
3	Fly
4	Eastern Carpenter Bee
5	Striped Sweat Bee
9	Long Horned Bee
6	Small Carpenter Bee
10	Pure Green Sweat Bee
7	Leaf Cutter Bee
11	Honey Bee
8	Wasp
12	Masked Bee



NYC BEE GUIDE

Name: _____ Date: _____

Large Bees

	Actual Size	Flight Period	Flight Range	Features
Eastern Carpenter Bee - <i>Xylocopa virginica</i>				
	23 mm	March–Nov.	> 1 mile	Shiny black abdomen. Spot on thorax.
Common Eastern Bumble Bee - <i>Bombus impatiens</i>				
	15–25 mm	March–Dec.	> 1 mile	Similar to the carpenter bee but with fuzzy abdomen with a yellow or brown belt. <i>Bombus impatiens</i> has yellow hairs on the first abdominal segment. <i>Bombus griseocollis</i> has yellow on the first segment and yellow or brown on the second segment.

Medium Bees

	Actual Size	Flight Period	Flight Range	Features
European Honey Bee - <i>Apis mellifera</i>				
	10–15mm	March–Dec.	> 1 mile	Striped honey-colored abdomen is common, but the abdomen can also be quite dark.
Leaf Cutter Bee - <i>Megachile</i> spp.				
	10–15mm	April–Nov.	< 500 yds.	Striped black abdomen. Scopa ¹ on underside of abdomen.
Wool Carder Bee - <i>Anthidium manicatum</i>				
	10–13mm	June–Oct.	< 500 yds.	Pronounced yellow stripes on abdomen which do not meet, like an open zipper.
Long-Horned Bee - <i>Melissodes</i>				
	10–15mm	June–Sept.	< 500 yds.	Females have very fuzzy hind legs. Males have especially long antennae.

¹ Scopa: pollen collecting hairs

Name: _____ Date: _____

NYC BEE GUIDE

Small Bees

	Actual Size	Flight Period	Flight Range	Features
Striped Sweat Bee - <i>Agapostemon</i> spp.				
	10–12mm	May–Oct.	< 500 yds.	Males have a yellow and black striped abdomen. Females have either a brown abdomen or a green abdomen.
Pure Green Sweat Bee - <i>Augochlora pura</i>				
	8mm	April–Oct.	< 500 yds.	Shiny green thorax and abdomen.
Small Carpenter Bee - <i>Ceratina calcarata</i>				
	< 8mm	March–Oct.	< 500 yds.	Slender bluish-black shiny body.
Masked Bee - <i>Hylaeus</i> spp.				
	< 8mm	May–Sept.	< 500 yds.	Similar to small carpenter bee but with yellow markings on head and thorax. Males have a large yellow mask. They carry pollen and nectar internally so have no scopa.

Bee Look Alikes

Wasps				
	25–25 mm	May–Oct.	>1000 yds.	Wasps don't have scopa to collect pollen and have spindly legs and narrower waists. They usually don't spend as much time on flowers as bees.
Flies				
	varies across species	April–Oct.	varies across species	Flies don't have scopa to collect pollen and have two wings instead four like bees. They have short antennae and large eyes that are close together.

Name: _____ Date: _____

SORTING OUT THE BEES



Review the bee images with your partner or group.

Using your previous knowledge and the [NYC Bee Guide](#), try to identify each species and write the answer under the bee photo.

NYC Bee Images













Name: _____ Date: _____



Review the bee images with your partner or group.

Using your previous knowledge and the [NYC Bee Guide](#), try to identify each species and write the answer under the bee photo.

NYC Bee Images













SORTING OUT THE BEES

BEE SURVEY

Name: _____ Date: _____



Find a sunny spot near a flower to observe bees. Record your observations below.

School	Class
Time	Location
Temp.	Weather
Duration of data collection period: _____ minutes.	

Bee Species	Tally	Total	What flower?
Total Bees:			

The Monarch Life Cycle

Background

Butterflies and moths belong to the insect order Lepidoptera.

With about 180,000 different species, this insect order is second only to beetles (Coleoptera). Butterflies and moths are less efficient than bees at transferring pollen between plants; they lack the specialized structures to do so and have long thin legs that keep them perched above the flower. But they are a marvel to children and adults alike and, because of their reputation, are more approachable than bees. However, many species are under serious threat due to habitat degradation. These wondrous creatures are worthy of our protection.

Some insects such as grasshoppers and dragonflies have a simple **metamorphosis** involving only three life cycle stages: egg, nymph, and adult. The nymphs generally resemble the adult and will gradually **molt** in order to become an adult. It is different for Lepidoptera; they belong to a classification of insects that undergo **complete metamorphosis**. Instead of three stages, there are four stages in the butterfly and moth life cycle: egg, larva, pupa, and adult. The adult is completely different in appearance and requires different food than in its

earlier stages. Lucky are those who witness the beautiful and dramatic metamorphosis from caterpillar (larva) to butterfly (adult). Even entomologists still do not fully understand the process in which the larval cells are reshuffled into adult organs. Here is a brief and general overview of the butterfly's life cycle:

Egg (3–5 Days)

Females lay eggs directly on the host plant for the caterpillar, usually on the underside of leaves, ensuring that the caterpillar gets off to the right start. She detects the host plant through sensory cells on her prolegs and antenna. The monarch butterfly will lay her eggs on the leaves of milkweed plants, the only plant that the monarch caterpillar will eat.

Larva (11–18 Days)

Once the caterpillar emerges from the egg, its primary goal is to eat as much as it can to reach the next stage of development. The first thing it eats is its own egg shell, followed by the tender young leaves of its host plant. Caterpillars grow rapidly, and will molt several times to accommodate this growth. The caterpillars usually pass through

6 THE MONARCH LIFE CYCLE

BACKGROUND

The Monarch Life Cycle (Continued)

four or five instars (**molts**) and the color patterns of the caterpillar may change slightly with each instar.

Pupa (8–14 Days)

Once the caterpillar has completed its feeding, it crawls around to find a sheltered spot, where it hangs from a silk thread. When you see it hanging upside down, curling its head upward to form the shape of a “J”, it will pupate soon. In this shape the caterpillar sheds its skin one final time to become a pupa. The butterfly pupa is called a **chrysalis** and the moth encloses its pupa in a silk covering called a **cocoon**. Although it may appear as a dormant stage during its time as a pupa, the caterpillar undergoes a complete restructuring of body tissue and metamorphoses into a butterfly. By the end of this phase, you can sometimes begin to see the wings of a butterfly curled up inside the pupa.

Adult (2–6 weeks)

After the butterfly emerges from its pupal stage with crumpled wings, it pumps fluid from its swollen abdomen into its wings to dry and expand them. It will be ready to take its first flight after its wings have dried out for several hours. No longer interested in eating leaves as it was as a larva, the adult butterfly and moth now seek nectar from flowers. Whereas the primary purpose of the caterpillar is to eat and grow, the purpose of

the butterfly is to reproduce. In order to see butterflies in all life stages, it's important to have both host plants for caterpillars and nectar plants for butterflies; not all plants can serve both purposes.

The average life-span of a butterfly or moth is about one month if there is no resting stage. It's important to note that some species may enter hibernation or **diapause** at any one of these stages because conditions are not favorable or they must overwinter in cold climates. For example, the viceroy butterfly spends its winter as a larva, the swallowtail butterflies spend the winter as pupa (chrysalides), and monarch butterflies that migrate in the fall spend their winter as adults before heading back north in the spring.

Why do animals such as butterflies and moths undergo complete metamorphosis? What is the advantage in terms of survival and evolution? There are several explanations. First, there is less competition between the species for resources, since the larva and adult occupy very different ecological niches. Second, the pupa may be better able to withstand environmental challenges such as predators and seasonal changes than the adult. Finally, if each life cycle phase faces its own disease, predator, or parasite, there is less chance for the population to be affected by these impacts.

ACTIVITY



Lesson 6

Summary

Students illustrate the life cycle of the monarch butterfly and play a matching game that helps them identify common species of butterflies and moths, as well as their host plants.

Materials

- **6.1 Monarch Life Cycle**
- **6.2 NYC Butterfly Field Guide**
- **6.3 Butterfly Observation Worksheet**, pencils, clipboards, scissors, drawing tools, tape, paper plates.

Preparation

Introduction/Activity 1

- Print **6.1 Monarch Life Cycle** (one teacher copy, or use digital image, and two per table)

Activity 2

- Print **6.2 NYC Butterfly Field Guide** (two per group of 4 students. Cut out images from one)

Extensions

- Print **6.3 Butterfly Observation Worksheet** (one per student)

Objectives

Students will:

- learn the concepts of life cycle and metamorphosis using the monarch butterfly as an example.
- understand the unique habitat needs of the butterfly.
- learn how to identify common butterfly and moth species and use a field guide for reference.

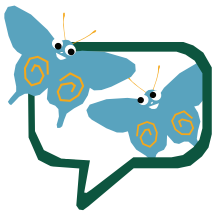
Introduction

Review the definition of a habitat and ask students what they were able to conclude about the neighborhood's habitat and biodiversity during their habitat walk. What happens when we replace natural areas with our cities? Is there a way that we can promote more biodiversity in our neighborhoods?

Many animals are **endangered** because

of habitat loss. One pollinator that has suffered because of habitat loss is the monarch butterfly. Show the [6.1 Monarch Life Cycle Diagram](#) and describe it; you can also read a story about the monarch butterfly or play one of the videos that show metamorphosis. Why do we call it a **life cycle** anyway? Explain that many insects undergo **metamorphosis**, which makes it difficult to see the resemblance between the baby and the adult. At what

ACTIVITY

Activity 2
Discussion

1. How do the colors of the caterpillars (larve) compare to butterflies (adults)? Do you notice any patterns?
2. What is a host plant? Which caterpillars have only one host plant (they are known as **specialists**)? Which caterpillars have more than one host plant?
3. What happens if the host plants disappear? Which butterflies are most vulnerable (would suffer the most if their host plant disappeared)?
4. Which of these caterpillars and butterflies have you seen before? Which one do you hope to see? Where would be a good place to look for them?

stage in the monarch's life cycle does it undergo metamorphosis? Did you know that all caterpillars become butterflies or moths? Can they think of other animals that undergo metamorphosis and look completely different from **larva** to adult? Frog, bee, beetle, grasshopper, dragonfly are a few examples.

Activity 1:
Make a Monarch Wheel

1. Give each student two paper plates. Ask them to divide the plates into 4 quadrants with a pencil (younger students may need help).
2. Cut out one quadrant of one of the plates.
3. Older students can make a window for the cut paper plate by gluing or taping the cut outer edge back to make a window. Younger students can just leave the quadrant cut out. This will become the top plate. Put it aside.
4. On the bottom plate, students should label each quadrant: egg, larva, pupa, adult in clockwise order.
5. Students can illustrate each quadrant using [6.1 Monarch Life Cycle](#) for reference.
6. When both wheels are finished they can attach the top plate to the bottom plate with a paper fastener and rotate the bottom plate clockwise to see the life cycle progress.

Activity 2:
Butterfly Matching Game

1. Divide class into groups of 3-4. Cut out images from [6.2 NYC Butterfly Field Guide](#).

2. Let students sort the images into four piles: host plant, larva, pupa, and adult.
3. For the first round, place the host plant and pupa cards to one side.
4. Spread out the larva and adult cards and ask students to try to match the larva (caterpillar) with the adult (butterflies).
5. Use the [6.2 NYC Butterfly Field Guide](#) to see if they were right. How many caterpillars and butterflies did they correctly match? What surprised them? Do the caterpillars resemble the butterfly in any way?
6. For the second round, add the pupa cards and see if students can find the larva, pupa, and adult cards of each species. If there is enough time, add the host plant cards during an additional round.
7. The students can also play a memory game in which all of the caterpillars are placed face down. Let each student pick a butterfly card and take turns to try to match the caterpillar with their butterfly. Once they find a match, let them choose another butterfly until they are all matched.

Extensions

1. Use [6.3 Butterfly Observation Worksheet](#) and the field guide as a reference to see if they can find butterflies and moths at various life stages in a local park or garden. Before going out, review where we might find the caterpillars and where we might find the butterflies. Take [6.2 NYC Butterfly Field Guide](#) or another field guide mentioned in the appendix to try to identify the species; or take photos and upload them to the online field guides listed in the appendix. If you are near a host plant you can check it for caterpillars or even eggs, usually

tiny white specks hanging from the underside of leaves.

2. Research what other animals undergo metamorphosis. There are many examples in the insect world. Another astonishing metamorphosis is found in the ladybug life cycle. Let students choose an animal and research its life cycle. Older students can make the distinction between simple and complex life cycles.
3. Have students save their data from the Field Observation and complete another observation in different seasons



Did you know?

Monarchs born in the spring and summer live 2–5 weeks, but those that are born in August migrate to Mexico and can live 8 months!

and compare results. Graph results.

4. Let students research more about milkweed. What makes it unique? Why might it be disappearing?

Books

Magnificent Moths

Martha Rustard

Ages 6–12

Profiles of moths from around the world.

Magnificent Monarchs

Linda Glaser

Ages 4–8

Nicely illustrated intro to the monarch life cycle.

A Butterfly is Patient

Dianna Hutts Aston

Ages 3–5

A beautifully illustrated and informative introduction to the world of butterflies.

Caterpillar Caterpillar:

Read & Wonder

Vivan French

Ages 4–8

A girl helps her grandfather in the garden and learns about the metamorphosis of the swallowtail butterfly.

Are You a Butterfly?

Judy Allen

Ages 4–8

Follows the metamorphosis of the butterfly. Look for other titles by the same author.

Take a Walk With Butterflies and Dragonflies

Judith Kirkland

Ages 8–13

Ideas for activities for children in their own backyards and schoolyards, as well as ideas for further study.

Peterson's Field Guides

Ages 6+

Editions for children include the "First Guide" series and also the "Young Naturalist" series.

Butterfly Gardens: Luring Nature's Loveliest Pollinators To Your Yard

Adult

Alcinda Lewis, editor Brooklyn Botanic Garden publication.

RESOURCES

Resources

Videos

- Watch a Monarch Caterpillar Become a Chrysalis: bit.ly/MonarchChrysalis
- Geo Kids: Tadpoles, Dragonflies, and the Caterpillar's Big Change (National Geographic Society).

Websites

- Butterflies and Moths of N. America butterfliesandmoths.org
- American Museum of Natural History bit.ly/AMNHConservatory
- A Visual Journey Through the Monarch Life Cycle bit.ly/MonarchJourney

Standards

K-LS1-1 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Use observations to describe patterns of what plants and animals (including humans) need to survive.

K-ESS3-1 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.

1-LS1-2 Structure, Function, and Information Processing Read texts and use media to determine patterns in the behavior of parents and offspring that help offspring survive.

1-LS3-1 Structure, Function, and Information Processing Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

3-LS1-1 Inheritance and Variation of Traits: Life Cycles and Traits Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

4-LS1-1 Structure, Function, and Information Processing Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Vocabulary

Endangered (adj) used to describe a type of animal or plant that has become very rare and that could die out completely.

Life Cycle (n) The series of stages through which a living thing passes

from the beginning of its life until its death.

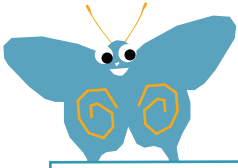
Metamorphosis (n): a major change in the form or structure of some animals or insects that happens as the animal or insect becomes an adult.



Source: Merriam-Webster Learner's Dictionary

Name: _____

Date: _____



Review the life cycle of the monarch butterfly. Use this diagram to help you illustrate your Monarch Wheel.

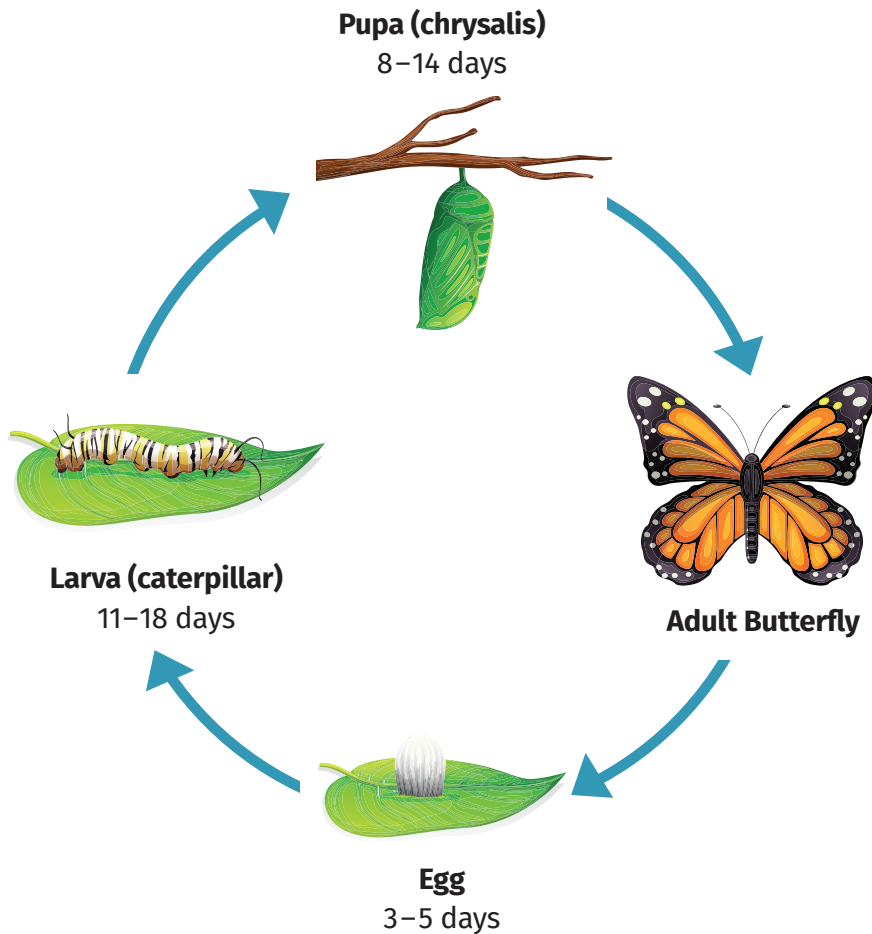
Monarch Butterfly Life Cycle

Egg to Adult

22–37 days

if temperatures are 72–82 degrees Fahrenheit.

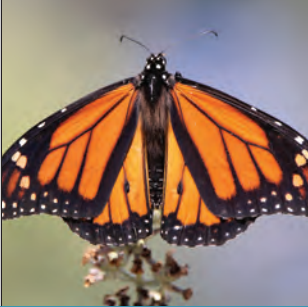
Monarchs develop more quickly in warm temperatures
and more slowly in cool temperatures.



MONARCH LIFE CYCLE

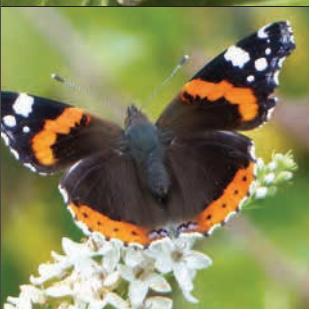
Name: _____ Date: _____

NYC BUTTERFLY FIELD GUIDE

		Monarch <i>Danaus plexippus</i>	Eastern Black Swallowtail <i>Papilio polyxenes</i>	Eastern Tiger Swallowtail¹ <i>Papilio glaucus</i>
	HOST PLANT	Milkweed plants 	Plants in the parsley family 	Wild cherry, linden, birch, ash, and willow trees, among others 
LIFE CYCLE PHASES	LARVA			
	PUPA			
	ADULT			

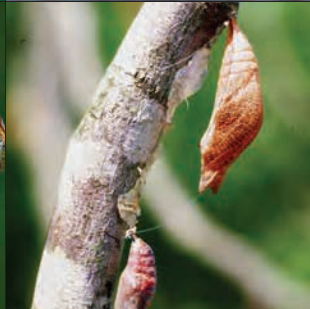
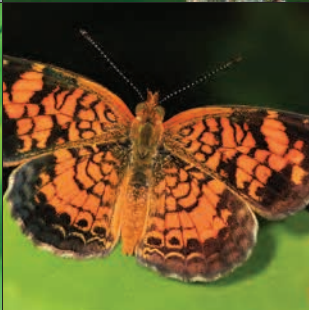
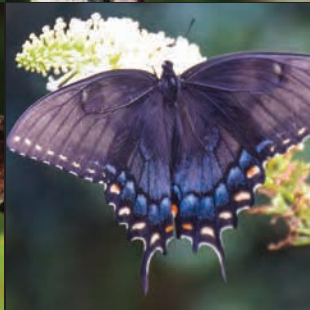
¹ Eastern Tiger Swallowtail: Female has blue on hindwing which is absent in male.

NYC BUTTERFLY FIELD GUIDE

		Red Admiral <i>Vanessa atalanta</i>	Cabbage White <i>Pieris rapae</i>	Painted Lady <i>Vanessa cardui</i>
LIFE CYCLE PHASES	HOST PLANT	Plants in the nettle family	Plants in the mustard family	Asters, sunflowers, hollyhock, and legumes, among others
				
	LARVA			
	PUPA			
	ADULT			

Name: _____ Date: _____

NYC BUTTERFLY FIELD GUIDE

		Common Buckeye <i>Junonia coenia</i>	Pearl Crescent <i>Phyciodes tharos</i>	Spicebush Swallowtail <i>Papilio troilus</i>
	HOST PLANT	Plants in the plantain family 	Plants in the daisy family 	Spicebush, sassafras, magnolia, and tulip trees 
LIFE CYCLE PHASES	LARVA			
	PUPA			
	ADULT			

Name: _____ Date: _____

NYC BUTTERFLY FIELD GUIDE

	HOST PLANT	Isabella Tiger Moth <i>Pyrrharctia isabella</i>	Orange Sulphur <i>Colias eurytheme</i>	Hummingbird Clearwing Moth <i>Hemaris thysbe</i>
		Asters, birches, clover, corn, elms, maples, cherry, and sunflowers, among other	Plants in the pea family	Cherry, Hawthorn, viburnum, and honeysuckle
LIFE CYCLE PHASES	LARVA			
	PUPA			
	ADULT			

BUTTERFLY OBSERVATION

Name: _____ Date: _____

Location: _____ Time: _____ Temperature: _____ Weather: _____



Look for butterflies and moths in a garden. Closely inspect plants and leaves for signs of each stage of their life cycle. Check off the stages of the butterfly or moth life cycle that you observed. Can you identify the species of butterfly or moth using a field guide?

Egg	Larva (Caterpillar)	Pupa	Adult (Butterfly)	Tally	Total	Species
						Example: Monarch butterfly

Plants for Pollinators

7 PLANTS FOR POLLINATORS

Background

Plants and pollinators co-evolved over millions of years and formed a number of mutual adaptations.

The flower itself is an adaptation that developed as a means to lure insects, birds, and bats to its nectar and aid in its reproduction. Flowers developed color, fragrance, and other physical traits to increase their dependency on specific pollinators. Likewise, animal pollinators have developed physical structures or characteristics to assist in plant pollination. Conversely, plants that are wind-pollinated have inconspicuous flowers that do not rely on pollinators. For example, compare the flowers of the elm tree to the flowers of the cherry tree. The flowers of the elm tree don't easily come to mind, but they bloom around the same time as the cherry's magnificent blossoms. The reason you don't notice the elm flowers is because they are wind-pollinated and thus have no need to attract the attention of pollinators. Other common native tree species that rely on insect pollination are black locust, horse chestnut, and tulip trees. Keep a look out for their blossoms in spring.

Floral Attractants

While each pollinator has unique floral preferences and needs,

flowers have some general adaptations designed to attract a range of pollinators. Contrasting colors on different parts of their flowers serve as a visual attractant. Spots and stripes serve as nectar guides, pointing the way to the nectar. Some flowers even change color to signal when they are ripe to accept visitors, or once their resources have expired or are depleted. The fragrance of the flower is another lure; insects detect odors with both their antennae and mouth-parts. Bees, butterflies and moths prefer sweet, fruity smelling flowers whereas flies prefer foul-smelling flowers (think of all those flies attracted to rotting fruit). Some flowers even emit a pheromone that mimics a female bee in order to attract the males.

Why Are Bees the Best Pollinators?

Bees have the reputation as the most efficient pollinator for several reasons.

- Because they collect pollen to make honey balls for their young, they are covered in hairs that carry an electrical charge designed to pick up pollen. Some bees like bumble bees even have a special concave structure on

BACKGROUND

Plants for Pollinators (Continued)

the female's hind legs that allow her to carry extra pollen in her "pollen sac" or pollen basket.

- Bees can also visit more flowers per day, sometimes numbering in the thousands, compared to other pollinators.
- In contrast to the butterfly's proboscis, a bee's tongue is relatively short in proportion to its body, which means that they must dive into the flower to reach the nectar, brushing against pollen on the way.
- While most bees are **generalists** (they forage on a variety of flowers), some are **specialists**, meaning they are attracted to flowers of one plant family due to their anatomy. For example, Leafcutter bees, with their short tongues and large bodies, cannot access long tubular flowers and will stick to visiting upright flowers with short clustered florets, like native sunflowers. Smaller bees can land on the bottom petals of deep-welled flowers and crawl deep inside for their nectar drink. (See Extensions for a full list of specialist bees). But even generalist bee species may choose to forage on one plant type for a given period ensuring that each flower receives the right pollen so that fertilization can occur.
- Some species like bumble bees, mining bees, and carpenter bees have a special trick to release pollen called "buzz pollination" that

works especially well for certain bell-shaped flowers and even tomato plants. The bee takes hold of the anthers with its forelegs and mouthparts and vibrates its flight muscles at a high frequency, releasing the pollen.

Other adaptations that have aided bees in their ability to detect and extract pollen and nectar include their ability to see the ultraviolet spectrum, beyond the range of human sight. This allows them to see nectar guides that are visible only to them. Bees also cannot see red, so their flower preferences are pink, purple, or blue, followed by white or yellow.

Other Pollinator and Flower Relationships

Butterflies and moths need a large landing platform and prefer flowers that are flat or globus. The exception is the hummingbird moth which has the ability to hover while drinking nectar. Butterflies are especially attracted to red, yellow, orange, pink, or purple blossoms. Moths are active at night and thus tend to be attracted to white flowers that have a strong fragrance, flower adaptations that help to attract them in low light conditions.

Hummingbirds feed on nectar rich flowers and almost anything red and tubular is a favorite; pink and orange are also desirable, followed in descending order of preference by purple, blue and yellow blossoms.

BACKGROUND

Plants for Pollinators (Continued)

They hover above the flower and use their long beak and brush-like tongue to reach nectar. As they do so, they may brush against the pollen with the top of their head.

Beetles cannot smell or see colors well so the flowers they prefer are usually white or green and may have no odor at all. Pollen is part of their diet, so the flowers they visit must supply enough pollen for them to eat. They don't need to visit many flowers like bees, so they are not considered effective pollinators.

Flies occasionally eat pollen and are also considered pollinators. They are typically attracted to dark purple or brown flowers with a putrid smell.

Native Plants and Pollinators

Recent research has demonstrated that native flowering plants are four times as likely to attract pollinators than exotic plants. Additionally, the presence of eight or more species of native plants in a landscape increases both the abundance and diversity of bees. Native plants support native animals because they co-evolved together. This is especially true of butterflies and specialist bees that depend on certain host plants or nectar plants. For example, milkweed—a native wildflower—is the only plant that can support the endangered monarch butterfly caterpillar. Members

of the aster family—another native wildflower—are host to 28 bee species that depend upon it exclusively for nectar and pollen.

Native plants also produce a reliable source of nectar and pollen throughout the year, upon which our native pollinators depend. For example, early spring is not an easy time for bees to find nectar sources. Many gardeners choose daffodils and exotic ornamentals, which are self-pollinating and thus don't support our pollinators. A better choice would be to plant native spring ephemerals, flowers that surface in early spring and provide nectar to bees as they emerge from their winter nests. Planting native species will also restore crucial habitat for other native wildlife species and thus promotes overall biodiversity.

We are learning that native bees themselves might be threatened by the European honey bee, a non-native species that has proliferated since European settlers introduced it for the cultivation of honey.

Honey bees can introduce diseases to wild bees and create competition for floral resources, especially where plant diversity or abundance is low. Farmers are also beginning to appreciate native bees for their role in agriculture. For example, the large mining bee, a native bee common in orchards can deposit two to three times more pollen than honey bees per visit.¹

¹ northeastipm.org/neipm/assets/File/Center-Funded-Publications/Wild-Pollinators-of-Eastern-Apple-Orchards.pdf

ACTIVITY



Lesson 7

Summary

Students examine the relationships between flowers and pollinators. They learn about the physical adaptations of pollinators and their flower preferences. Using tissue paper, they design and create a flower that will attract a specific pollinator.

Materials

- **7.1 Flowers Built for Pollinators Worksheet**, pencils, scissors, tissue paper, pipe cleaners, glue, tape, index cards, colored pencils, sketch pad

Objectives

Students will:

- investigate the interactions between flowers and pollinators.
- examine the flower preferences of pollinators.
- understand how some pollinators are better adapted for flower pollination.

Preparation

Activity 1

- Print Worksheet **7.1 Flowers Built For Pollinators** (one per group of 2–3 students)

Introduction

Why are flowers colorful and fragrant? How is the flower different than the leaf of a plant? What is its function? The flower is an adaptation of the plant that developed to attract pollinators. Why

does a plant want to attract pollinators? How does the flower make the plant better adapted to survive? Some flowers are adapted to attract specific pollinators; pollinators also have adaptations that enable them to collect pollen and nectar.

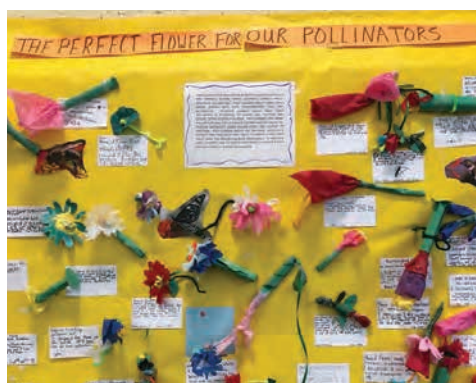
ACTIVITY

Activity 1: Flowers Built for Pollinators**Part 1**

1. Divide class into groups of 2-3 and distribute Worksheet [7.1 Flowers Built For Pollinators](#) to each group. Discuss the chart on the first page (Flower Preferences of Pollinators). Ask students to complete the table, predicting the pollinators that are attracted to each flower. For grades K-2, the table can be completed together as a class.

Part 2

1. Ask students to choose one of the pollinators and design a tissue paper flower for it. See the P.S. 29 Flower Designs below for inspiration. They can copy a real flower or invent a flower based on the pollinator's flower preferences.
2. On an index card, ask them to write the name of the real or invented flower, the pollinators it attracts, and why it attracts those pollinators in particular.



P.S. 29 Flower Designs

Discussion

1. Which flowers attracted the greatest variety of pollinators? Which flowers attracted the least variety?

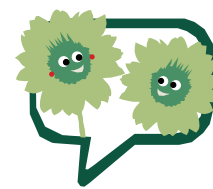
2. Why are some pollinators better adapted to pollinating certain flowers?
3. Why is it important to have a variety of flowers in a garden? Why is it important to support a variety of pollinators in an area?

Activity 2: Flower Scavenger Hunt (outdoors)

1. Take the class outdoors to a spot with plants in bloom.
2. Each student can choose one pollinator. Ask them to try to find at least three different flowers in the garden that their pollinator would visit. Students can use [7.1 Flowers Built For Pollinators](#) as a reference. If there is enough time, they can sketch the flowers and try to identify their names.

Extensions

1. Visit the garden regularly and keep a record of the flowers and the pollinators that visit them during each visit.
2. Track a particular plant or animal in the garden using the citizen science platforms in the **Resource** section. When was the flower in bloom? How many pollinators visited it during your visits? How does climate change impact phenology (life cycle events)?
3. Look at a list of local specialist bee species here: greatpollinatorproject.org/pollinators/bees/specialist-bee-plants. How can we best support them?
4. If you were to plan a pollinator habitat, what would be your top considerations in selecting plants? Ask students to sketch their vision for a pollinator garden.

**Activity 2 Discussion**

1. Why did you choose these three flowers for your pollinator?
2. Did you see any pollinators on the flowers?

RESOURCES

Community Science

Bumble Bee Watch
bumblebeewatch.org/

The New York Phenology Project
nyphenologyproject.org/

Nature's Notebook
usanpn.org/natures_notebook

5. One special adaptation of bees is their hair's electromagnetic charge, which allows them to pick up pollen. Can you test it out? Empty the paper dots from a hole puncher or scatter confetti on a desk. Rub a balloon on your head and then hover the balloon over the confetti.

Standards

2-LS4-1 Interdependent Relationships in Ecosystems Make observations of plants and animals to compare the diversity of life in different habitats.

3-LS4-2 Inheritance and Variation of Traits: Life Cycles and Traits Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

4-LS1-1 Structure, Function, and Information Processing Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

4-LS1-2 Structure, Function, and Information Processing Use a model to describe that animals receive different types of information through their



Did you know?

Just as butterflies lay their eggs on specific host plants, some bees—described as specialists—also forage for nectar on specific flowers. In the eastern United States, about 25% of the native bee species are specialists.¹ For example, the squash bee (*Peponapis pruinosa*), will only visit blossoms of squash plants. Males can often be found sleeping inside squash blossoms, waiting for the females to visit.

senses, process the information in their brain, and respond to the information in different ways.

Vocabulary

Adaptation (n): a change in a plant or animal that makes it better able to live in a particular place or situation.

Source: Merriam-Webster Learner's Dictionary

Books

Bees: An Identification and Native Plant Forage Guide

Heather Holm

Adult

A comprehensive guide illustrating the bees that occur in north-central and eastern United States and southern Canada.

Next Time You See a Bee

Emily Morgan

Ages 10+

Visual reference book full of information that shows how the physical features of bees make them pros at collecting and spreading pollen.

¹ jarrodflower.com/specialist_bees.html

Name: _____ Date: _____



Which flowers do pollinators prefer? Review the table below to find out the types of flowers that each pollinator visits.

Flower Preferences of Pollinators*

Flower Traits	Flower Shape	Flower Color	Flower Scent
Bees			
	Shallow; with a landing platform	Bright white, yellow, pink, purple, blue	Mild, pleasant
Butterflies			
	Narrow tube with spur; wide landing pad	Bright colors, including red and purple	Faint but fresh
Moths			
	Tube-shaped without a lip	Pale red, purple, pink, and white	Strong, sweet; emitted at night
Hummingbirds			
	Shaped like a funnel or tube; often with a spot to perch or land	Red, orange	None
Flies			
	Shallow; complex or funnel like	Pale and dull red to dark brown or purple	Rotten or foul-smelling (stinky!)
Beetles			
	Large; often shaped like a bowl	Dull white or green	None to strongly fruity or foul-smelling

FLOWERS BUILT FOR POLLINATORS

*adapted from Selecting Plants for Pollinators: pollinator.org/PDFs/Guides/EasternBroadleafOceanicrx20FINAL.pdf

FLOWERS BUILT FOR POLLINATORS

Name: _____ Date: _____



Which pollinators are attracted to each flower? Use the table to help you make predictions. Write a check mark in the pollinator column if you think it will visit the flower. Hint: many flowers are visited by more than one pollinator!

Flower	Bees	Butterflies	Moths	Beetles	Flies	Humming-birds
Wild Rose						
						
Raspberry						
						
Butterfly Weed						
						
Elderberry						
						
Wild Columbine						
						
Wild Geranium						
						

Name: _____ Date: _____



Which pollinators are attracted to each flower? Use the table to help you make predictions. Write a check mark in the pollinator column if you think it will visit the flower. *Hint: many flowers are visited by more than one pollinator!*

Flower	Bees	Butterflies	Moths	Beetles	Flies	Humming-birds
Cardinal flower						
						
Coneflower						
						
Sunflower						
						
Wild Bergamot						
						
Goldenrod						
						
Magnolia						
						

FLOWERS BUILT FOR POLLINATORS

8 FLOWER TO SEED

Flower to Seed

Background

This lesson brings us back to pollinators and their vital role in plant reproduction.

All summer long those pollinators have been busy at work on the flowers, collecting pollen and nectar, all the while doing a favor for those flowers by transferring pollen from one to the other. In late summer through fall, we literally see the fruits of their labor when flowering plants—which have been fertilized through the assistance of the pollinators—produce **fruits** which contain **seeds**.

Late summer through fall is an excellent time to make observations and learn about the life cycle of plants in the garden. The flowers, which have served their purpose in attracting the insects that help with pollination, are now expiring. As the flower petals fade, turn brown, and fall, the ovary of the flower, which contains the maturing seeds, swells into a fruit. This fruit may be the fleshy kind we normally think of, but can also be dry, like a nut, pod, capsule, or follicle. Even the dandelion seed puff

that forms after the flower fades is composed of many tiny seeds which, botanically speaking, are each tiny dried fruits called achenes.

When taking students to explore seeds in the garden, pay attention to the diversity of the fruits in which they are found. In some cases the seed capsule may need to be removed from the plant and brought indoors for further exploration. This will not harm the plant, just as removing an apple will not harm the apple tree. Besides, this is an excellent opportunity to save seeds for planting next year or giving as gifts to the community.

Lesson 8

Summary

Students learn about the role of seeds in the life cycle of the plant and make connections to plant pollination. They go on a seed hunt to look for seeds on plants and may collect seeds for saving.

Objectives

Students will:

- understand the purpose of seeds and their place in the life cycle of a plant.
- understand the relationship between flower, fruit, and seed.
- understand the diversity of seeds.

Preparation

Introduction

- Print **8.1 Flower to Fruit** (one copy for class, cut out images)
- Examples of various seeds and fruits such as an acorn, apple, beans, flower seed pods, etc.

Activity 1

- **8.2 Seed Hunt Worksheet** (one per student)

Materials

- **8.1 Flowers to Fruit**
- **8.2 Seed Hunt Worksheet**, pencils, clipboard, envelopes, collection of seeds or fruits

ACTIVITY



Introduction

If this lesson is taking place in autumn, use a seasonal fruit, like a pumpkin, as an example to begin the discussion about fruits and seeds. Ask students if they have carved pumpkins; what do they do with the seeds? Ask them what might happen if they planted the seeds. See if any of them have previously planted seeds or ever eat seeds. Explain that the fruit is the part

of the plant that holds the seeds. Can they think of examples of a fruit that has seeds inside? Do they remember how the fruit develops? How do pollinators play a role in the formation of seeds and fruit? See if anyone can remember. Pass out **8.1 Flower to Fruit**. Can they match the flower to the fruit? Discuss how pollinators play a role. When seeds are produced on a plant that means the flower was pollinated!

ACTIVITY



Activity 2 Discussion

1. How many different kinds of seeds did they find? How were the seeds different from each other? What animals were seen in the garden? Were any eating any seeds?
2. What should we do with the seeds we collected?
3. What observations did they make in their field journal? What changes did they notice in their plant?
4. What other changes did they notice in the garden?

Why do plants produce seeds? Show a variety of fruits such as an apple, acorn, bean, or wildflowers to illustrate that fruits come in many forms, but all of them contain one or more seeds. Review the plant life cycle and explain that, in order to reproduce, plants form seeds after the flower is fertilized. It is through the help of pollinators that the flower becomes a fruit that contains seeds. If time allows, read one of the books in the Resources section. Tell students that today they will be going on a seed hunt to see how many different kinds of seeds they can find.

Activity 1: Seed Hunt (outdoors)

Visit a local park or garden to go on a seed hunt. Fall is a good time to look for seeds because many plants have finished making their flowers and are now making seeds. Good places to hunt for seeds would be under trees and where flowers were once seen on the plant. You may need to open the capsule or pod, but be aware that the seeds may not be mature until the pod has opened. You could take a pod back to the classroom to dry it. Take a tree or plant guide along and see if students can identify the plant or tree from which the seeds came. There may be some leaves nearby as clues.

1. Students can use [8.2 Seed Hunt Worksheet](#) to record observations. How many different seeds can they find? Are there many flowers? Students may need some guidance as some seeds are more difficult to find than others. If you are lucky enough to find milkweed plants, show the students what is hiding inside the pod.

2. Can they collect some seeds in tiny envelopes and save them for next season? Each student can be given a few envelopes, which they then label with the name of the plant and the date it was collected. Before beginning this activity, ask the students why we may want to save some seeds on the plants. What purpose might they serve?

Activity 2: Field Journal (outdoors)

1. Ask students to choose a perennial plant or tree that they will be able to observe over the year. Students can sketch the plant, including insects or wildlife visiting the plant. Let them return to the plant three more times during different seasons, such as January, April, and June to observe changes in the plant.

Extensions

1. Seed dispersal: explain that seeds often travel away from their mother plant rather than just falling down at her roots. Can anyone think why this may be? What does a plant need to grow? What if an acorn fell from a mature oak in a crowded forest. What might hinder its growth? How does an acorn travel? Can they think of other seeds that may move around with help from animals? Many seeds in berries, eaten by birds, need to be ingested in order to wear down the hard seed coats so they can sprout. Can they think of a seed in the garden that can be ingested by animals? Can they think of an example of a seed they saw in the garden that is dispersed by wind? Look for seeds like the maple samara (helicopter) or the elm samara dispersed by wind.

ACTIVITY

2. Save seeds with your class. Visit seedsavers.org/ for tips on how to save seeds and other resources.
3. If you can find some specific pollinator friendly plants outside, you can save the seeds and plant them in your NWF Schoolyard Habitat®. If you aren't planting the seeds in the fall, they will need to be dried for a week and then put in cold storage, like the refrigerator for an extended period to mimic the winter chill and then planted outdoors after the last frost.
4. What are some edible seeds? Can you think of some that you have eaten? What are some other parts of the plant that we eat? Can you think of examples?
5. Write "Seed Stories". Students can research crops that have sustained humans' cultural, spiritual, or food systems and write stories that outline the seed's history and its importance to people.

Standards

1-LS3-1 Structure, Function, and Information Processing Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

2-LS4-1 Interdependent Relationships in Ecosystems Make observations of plants and animals to compare the diversity of life in different habitats.

3-LS1-1 Inheritance and Variation of Traits: Life Cycles and Traits Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.



Did you know?

Just as many plants rely on pollinators to help transport their pollen from flower to flower, many also rely on animals to transport their seeds. The oak tree relies on squirrels and birds to transport its acorns. The burdock has a spiky seed called a burr which sticks to the fur of animals as they pass by. Can you think of any other ways seeds get around?

4-LS1-1 Structure, Function, and Information Processing Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Lesson 8 Resources

- Seed Savers Exchange
seedsavers.org/learn

Vocabulary

Reproduce (v): to produce new individuals of the same kind.

Source: Merriam-Webster Learner's Dictionary

RESOURCES

Books

Seeds**Ken Robbins**

Ages 6–11

Profile of different kinds of seeds and their dispersal methods.

It Starts With a Seed**Laura Knowles**

Ages 4–8

Story of how a samara seed becomes a maple tree.

A Seed is Sleepy**Dianna Hutts Aston**

Ages 6–12

Vividly illustrated overview of the diversity of seeds.

A Fruit is a Suitcase for Seeds**Jean Richards**

Ages 5–9

A simple graphic introduction to seed dispersal with a focus on fruits.

From Seed to Plant**Gail Gibbons**

Ages 4–8

Introduces readers to the life cycle of the plant including pollination and seed germination with simple language and vivid illustrations.

The Dandelion Seed**Joseph Anthony**

Ages 4–8

A picture book that tells the life cycle story from the perspective of a dandelion seed.

In a Nutshell**Joseph Anthony**

Ages 4–8

An acorn overcomes many challenges to become a mighty oak.

Flip, Float, Fly: Seeds on the Move**Joann Macken**

Ages 6–9

A picture book about seeds and seed dispersal.

Botanicum: Welcome to the Museum**Kathy Willis**

Ages 9+

Gorgeous and scientific botanical illustrations reveal the life cycle and parts of the plant.

Who Will Plant a Tree?**Jerry Pallotta and Tom Leonard**

Ages 5–7

From dropping them while flying by, to disposing of them through digestion, this fun book explores the various ways seeds become planted.

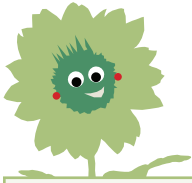
The Complete Guide to Saving Seeds: 322 Vegetables, Herbs, Fruits, Flowers, Trees, and Shrubs**Robert Gought**

Adult

Field Guide to the Street Trees of New York City**Leslie Day**

Adult

Name: _____ Date: _____



Compare the flowers of each plant with the fruit of the same plant. How do pollinators assist with the formation of fruit on plants?

FLOWER TO FRUIT

Flower	Fruit
Zucchini	
	
Milkweed	
	
Blueberry	
	
Raspberry	
	

FLOWER TO FRUIT

Name: _____

Date: _____



Compare the flowers of each plant with the fruit of the same plant. How do pollinators assist with the formation of fruit on plants?

Flower	Fruit
Tomato	
	
Serviceberry Tree	
	
Apple Tree	
	
Strawberry	
	

Name: _____ Date: _____



Visit a park or garden to look for seeds, fruits, and flowers.
Write and sketch your observations below.

How many different kinds of seeds were you able to find in the garden today?

How many different kinds of flowers were found in the garden today?

Draw two different kinds of fruits (the part of the plant that contains the seeds):

How are they different?

SEED HUNT

SEED HUNT

Name: _____ Date: _____



Visit a park or garden to look for seeds, fruits, and flowers.
Write and sketch your observations below.

Draw two different kinds of flowers:



--	--

How are they different?

Did you see any animals eating the seeds? What kind?

Did you see any pollinators visiting flowers? What kind?

9 WINTER SURVIVAL

Winter Survival

Background

All insects have strategies for surviving winter and adaptations that enable this survival.

Have you ever seen a bee in the winter? Most likely not. Depending on the insect, it may overwinter at any stage of development: egg, larva, pupa, or adult.

Insects technically don't enter a period of hibernation like some vertebrates, but many enter **diapause**, a state of developmental arrest (as if they are frozen in time) triggered by the amount of daylight.

During diapause, the insect has just enough metabolic activity to keep it alive but it does not eat, move, or grow. Adult insects have many defenses: they may expel all moisture from their bodies to avoid freezing or even excrete a special antifreeze enzyme; they may also seek shelter under logs, rocks, or in leaf litter; they may burrow in the soil or dig holes into the side of trees. Often the adult will die before winter, having fulfilled its task, leaving behind eggs, larva, or pupa to overwinter.

Below are examples of how bees, butterflies, and moths survive winter.

Butterflies and Moths in Winter

Migrants

As we have learned in previous

lessons, some insects migrate.

The most well known example is the monarch butterfly which may fly up to 3,000 miles in autumn to its winter home, and then make a reverse migration northward in the spring. However, this two-way migration is a rare exception. Some species of butterflies found here in NYC are only summer residents, having slowly migrated northward through several generations from the south. These temporary residents include the Painted Lady, American Lady, Red Admiral, Common Buckeye, Long-tailed Skipper, Clouded Skipper, Fiery Skipper. They cannot overwinter here, only in the south.

Overwintering as Adults

Two butterflies in NYC that overwinter as adults include the Comma and Mourning Cloak butterflies. They withstand the freezing temperatures by secreting a special chemical in their bodies that acts as a kind of antifreeze. On milder winter days they open their wings to absorb the light of the sun through their dark scales. Several species of moths can survive winter thanks to the insulation provided by the dense fur on their bodies.



BACKGROUND

Winter Survival (Continued)

Insects that overwinter as adults are the first to emerge in spring and can be seen flying around during the early warm days of spring.

Overwintering as Pupae

Several species of moths survive their winters as pupae because the silk encasement of the cocoon provides the warmth needed for winter. The Polyphemus moth and Cecropia moth are two such species of local moths that overwinter as pupae. The swallowtail butterflies as well as the sulphurs can spend the entire winter as pupae in their chrysalis, entering a period of diapause, unlike their summer generations which emerge from the chrysalis only after about ten days. If you see a butterfly flying around in March or April, it likely spent its winter as a pupa and emerged with the first warm days of spring. The flowers may only have begun to bloom, but no need to worry, many butterflies also drink sap from the trees!

Overwintering as Larva

Have you ever seen a woolly bear caterpillar, so named because of its hairy bands of black and reddish-brown “fur?” This is the larva of the Isabella Tiger moth. It emerges from its egg in fall, and overwinters as a caterpillar. With the coming of winter, it finds a thick leaf or bark on the ground and curls up inside it. Although it

freezes solid, it produces a special chemical which prevents tissue damage. Once spring arrives it will thaw and make its cocoon. If a woolly bear is found by students, they will surely want to touch it, but it may cause dermatitis for those with sensitive skin.

Other butterflies that overwinter as larvae (caterpillars) include the Viceroy, Tawny Emperor, and Red Spotted Purple and White Admiral. The last generation of these caterpillars born in late summer create a hibernaculum, or winter refuge out of the leaves of their host plant. They use a silk thread to attach the leaf to the twig to prevent it from falling to the ground with the rest of the leaves. Then they use another silk thread and coat the leaf. As the thread dries, it shrinks, curling the leaf, thus fashioning a tunnel in which the caterpillar can curl up inside. Other caterpillars, like the Eastern Tailed Blue, will spend the winter curled inside a seed pod. In spring, they pupate and emerge as butterflies.

Overwintering as an Egg

Overwintering as eggs is less common for pollinator insects. The Banded Hairstreak butterfly is one butterfly that overwinters as eggs on walnut, oak, hickory, ash and boxelder twigs. The eggs remain dormant through the winter and hatch in the spring.

BACKGROUND

Winter Survival (Continued)

 Bees in Winter**Social Bees**

Compared to butterflies, there is less variability in how bees spend their winter. Bumble bees and social wasps overwinter as adults, but only the queen. In the fall, she gorges on nectar and pollen to store up fat reserves, while the rest of the colony dies off slowly. She then burrows underground below the frost line to pass the winter. Once spring comes she finds a suitable nest in which to lay her eggs, having already mated before winter.

The honey bee is a special case. The honey bee workers born in autumn survive winter in the hive with their Queen bee. All the male (drone) bees are literally dragged out of the hive before winter since the queen has mated. They would just become a drain on resources. Only the females remain in the hive. Unlike other bees and most insects, they remain active inside. When temperatures outside fall below 50 degrees, they cluster in the hive in order to maintain warmth; they attach themselves to each other with the Queen at the center and “shiver” by vibrating their wings which keeps the center of the hive at about 90 degrees. All of this takes a great deal of energy, which is why honey bees must store a significant amount of honey in the hive to sustain them over the winter. Although you won’t see a honeybee

flying in freezing temperatures, they are still keeping busy in their hive waiting for that first warm spring day and first flowers to bloom. Just like the monarchs that must migrate up to 3,000 miles in fall, these overwintering honey bees have a longer lifespan than the generations born in the summer. Rather than a lifespan of a few weeks, they can live up to 6 months.

Solitary Bees

The carpenter bee is a solitary bee species that also overwinters as an adult; both the male and female overwinter. They return to the same nest in which they were born. Then come spring, once the female has mated, she excavates a new nest to lay her eggs. These eggs hatch into larvae and emerge from the nest as adults who, like the generation before them, will return to this nest to overwinter.

With the exception of the carpenter bee, most solitary native bees spend the winter in their nest cells as pupae, emerging as adults the following spring or summer. The mason bee, which builds her nest in narrow cavities, is an example. Once the eggs hatch, the larva, having consumed all of the provisions left by the mother, enters the pupal stage and matures in the fall or winter. It remains in its cocoon until the spring temperatures allow it to emerge as an adult.

ACTIVITY



Lesson 9

Summary

Students compare and contrast the winter adaptations of eight butterfly and moth species. They create a mural that illustrates the four seasons and the butterfly's corresponding phase of its life cycle.

Objectives

Students will:

- learn about the adaptations of local butterflies and moths for surviving winter.
- form hypotheses by comparing adaptations of butterfly species and by analyzing existing data.

Materials

- **9.1 Butterflies in Winter Cards**
- **9.2 Worksheet**, pencil, drawing/art tools

Preparation

Activity 1

- Grades K-2
Print **9.1 Butterflies in Winter Cards** (one teacher copy, pre-cut)
- Grades 3-5
Print **9.1 Butterflies in Winter Cards** (one copy, pre-cut)
Print **9.2 Butterfly Adaptation Worksheet** (one per student)

Introduction

Ask students if they see as many animals outside during winter as in the other seasons. Why not? Where are they? Some animals hibernate while others migrate. Why? Think of some animals that hibernate (bears, skunks, frogs, chipmunks, etc.) and others that migrate (birds, monarchs, whales, etc.). Which animals have you seen in the winter? What about insects? Where are they?

Many insects like bees, butterflies, and moths hibernate in the winter or even go through a stage where they stop growing. Ask students if they can recall the stages of development of the butterfly (egg, larva, pupa, adult). Tell them that insects pass the winter in one of these stages. Explain to them that in today's lesson they will explore how butterflies, moths, and bees survive winter and get ready for spring.

ACTIVITY

Activity 1: Hibernation or Migration?

Grades K–2

1. Create a chart on the board with four columns titled:
 - a. Egg
 - b. Larva (Caterpillar)
 - c. Pupa (Chrysalis)
 - d. Adult (Butterfly)
2. Hold up one [9.1 Butterflies in Winter Cards](#) at a time and read the description on the back and show image. Ask volunteers to place it in the correct column which explains how it passes the winter.
3. What is the most popular way for these butterflies to spend winter?

Grades 3–5

1. Divide the class into four groups. Place two of the eight [9.1 Butterflies in Winter Cards](#) at each table.
2. Let the students use the two-sided cards to complete the [9.2 Butterfly Adaptation Worksheet](#). Rotate the groups around the tables until everyone has had time to complete the worksheet.

Activity 2: Artistic Exploration

1. Create a class mural with a large roll of poster paper divided into the four seasons. Students can illustrate the seasons. Ask students to make drawings or a collage of the four different life cycle stages of one of the eight butterflies described in the [9.1 Butterflies in Winter Cards](#) (online images can serve as inspiration for

each life cycle stage). Cut out student drawings, or simply cut printed images, and let students paste the four stages (egg, larva, pupa, adult) in the corresponding season on the mural, labeling the name of the butterfly. They can infer which season to place each life cycle stage based on [9.1 Butterflies in Winter Cards](#).

Discussion

1. What are some ways butterflies survive winter?
2. Which of these butterflies have similar winter adaptations?
3. What are some of the benefits and risks to each winter adaptation?
4. Which of these butterflies may have a head start and appear earlier in spring? Why?
5. Which butterflies may not appear until later in the spring or summer? Why?
6. What are some ways we can help these butterflies in the winter?

Extensions

1. Grades 3–5: hypothesize which season has the most or fewest observations of each species in New York. Then check the hypotheses by looking at the data on iNaturalist. Does this pattern correlate with what we learned about the species in this lesson? What inferences can we draw from the observation periods on iNaturalist in regards to their life cycle? Search iNaturalist to determine which members of Lepidoptera (Butterflies and Moths) were found in New York by using date filters. Which ones were first observed in March and April? What can we infer about their life cycle?

ACTIVITY/RESOURCES

2. Read or research how other local animals adapt to winter. Do they hibernate or migrate? Choose an animal and tell its story through the seasons.
3. Go on a winter animal scavenger hunt. On a warmer winter day, dig in the soil if it can be worked or go on a hike to see what animals are active above and below the soil. Look for beetle grubs (white beetle larvae). Turn over a log or rock and see if there is anything hiding underneath. Look for holes in the ground and holes in trees. What animals might live there? Look for galls or cocoons on plant stalks.
4. Create a life cycle wheel as described in Lesson 6; this time, do not label the quadrants with the life cycle stage, instead label the season. Label the top wheel with the name of the species from [9.1 Butterflies in Winter Cards](#).

Standards:

K-LS1-1 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Use observations to describe patterns of what plants and animals (including humans) need to survive.

K-ESS2-2 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.

1-LS1-2 Structure, Function, and Information Processing Read texts and use media to determine behavior patterns of parents and offspring that help offspring survive.

**Did you know?**

The Woolly Bear Caterpillar once helped farmers predict the weather. It was believed that the larger the black bands were on either end of the caterpillar, the more severe the coming winter would be. Research has debunked this legend by showing the amount of black varies with the age of the caterpillar and the moisture levels in the area where it developed. Who knows, maybe you can test the theory for yourself!

3-LS1-1 Inheritance and Variation of Traits: Life Cycles and Traits Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

3-LS2-1 Interdependent Relationships in Ecosystems Construct an argument that some animals form groups that help members survive.

3-LS4-4 Interdependent Relationships in Ecosystems Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

4-LS1-1 Structure, Function, and Information Processing Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

RESOURCES

Books

Over and Under the Snow**Kate Messner**

Ages 5–7

This nonfiction picture book reveals how many animals survive winter.

Bugs and Bugsicles: Insects in the Winter**Amy S. Hansen**

Ages 5–7

A picture book that describes the various ways insects survive winter.

Not a Buzz to Be Found: Insects in Winter**Linda Glaser**

Ages 7–10

Discusses 12 different insects and their winter adaptations.

Buzzing with Questions: The Inquisitive Mind of Charles Henry Turner**Janice N. Harrington**

Ages 7–10

As the first Black entomologist, Charles Henry Turner was fascinated by plants and animals and bugs. This picture book highlights Turner's unstoppable curiosity and his passion for science.

Vocabulary

Adaptation: (n) a change in a plant or animal that makes it better able to live in a particular place or situation.

Hibernate: (v) to spend the winter sleeping or resting.

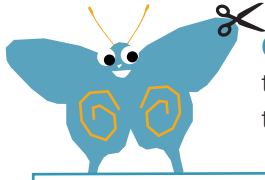
Migrate (v) to move from one area to another at different times of the year.

Source: Merriam-Webster Learner's Dictionary



Name: _____

Date: _____



Cut out each of the butterfly cards. Read the back of the card to find out how each species spends winter. Use the cards to complete the Butterfly Adaptations Worksheet.

BUTTERFLIES AND MOTHS IN WINTER

Front of Cards



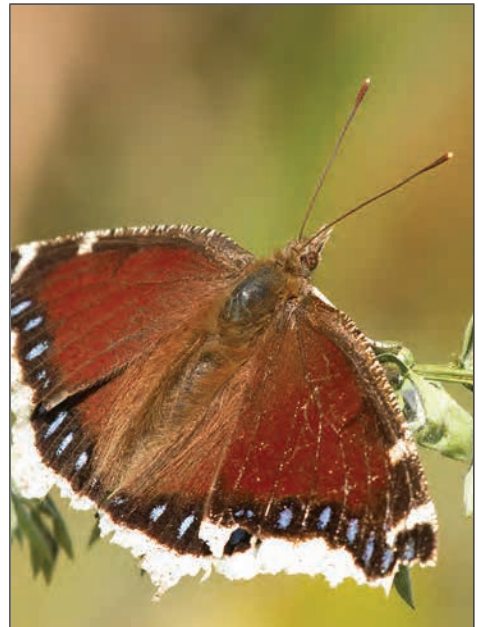
Monarch Butterfly



Isabella Tiger Moth



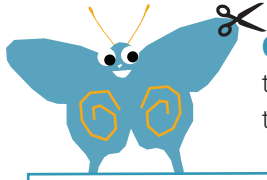
Cecropia Moth



Mourning Cloak Butterfly

Name: _____

Date: _____



Cut out each of the butterfly cards. Flip the cards to see what the butterfly or moth looks like as an adult. Use the cards to complete the Butterfly Adaptations Worksheet.

Back of Cards

Isabella Tiger Moth

The Isabella Tiger Moth spends the winter as the **Woolly Bear Caterpillar**.

Why do you think it is fuzzy?

As the weather gets cooler, it finds itself a thick leaf or bark on the ground and curls up inside. Although it freezes solid, it produces a special chemical which prevents the tissues from damage. Once spring arrives will it thaw and make its cocoon.



Monarch Butterfly

The Monarch butterfly **migrates** thousands of miles to reach its winter destination, riding warm air currents to conserve energy. The largest winter colony is in the temperate mountain forests of Mexico, which provides the right climate for Monarchs. There, tens of millions of monarchs congregate each year, covering the fir trees. How does a new generation of monarchs find the same winter home each year? Scientists are still researching that question.



Mourning Cloak Butterfly

The Mourning Cloak Butterfly spends the winter as an **adult**, though some also migrate south. To withstand cold temperatures, it stores extra fat in the fall and also replaces some of the water in its body with a special chemical that acts as an anti-freeze! On milder winter days it opens its wings to absorb the light of the sun through its dark scales.



Cecropia Moth

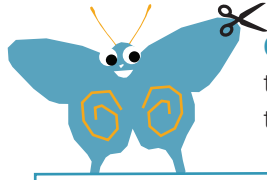
At the end of the summer, the five-inch-long Cecropia caterpillar seals itself into a **cocoon** along the length of a twig, usually in a dark protected area to escape predators. Once spring arrives it emerges after a long winter hibernation as a moth.



BUTTERFLIES AND MOTHS IN WINTER

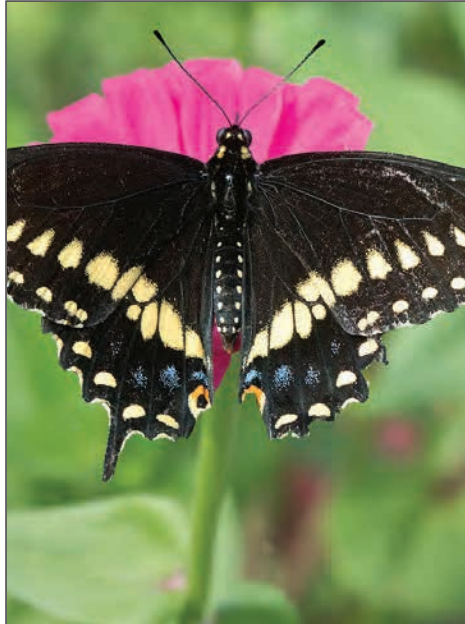
Name: _____

Date: _____



Cut out each of the butterfly cards. Read the back of the card to find out how each species spends winter. Use the cards to complete the Butterfly Adaptations Worksheet.

Front of Cards



Eastern Black Swallowtail



Banded Hairstreak Butterfly



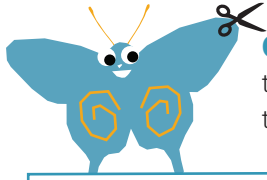
Painted Lady Butterfly



Red-spotted Purple Butterfly

BUTTERFLIES AND MOTHS IN WINTER

Name: _____ Date: _____



Cut out each of the butterfly cards. Flip the cards to see what the butterfly or moth looks like as an adult. Use the cards to complete the Butterfly Adaptations Worksheet.

Back of Cards

Banded Hairstreak Butterfly

Banded Hairstreaks live around woodlands because their host plants are trees such as oaks, hickory, and walnut. Adults lay eggs on woody twigs or bark of the host plant where they remain the entire winter! The caterpillars emerge in spring. We finally see the adult butterflies in flight by June.



Eastern Black Swallowtail

The Eastern Black Swallowtail spends the summer eating the leaves of its host plants: parsley, dill, carrots, fennel, and celery. Then it finds a sheltered and secure place to build its **chrysalis**, which is either brown or green to blend in with its environment. It spends the entire winter there and emerges as a butterfly in the spring!



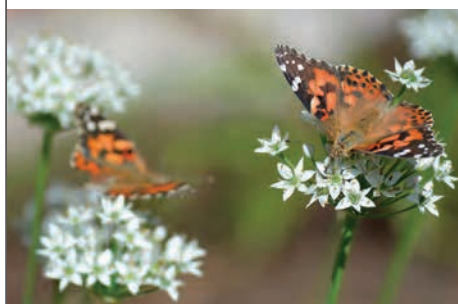
Red-spotted Purple Butterfly

In autumn, the Red-spotted Purple caterpillar creates a tiny **shelter** out of the leaves of its host plant. It uses a silk thread to coat a leaf and attaches itself to a twig. As the thread dries, it shrinks, curling the leaf like a sleeping bag with the caterpillar curled up inside. When spring arrives, the caterpillar crawls out and continues to eat from its host plant.



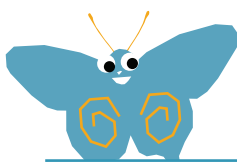
Painted Lady Butterfly

The Painted Lady has the largest habitat range of all the butterflies. It is found on every continent except Australia and Antarctica! One reason for this is because its host plants are members of the thistle family, which grow just about everywhere. The other reason is, like the monarch, it is migratory. It will spend spring and summer in the north and will **migrate** to the south in the fall and winter.



BUTTERFLIES AND MOTHS IN WINTER

Name: _____ Date: _____



Read the Butterfly in Winter Cards at your table. Check off how each insect spends the winter. Note any special adaptations it has to survive winter.

	Egg	Larva	Pupa	Adult	Adaptations
Monarch					Example: The monarch migrates for the winter.
Cecropia Moth					
Mourning Cloak Butterfly					
Eastern Black Swallowtail Butterfly					
Banded Hairstreak Butterfly					
Isabella Tiger Moth					
Painted Lady Butterfly					
Red-spotted Purple Butterfly					

BUTTERFLY ADAPTATIONS

10 BEE HOMES

Bee Homes

Background

Unlike honey bees, which live in hives, the majority of bee species are solitary.

Solitary or Social?

You may be surprised to learn that the honey bee, which is not native to North America, is only one of about 4,000 species of bees found across the United States, the majority of them native. Diversity of bees is four times greater than birds and ten times greater than mammals in North America. The NYC area is home to over 230 species¹ of native bees, 11 of which have been discovered since 2008. That number may grow as more species are discovered.

It may also come as a surprise that the majority of species—over 90%—are **solitary**, meaning each female builds her own nest. Conversely, bumble bees and honey bees are social species, meaning they live in hives—colonies with one reproductive “queen” bee, other female “worker” bees, and a small number of male “drones.” A bumble bee hive may contain up to 400 bees. A honey bee hive may contain up to 50,000 bees.

Carpenters, Miners, and Masons

We frequently observe bees buzzing around flowers, but where do bees make their nests? Seventy percent (70%) of female bees excavate their

nests in the soil; the other 30% excavate or find narrow cavities in stems, wood, or masonry. Wild bumble bees and honey bees will make their hives in the hollows of trees or abandoned rodent burrows. The exposed nest hanging from a tree or under the eaves of a building probably belongs to a wasp.

The overwintering habitats of bees is especially important to their population growth. For example, the mining bee which burrows tunnels in the soil, is one of the first bees to emerge each spring and is responsible for the pollination of fruit trees, shrubs, and other spring ephemerals. Keeping some leaf litter, dead twigs, and stems in the garden will help insects through the winter, as opposed to an overly neat and manicured landscape.

Life Cycles of Bees

The majority of solitary bees live one year. We are accustomed to seeing bees foraging for nectar and pollen among flowers during their adult stage, but this is typically the shortest period of the bee’s life cycle, usually lasting only three to six weeks. The rest of the year is spent in darkness inside

¹ <http://greatpollinatorproject.org/>

BACKGROUND

Bee Homes (Continued)

the nest. Like butterflies and moths, bees undergo a complete metamorphosis from egg, to larva, to pupa, to adult. Males usually emerge first from the nest and wait for the females to emerge in order to mate. Mating once is enough to provide females with a lifetime supply of sperm, which she stores in a special organ until she is ready to lay an egg. The males recognize which females have mated and avoid her.

The female then devotes all her time and energy to building and provisioning her nest. She builds individual cells in the nest and lays her eggs in them. Some bees fluff the nests with down from leaves or line them with a protective covering. The mother provides each egg with a ball of honey—a mass of pollen and nectar—which the larva will ingest upon hatching. The term “busy as a bee” is apt because bees can visit hundreds of flowers during each trip from the nest and must gather up to four times their weight in pollen for just one nest cell. Solitary bees never meet their young; they die off once they have laid their eggs and provided it with everything it will need to survive.

An egg hatches a few days after being laid. The larva, which resembles a tiny white caterpillar, does nothing but eat the provisions left by its mother. As the larva grows, it

molts several times, shedding its outer skin. Just before transitioning to the next stage, the bee expels all the waste from the pollen it consumed and enters into the pupa phase. Some bees spin a cocoon like moths, but this phase does not last as long. In this dormant phase, the bee develops its wings, sprouts hairs, and becomes a fully formed adult. Many bees overwinter as pupae. When complete, it chews its way out of the nest and emerges as an adult.

What About the Sting?

Bees are often feared because of their ability to sting. The risk is largely over-blown because bees are frequently mistaken for their more aggressive cousins, the wasps. The stinger is an adapted ovipositor (egg-laying device), which means that only female bees can sting. A bee needs to feel threatened in order to sting. Because the majority of bee species are solitary, most do not need to aggressively defend their colony from invaders. Even honey bees must risk their lives to sting; they have a barbed stinger which gets stuck and rips their abdomen when they try to extract it, killing them. Certainly we should approach bees with respect, but it is important to dispel rumors that bees are naturally aggressive and dangerous.

ACTIVITY



Lesson 10

Summary

Students examine the physical characteristics and habitats of different species of bees. Using art materials, they create a model of a bee's nest.

Objectives

Students will:

- become familiar with the names of different species of bees.
- describe different nesting habitats of bees.
- compare and contrast bee species by their behavior and other features.

Materials

- 10.1 Bee Nests
- 10.2 Comparing Bees
- 10.3 A Bee Like Me
- The Great Sunflower Project Bee-Ball Cards (bit.ly/Bee-Ball-Cards)
- Art materials

Preparation

Introduction

- Print **10.1 Bee Nests** (one per group or share as digital image)

Activity 1

- Print The Great Sunflower Project Bee-Ball Cards: bit.ly/Bee-Ball-Cards (one copy pre-cut for grades K–2, one copy per group of 4–6 students, for grades 3–5)

- Print **10.3 Comparing Bees** (one copy per group of 4–6 students, for grades 3–5)

Activity 2

- Collect art materials like cellophane, construction paper, cardboard, paper towel rolls, small boxes, paper cups, paper bags, gauze, pipe cleaners, egg cartons, clay, plasticine or beeswax, enough for each table.
- Print **10.3 A Bee Like Me** (one copy per group of 4–6 students)

Introduction

When you think of a bee, what comes to mind? Most students will probably think of the honey bee and its hive. Make a KWL chart to list what students already know about bees. Did you know that the honey bee is only one of 230 species

(types) of bees in NYC, 4,000 different species of bees in North America, and over 20,000 worldwide? You might also be surprised to learn that most bees (70%) don't live in hives but are solitary ground nesters, which means they live alone in the ground. Other species of

ACTIVITY

bees are solitary cavity nesters, which means they live alone in holes in wood, hollow stems, or even cracks in buildings. Think back to the last time you saw a bee. What was it doing? What do bees do for the flower (recall lesson 6)? Can anyone tell us what the flower does for the bee? Who has heard the expression “busy as a bee”? Why are bees so busy? Why do you think they need to collect so much pollen? Unlike butterflies, bees provide food for their babies. They need to gather about four times their weight in pollen, just for one egg. Imagine how many trips that might take!

Pass out or show students the [10.1 Bee Nests](#). See if they can make comparisons with what they already learned about the butterfly/moth life cycle. Briefly explain the life cycle of a solitary bee (see Background). You can also point out the difference between the solitary and social species using the three nest types as an example. As explained in the Background, the majority of species are solitary, meaning they live alone rather than in a hive. The solitary queen (mother) bees never meet their young; they die off once the eggs are laid. In social species like bumble bees and honey bees, the queen lives more than a year and lives with her offspring.

Activity 1: Getting to Know Our Native Bees

1. Divide the class into groups of 4–6 and give each group a number; they can write their group number on an index card at their table. Give each group a copy of [The Great Sunflower Project Bee-Ball Cards](#), which should be cut out.
2. Let the groups look at the cards and discuss what the different icons mean.



Did you know?

There are 230 species of bees in NYC, 4,000 different species of bees in North America, and over 20,000 worldwide!

See if the groups have any questions.

3. Give each group a copy of [10.2 Comparing Bees](#). Ask students to complete the worksheet; one student in each group can record the answers. Review the answers as a class.
4. Ask the groups to classify the bees and sort the bee cards into these categories. They can classify the bees by size, nest type, or flight season.
5. Let the groups visit other groups' sorted bee cards, being careful not to take them out of order. Using the second page of [10.2 Comparing Bees](#), the recorder notes what the group thinks was the classification used by each of the other groups to sort the bees.
6. Groups go back to their original places and share their responses.

Adaptations for K–2

1. Divide the class into pairs. Give each pair one Bee-Ball Card.
2. Ask the class to group themselves in various ways. For example, you might say, “Find a bee that belongs to your family.” Once everyone has sorted themselves into groups, let each group announce their family name to the class. Ask them if they can find something those family members might have in common. For example,

ACTIVITY

you might say, “find a bee that has the same flight period as you,” or “find a bee that has the same nest location as you.” After each sorting period, give the group time to present to the class what those bees have in common.

Activity 2: Bee Homes

1. Divide the class into groups of four. Each group receives one Bee-Ball Card; make sure that at least one bee from each nest type is distributed. Each group should receive a different bee card. As a group, let them first answer the questions on [10.3 A Bee Like Me](#).
2. Provide groups with art materials like cellophane, construction paper, cardboard, paper towel rolls, small boxes, paper cups, paper bags, gauze, pipe cleaners, egg cartons, clay, plasticine, and images of various bees. Ask them to work with their group to construct a diorama or collage of their bees’ nest (they can construct the interior or exterior of the nest).
3. Let each group present facts about their bee and their model of its nest to the class.

Extension

1. Individually or in groups, make a drawing or collage depicting one or more nest types of bees. If you were walking in a park, for instance, where might bees be nesting? How can you show that in a drawing or collage?



Activity 2 Discussion

1. How are bees different from each other?
2. What have you learned about bee habitats from this lesson? Why is it important to understand how bees make their nests? How might this knowledge help you in protecting bee habitats?
3. Is there one bee you think you have seen before? Have you ever seen evidence of a bee nest?
4. Which bees do you hope to see?

Books

Next Time You See a Bee

Emily Morgan

Ages 10+

Visual reference book full of information. Reveals the big impact these little insects have on the world.

The Bees in Your Backyard

Joseph Wilson and

Olivia Messinger Carril

Adult

A comprehensive and clear guide to the native bees of North America with many visuals.

Our Native Bees

Paige Embry

Adult

Explores the importance of native bees and focuses on why they play a key role in gardening and agriculture.

Bees: An Identification and Native

Plant Forage Guide

Heather Holm

Adult

A comprehensive guide illustrating the bees that occur in north-central and eastern United States and southern Canada.

Mason Meets a Mason Bee: An Educational Encounter with a Pollinator

Dawn V. Paep and Heather Holm

Ages 4–8

A boy is afraid of bees but meets a native bee and finds a new appreciation.

RESOURCES

Lesson 10 Resources:

- The Great Sunflower Project
www.greatsunflower.org/
- Xerces Society
bit.ly/NestingHabitat
- The Native Bees of NY
thehoneybeeconservancy.org/nyc-bees/

Standards

K-LS1-1 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Use observations to describe patterns of what plants and animals (including humans) need to survive.

K-ESS2-2 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.

K-ESS3-1 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.

1-LS1-2 Structure, Function, and Information Processing Read texts and use media to determine patterns in the behavior of parents and offspring that help offspring survive.

1-LS3-1 Structure, Function, and Information Processing Make observations to construct an evidence-based account that young plants and

animals are like, but not exactly like, their parents.

2-LS4-1 Interdependent Relationships in Ecosystems Make observations of plants and animals to compare the diversity of life in different habitats.

K-2-ETS1-1 Engineering Design Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

3-LS2-1 Interdependent Relationships in Ecosystems Construct an argument that some animals form groups that help members survive.

3-LS1-1 Inheritance and Variation of Traits: Life Cycles and Traits Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

4-LS1-1 Structure, Function, and Information Processing Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

3-5-ETS1-2 Engineering Design Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3 Engineering Design Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

BEE NESTS

Name: _____ Date: _____

Unlike honey bees, the majority of bee species do not make their nests in hives.

Read below to learn more about different types of bee nests.

A. Ground Nesting Bees build their nests in dirt or sand and prefer areas in direct sunlight. Some find existing holes or burrows; others dig their own tunnels.



B. Cavity Nesting Bees dig a tunnel in wood or stems or find an existing hole to make their nests.



C. Hive Nesting Bees are social species that build their colonies in existing large cavities like rodent burrows or above ground in the hollows of trees.



Group Number: _____ Date: _____



Review the Bee-Ball Cards with your group and answer the questions below.

COMPARING BEES

1. Name two bees that nest in...

the soil:

cavities:

2. Name a bee which excavates its own nest:

3. Name a bee which finds an existing hole or cavity:

4. Name two bees that...

are solitary
(one female nesting alone):

are social
(a queen bee and her workers):

5. Which bee is the smallest?

6. Which bee is the largest?

7. Which bees will be the first ones you see after winter?

8. Which bees will be the last you see before winter?

Group Number: _____ Date: _____



Working with your group, develop a classification system for the bees. You can classify the bees by size, nest type, flight season, or choose a different category to group the bees.

COMPARING BEES

9. Explain the classification method your group chose to sort the bees:

10. Visit other groups to find out how they classified their bees. Write the group number and classification method in the table below.

Group Number	Classification

A BEE LIKE ME

Group Number: _____ Date: _____



Review the Bee-Ball Card with your group and answer the questions below.

1. Name of Bee:
2. Where does the bee make its nest?

Soil

Cavity

Description

3. Is this bee solitary (living alone) or social (living in a colony)?
4. List up to five unique characteristics of this bee that you'd like to share with the class.

1.

2.

3.

4.

5.



February-June



11 AMAZING ADAPTATIONS

Amazing Adaptations

Background

Through the process of natural selection, organisms become adapted to their environment.

These adaptations ensure that the organism will be able to survive. Because insects are the most biodiverse class in the animal kingdom, they provide many excellent examples of adaptations. By now, students may have learned a few adaptations of the pollinators. This lesson aims to take a closer look.

There are two main types of adaptations in the animal kingdom: structural (biological) and behavioral. **Structural adaptations** are physical features of an organism which aid its survival, like the bill on a bird or the fur of a bear. **Behavioral adaptations** are things that the organism does to survive, like bird calls or migration.

Structural Adaptations

Butterflies have remarkable structural adaptations, which change depending on the stage of their life cycle. For example the caterpillar spends most of its existence eating as it grows. Its mouthparts are designed for shredding and consuming leaves of plants; its main organ is a large intestine. Once it undergoes metamorphosis, the caterpillar

transforms from an eating insect to an adult adapted for mating and depositing eggs. It no longer eats leaves, but sips nectar with its long proboscis. Why do insects undergo metamorphosis in the first place? This is an adaptation, providing the insect with strategies for surviving winter while also avoiding other environmental challenges such as competition, predation, and disease.

One can easily see how bees are adapted for collecting pollen with the hairs all over their bodies. Some species like bumble bees and honey bees even have specialized pollen baskets—concave tibia on their legs—which allow them to store pollen on their foraging runs.

Butterflies, bees, and wasps display remarkable adaptations in their coloration, either as a means to disguise themselves or as a warning sign to potential predators. Thousands of insects are camouflaged and barely noticeable until they move, including many moths and caterpillars. There are just as many that use the opposite strategy, exhibiting bold and bright colors. Think of bees and wasps with their bold yellow and black



BACKGROUND

Amazing Adaptations (Continued)

stripes or the monarch with its orange and black patterns. These colors send a message to predators, "I don't taste good and I may harm you so stay away!"

There are many examples of **mimicry** among pollinators. The syrphid (hover) fly is often mistaken for a small bee or wasp because it mimics both in color, an adaptation which helps it defend itself without a stinger. Many insects that visit the poisonous milkweed plant are adapted to eat that plant; they become poisonous to predators and their orange and black contrasting colors serve as a warning. Other insects, like the viceroy and queen butterfly, mimic the monarch so closely it is often hard to distinguish them.

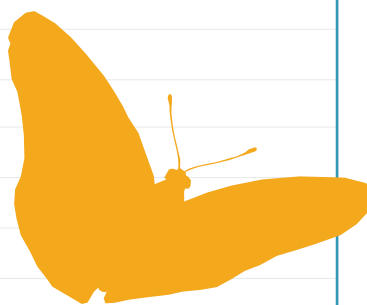
Behavioral Adaptations

We can find many examples of behavioral adaptations among pollinators. The migration of the monarch is a classic example. Pollinators' winter survival strategies, as discussed in Lesson 9, are additional behavioral adaptations.

Although solitary bees never meet their young, they invest a great deal of time and energy to ensure their survival. The cellophane bee and the masked bee, both members of the Colletidae family, secrete a cellophane like substance that they

use to line their nests to keep out moisture and fungi. Leaf-cutter bees line their nests with leaves; mason bees are known to use flower petals. While the female carpenter bee drills down into wood to make a nest and lay eggs, the male will hover nearby, dive-bombing any threats or competition.

The parasitic wasps and bees have their own survival strategies. The cuckoo bee waits outside the nest of another bee until the mother has vacated it, and then flies inside to lay her own egg concealed inside the cell wall or under the pollen loaf made by the host bee. When the bee hatches, the cuckoo bee larva will kill it and eat the pollen loaf for itself. The cuckoo wasp, which is stingless, has its own defense mechanism. If it should be discovered by the host of the nest, it will curl itself in a ball like an armadillo, exposing its exoskeleton as armor. After it is bounced out of the nest by the bee, it will unfurl and look for another nest in which to deposit its egg.



ACTIVITY



Lesson 11

Summary

Students explore the adaptations of pollinators—such as mimicry—and the functions these adaptations serve.

Objectives

Students will:

- understand the concept of adaptations.
- learn different types of insect adaptations and their functions.
- apply their understanding of adaptations to new situations.

Materials

- 11.1 Mimicry Examples
- 11.2 Monarch Adaptations Worksheet
- 11.3 Monarch Mimics

Preparation

Introduction

- Print **11.1 Mimicry Examples** (one per group, or use digital images)

Activity 1

- Print **11.2 Monarch Adaptation Worksheet** (one per pair of students)

Activity 2

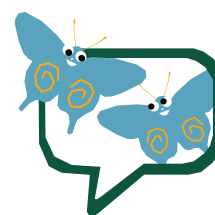
- Print **11.3 Monarch Mimics** (one per group of 3-4 students)

Introduction

Today we'll look at some of the ways that pollinators protect themselves from predators or the environment. Behaviors (what an animal does) and physical characteristics (how an animal appears) that help an animal survive are called **adaptations**. See if any student can think of any animal or insect adaptations

(camouflage, nocturnal activity, mimicry, etc.). One popular adaptation in the insect world is to **mimic** something else in nature, usually another animal that will frighten predators away. Their physical characteristics may also help them blend in with their surroundings. Pass out [11.1 Mimicry Examples](#) so students can see a few examples of insect mimicry.

ACTIVITY

Activity 2
Discussion

1. Which butterflies are the “mimics”? Why are they mimicking the other pollinator?
2. What are some ways to tell them apart?

Activity 1:
Monarch Adaptations

1. Divide students into pairs and pass out the [11.2 Monarch Adaptations Worksheet](#). For younger students, this can be completed as a whole class activity, where the teacher reads the questions aloud and students participate in a “think-pair-share.”
2. After students work together to complete the worksheet, discuss their inferences about the monarch butterfly’s adaptations.
 - a. **Egg:** Laying the egg on the underside of the leaf protects it from predators. This is an example of a behavioral adaptation.
 - b. **Larva:** Milkweed is poisonous to predators of the monarch so the bold colors of the caterpillar that eats the milkweed serve as a warning.
 - c. **Chrysalis:** The green color helps to camouflage the chrysalis.
 - d. **Adult:** Just like the monarch caterpillar, the adult monarch butterfly’s bold colors serve as a warning to predators. The monarch’s migration is another example of a behavioral adaptation.

Activity 2:
Mimics

1. Divide students in groups and pass out [11.3 Monarch Mimics](#). Ask groups to closely observe the monarch butterfly’s wing colors and patterns and compare it to the butterflies that mimic it. How can they distinguish these butterflies from each other?



Did you know?

The Eastern Tiger Swallowtail caterpillar resembles a bird dropping in its early stages. Can you think why? As the caterpillar matures, the harmless bird droppings turn into a snake. In its later stages (instars), the caterpillar turns bright green with two yellow markings that look like snake eyes. It even ejects what looks like a red forked snake tongue when it feels threatened!

2. Ask groups to work together to complete side 2 of the worksheet. Find the monarch butterfly examples.
3. Discuss the answers with the class.
Note: In actuality the viceroy is the only mimic here, as both the monarch and queen butterflies are members of the same genus, *Danaus*, and both eat milkweed, which is poisonous.

4.

Answer Key for 11.3, Side 2 Monarch Mimics Worksheet	
A. Viceroy	B. Queen
C. Monarch	D. Viceroy
E. Queen	F. Monarch

ACTIVITY

Extensions

1. Students can design or invent a new caterpillar or butterfly. They can draw, construct, or make a collage of the caterpillar/butterfly using art supplies. How is it adapted to its environment? How does it defend itself from predators?
2. Play a mimicry game with the class in which one student leaves the room and the rest of the class chooses a leader to copy. They sit in a circle and copy whatever the leader does. The child is invited back into the room and has to guess the leader.
3. Students can select a pollinator and learn about its habitat, anatomy, life cycle, behavior, etc. Identify its behavioral and physical adaptations.
4. Explore related plant adaptations. Choose a plant and research how it has adapted to its environment. How does it attract pollinators? In what kind of habitat is it found? How does it disperse its seeds?

Standards

1-LS1-2 Structure, Function, and Information Processing Read texts and use media to determine behavior patterns of parents and offspring that help offspring survive.

1-LS3-1 Structure, Function, and Information Processing Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

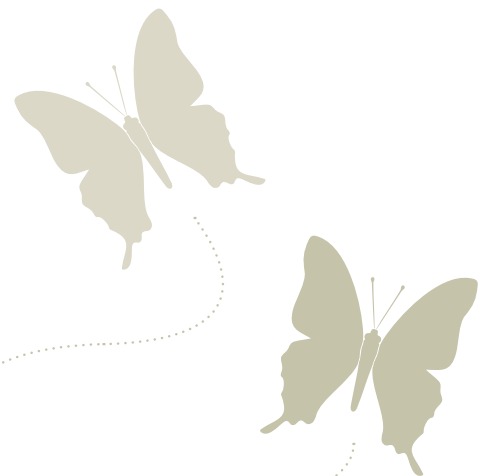
2-LS4-1 Interdependent Relationships in Ecosystems Make observations of plants and animals to compare the diversity of life in different habitats.

3-LS2-1 Interdependent Relationships in Ecosystems Construct an argument that some animals form groups that help members survive.

3-LS3-1 Inheritance and Variation of Traits: Life Cycles and Traits Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.

3-LS4-2 Inheritance and Variation of Traits: Life Cycles and Traits Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

4-LS1-1 Structure, Function, and Information Processing Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.



RESOURCES

Books**Claws, Coats, And Camouflage****Susan E. Goodman**

Ages 6–9

A photographic look at the many ways in which animals adapt to their environment and survive as a species. Includes sections on fitting into the environment, staying safe, getting food, and making a new generation.

Stellaluna**Janell Cannon**

Ages 6–9

A fruit bat is separated from her mother and has to survive with a family of birds, mimicking the behavior of this different species.

What Do You Do With a Tail Like This?**Steve Jenkins**

Ages 5–7

Explores different animal body parts including tails, ears, and mouths, and explains how each variation helps animals survive.

Why Do Some Moths Mimic Wasps?: And Other Odd Insect Adaptations (Odd Adaptations)**Kate Light**

Ages 8–12

Young entomologists will learn so much about the amazing world of insects with the intriguing text and photographs.

Vocabulary

Adaptation (n): a change in a plant or animal that makes it better able to live in a particular place or situation.

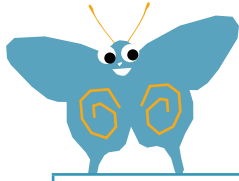
Camouflage (n): something (such as color or shape) that protects an animal from attack by making the animal difficult to see in the area around it.

Mimic (v): to naturally look like something else.

Source: Merriam-Webster Learner's Dictionary

Name: _____

Date: _____



Review the worksheet to find examples of insect mimicry.

MIMICRY EXAMPLES

Owl Butterfly

The owl butterfly received its name because the patterns on its wings mimic owl eyes.



Spicebush Swallowtail Butterfly

The spicebush swallowtail butterfly larva (caterpillar) mimics a snake. It will even rear its head like a snake when threatened.



Oak Hook-tip Moth

The oak hook-tip moth larva (caterpillar) mimics a dead leaf.

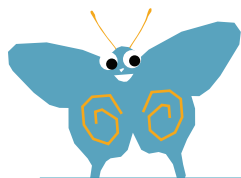


Greater Angle-wing Katydid

The greater angle-wing katydid mimics a leaf.



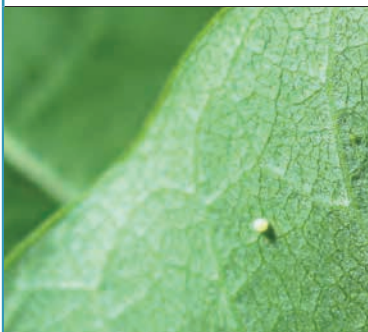
Name: _____ Date: _____



How do the monarch butterfly's physical characteristics or behaviors help it survive during each phase of its life cycle? Make predictions about these adaptations below.

MONARCH ADAPTATIONS

Egg



Adaptation:

Clue: Where does the monarch lay her egg?

Larva



Adaptation:

Clue: How might those bold colored stripes protect it from a predator?

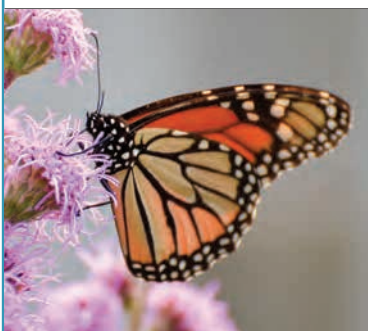
Pupa



Adaptation:

Clue: What color is the chrysalis?

Adult



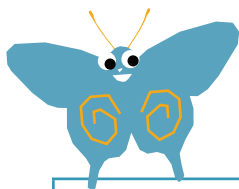
Adaptation:

Clue: How might those bold colors protect it from a predator? What does the adult do in the winter? Why?

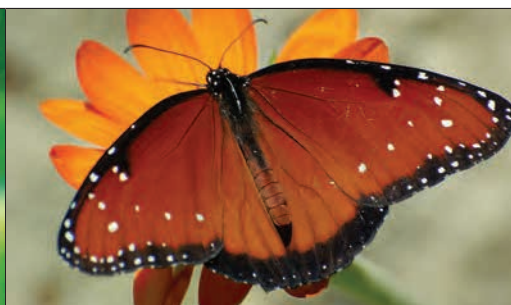
MONARCH MIMICS

Name: _____

Date: _____



Look closely at the photos below. Notice the differences between the three butterflies.

Monarch**Queen****Viceroy**

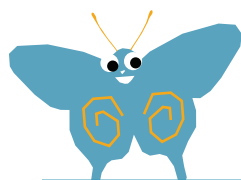
The queen butterfly has white spots on its hindwings.

The viceroy butterfly can be identified by the black line across its hindwings.

The queen and viceroy butterflies **mimic** the monarch butterfly to protect themselves against predators. Their bright orange and black colors are a signal to predators that they taste bad, just like the monarch butterfly.

- The **queen butterfly** has white spots on its hindwings. It is also a darker orange color than the monarch. When the wings of a queen butterfly are open, it's a bit easier to tell the two species apart.
- The **viceroy butterfly** can be identified by the black line across its hindwings; the monarch does not have this.

Name: _____ Date: _____



Can you find the monarch butterflies? Circle your answers.
Bonus: identify the viceroy and queen butterflies!

MONARCH MIMICS

A. 	B. 
C. 	D. 
E. 	F. 

12 BEES AND BUTTERFLIES

Comparing Bees and Butterflies

Background

Scientists have discovered over one million species of insects, yet they believe that this represents only 20% of all insect species on Earth.

Many pollinators—such as bees, butterflies, wasps, ants, and beetles—are insects, the largest and most diverse class of animals. They represent over 75% of all animals on Earth. Millions of new species have yet to be discovered.

Classification

The word insect comes from the latin word insecta, meaning “segmented.” All insects share certain characteristics:

- An exoskeleton.
- Three body parts: head, thorax, abdomen.
- Six legs attached to the thorax.
- Many adult insects have two or four wings also attached to the thorax.
- Many adult insects have two antennae attached to the head.

Many creatures closely resemble insects and are often mistaken for them. Ticks and spiders are a common example. Although they share the same phylum,

Arthropoda (“jointed leg”), they are members of a different class, Arachnida. You’ll see that they don’t share many of the characteristics of insects above. The name bug refers to certain insects with piercing and sucking mouthparts, but is also commonly applied to insects in general.

It is helpful to know how common pollinators like bees and butterflies are classified within the larger insect class. Butterflies and bees occupy different orders. Bees share the same order as ants and wasps, with whom they also share a common ancestor. Bees eventually diverged from ants and wasps by specializing in pollen and developed physical adaptations in order to collect it.

Kingdom:

Animalia

Phylum:

Arthropoda

Class:

Insecta

BACKGROUND

Comparing Bees and Butterflies (Continued)

Order:	Importance
Lepidoptera (Butterflies and Moths)	The importance of insects cannot be overstated. Insects play an essential role in our ecosystem and economy. Aside from pollinating over 75% of all flowering plants, including the crops we eat, insects also provide the basis of the natural food web, supplying food for small mammals, birds, amphibians, and reptiles. Some insects also cycle nutrients through the ecosystem by decomposing organic matter. Others are beneficial predators to a host of pests, and others provide us with products like honey, wax, and silk. As previously mentioned, insects are the most biodiverse class of animals, and that is as true in cities as elsewhere. Along with the many exotic insects that have reached our cities through travel and trade, there are also a myriad of native insects that have lived here throughout history. Many insects—like mosquitoes—have proven to be highly adaptable; others—like bees and butterflies—need our help to protect their habitat in cities.
Hymenoptera (Ants, Bees, Wasps and Sawflies)	
Family: Apidae (Bees)	
Growth and Development	
Insects have an exoskeleton which they shed periodically as they grow through a process called molting. Each period between molts is called an instar. Insects may have several instars before they reach their adult size or the next phase of development. Some juvenile insects simply grow bigger until they reach their adult size. Others like dragonflies, grasshoppers, and cicadas go through an incomplete metamorphosis. It's called "incomplete" because the nymph (juvenile) may lack wings or other features, but otherwise are similar in appearance to the adult. Others like bees, butterflies, and moths go through a complete metamorphosis in which the larvae (juveniles) have a final molt called a pupa and remain in that inactive phase for a time before they emerge as completely transformed adults.	

ACTIVITY



Lesson 12

Summary

Students compare the anatomy of the bee and butterfly and go on an insect scavenger hunt outdoors.

Materials

- 12.1 Compare the Bee and Butterfly Worksheet
- 12.2 Insect Scavenger Hunt Worksheet
- Insect field guide, pencils, clipboards

Preparation

Activity 1

- Print **12.1 Compare the Bee and Butterfly Worksheet** (one per student or pair of students)

Activity 2

- Print **12.2 Scavenger Hunt Worksheet** (one per student)

Objectives

Students will:

- appreciate the diversity of insects.
- learn how to identify insects.
- compare and contrast bee and butterfly anatomy.

Introduction

Ask students to think of an animal and hold it in their mind. Write each of their answers on the board. You might also give older students five minutes to write down all the animals they can think of. Ask them to count how many of their animals are insects. They probably haven't thought of many. Mammals are usually the first animals that come to mind, yet

students may be surprised to learn that insects make up 75% of all animals on Earth. More than one million species have been identified compared to approximately 4,500 species of mammals. And scientists estimate that this is just a small fraction of the overall number of insect species that live on the planet.

What is an insect? Ask students to share what they know about insects. Review

ACTIVITY

insect characteristics or share an image of insect anatomy with the class.

- Insects have an exoskeleton and three main body parts: head, thorax, abdomen.
- Insects have six legs attached to the thorax.
- Most adult insects have two or four wings also attached to the thorax.
- Most adult insects have two antennae attached to the head.

Activity 1: Comparing the Bee and Butterfly

Individually or in pairs, ask students to complete [12.1 Compare the Bee and Butterfly Worksheet](#).

Students will compare and contrast the anatomy of the bee and butterfly. What is similar, what is different? Start with general observations, are they both insects? How do we know? Then compare the details: eyes, mouthparts, tongue, wings, antennae, body. Use a reference book or an online encyclopedia to learn more.

Students can infer how different parts of the body support the insect in gathering pollen or nectar. Older students may also compare life cycles, habitat, and behavior.

Note: This activity can be adapted to younger students by making this a whole class activity or a group activity with a teacher assigned to take notes for each group. You might also read aloud the function of each body part and the students will infer the name of the part you are describing.

Discussion

1. What is similar, what is different?

2. Which insect looks better **adapted** for collecting pollen? Why? Which looks better adapted to collecting nectar, why?
3. What are other physical adaptations for each insect that we can infer from their anatomy?
4. Butterflies don't need to collect pollen for their young, they only drink nectar for themselves; bees need to transport pollen and nectar back to their nest. Can you observe different physical adaptations in the bee and butterfly that support these different behaviors?

Activity 2: Insect Scavenger Hunt (outdoors)

1. Take students outside and look for insects. Look near plants and under soil. Use magnifying lenses to get a closer look and complete worksheet [12.2 Insect Scavenger Hunt](#).
2. If students aren't familiar with an insect they see, this is a good opportunity to use a field guide listed in the appendix or an online resource like iNaturalist listed below. You can take a photo of the animal for reference and even upload it for identification.

Extensions

1. **Research** an insect and make presentations to the class. Include information about the species like its habitat, anatomy, life cycle, range (where it is found), behavior, and adaptations.
2. Scientists use a system of classification called **taxonomy** to group living things with similar characteristics. Give



Activity 2 Discussion

1. How do you know these are insects?
2. Which ones are actually NOT insects and why?
3. Did you find any other animals in the garden that are not insects?
4. Can you make an inference about the diet of some of the insects from your observations? Explain.

ACTIVITY

students some images of different animals and let them work together to sort them into groups by similar characteristics. Older students can be challenged to sort the different orders within a class of animals. Younger students may only go so far as sorting animals into different classes (e.g. mammals, reptiles, birds, and insects). Ask them to explain their reasoning for the groupings. Why did they sort animals in that way? Compare this with how the animal is scientifically classified.

3. Play **“Heads, Bodies, and Legs”** — insect version. Review the parts of an insect. Divide the class into groups of three. Each child receives a piece of paper and folds it into thirds on the short edge. The first section is for the head, the next section is for the thorax, and the third is for the abdomen. Children begin by drawing a head of an imaginary insect including antennae, eyes, and mouthparts. Then they fold the first section so the head is no longer visible and create a little neck in the next section to indicate where the thorax should be placed. They pass their paper to the child on their left. The next child draws a thorax of an imaginary insect including the six legs and wings, folds it so it is hidden and indicates in the next section where the abdomen should be attached. Then they pass it along to the child to their left. Once the abdomen is drawn, it is folded and passed to the left back to the first child. Unfold the paper to reveal the unique insect. The child can name the insect, label it, or describe its behaviors and adaptations.



Did you know?

The name “bug” refers to certain insects with piercing and sucking mouthparts, but it is also commonly applied to insects in general.

Standards

2-LS4-1 Interdependent Relationships in Ecosystems Make observations of plants and animals to compare the diversity of life in different habitats.

3-LS1-1 Inheritance and Variation of Traits: Life Cycles and Traits Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

4-LS1-1 Structure, Function, and Information Processing Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Resources

- Insect Identification: insectidentification.org/
- iNaturalist: inaturalist.org/
- Discover Life: discoverlife.org
- The Insect Apocalypse is Here: bit.ly/InsectDecline
- Why Insect Populations are Plummeting: bit.ly/InsectPopulations

RESOURCES

Books

The Illustrated World Encyclopedia of Insects

Martin Walters

Ages 9–12

Insects For Kids: A Children's Picture Book About Insects

Melissa Ackerman

Ages 5–8

The Thing About Bees: A Love Letter
Shabazz Larkin

Ages 3–7

A tribute to the bees that pollinate the foods we love to eat, children are introduced to different kinds of bees in this love poem from a father to his two sons.

Vocabulary

Abdomen (n): the last of an insect's three main body parts.

Adaptation (n): any structure or behavior of an organism that improves its chances for survival.

Antenna (pl antennae) (n): the thin feelers on the head of an animal like a crayfish, isopod, or insect. Antennae are used to sense the environment.

Arthropods (n): a group of animals with exoskeletons, jointed legs and segmented bodies, including insects, spiders, ticks, scorpions, centipedes, crabs and shrimp.

Entomologist (n): a scientist who studies insects.

Exoskeleton (n): a hard, protective covering found in all arthropods, which provides structure like a skeleton, but is on the outside.

Habitat (n): the place or type of place where a plant or animal naturally or normally lives and grows.

Head (n): the first of an insect's three main body parts.

Insects (n): a group of arthropods that is characterized by having a three-part segmented body, six legs, and two antennae, including beetles, ants, and bees.

Larva (pl. larvae) (n): the wormlike early stage in the life cycle of an insect.

Metamorphosis (n): the change of an insect (or other animal) from one form into another as it develops into an adult. Butterflies are a well-known example.

Thorax (n): the middle of an insect's three body parts. An insect's legs and wings are always attached to the thorax.

COMPARE THE BEE AND BUTTERFLY

Name: _____

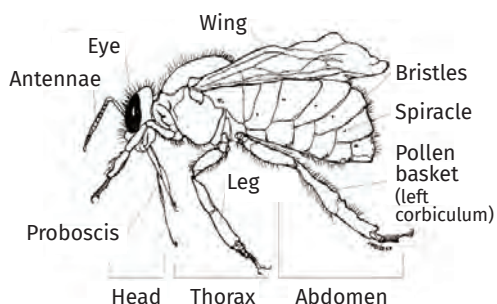
Date: _____



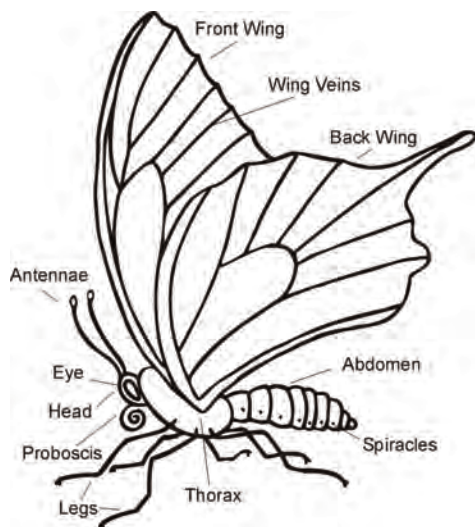
Examine the body parts of the bee and butterfly.

Which body parts do they use during pollination? Use the diagrams to complete the charts.

Parts of a Bee



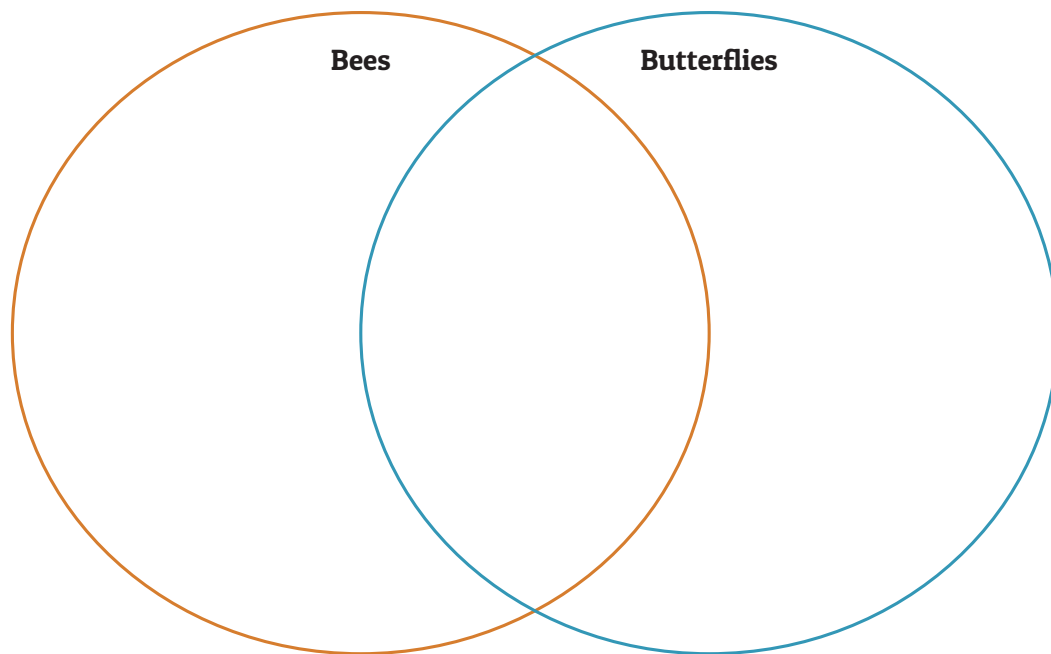
Parts of a Butterfly



Name: _____ Date: _____



How are bees and butterflies similar? How are they different? Complete the Venn diagram—list their similarities in the center of the diagram where the two circles intersect.

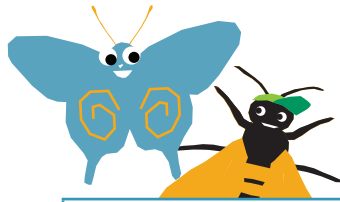


List the bee and butterfly body parts and describe their purpose.

Body Part	Purpose for Bee	Purpose for Butterfly

COMPARE THE BEE AND BUTTERFLY

Name: _____ Date: _____



Visit a the schoolyard or a park to hunt for insects.

Sketch a picture of the animals that you find. Do you think it is an insect? Answer the questions on the back after you sketch your animals.

INSECT SCAVENGER HUNT

Sketch

How many?

Where did you find it?

Name

Sketch

How many?

Where did you find it?

Name

Sketch

How many?

Where did you find it?

Name

Sketch

How many?

Where did you find it?

Name

Name: _____ Date: _____



Answer the questions after you sketch your animals.

1. How many different types of insects did you find?

2. How do you know they are insects?

3. Did you find any other animals in the garden that are not insects?

4. Can you make an inference about the diet of some of the insects from your observations? Explain.

COMPARING BEES AND BUTTERFLIES

13 MONARCH MIGRATION

Magnificent Monarch Migration

Background

The monarch butterfly is an iconic species found across North America.

Its bold orange, black, and white markings make it fittingly the king among North American butterflies. It is also the only butterfly known to make a two-way annual migration just like some birds, traveling up to 3,000 miles from southern Canada to central Mexico. While other butterflies can overwinter as an egg, larva (caterpillar), pupa (chrysalis), or even as an adult, the monarchs cannot survive the harsh winters in northern latitudes. Using environmental cues such as the angle of the sun, the monarchs begin to migrate southward beginning in late August. Scientists have discovered that they have an internal mechanism that acts like a magnetic compass, allowing them to find their way even when it's cloudy. They can travel up to 100 miles per day, using air currents and updrafts called thermals in order to conserve energy. They have been spotted flying by tall buildings such as the Empire State Building at more than 1,000+ feet, but can reach thousands of feet. Monarchs fly by

day and stop to feed on nectar to fuel their journey. Although they are solitary in their migration, they often cluster in the same trees when roosting at night.

Monarchs west of the Rockies overwinter along the California coast. Monarchs east of the Rockies overwinter in the Sierra Madre mountains of Mexico. "Most monarchs joining the migration each fall are three or four generations removed from those that made the journey the previous year – yet somehow, they find the same groves of trees visited by their ancestors! How monarchs navigate to these forest groves remains an unsolved scientific mystery."¹ In these high altitude colonies, tens of thousands of monarchs can cluster together on a single tree in order to keep warm. Fifteen percent (15%) of overwintering monarchs fall victim to predators.

As spring approaches, the winter diapause comes to an end and monarchs become more active; over three to five weeks, monarchs mate in preparation

¹ <https://www.pollinator.org/pollinator.org/assets/generalFiles/NAPPC.Monarch.broch.Aug.2019.hiRes.pdf>

BACKGROUND

Magnificent Monarch Migration (Continued)

for their return migration. By the middle of March, they begin to migrate north in search of nectar and milkweed on which to lay their eggs. Milkweed is the only plant on which the monarch caterpillar feeds. The fall generation that made the 3,000 mile journey south won't be the ones to return north, but rather a successive relay race of several generations that will gradually return north.

The "Summer" monarchs live only two to five weeks. The changes in sunlight, cooler nights, and the dying of the milkweed toward the end of summer are cues that signal a reproductive diapause in the "Autumn" monarchs that emerge in late August and September. They are now interested in one thing: migrating southward. If lucky, they will make it all the way to Mexico and live up to 8 months.

The fascinating story of how this migration was first discovered is a great example of scientific inquiry. For many years people didn't know about this migration. To the Indigenous and Mexican people who witnessed the mass migration to the winter colonies, the sudden arrival of thousands of monarchs around the "Day of the Dead" celebration was recognized

as a visit from the spiritual world, each monarch carrying the soul of an ancestor. No one knew that the monarchs in the winter colonies in Mexico were the same ones who had left the northern latitudes in the fall. That is, not until a Canadian scientist named Dr. Fred Urquhart, together with his wife and help from volunteers, began tagging monarchs with tiny stickers on their wings to track them in the 1970s.

They first had to spend many years designing the perfect sticker that would stick and stay on the delicate butterfly's wing. Once they accomplished this, they enlisted hundreds of volunteers across the country in their project to tag and track monarchs. Among these volunteers were two school boys from Minnesota. They placed the fateful tag on a butterfly near their school which, on January 9th, 1976, at 10,000 feet high in the remote Sierra Madre mountains, would be the very first one that Dr. Urquhart discovered among millions of monarchs, and only after five minutes of searching! This amazing story of how the monarch migration was discovered by Dr. Urquhart is almost as amazing as the monarch migration itself.

ACTIVITY



Lesson 13

Summary

Students learn about the monarch's seasonal migration and visit a park or garden to look for monarchs during each phase of their life cycle.

Objectives

Students will:

- understand the concept of migration and how it applies to the monarch butterfly.
- observe the specific habitat needs of the monarch butterfly.
- understand the importance of protecting the monarch.

Materials

- **13.1 Monarch Life Cycle Cards**
- **13.2 Monarch Observation Worksheet**
- **6.2 NYC Butterfly Field Guide** (p.62), pencils, clipboards

Preparation

Introduction

- Print **13.1 Monarch Life Cycle Cards** (One copy per group; cut out images)

Activity

- Print **13.2 Monarch observation worksheet** (one per student)
- Print **6.2 NYC Butterfly Field Guide** (several copies for reference)

Introduction

Review the life cycle of the monarch butterfly by sequencing the [13.1 Monarch Life Cycle Cards](#) (egg, larva, pupa, adult). Students can place them in order at their tables or they can form a human timeline of the life cycle with the images. After the cards are sequenced correctly, they can explain their phase of the monarch life cycle. For a more creative version, volunteers can act out

the monarch life cycle. There can be a narrator and actors for each phase.

Review host plants. The host plant for the monarch is milkweed. The monarch larva (caterpillar) will only eat the leaves of milkweed plants. Because milkweed is poisonous to other animals, when the caterpillar eats it, it becomes poisonous too. Not all birds know this, but they only have to learn it once to remember not to eat monarchs. What happens if there is

ACTIVITY

no milkweed for the monarch? Can it eat another plant? Will the butterfly lay her egg on any other plant? The answers to these questions are “no”.

That is not the only challenge for the monarchs. Discuss how the monarch is the only butterfly to make a two-way migration (just like many birds). Why do they migrate? Where do they migrate? Here you may choose to read a story or allow children to research this on their own. Do you think they make the 3,000 mile journey in one stretch? What might they need on their journey to and from Mexico (milkweed on which to lay caterpillar eggs, nectar sources, places to roost, water).

If conducting this activity in the fall, you can tell the students that if they do see monarchs, they are on their way to Mexico and we should wish them a safe journey. If in the spring, any monarchs observed will be the new generation of monarchs whose parents or grandparents made it to Mexico.

Activity: Monarch Field Observation (outdoors)

Prepare for the trip

1. If you don't have a pollinator habitat garden at your school or in your neighborhood, find a field trip site in the appendix. Jamaica Bay Wildlife Refuge is on the migratory flyway for monarchs and birds and is a great place to observe them on their migration.
2. If visiting a park, call ahead to find the best spots to observe monarchs. Native planting areas, where milkweed and other wildflowers are found, will attract monarchs as well as other pollinators.

3. Choose a warm sunny day because monarchs—as cold-blooded creatures—cannot produce their own heat, but need to absorb it from their environment. As a general rule, monarchs need air temperatures of at least 50°F on a sunny day (or 60°F on a cloudy day) in order to fly. You also want to choose the right time of year in order to observe monarchs. In spring, visit Journey North (journeynorth.org/maps) where you can find data on monarch and milkweed sightings.

During the trip

1. Each student should have a copy of the [13.2 Monarch Observation Worksheet](#) to record their observations.
2. Look for evidence and examples of monarchs at various stages of their life cycles. Use the [13.1 Monarch Life Cycle](#) to help with identification. It will also be helpful to bring copies of the [6.2 NYC Butterfly Field Guide](#), or other field guides recommended in the appendix for reference.
3. For the younger students (K-2), the worksheet can be adapted or can be used by the teacher to guide observations and take notes rather than directly used by students.

Discussion Questions

1. How many of you saw monarch butterflies, caterpillars, chrysalises, or eggs (show images)?
2. Did you see other butterflies or caterpillars? How many different kinds?
3. Did you find milkweed flowers blooming? Did you observe any interactions between the plants and monarchs?
4. What else did you notice that you want to share?

ACTIVITY

Extensions**Grades K–5**

1. Compare monarch migration to bird migration. What are some local birds that migrate? What do they have in common with monarchs? How are they different?
2. Learn more about the Day of the Dead celebration and how monarchs play a role in the annual tradition. See: bit.ly/MonarchsDayOfDead
3. Research the risks monarchs face and some of the solutions that will help protect them.

Grades 3–5

4. Journey North (journeynorth.org/monarchs/resources) has many great resources and lessons for the middle grades. Students can upload their observations and look at maps and charts to compare and analyze data on monarch migrations and populations.
5. Meet some of the children and families who share their mountain homes with the monarchs every winter. View videos, slideshows, and stories here: journeynorth.org/tm/monarch/LifeSanctuaryRegion.html. Discuss the

**Did you know?**

Some monarchs fly as much as 3,000 miles to reach their winter destination. Pretty amazing for an insect that weighs no more than a paperclip!

cultural traditions and conservation practices of people from this region of Mexico.

Standards**K-LS1-1 Interdependent Relationships in****Resources****Videos**

- Flight of the Butterflies (IMAX, 2016)
- The Incredible Journey of the Butterflies (PBS, 2009)
- The Incredible Story of the Monarch Butterfly: Four Wings and a Prayer (Primitive Entertainment, 2007)

Vocabulary

Endangered (adj): used to describe a type of animal or plant that has become very rare and that could die out completely.

Life Cycle (n): The series of stages through which a living thing passes from the beginning of its life until its death.

Metamorphosis (n): a major change in the form or structure of some animals or insects that happens as the animal or insect becomes an adult.

Migrate (v): To move from one country, place, or locality to another.

Source: Merriam Webster Learner's Dictionary

RESOURCES

Ecosystems: Animals, Plants, and Their Environment Use observations to describe patterns of what plants and animals (including humans) need to survive.

K-ESS3-1 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.

1-LS1-2 Structure, Function, and Information Processing Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.

3-LS1-1 Inheritance and Variation of Traits: Life Cycles and Traits Develop

models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

3-LS2-1 Interdependent Relationships in Ecosystems Construct an argument that some animals form groups that help members *survive*.

4-LS1-1 Structure, Function, and Information Processing Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Classroom Resources

- National Wildlife Federation: bit.ly/ButterflyHeroes
- Monarch Joint Venture: monarchjoint-venture.org
- Monarch Larva Monitoring Project: mlmp.org
- Monarch Watch: monarchwatch.org
- Journey North: journeynorth.org/monarchs
- Monarch Butterfly Fund: monarch-butterflyfund.org
- Posters: shop.monarchwatch.org/category/Posters

Books

Magnificent Monarchs

Linda Glaser

Ages 4–8

Nicely illustrated introduction to the monarch life cycle.

The Monarch

Kylee Baumie

Ages 12+

A great reference book about the monarch and how to protect them

Travelling Butterflies

Susumu Shingu

Ages 4–7

A simple story of monarch migration.

Gotta Go

Sam Swope

Ages 4–9

Story of a monarch's migration.

Isabel's House of Butterflies

Tony Johnston

Ages 5–9

Fictional story of a Mexican girl whose family must either cut down the butterfly tree for their own resources or save it for the monarchs.

Hurry and the Monarch

Antione Flatharta

Ages 5–8

A monarch migrating to Mexico meets other animals on the way. Many facts are woven into this lyrical story.

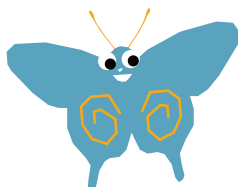
How to Raise Monarch Butterflies: A Step-by-Step Guide for Kids

Carol Pasternak

Ages 6–12

Name: _____

Date: _____

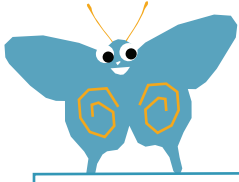


Teacher instructions: Cut out the cards and distribute them to student groups. Let students arrange them in sequential order. They can work at their desks or stand in sequential order in the classroom.

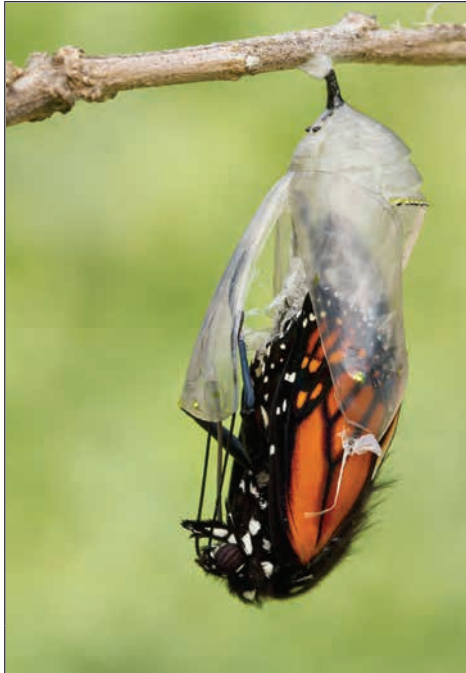
MONARCH LIFE CYCLE CARDS



Name: _____ Date: _____



Teacher instructions: Cut out the cards and distribute them to student groups. Let students arrange them in sequential order. They can work at their desks or stand in sequential order in the classroom.

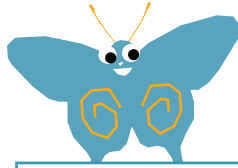


MONARCH LIFE CYCLE CARDS

MONARCH OBSERVATION

Name: _____ Date: _____

Location: _____ Time: _____ Temperature: _____ Weather: _____

**Visit a park or garden to look for monarch butterflies**

during each phase of their life cycle. Record your observations and answer the questions below.

Monarch Eggs

Where did you find it?

How many did you observe?

Monarch Larva (Caterpillar)

Where did you find it?

How many did you observe?

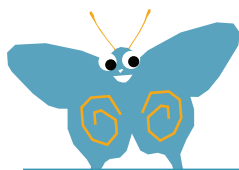
Monarch Pupa (Chrysalis)

Where did you find it?

How many did you observe?

Name: _____ Date: _____

Location: _____ Time: _____ Temperature: _____ Weather: _____

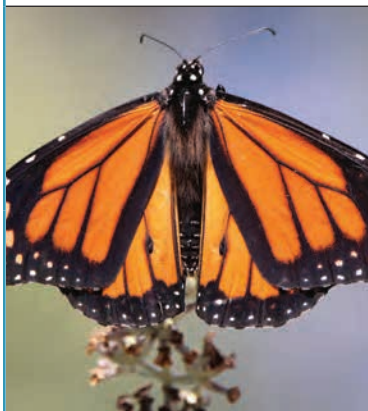


Visit a park or garden to look for monarch butterflies

during each phase of their life cycle. Record your observations and answer the questions below.

MONARCH OBSERVATION

Monarch Adult (Butterfly)



Where did you find it?

How many did you observe?

Common Milkweed



Where did you find it?

How many did you observe?

Butterfly Milkweed



Where did you find it?

How many did you observe?

14 THE MILKWEED COMMUNITY

The Milkweed Community

Background

Every species of butterfly has specific host plants on which they raise their young.

For the monarch butterfly, the host plant is the milkweed. The milkweed sap contains toxins which render the monarch caterpillar toxic to its predators. The predators learn to recognize the monarch by its coloration and keep away. As noted earlier, the monarch population has declined by 90% in the last 20 years, and this is primarily due to loss of milkweed habitat.

There are several species of milkweed that you can plant depending on your site's conditions and climate zone. If you plant a patch of milkweed, you will not just be helping to save the monarch butterfly, but will also be rewarded with a biodiverse community for students to explore because the milkweed is a host to other insects and their predators. It is a great example of an ecosystem and biotic community at work. You can take students out at various times of the day or stage of the plant's life cycle to compare observations. Here is a list of common milkweed residents:

Herbivores

1. **The Monarch** caterpillar is the most famous resident of the milkweed plant. After spending about 2 weeks eating the milkweed and growing about 60 times its original size, it will find a sheltered place near the plant to create its chrysalis.
2. **The Milkweed Tussock Moth** (also known as the Milkweed Tiger Moth or Harlequin Moth) The caterpillar looks like frayed pieces of colored yarn tied together. It advertises its toxicity to predators with the same colors as the monarch caterpillar. They don't eat the entire milkweed leaf, but rather leave the lacy framework of veins behind. The larva transforms into a cocoon, felted with the hairs of its body, where it spends the winter. The moth that emerges from the cocoon is a dull gray, and the only echo of color is a bright orange stripe on the abdomen. The female lays eggs in clusters of fifty or more on the underside of leaves.



BACKGROUND

The Milkweed Community (Continued)

3. **Delicate Cynia** (also known as Dogbane Tiger Moth) is another caterpillar that feeds on milkweed and is covered in fine long gray hairs. The caterpillar also feeds on the dogbane plant, a member of the same family as milkweed. The adult moth has beautiful white and gold rimmed wings.

4. **The Milkweed Beetle** (also known as the Long-horned Beetle) spends its entire life on or near the milkweed plants. These beetles prefer the most tender leaves, and so climb to the very top of the plant where the leaves are youngest. The beetle will also eat flower buds or flowers if available. The beetles lay eggs in the soil and the grubs (larva) feed on the milkweed roots.

5. **Milkweed Bugs** belong to a group of insects known as true bugs (Order Hemiptera) which are distinguished by their specialized piercing and sucking mouthparts. Milkweed bugs specialize on the milkweed seed, which they consume by injecting saliva into the seed and then sucking up the liquid mush that is produced. They often fall to the ground and play dead when disturbed. There are two common

species of milkweed bug, large and small. They are both red-orange and black in coloring. The small milkweed bug has a red "X" on its back or a black heart, depending on how you look at it. As an adult, the small milkweed beetle is not strictly herbivorous. It will scavenge insects trapped in the flower, eat monarch pupae and even engage in cannibalism.

6. **Aphids** also belong to the group known as true bugs (Order Hemiptera). Several species are found on milkweed, including black, green, and oleander (yellow) aphids. Oleander aphids are common, but they are an exotic species, named after their primary host, the oleander plant, closely related to milkweed. Aphids suck the milkweed sap and excrete a sweet "honeydew," the excess sugar which they can't process, which is enjoyed by other insects like ants. Females reproduce asexually, an evolutionary adaptation that has allowed for large populations. They give birth to live nymphs. Males are born in the final generation in fall so that the female may mate and lay the eggs in the soil near the host plant where they overwinter. Another interesting

BACKGROUND

The Milkweed Community (Continued)

adaptation; while most aphids are wingless, winged aphids are produced when a population is overcrowded. They are blown by the wind hundreds of miles and become receptive to yellow light, characteristic of young plants. They must land on or near the correct host plant and when they do so, they lose their wings. Aphids can cause damage by sucking the plant dry of its sap. To control them you can spray them off with water. They typically will have a hard time finding their way back. There are also several predators (see below).

7. **The Milkweed Leaf Beetle**

resembles a large version of the ladybug, yet unlike their cousins, these beetles are herbivores with both adults and larva feeding on milkweed leaves. Although they are not toxic themselves, by mimicking the colors of some other milkweed insects that are toxic to predators, they are also protected.

Predators

1. **The Ladybug** is a welcome beetle to gardens because it does not cause damage to plants. Its main diet is aphids, which earns its status as a beneficial insect. Both larvae and adults feed on aphids. The ladybug deters predators

with its bright coloring, and any predators that dare will be met with a foul smell and taste.

2. **Lacewings** are insects that undergo a complete metamorphosis just like butterflies. As adults they are beautiful delicate winged insects that feed on nectar. The larva which looks nothing like an adult and is known as the “aphid lion.” It is known to devour 200 aphids in a week, but they will also devour other larvae including their own kind. After 2–3 weeks, they spin a cocoon and emerge about 10 days later.

3. **Syrphid Flies**, also known as hover flies, are another insect that feeds on nectar (and pollen) as an adult, but is carnivorous as larva. The tiny slug-like larvae feed on aphids and other insects. The larvae overwinter in the soil and then pupate, emerging as adults in the summer.

4. **Spiders** find a lot of reasons to take up residence on a milkweed plant for all of the easy prey found there. One spider with a special adaptation is the crab spider. It is pinkish white, like the milkweed flower in which it hides and waits to ambush an unsuspecting visitor.

BACKGROUND

The Milkweed Community (Continued)

5. **Assassin Bugs** hide in flowers or foliage and wait until an unsuspecting prey lands. The assassin bug grabs its prey with its long forelegs and injects it with its toxic saliva which dissolves the insides. The assassin bug then drinks up the juices with its straw-like mouth piece.

Omnivores

1. **Wasps** are predators, paralyzing their prey with their stinger and carrying them back to their nest to feed larvae. They also consume nectar (see below).
2. **Ants** can be predators of monarch eggs and young caterpillars, which they carry back to the nest to feed their young. They are also nectarivores of both the flower and the aphid honeydew.

Parasites

1. **Tachinid Flies** look like house flies but are larger and hairier with red eyes. They are parasites of insect larvae, especially the monarch, on which they lay their eggs. When the eggs hatch the fly larvae burrow into its host caterpillar, consuming it from the inside. They eventually kill their host and exit on a long silky

thread. If you see a limp looking monarch caterpillar with the thread hanging from it, you know it was a victim of the tachinid fly. The adult fly is also a pollinator and will visit the flower for nectar.

2. **Parasitic wasps** are a diverse family of wasps and all lay their eggs on a host, typically caterpillars. Some common parasites include the ichneumon wasp, braconid wasps, and chalcid wasps.

Nectarivores

The milkweed flower itself attracts a wide variety of **butterflies, bees, flies, and wasps**.

Other

Birds generally have learned to keep away from the milkweed insects because of their toxicity, but some use the milkweed silk and other plant fibers for nest building.

A note of caution: Milkweed sap is toxic not just to most animals, but also humans. It can be interesting to identify the milkweed by breaking a leaf and observing the milky sap that flows, but it can cause skin irritation. It's best to wear gloves around milkweed, or wash hands thoroughly with soap if sap gets on the skin.

ACTIVITY



Lesson 14

Summary

Students explore the ecosystem of the milkweed community. They learn about the biodiversity supported by the milkweed plant and the roles of each animal in the community through activities and observations.

Objectives

Students will:

- appreciate the biodiversity that is supported by native plants like milkweed.
- understand the concepts of “community” and “ecosystem.”
- understand the interactions between animals in an ecosystem, using the milkweed community as an example.

Materials

- 14.1 Milkweed Community Member Cards
- 14.2 Milkweed Observation Record
- markers, chart paper, pencils

Preparation

Activity 1

- **Print 14.1 Milkweed Community Member Cards** (one per group of 2 students. Cut out images of animals).

Activity 2

- **Print 14.2 Milkweed Observation Record** (one per student).
- **Print 14.1 Milkweed Community Member Cards** (a couple for reference).

Introduction

Create a concept map with the word **community** in the center. What are some words that come to mind when you think of the word “community?” What are some examples of a community (e.g., class, school, neighborhood)? Each member plays a role in their community.

For example, grocers provide food for the residents in a neighborhood and the residents provide business for the grocer. Can you think of another role that someone plays in your neighborhood community? Our classroom is a community of learners and together we help each other learn and be our best.

ACTIVITY

When a group of animals live together in the same place we also call it a **community**. Do you remember what a habitat is? A habitat can be very large and is made up of different communities, just like our city is made up of different neighborhoods. For example, a forest habitat is made up of live trees and dead trees, each of which may host their own community of animals. Today we are going to look at the milkweed community. Who remembers the name of a caterpillar that only eats the milkweed plant? Why is it especially important that we protect and plant milkweed?

Did you know that milkweed also supports over 20 other animals? Together they make up the milkweed community. Some feed directly on the milkweed plant and are called **herbivores**. Others are **predators** of these animals and are **carnivores**. Some are **omnivores**, meaning they eat both plants and animals, and others are **nectarivores**. What do you think they eat? And finally, some are **parasites**, meaning they live in or on another animal or plant and get food from it. Under which of those categories would you place the monarch butterfly? How about the caterpillar? We call all of the interactions between members of a community an **ecosystem**.

Activity 1: The Milkweed Community

1. Divide the class into groups of two.
2. To help students learn the insects, cut out [14.1 Milkweed Community Member Cards](#) with just the image and name of the animal and give each pair of students a set.

3. Ask students to group the cards into 5 piles: **herbivore**, **carnivore**, **omnivore**, **nectarivore**, and **parasite**. The cards are labeled to help with the sorting. The omnivores are so categorized if they are omnivorous at their adult stage. The other insects may be carnivorous at the larval stage but nectarivorous at the adult stage. In this case they have been classified as predators since that is generally their main role in the milkweed community. Check answers as a class.
4. Students can arrange the cards into a **food web** by reading the description of each insect to determine its place on the web. Begin with the milkweed at the center. Once they've arranged the web, they can paste the images on a poster. Younger students may simply arrange the insects into various food chains. How many food chains can they make?

Discussion

1. How many different animals are supported by this one plant? How many different interactions did you count in this community (lines drawn between the animals) or how many food chains?
2. Can you think of any other animals that might be part of this community that were not listed (several additional species of bees, butterflies, flies, and beetles are supported by milkweed)?
3. What happens when we lose milkweed habitat? Why is biodiversity important?

ACTIVITY

Activity 2: Milkweed Field Observation (outdoors)

1. Visit a milkweed patch. If there is not one at your school or in your neighborhood, see “Field Trips to NYC Pollinator Habitats” in the Appendix and call ahead to see if they have milkweed that students could observe.
2. Using a list and the [14.2 Milkweed Observation Record](#), count the number of organisms that the students find, where they find them, what they are doing. Take a copy of the [14.1 Milkweed Community Member Cards](#) for reference. If possible, visit the milkweed at different times of day and at different seasons. How does the community change?

Discussion

1. How many different kinds of animals did you observe?
2. On what part of the plant did you observe it? Why do you think it was there?
3. Which animal was most abundant? Why do you think so?
4. Are there any conclusions or inferences we can draw from the observations?

Extensions

1. Milkweed is also useful to people. Students can research all of its historical uses.
2. Milkweed seeds are a great example of seed dispersal by wind. What are some other plant adaptations for spreading seeds?
3. How did milkweed get its name? If you break a leaf off you will see why (see note of caution in Background section).



Did you know?

You may have noticed that most of the insects that feed directly on the milkweed plant display bold colors and patterns. Milkweed is toxic to all other animals; by eating milkweed, these insects become toxic to other animals. Their colors are a warning to predators to keep away or suffer the consequences!

This is also a great way to identify members of the milkweed family (though it is not the defining characteristic).

4. Use NWF plant finder (nwf.org/Native-PlantFinder/Plants) to discover how many caterpillars are supported by other native plants. What other wildlife does the plant support and which wildlife, in turn, is supported by those herbivores? Can students create a food web for that plant?

Books

**Milkweed, Monarchs and More:
A Field Guide to the Invertebrate
Community in the Milkweed Patch**
Karen Oberhauser, Ba Rea,
and Michael A. Quinn

Ages 12+

A comprehensive survey of all the animals in a milkweed patch and their ecological roles; also discusses the plants in the milkweed family.

RESOURCES

Standards

K-LS1-1 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Use observations to describe patterns of what plants and animals (including humans) need to survive.

K-ESS3-1 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.

1-LS1-2 Structure, Function, and Information Processing Read texts and use media to determine behavior patterns of parents and offspring that help offspring survive.

1-LS3-1 Structure, Function, and Information Processing Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

2-LS4-1 Interdependent Relationships in Ecosystems Make observations of plants and animals to compare the diversity of life in different habitats.

3-LS2-1 Interdependent Relationships in Ecosystems Construct an argument that some animals form groups that help members survive.

3-LS1-1 Inheritance and Variation of Traits: Life Cycles and Traits Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

4-LS1-1 Structure, Function, and Information Processing Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

5-LS2-1 Matter and Energy in Organisms and Ecosystems Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

Vocabulary

Carnivore (n): an animal that eats meat.

Community (n): A group of plants or animals that live in the same place, usually interacting with each other and their environment.

Ecosystem (n): The interaction of living and non-living things in a particular environment.

Herbivore (n): an animal that only eats plants.

Omnivore (n): an animal that eats both plants and other animals

Nectarivore (n): An animal that consumes nectar.

Parasite (n): an animal or plant that lives in or on another animal or plant and gets food or protection from it.

Predator (n): an animal that lives by killing and eating other animals : an animal that preys on other animals.

Prey (n): an animal that is hunted or killed by another animal for food.

Online Resources

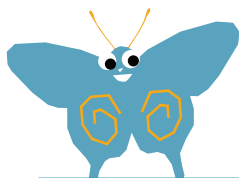
- National Wildlife Federation: bit.ly/ButterflyHeroes
- Monarch Joint Venture: monarchjointventure.org
- Monarch Larva Monitoring Project: mlmp.org
- Monarch Watch: monarchwatch.org
- Journey North: journeynorth.org/monarchs
- Monarch Butterfly Fund: monarchbutterflyfund.org
- Posters: shop.monarchwatch.org/category/Posters

Source: Merriam Webster Learner's Dictionary

MILKWEED COMMUNITY MEMBER CARDS

Name: _____

Date: _____



Study the cards to learn about a few insect species that depend on an ecosystem where milkweed grows. How do these species interact with milkweed plants and each other?

Monarch Caterpillar



The **Monarch caterpillar** is the most famous resident of the milkweed plant. After spending about 2 weeks eating the milkweed leaves and growing about 60 times its original size, it will find a sheltered place near the plant to create its chrysalis.

Herbivore

Milkweed Tussock Moth Caterpillar



The **Milkweed tussock moth** larva doesn't eat the entire milkweed leaf, but rather leaves a lacy framework of veins behind. The pupa overwinters in a cocoon felted with the hairs of the larva.

Herbivore

Milkweed Bug



Milkweed bugs specialize on the milkweed seed, which they consume by injecting saliva into the seed and then sucking up the liquid mush that is produced. They often fall to the ground and play dead when disturbed. The small milkweed bug has a red "X" on its back.

Herbivore

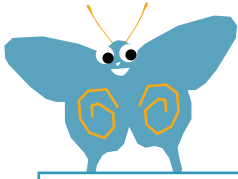
Milkweed Leaf Beetle



The **Milkweed leaf beetle** resembles a large version of the ladybug, yet these beetles feed only on milkweed leaves. Although they are not toxic themselves, by mimicking the colors of some other milkweed insects that are toxic to predators, they are also protected.

Herbivore

Name: _____ Date: _____



Study the cards to learn about a few insect species that depend on an ecosystem where milkweed grows. How do these species interact with milkweed plants and each other?

MILKWEED COMMUNITY MEMBER CARDS

Aphid



Aphids suck the milkweed sap and excrete a sweet “honeydew,” an excess sugar which they can’t process, which is enjoyed by other insects like ants.

Herbivore

Ladybug



The **Ladybug** does not cause damage to plants. Its main diet is aphids, which earns its status as a beneficial insect. Both larva and adult feed on aphids. The ladybug deters predators with its bright coloring, which will be met with a foul smell and taste if they try to eat it.

Predator

Hover (Syrphid) Fly



Hover flies are another insect that feeds on nectar and pollen as an adult, but is carnivorous as larva. The tiny slug-like larvae feed on aphids and other insects. The larvae overwinter in the soil and then emerge as adults in the summer.

Nectarivore

Assassin Bug



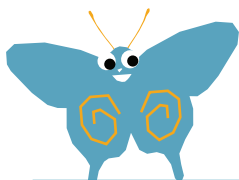
Assassin bugs hide in flowers and wait for unsuspecting prey to land. The assassin bug grabs its prey with its long forelegs and injects it with its toxic saliva, which dissolves the insides. The assassin bug then can drink up the juices with its straw-like mouth piece.

Predator

MILKWEED OBSERVATION

Name: _____ Date: _____

Location: _____ Time: _____ Temperature: _____ Weather: _____



Visit a milkweed patch—a park or garden where milkweed is growing—to look for insects in the milkweed community. Record your observations below.

Bee

On what part of the plant did you observe it?

Tally

Total

Butterfly

On what part of the plant did you observe it?

Tally

Total

Hover Fly

On what part of the plant did you observe it?

Tally

Total

Caterpillar

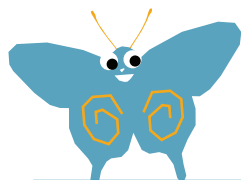
On what part of the plant did you observe it?

Tally

Total

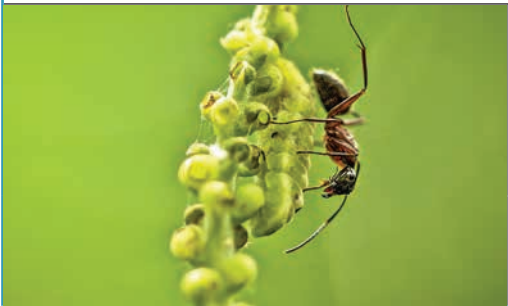
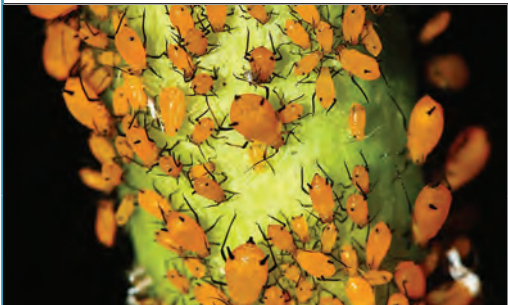
Name: _____ Date: _____

Location: _____ Time: _____ Temperature: _____ Weather: _____



Visit a milkweed patch—a park or garden where milkweed is growing—to look for insects in the milkweed community. Record your observations below.

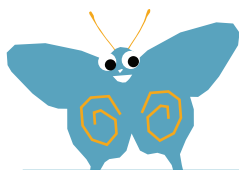
MILKWEED OBSERVATION

Ant		
	On what part of the plant did you observe it?	
	Tally	Total
Aphid		
	On what part of the plant did you observe it?	
	Tally	Total
Milkweed Bug		
	On what part of the plant did you observe it?	
	Tally	Total
Milkweed Leaf Beetle		
	On what part of the plant did you observe it?	
	Tally	Total

MILKWEED OBSERVATION

Name: _____ Date: _____

Location: _____ Time: _____ Temperature: _____ Weather: _____



Visit a milkweed patch—a park or garden where milkweed is growing—to look for insects in the milkweed community. Record your observations below.

Assassin Bug

On what part of the plant did you observe it?

Tally

Total

Ladybug

On what part of the plant did you observe it?

Tally

Total

Other

On what part of the plant did you observe it?

Tally

Total

Other

On what part of the plant did you observe it?

Tally

Total

15 HABITAT HEROES

Habitat Heroes

Background

In the mid 1990s, there were approximately one billion monarch butterflies overwintering in Mexico.

Nearly thirty years later, Eastern monarch populations have declined by as much as 90%. This dramatic decline helps to bring attention to the threats faced by all pollinators and calls us to action. There are many reasons for this devastating decline:

habitat loss affecting the supply of milkweed and nectar sources, overwintering habitat, pesticides and herbicides, and threats brought about by climate change.

Breeding Habitat Loss

Milkweed used to be pervasive in the prairies of the Midwest, where the central population of monarchs breed and fly to Mexico. When farmers started to freely apply herbicides to their fields and use genetically modified crops resistant to herbicides, milkweed was devastated by chemicals. Research by scientists from the Universities of Iowa and Minnesota in 2012 showed a direct correlation between declining monarch numbers and increasing adoption of herbicide-tolerant soybeans and corn.¹ Development has further impacted the range

and abundance of milkweed. Scientists estimate that 99% of tall grass prairies, which once stretched over 90 million acres on the eastern edge of the prairie states, have been lost to development and farming.

Overwintering Habitat Loss

Every year, monarchs travel to the same Oyamel fir forests in Mexico to spend the winter. This is the winter refuge for 99% of North American monarchs. Illegal logging was destroying vast expanses of this forest until “the Mexican authorities began effectively enforcing regulations to protect monarch reserves about seven years ago [in 2008],” says Scott Hoffman Black, executive director of the Xerces Society for Invertebrate Conservation and co-chair of the Monarch Joint Venture, a partnership of more than 20 U.S. federal and state agencies, universities and nongovernmental organizations, including the National Wildlife Federation. “Enforcement, along with economic support for local people, has mostly curtailed

¹ monarchjointventure.org/monarch-biology/threats/breeding-habitat-loss

BACKGROUND

Habitat Heroes (Continued)

large-scale logging.”¹ However, small scale logging remains a problem and impacts the unique microclimate that monarchs seek in the Oyamel fir stands, which may increase monarch mortality.

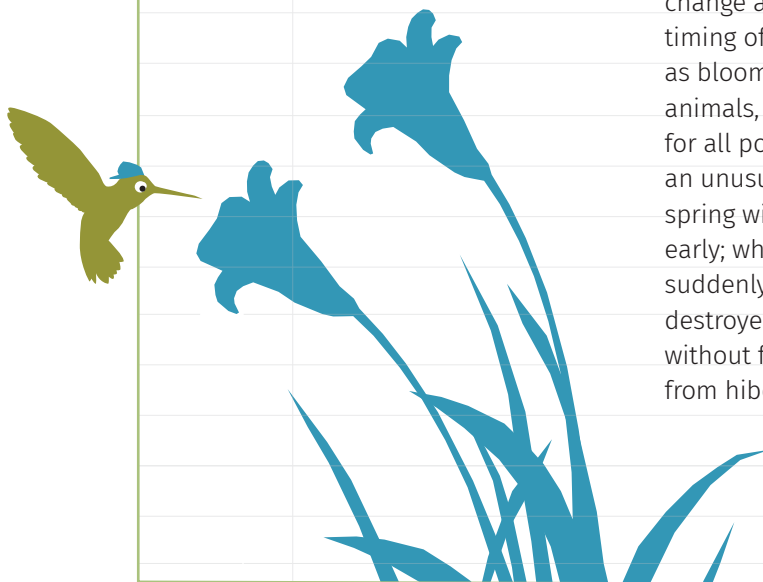
Pesticides

Pesticides do not discriminate. The application of herbicides and insecticides affects all insects and plants, not just the insect or plant pests they are meant to target. Herbicides kill larval host plants like milkweed, in addition to the “weeds” they are meant to eradicate. Insecticides kill beneficial insects such as pollinators as well as those considered “pests.” Pesticides known as neonicotinoids are

especially harmful to pollinators because they are systemic, meaning their compounds are distributed to all parts of the plant, rendering everything—leaves, nectar, pollen, seeds—toxic to the insects. This toxicity can then be transferred to the animals that feed on these insects.

Climate Change

Monarchs, which depend on environmental cues such as temperature and weather to initiate reproduction, migration, and hibernation are especially vulnerable to the impacts of climate change and extreme weather events. These conditions influence the availability of breeding and overwintering habitat, including the bloom times of flowering plants. When climate change affects phenology, the timing of biological events such as bloom time or breeding of animals, this can create a problem for all pollinators. For example, an unusually warm spell in early spring will cause flowers to bloom early; when the temperatures suddenly cool, those buds can be destroyed by frost, leaving the bees without flowers when they emerge from hibernation.



¹ nwf.org/Magazines/National-Wildlife/2015/AprilMay/Conservation/Battle-for-Butterflies

Lesson 15

Summary

Students play a game that simulates the monarch butterfly's migration journey and its challenges.

Materials

- 15.1 Maine to Mexico Migration Game Action Cards
- chart paper, markers, tape

Preparation

Activity

- Print 15.1 Maine to Mexico Migration Game Action Cards
- Playground cones
- Optional: Cardboard with sun painted on one side and a rain cloud on the other
- Optional: bandanas, or other item to distinguish the three birds from monarchs

Objectives

Students will:

- understand the habitat needs of the monarch butterfly.
- understand how habitat resources are affected by human activity.
- understand how people can protect habitats through environmental stewardship.

ACTIVITY



Introduction

Review the components of a habitat. What resources does an animal need to find in a habitat (food, water, cover, places to raise young)? Ask students to imagine they are monarch butterflies. What might be their source of food, etc? Will that change at different points in their life cycle (think caterpillar vs. butterfly)? In Lessons 6 and 13, students learned that

milkweed is the only source of food for the monarch caterpillar and a valuable source of nectar for the adult as well.

Ask the class to stand up. Now ask 90% of the class to sit down. That is how many monarchs have disappeared in the last 20 years. Why have their numbers declined so dramatically? What happens if they don't find enough milkweed or flowers for nectar? Why might they not find enough?

ACTIVITY

Activity: Maine to Mexico Migration Game**Summary**

This game gives students a chance to simulate the monarch migration in order to learn some of the challenges monarchs face on their journey. **The objective of the game is for each monarch to try to survive their migration to Mexico in the face of many challenges.** It is not designed to be competitive, although some students will complete the migration before others.

Set up the game

1. **This game is best played outdoors but can also be played in a gym.** Review the procedure with the class.
2. **Set up the playing area with cones or other objects.** One end of the play area is the northern start of the monarch's journey (Maine); the opposite end is the monarchs' destination, their overwintering grounds in Mexico. Designate other boundaries on the sidelines.
3. Split students into **three groups**:
 - a. The first group will be the "flowers".
 - b. The second group will act as "trees".
 - c. The third group will be the "monarchs".
4. The **"trees"** will hold their arms in a certain way to mimic trees; the **"flowers"** will hold their arms another way to look like flowers. The trees act as a shelter for the monarchs to rest at night or when it is raining to stay dry. Monarchs can't fly with wet wings. The flowers represent nectar sources that the monarchs must visit in order to refuel for their journey. They should place themselves randomly across the playing field.

5. Designate three students as **"birds"** (predators). Monarchs carry a poison in their body from ingesting milkweed as a caterpillar. When a bird eats them, they will vomit and learn not to eat them again. When the bird tags a monarch, the monarch will become the new bird and the bird will now become a monarch. There are no "tag backs". The bird can only tag one monarch at a time since they learn quickly not to catch any more. It may be helpful to designate these birds with a bandana so that it is easy to identify them.
6. Designate one leader as the **"Sun and Rain"** who will stand on the side of the playing field. He/she will either call "sun," "rain," or "night." If you have posters, the leader can also hold them up as a visual cue and put the poster down when they call "night."
7. Students will switch roles each round so that students get a chance to be a flower, a tree, a butterfly, and predator.

Play the game

1. **Tell the butterfly students that they are monarch butterflies about to begin their journey from Maine to Mexico.** They need to think like a butterfly and follow these rules:
 - a. Students will start at one end of the playing area, which represents Maine.
 - b. Depending on the size of your field, the flying monarchs can walk, run, or even hop on one foot. Let them use their wings!
 - c. They need to stop and drink nectar from a flower every day. They need to stay on the flower for 5 seconds.
 - d. They can only "fly" when the sun is out.

ACTIVITY



Did you know?

The Eastern monarch populations declined by 90% in a 20 year period beginning in 1990. Recent conservation efforts have led to a modest but encouraging population rebound.

- e. When the leader calls “rain,” they must get to a tree for shelter. When the leader calls “night” they must also find a tree. When this happens, pause and let monarchs know who the birds are, since it may have changed.
 - f. They can start “flying” south when the leader calls “sun.”
 - g. **The game ends when all students have arrived at the other end of the playing area**, which represents the overwintering site in Mexico.
 - h. After the game, discuss how long the journey really takes, and talk about what challenges the monarchs may face on their journey.
 - i. You can also play this in reverse. After spending the winter in Mexico and finding a mate, the monarchs have to travel north. Explain that one monarch does not make the complete journey; but like a relay race, they lay their eggs on the milkweed they find along the way, die, and their offspring continue the journey. It is imperative that they find milkweed because it’s the only plant that they can lay their eggs on. See if they remember why. So now some of the wild flowers will also be milkweed.
2. **Add challenges during the journey.**
- a. The teacher can call “freeze!” and read an action card from [15.1 Maine to Mexico Migration Action Cards](#). Each time a card is read, all the monarchs have to perform the action on the card, either moving forward or backward. At that time they cannot be caught by the predator. They must wait until the leader calls “sun” before they can move again.

Debrief the game

1. After the game, either in the play area or back in the classroom, review the habitat needs of animals.
2. As a class or in groups, divide a chart paper into quarters (you can also create a quadrant with chalk or rope if outdoors). Write one of the monarch’s habitat needs in each quadrant: **food, water, cover, places to raise young**.
3. Have the students (or yourself) read aloud one [15.1 Maine to Mexico Migration Action Cards](#) and place it in the quadrant that it impacts. You can do this with both positive and negative impacts.
4. For example, if the card states, “You find a meadow full of wildflowers, move FORWARD 2 flowers”, the card will be placed in the “food” quadrant because the monarch’s food source is nectar from flowers.
5. If a card applies to more than one quadrant, place it near the border between both. If all quadrants are impacted the card can go in the center.

ACTIVITY/RESOURCES

Discussion

1. Was it challenging to be a monarch? Why?
2. Ask each group to choose a quadrant and name the action cards they placed there. Discuss if others had anything different. Use the answer key to help guide the discussion. How do these actions affect habitat?
3. Which impacts are caused by nature and which are caused by humans?
4. Look at the negative impacts. What is one thing people can do to prevent or reduce these impacts? How can we become “Habitat Heroes?”

Extensions

1. Use the charts and maps at bit.ly/MonarchRecovery and compare data on the decline of monarch populations

to the loss of monarch habitat, particularly milkweed.

2. Research the overwintering habitat of the Monarchs in mountains of Mexico: bit.ly/OverwinteringMonarchs. What makes it unique? What are the threats to this habitat?
3. Visit welikia.org for a list of species that once lived in NYC. Use a guide book or iNaturalist to find out their current range. Why do you think they disappeared from this area?

Resources

National Wildlife Federation Magazine | Battle for Butterflies: bit.ly/BattleForButterflies

Monarch Joint Venture | Monarchs at Risk: bit.ly/MonarchsAtRisk

Answer Key

1. *You find a meadow full of wildflowers:* **impacts to Food.**
2. *You find an unmowed field full of milkweed, perfect for your baby caterpillars:* **impacts to Food and Place to raise young.**
3. *You find a muddy puddle in which to have a drink:* **impacts to Water.**
4. *A school has planted a butterfly garden:* **impacts to Food, Water, Shelter, Place to Raise Young.**
5. *You find an organic farm with flowers:* **impacts to Food.**
6. *A farmer mows the field of wildflowers to make room for cattle:* **impacts to Food.**
7. *A farmer sprays some pesticides on the field to get rid of weeds:* **impacts to Food, Place to raise young.**
8. *A field of milkweed is cleared for a new mall:* **impacts to Place to raise young.**
9. *The Oyamel fir forest in Mexico has suffered drought conditions:* **impacts to Shelter.**
10. *An acre of the Oyamel fir forest has been cleared by logging:* **impacts to Shelter.**

Adapted from Jennifer Palmer of Brooklyn Nature Club

RESOURCES

Standards

K-LS1-1 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Use observations to describe patterns of what plants and animals (including humans) need to survive.

K-ESS3-3 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

3-LS4-4 Interdependent Relationships in Ecosystems Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

Vocabulary

Habitat (n): The place or type of place where a plant or animal naturally or normally lives or grows. The place that provides the animal with food, water, shelter, and a safe place to raise young.

Source: Merriam Webster Learner's Dictionary

**Books**

The Monarchs are Missing
Rebecca Hirsch

Ages 12+

Discusses why monarchs are disappearing and what we can do to help.

Back from the Brink
Nancy F. Castaldo

Ages 9–12

Profile of animals that have come close to extinction and the passionate individuals who work to protect them.

Isabel's House of Butterflies
Tony Johnston

Ages 5–9

Fictional story of a Mexican girl whose family must either cut down the butterfly tree for their own resources or save it for the monarchs.

MAINE TO MEXICO MIGRATION CARDS

Name: _____

Date: _____



Teacher instructions: cut out the cards and use them during the Maine to Mexico Migration Game.

1. You find a meadow full of wildflowers. Move FORWARD 2 flowers.	2. You find an unmowed field full of milkweed, perfect for your baby caterpillars. Move FORWARD 2 flowers.
3. You find a muddy puddle in which to have a drink. Move FORWARD 1 flower.	4. A school has planted a butterfly garden. Move FORWARD 2 flowers.
5. You find an organic farm with flowers. Move FORWARD 1 flower.	6. A farmer mows the field of wildflowers to make room for cattle. Move BACKWARD 2 trees.
7. A farmer sprays pesticides on the field to get rid of weeds. Move BACKWARD 2 trees.	8. A field of milkweed is cleared for a new mall. Move BACKWARD 2 trees.
9. The Oyamel fir forest in Mexico has suffered drought conditions. Many trees have died. Move BACKWARD 1 tree.	10. An acre of the Oyamel fir forest has been cleared by logging. Move BACKWARD 1 tree.

16 A POLLINATOR FOOD WEB

A Pollinator Food Web

Background

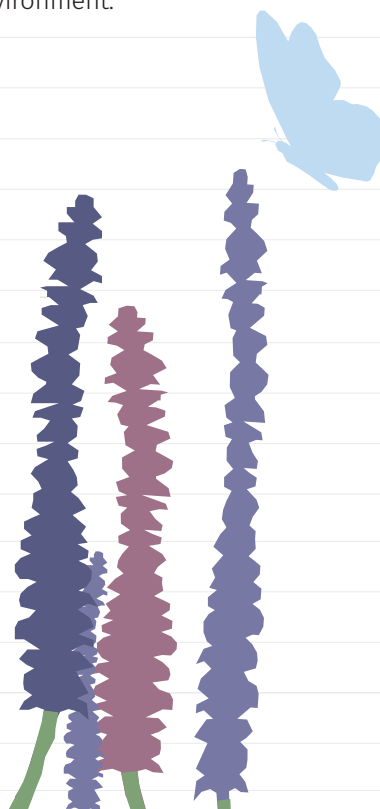
Pollinators are a vital link in the natural food web.

In [Lesson 4: Why Pollinators?](#), we learned how pollinators play an essential role in agriculture. In this lesson, we focus on how they support the foundation of an ecosystem, in general. Over 75% of flowering plants depend on pollinators to reproduce.¹ Fruits and seeds derived from insect pollination are a major part of the diet of approximately 25% of all birds and mammals.² These primary consumers become food for larger mammals and predators.

Pollinators themselves are also the basis of the natural food web; a pair of chickadees needs 6,000 to 9,000 caterpillars just to feed one brood of hatchlings.³ Some birds and other insects also prey on bees. Because of their role in producing the foods that so many people and animals rely upon – and also facilitating plant reproduction – pollinators contribute to biodiversity as well as to clean air, carbon

sequestration, and stable soils.⁴

The natural predators of pollinators pose little threat compared to the human impacts such as habitat loss, pesticide use, climate change, and the introduction of disease and competition. These threats to pollinators are also threats to the foundations of our ecosystems. The first step in restoring the delicate balance in ecosystems is understanding the indispensable role that pollinators play in our environment.



¹ <https://xerces.org/pollinator-conservation/>

² <https://xerces.org/pollinator-conservation/>

³ Tallamy, Douglas W. Bringing Nature Home: How You Can Sustain Wildlife with Native Plants. Timber Press, 2009.

⁴ Costanza R, d'Arge R, de Groot R, Faber S, Grasso M, Hannon B, Limburg K, Naeem S, O'Neill RV, Paruelo J, Raskin RG, Sutton P, and van den Belt M. 1997. The value of the world's ecosystem services and natural capital. Nature 387:254-260.

ACTIVITY



Lesson 16

Summary

Students learn about the importance of pollinators in our ecosystems by creating a food web and planting sunflower seeds outdoors.

Materials

- **16.1 Pollinator Food Web Images**, scissors, colored yarn, markers, tape, glue sticks, poster board, sunflower seeds, journals, pencils

Preparation

Activity 1

- Print **16.1 Pollinator Food Web Images** (one copy per group of 4–6 students)

Activity 2

- Order several varieties of sunflower seeds.

Objectives

Students will:

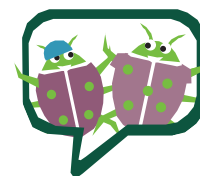
- develop a basic understanding of food chains and food webs.
- understand the concept of interdependence.
- recognize the important role of pollinators in ecosystems.

Introduction

We have learned that pollinators are responsible for bringing us many of the foods that we eat. Ask students to recall how pollinators play that role. Remind students of some of the foods that are the result of animal-pollination (apples,

blueberries, grapes, etc.) or review [4.1 Animal- and Wind-Pollinated Crops](#). Are we the only ones that eat these crops? Are there any animals that may eat them as well? Which ones? For example, birds and bears eat berries and monkeys eat bananas.

ACTIVITY

Activity 2
Discussion

1. How will we know if the sunflower has been pollinated?
2. Which animals eat sunflower seeds? How are they dependent on pollinators?

Activity 1:
Build a Pollinator Food Web

1. Discuss with the class the concept of a **food chain** or **food web**. You can introduce the terms: herbivore, carnivore, omnivore, predator, and prey. For older students you may also discuss trophic levels (producer, primary consumer, secondary consumer, tertiary consumer).
2. Divide the class into groups and give each group a copy of [16.1 Pollinator Food Web Images](#).
3. Students will cut out the images and organize them into a food chain (for younger students) or a food web (for older students). The image of the sunflower (which is pollinated by bees) can be placed in the center of the web.
4. After the groups are satisfied with their food chains or webs, ask them to glue the images onto poster board or a large sheet of paper. They can use markers or yarn to link the animals. Let them display this either as a collage or in another artistic way and then share with the rest of the class

Discussion

1. How many animals depend on the sunflower? What part of the plant do they eat? (bees eat pollen and nectar; other animals eat the seeds).
2. How do the seeds get there (through bee and insect pollination)?
3. What are some predators of bees (birds and spiders)?
4. What if there were no bees?

Activity 2: Planting
Sunflowers (outdoors)

1. To demonstrate the influence of pollinators in the food chain, plant sunflowers with the students in the spring. Pass out seed packets to groups and explain the terms **germination** (when the seeds will sprout) and **days to maturity** (when the plant will bear new seeds) that appear on the seed packets.
2. Seeds can be planted directly in soil, according to the information on the seed packets. Sunflowers typically prefer sunny locations, sprout easily, and are quite hardy. It's nice to plant a few varieties in the same bed. You might keep a seed of each variety for later comparison and let students try to match those original seeds with the new seeds that the mature plants produce.
3. Students can keep a **sunflower journal**. They can record the date they planted the seed and a description of the steps that they took to plant them. Ask students to predict when the sunflowers will emerge based on the germination timeline and the month or date that they will reach maturity. They can continue to observe and document the changes in the growing plants, including the pollinators that visit the flowers. During the next fall, they can observe the birds or other animals that visit the sunflowers.
4. In the fall, the class can harvest a sunflower and look at the seeds arranged in a beautiful pattern. Each seed was the base of a flower; sunflowers are actually made up of hundreds of tiny flowers within a larger flower. In botany this is called an **inflorescence**.

ACTIVITY

Extensions

1. In the schoolyard or the gym, play **Bee, Thrush, Hawk**.
 - a. A group of students makes a circle by joining hands. This is the **bee nest**.
 - b. Another group is scattered around outside the circle. They are the **trees**.
 - c. A hula hoop is placed at the far end. This is a **flower**.
 - d. One student is chosen to be the **bee** and begins inside the circle (nest). Another student is chosen to be the **thrush** and stands at a tree. A third student is chosen to be the **hawk** and stands at another tree.
 - e. The bee has to reach the flower and return to the nest without being tagged by the thrush, while the thrush tries to avoid being tagged by the hawk. The bee is safe only in the nest or the flower. The thrush is safe from the hawk only when touching a tree.
 - f. Rotate roles.

Vocabulary

Carnivore (n): An animal that eats meat: a meat eater.

Ecosystem (n): the interaction of living and non-living things in a particular environment.

Food chain (n): a series of types of living things in which each one uses the next lower member of the series as a source of food.

**Did you know?**

Pollinators are also the basis of the natural food web. Fruits and seeds derived from insect pollination are a major part of the diet of approximately 25% of all birds and mammals.¹ A pair of chickadees needs 6,000 to 9,000 caterpillars just to feed one brood of chicks!

2. Research organic farming practices or integrated pest management (IPM). What do you think happens to the food chain when gardeners or farmers apply pesticides? How might the other animals that prey on these “pests” be affected? Can you think of other solutions to help farmers prevent pests from eating their crops?



Source: Merriam-Webster Learner's Dictionary

¹ <https://xerces.org/pollinator-conservation/>

RESOURCES

Books

Up in the Garden, Down in the Dirt**Kate Messner**

Ages 6–10

A girl learns about the animals that live in the garden as she tends it through the seasons

Connected Wisdom: Living Stories**About Living Systems****Linda Booth Sweeney**

Ages 6–10

Parable-like stories from around the world that encourage young readers to think in systems and appreciate the complexity of the living world from an early age.

Sunflower House**Eve Bunting**

Ages 4–7

A charming tale about inventive children who plant sunflower seeds.

On Meadowview Street**Henry Cole**

Ages 5–8

After moving to a new house, young Caroline and her parents encourage wildflowers to grow and birds and animals to stay in their yard, which soon has the whole suburban street living up to its name.

Standards

K-LS1-1 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment

Use observations to describe patterns of what plants and animals (including humans) need to survive.

K-ESS3-1 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment

Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.

1-LS3-1 Structure, Function, and Information Processing

Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.

2-LS4-1 Interdependent Relationships in Ecosystems

Make observations of plants and animals to compare the diversity of life in different habitats.

3-LS2-1 Interdependent Relationships in Ecosystems

Construct an argument that some animals form groups that help members survive.

3-LS1-1 Inheritance and Variation of Traits: Life Cycles and Traits

Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.

5-LS2-1 Matter and Energy in Organisms and Ecosystems

Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

POLLINATOR FOOD WEB IMAGES

Name: _____

Date: _____



Cut out the images below. Work with your group to create a food chain or food web with the images. Glue the images on poster board and show connections with yarn or markers.

Sunflower	Human
	
Bee	Bear
	
Bird	Caterpillar
	
Spider	Squirrel
	

17 POLLINATOR PATHWAYS

Pollinator Pathways

Background

Insect populations have declined dramatically in recent decades.

If you have lived long enough, you may sense that there is something off in the insect world—it seems that insects are not as abundant as they once were. Recent studies have confirmed these observations with alarming facts. A 2016 “German study found that, measured simply by weight, the overall abundance of flying insects in German nature reserves had decreased by 75 percent over just 27 years. If you looked at midsummer population peaks, the drop was 82 percent... In the United States, scientists recently found the population of monarch butterflies fell by as much as 90 percent in the last 20 years, a loss of 900 million individuals. The rusty-patched bumblebee, which once lived in 28 states, dropped by as much as 87 percent over the same period [and is now an endangered species].”¹

As this research makes evident, pollinators are in crisis. The decline in populations and biodiversity is attributed to several factors, the main one being **habitat loss and**

fragmentation. In just over two centuries, the North American landscape has been dramatically altered by human settlement, agriculture, and other economic activities. Prairies once covered 48% of the lower 48 states. Scientists estimate that 99% of tall grass prairies, which once stretched over 90 million acres on the Eastern edge of the prairie states, have been lost to development and farming. Over 50% of wetlands in the lower 48 states have been cleared, drained, filled, or destroyed and more than 90% of old-growth forests of the Pacific Northwest have been disturbed by development and logging.² For pollinators, the loss of habitat means fewer places to nest or lay eggs and fewer flowers for foraging. Pollution, pesticides, and climate change are also contributing to the decline of pollinators and many other classes of animals.

There is no doubt that, just as we have created this crisis, we can also help to remedy it. No matter where we live, we all have the

¹ <https://www.nytimes.com/2018/11/27/magazine/insect-apocalypse.html>

² https://www.nwf.org/-/media/PDFs/Eco-schools/SchoolyardHabitatsHowToGuide_Part2.pdf

³ Hall, Damon M. et al. 2016. The City as a Refuge for Insect Pollinators. *Conservation Biology*. 31, No. 1: 24–29.

⁴ <http://greatpollinatorproject.org/>

⁵ <https://www.naba.org>

⁶ <https://www.nationalgeographic.com/environment/2019/06/monarch-butterflies-dying-out-cities-could-help-save-them/>

BACKGROUND

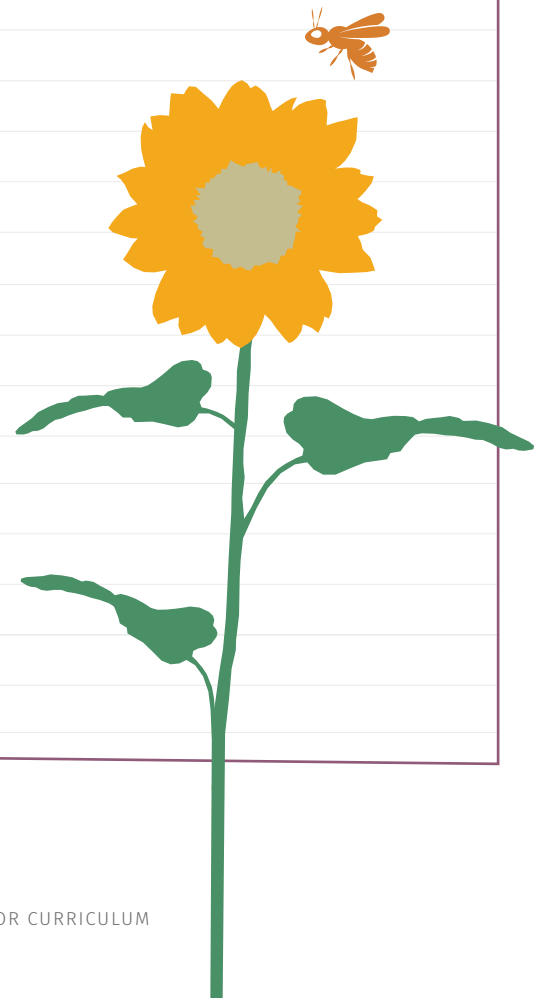
Pollinator Pathways (Continued)

power to help pollinators in some way—creating a schoolyard habitat is an excellent way. We often think of cities as biological deserts, yet several new studies reveal that urban centers support a diverse community of bees and, depending on the species, sometimes greater than the surrounding countryside. Furthermore, the biodiversity of bees found in urban areas has been shown to affect the biodiversity in nearby agricultural lands.³ There are over 230 different species of bees⁴ and 120 species of butterflies⁵ in New York City alone. A recent study concluded that cities can provide a significant 30% of the milkweed habitat needed to save the populations of Eastern monarchs from decline.⁶

Therefore, cities have the potential to support pollinator biodiversity and overall populations. Compared to larger mammals, pollinators have relatively low functional requirements when considering their habitat range, life cycle, and nesting behavior. This is promising research given the expansion of urban areas worldwide.

Through education and proper land management of yards, rooftops,

public parks, community gardens, school gardens, and greenways, cities can indeed become refuges for pollinators. By incorporating pollinator habitats into existing urban green spaces and expanding the network of such spaces, we can address habitat fragmentation by creating a connected patchwork of urban parks and gardens. If we can link our isolated gardens to create green corridors, pollinators can more easily forage, find shelter, and reproduce, ensuring the survival of the species and fostering diverse, resilient urban ecosystems.



ACTIVITY



Lesson 17

Summary

Students learn how habitat fragmentation affects animals and the importance of restoring and connecting habitat for pollinators. They will take a walk in the neighborhood to assess the potential of creating a larger network of interconnected pollinator habitats.

Objectives

Students will:

- develop mapping skills.
- understand how habitat fragmentation affects animal populations.
- understand the importance of habitat connectivity.
- conduct a neighborhood habitat site assessment.

Materials

Grades K–2

- 17.1 Mapping Habitats

Grades 3–5

- Google Maps, hula hoops, cones or sidewalk chalk

Preparation

Activity 1

- Set-up cones or hula hoops as described in activity.

Activity 2

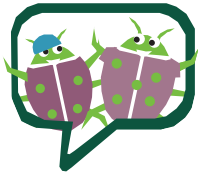
- Print **17.1 Mapping Habitats** (one copy per student)
- Grades K–2
 - Print Google map with school address for your reference.
- Grades 3–5
 - Print Google map with school address.
 - Draw a one mile radius around the school, to scale.

Introduction

Several centuries ago, when Lenape people inhabited this land we now call New York, many different wildlife species also lived here. Wolves, foxes and bears once roamed in the places that are now paved by streets. Why have they disappeared? We now have parks and community gardens in the city, but these are only a small **fragment** or piece of what

the original wolf habitat may have looked like. When a habitat becomes fragmented, it's not possible for many species to find all their needs, especially if they normally have a large habitat range. That is why large mammals like wolves and foxes disappeared from here, while the smaller ones like gray squirrels remained. Why is that? Parks and green spaces provide enough habitat resources to support a

ACTIVITY

Activity 1
Discussion

1. How do more gardens help meet the foraging needs of bees?
2. Besides adding more gardens, what else was important?
3. Did the bees gather enough nectar when the gardens were clustered together? What about when they were far apart?

population of squirrels but not enough for wolves. Pollinators like butterflies and bees can fly between these “habitat islands,” but they also need places to rest and gather food. What if the “habitat islands” are too far apart?

Do you think our schoolyard will provide all of the habitat needs for pollinators? Look at [5.1 NYC Bee Guide](#) for bee ranges. Help them notice that the bee range depends on its size. Smaller bees may fly no further than 500 yards from the nest, while larger bees like bumble bees can fly more than a mile. Does this mean they need to make a nest right where their food source is? What about an ant? Do you think its habitat is as large as the bee? Why not? What about the butterflies? Do you think they can meet all of their habitat needs for food, water, shelter, and a place to lay eggs in just one garden? And what about butterflies that migrate, like monarchs? Why is it important to look beyond our schoolyard when creating a pollinator habitat?

Activity 1:
Connect-the-Habitat-Dots

Set-Up

1. Place cones or hula hoops around the schoolyard or gym. If the school doesn't have these supplies, you can use sidewalk chalk or rope. Place some near each other and some far apart.
2. Students can be divided into groups, evenly distributed at all the cones.
3. The cones represent gardens and parks in the city where the bees nest.
4. **The students are bees.**

Round 1

1. **Bees (students) must travel to at least three gardens (cones) in order to gather enough nectar to meet their needs.** Younger students (K-2) may visit one or two gardens.
2. In round one, all students are small carpenter bees (*Ceratina* spp.) They have a small range of less than 500 yards. To travel to the gardens, they can only take four leaps between each cone. Let them see if they can visit three gardens and return home. Once they all return home, ask for a show of hands to see who was able to meet their needs (gather enough nectar)?
3. Add more cones to the area to represent additional schoolyard habitats or community gardens. Play another round. Again take a show of hands to find out which students (bees) were able to gather nectar from three gardens. Were they more successful with additional gardens?

Round 2

4. Start with the same number of cones as round 1, but move them further apart. **Now students are large bumblebees with a range of over 1 mile. They need to visit five gardens to gather enough nectar.** They must take seven leaps between gardens.
5. Take a show of hands to find out which students (bees) were able to gather nectar from five gardens.
6. Add more cones to the area to represent additional gardens but cluster some close together, while leaving others further away.
7. Play again. Were they more successful with additional gardens?

ACTIVITY

Activity 2: Mapping Habitats

Grades K–2

1. Tell students that they will be taking a walk around the school to see if they can locate any sites that can serve as a pollinator habitat that will connect to our schoolyard habitat.
2. Print a Google map of your school location. Decide on a radius or how many blocks to explore around the school with students. Use this for your own reference.
3. As they saw in the first activity, when habitats are connected, pollinators can travel and find what they need. The neighborhood sites don't necessarily need to have anything growing there yet, but should have a sunny space that may allow for a planted pollinator garden. Give each student Worksheet [17.1 Mapping Habitats](#) to record open space in the neighborhood.

Discussion

1. Are there any sites that may already serve the habitat needs of bees?
2. Where are the opportunities to expand habitat other than our own schoolyard? How can we help achieve that goal?

Grades 3–5

1. Print a Google map of your school location. If you are working with a set radius, you can print a Google Map of your location and use the scale to draw a radius from your location (unfortunately at the time of publication, Google did not offer this tool so it needs to be done manually). Print a copy for each student.
2. Tell students that they will be taking a walk in the neighborhood to see if they can locate the green spaces on the map. They should indicate the following on their maps using a legend. Let them decide what to include in the legend. For example:
 - a. Existing community gardens
 - b. Existing parks
 - c. Existing school gardens
 - d. Vacant lots
 - e. Public property (schools, libraries, street trees, public housing with open space).
3. Take the maps and any necessary writing and drawing tools on a walk around the school to map the green spaces in the neighborhood using the legend. They can write the addresses of these green spaces on [17.1 Mapping Habitats](#).

Discussion

1. How many of each type of open space exists in the neighborhood? How many community gardens? Vacant lots?
2. Look at [5.1 NYC Bee Guide](#) to find the foraging **range** of bees. This tells us how far bees will fly from their nests for food. Which bees, if any, would be satisfied by the habitat around the school? Remember pollinators prefer certain types of flowers and bees can visit one thousand or more flowers per day. Are there any undisturbed areas where bees can nest?
3. How can we make our neighborhood more pollinator friendly? Where are the opportunities to expand habitat other than our own schoolyard? How can we help achieve that goal?

ACTIVITY/RESOURCES

Extensions

1. Find out if your Mayor has signed on to the NWF Mayors' Monarch Pledge (bit.ly/MayorsMonarchPledge). If not, students can write to the Mayor's office and ask the Mayor to sign on, stating why it is important and how their school is leading the way.
2. Did you find an unused lot in the neighborhood? Contact Green Thumb (bit.ly/NYCGreenThumb) to learn about the process of starting a garden. How can students get involved?
3. Create a pollinator habitat in the street tree beds outside the school. Refer to (bit.ly/TreeBeds) for tips on planting in tree beds.
4. Reach out to a local community garden to see if there are opportunities to create habitat or educate garden members. Create a small pollinator patch or design signs or artwork about pollinators and the plants they prefer.

Standards

K-LS1-1 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Use observations to describe patterns of what plants and animals (including humans) need to survive.

Online Resources

- NYC City Map
gis.nyc.gov/doitt/nycitymap/
- Green Thumb Community Gardens
bit.ly/NYCGreenThumb
- The Welikia Project
welikia.org/

**Did you know?**

Some bees, like the bumble bee, are known to travel up to 3 miles from their nest.

K-ESS3-3 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment

3-LS4-3 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

3-LS4-4 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

5-ESS3-1 Earth's Systems Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

3-5-ETS1-1 Engineering Design Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

RESOURCES

Books

Back from the Brink**Nancy F. Castaldo**

Ages 9–12

Profiles of animals that have come close to extinction and the passionate individuals who work to protect them.

Don't Let Them Disappear**Chelsea Clinton**

Ages 4–8

Picture book that introduces young readers to a selection of endangered animals from around the world. Provides a positive message on what we can do to help them.

The Wolves are Back**Jean Craighead Geore**

Ages 4–8

Tells the story of how wolves nearly became extinct in the United States and were gradually reintroduced to places where they are thriving again.

The Curious Garden**Peter Brown**

Ages 5–7

While out exploring one day, a little boy named Liam discovers a struggling garden and decides to take care of it. As time passes, the garden spreads throughout the city, transforming it into a lush, green world.

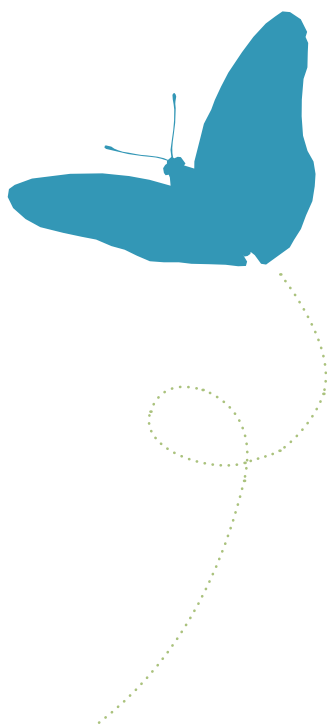
3-5-ETS1-2 Engineering Design Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Vocabulary

Fragment (n): A broken part or piece of something.

Range (n): The area in which an animal or plant naturally lives.

Source: Merriam Webster Learner's Dictionary



MAPPING HABITATS

Name: _____ Date: _____



Take a walk in the neighborhood. Use your map to help you find green spaces. Write the name of the property and its address. Check the box if it looks like a good habitat for pollinators or a potential site for a new pollinator habitat. Reminder: pollinators need food (nectar or leaves from plants), water, cover, and places to nest.

Property Name and Address	Existing pollinator habitat?	Potential future pollinator habitat?
Community Garden		
School Garden		
Park		
Public Property (library, community center, etc.)		
Other		

18 SCHOOLYARD HABITAT AUDIT

Urban Schoolyard Habitat Audit

Background

Students will apply what they have learned about pollinators to create their own urban schoolyard habitat, gaining a sense of stewardship and agency.

As outlined in the [NWF Schoolyard Habitats® How-to-Guide](#), the creation of a schoolyard habitat involves a team and a vision. If you haven't already, now is the time to put together the Habitat Team, gain support from the staff, and fundraise for the project.

After the Habitat Team has been formed, and a vision for the urban schoolyard habitat project has been developed, it's time to engage students in an audit of the schoolyard in its present state. This assessment of the schoolyard is called a "site inventory" because it includes taking an inventory of various physical and biological components of the schoolyard. The purpose of the site inventory and the analysis of the information collected is to discover the opportunities and constraints of your site. A thorough understanding of the site conditions helps the Habitat Team make decisions about the design and use of the schoolyard habitat. Before you decide on a

location for your habitat project, investigate the school grounds and consider sunlight, traffic patterns, and accessibility. The inventory and analysis process will make you aware of many schoolyard features which may not be readily apparent.

A site inventory is an important educational step in the development of an urban schoolyard habitat site. In this first phase of the project, team members and students go outdoors to familiarize themselves with the schoolyard. Subsequent mapping activities will help students create a "big picture" of all the observations and data collected during the site inventory. These activities will create connections between students and will also provide invaluable information to plan the garden. Conducting a thorough site analysis requires spending a good deal of time out on the site.



BACKGROUND

Urban Schoolyard Habitat Audit (Continued)

In selecting the site for a schoolyard habitat, there are several important considerations for the Habitat Team:

- **Traffic Patterns:** study foot traffic on your site. While the habitat can be incorporated into a play area, it should be protected from areas of active play and ball games.
- **Water Accessibility:** choose a site that is near to a water spigot for a hose. You may also choose a sustainable method of watering by harvesting water off the school building.
- **Sunlight:** many native pollinator plants are wildflowers adapted to a meadow habitat, meaning they prefer full sun (6-8 hrs./ day). Others are adapted to woodland edges, meaning they prefer part-sun (3-4 hrs./day).
- **Land Use:** are you planning to install raised beds on pavement or is there already a place on the school grounds that is unpaved for in-ground planting? Will you be excavating pavement? Contact the custodian for blueprints to ensure that there are no underground utilities that will interfere with the garden creation. Additionally, consider how the adjacent land is being used. You want to avoid areas within 100 feet of dumpsters to prevent rodents;

if it's near a busy street, you will want to create some sort of buffer from car exhaust and street litter.

- **Soil:** make sure to get the soil tested before you begin planting to ensure it is safe. See Garden Resources in the Appendix.

As you conduct the audit, be sure to document the process. **Take photos of the site before you begin work;** people will be amazed how the space was transformed when they see what existed before. Keep a record of the data and observations students make. After the habitat is established, the class can conduct a post-audit in the same season as the baseline audit, and compare observations. One of the goals of the audits are to document how the urban schoolyard habitat increases the presence of wildlife, especially pollinators.

You can also use these audits and photos to apply for an Eco-Schools award: www.nwf.org/Eco-Schools-USA/Awards.

Lesson 18

Summary

Students survey their schoolyard to determine the best location for a pollinator habitat. Once the site is selected, they assess its existing physical and ecological features.

Objectives

Students will:

- investigate how the school grounds are used.
- collect, record, map, and analyze data about their schoolyard habitat site.
- identify ways to improve pollinator habitat and ways to increase overall biodiversity.

Materials

- 18.1 Pollinator Habitat Survey
- 18.2 Choosing a Site
- 18.3 Urban Schoolyard Habitat Audit Worksheet Grades K–3
- 18.4 Urban Schoolyard Habitat Audit Worksheet Grades 4–5
- 6.2 NYC Butterfly Field Guide
- clipboards, pencils, drawing materials.

Preparation

Introduction

- Students should have their worksheets from Lessons 1 on hand.

Activity 1

- Print **18.1 Pollinator Habitat Survey** (one per student)
- Print **6.2 NYC Butterfly Field Guide** (one copy per table)

Activity 2

- Print **18.2 Choosing a Site** (one per group of 3–4 students)

Activity 3

- Grades K–3: Print **18.3 Urban Schoolyard Habitat Audit Worksheet K–3** (one per student)
- Grades 3–5: Print **18.4 Urban Schoolyard Habitat Audit Worksheet 4–5**

ACTIVITY



ACTIVITY



Introduction

Discuss the animals and wildlife that are observed in both the natural and built environments. If available, review the data collected from [Lesson 1: Habitat Hunt](#). Why do you think we observed more biodiversity (variety of living things) in the park or garden than on the street? Why might parks and gardens be a better habitat for wild animals than a city street? Why are parks and gardens important in a city? How can small community gardens, backyards, and even school gardens help wildlife and pollinators? Do you think our schoolyard provides a good habitat for pollinators? Why or why not? Today we're going to investigate these questions.

Activity 1: Think Like a Pollinator

1. Let each student or group choose a pollinator to focus on. They may choose any of the pollinators they studied in previous lessons or butterflies listed on [6.2 NYC Butterfly Field Guide](#). They may also choose the ruby-throated hummingbird, a species that has been observed in New York City.
2. Using [18.1 Pollinator Habitat Survey](#), ask students to complete Part 1 using guides listed in the Appendix or materials from previous lessons. Ask them to be as detailed as possible when answering the questions. For example, name the species of flowers that their pollinators prefer for food?
3. Take a walk around the schoolyard or a specific site where you plan to create the pollinator garden and ask students to complete parts 2 and 3 of the worksheet.
4. Back in class, discuss answers to Part 3.

Adaptations for K–2

5. Students may simply choose the type of pollinator by order: Bee, Butterfly, or Hummingbird rather than the genus or species level (i.e. type of bee or butterfly). You may also conduct the survey as a class or in larger groups.

Activity 2: Site-Inventory

1. Tell students to close their eyes and imagine their schoolyard; ask them to imagine where they can create a schoolyard habitat. Let them share their reasons. If necessary, discuss some of the considerations outlined in the [Background](#) like traffic patterns and land use.
2. Bring students out to survey the schoolyard with the goal of selecting a site for the habitat. Whether or not the site has been chosen by the Habitat Team, it's important for the students to feel a part of the process.
3. Break students into groups of 3-4 and let each group choose one spot that would make a good site for the schoolyard habitat, and another that would not be a good site. Review the components of habitat.
4. Ask them to write or explain a reason why they chose their locations on the [18.2 Choosing a Site](#) worksheet. The groups can share with each other.
5. Share your feedback. For example if a group selects a sunny site near the dumpster, point out why that may not be ideal and ask students to think of how that problem might be resolved.

ACTIVITY

Activity 3: Urban Schoolyard Habitat Audit

Now you are ready to conduct the baseline audit. The baseline audit can be completed anytime of the year when the ground is not frozen. Whether you are conducting a baseline audit before the urban schoolyard habitat is established or a post audit years later, the worksheets can be used for both purposes and the data can be analyzed and compared.

Grades K–3

1. Once the final site is chosen for the urban schoolyard habitat, let each student individually complete worksheet [18.3 Urban Schoolyard Habitat Audit](#), describing what they observed. What living and non-living features already exist in the schoolyard? Let them inventory any animals and plants they saw under the “living section.” How many trees? How many birds? Etc? See if they can be specific. Let them draw what they observe in the appropriate spaces.
2. Back in the classroom, ask students to draw what they imagine their urban schoolyard habitat will look like in the future once the garden is created.
3. The entire process can be documented with photos of the schoolyard sites and displayed alongside the students’ work.

Grades 4–5

1. Once the final site is chosen, students will create a baseline map of the site. As a precursor to the mapping activity, you may want to show students examples of aerial maps and ask them to make an aerial map of their classroom as practice.
2. Students can develop maps by measuring the schoolyard habitat site; then they can use these measurements to draw baseline maps to scale back in the classroom. Or if you want a shortcut, you may ask if the school already has a copy of the schoolyard plan. Photocopy these baseline maps so students have several copies for different plans.
3. Explain how landscape designers use symbols and legends to map features like vegetation and buildings. Let them take their baseline maps on clipboards and colored pencils back out to the site. Ask them to add details such as existing trees, vegetation, water, and the built environment on their map. Let them add a legend and the cardinal directions using a compass.

Discussion

1. Does our urban schoolyard habitat site currently support pollinators?
2. What wildlife, if any, does it support now?
3. What steps can we take to attract more pollinators to our schoolyard?
4. What challenges might we encounter in creating this schoolyard habitat? How might we work around those?



RESOURCES

Extensions

1. Plants need specific conditions to thrive; soil quality plays a big part. Conduct a soil test for pH, nitrogen, phosphorus, and potassium—elements needed for healthy plant growth. LaMotte makes safe soil tests for elementary students.
2. Students can also check soil texture by performing the “ribbon test.” Squeeze a handful of soil and see if it sticks together (clay soil) or falls apart (sandy soil). Loam soil, which is ideal for gardening, will stick together but crumble when tapped with a finger. If the garden has sandy conditions, you can select plants that prefer drier conditions. Or conversely, if your soil is mostly clay, it means that it will hold water well and suits plants that thrive in moist conditions. Soil can be amended with compost and topsoil to achieve loamier texture.
3. Sunlight is essential to the growth of plants. Many native pollinator plants are wildflowers adapted to a meadow habitat and prefer full sun (6–8 hours/day). Others are adapted to woodland edges and prefer part-sun (3–4 hours/day). Conduct a study of how the sun moves across the sky. Where does it rise, where does it set? What direction is the sun at midday (due south at 12pm, which is one way to tell direction and time)? You can also observe how the shadows change with a stick planted outdoors or even a flag pole.

Standards

K-ESS3-3 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Communicate solutions that will reduce the impact of humans on the

land, water, air, and/or other living things in the local environment.

K-2-ETS1-1 Engineering Design Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

3-LS4-4 Interdependent Relationships in Ecosystems Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

3-5-ETS1-1 Engineering Design Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

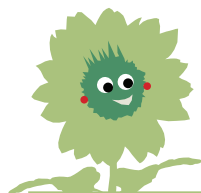
3-5-ETS1-2 Engineering Design Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Resources

- NWF Schoolyard Habitats®
How To Guide
bit.ly/SchoolyardHabitatsGuide
- Soil Science Resources
soils4teachers.org/

POLLINATOR HABITAT SURVEY

Name: _____ Date: _____



Part 1: Urban Habitat Needs of Your Pollinator:

Choose a Pollinator and imagine you are that pollinator. If you live in a city, what habitat needs do you have? Answer the questions below.

Your Pollinator's Name

(Common): _____

Your Pollinator's Name

(Latin/Scientific): _____

Describe or draw your preferences in the spaces below.

Food Source

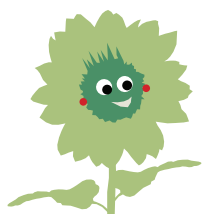
Water Source

Place to Seek Cover

Nest or Place to Raise Young

POLLINATOR HABITAT SURVEY

Name: _____ Date: _____



Part 2: Habitat Rating Rate the schoolyard on a scale of 1–10 for its value to your pollinator. 1 means there is nothing in the schoolyard that supports your pollinator; 5 means there is something that could provide this need, but it can be improved; and 10 means that your schoolyard would fully support this need and nothing needs to be improved.

Food: 1 2 3 4 5 6 7 8 9 10 Poor Excellent	Cover: (all types: nesting, wintering, resting, and protection) 1 2 3 4 5 6 7 8 9 10 Poor Excellent
Water: 1 2 3 4 5 6 7 8 9 10 Poor Excellent	Places to Raise Young: 1 2 3 4 5 6 7 8 9 10 Poor Excellent
Total Habitat Score: _____ /40	

Part 3: Assessing Your Site:

1. Will your pollinator stay and make your home here? Why or why not?	
2. Does your schoolyard provide any of your habitat needs for food, water, cover, or a place to raise young? If yes, which needs were met and describe how.	
3. What can be improved in order for you to make your home here?	
4. Numbers of pollinators observed:	Which ones?
5. Other wildlife observed, if any:	

Adapted from NWF Schoolyard Habitat® How To Guide, Section IV

Group: _____ Date: _____



With your group, find two sites on the schoolyard: one that would make a good schoolyard habitat site and one that would not make a good habitat site. Give at least three reasons why or why not.

CHOOSING A SITE

1. Location of site: _____

Why is this a good site for our urban schoolyard habitat?

1.

2.

3.

2. Location of site: _____

Why is this not a good site for our urban schoolyard habitat?

1.

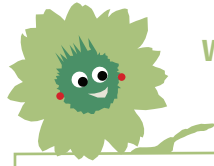
2.

3.

SCHOOLYARD HABITAT AUDIT

(GRADES K-3)

Name: _____ Date: _____



What exists in our urban schoolyard habitat site?

List the living and non-living things in the appropriate boxes below.

Living:

Non-Living:

Sketch the site, include all of your observations:

Name: _____ Date: _____

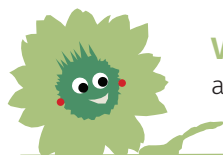


Visit your **schoolyard habitat site** and closely observe plants and animals. Write down your observations in the table.

Existing Plants		
	Species Name	How Many?
Trees		
	Total	
Shrubs		
	Total	
Grasses		
	Total	
Herbaceous Plants (no woody stem)		
	Total	
	Grand Total	
How many of the above plants are flowering?		

SCHOOLYARD HABITAT AUDIT (GRADES 4-5)

Name: _____ Date: _____



Visit your **Schoolyard Habitat site** and closely observe plants and animals. Write down your observations in the table.

Wildlife		
	Species Name	How Many?
Birds		
		Total
Insects		
		Total
Mammals		
		Total
Other		
		Total
	Grand Total	

SCHOOLYARD HABITAT AUDIT

(GRADES 4-5)

19 HABITAT ACTION PLAN

Schoolyard Habitat Action Plan

Background

After the urban schoolyard habitat audit has been completed, it is time to design the schoolyard habitat.

Similar to the audit, you can decide to what extent you want to involve the students in the design of the habitat and selection of plants. The goal of the lesson is to engage students in the process and help them feel ownership of the garden.

In addition to the baseline audit, the [NWF Schoolyard Habitats® How-to-Guide](#) can help guide the design process. Consider the following questions when finalizing the garden details: What is our vision for the space? What existing resources do we have and what do we need to create? What additional partners or members of our school community can help?

Keep in mind the needs of pollinators and wildlife when creating a schoolyard habitat.

Food (Plants)

- When selecting plants for a pollinator garden, be sure to choose native plants that provide both nectar for pollinators and food (leaves) for caterpillars. Use the plant guides in the Appendix for reference as well as the other online resources listed in the lesson.

- Overlap the blooming time of the flowering nectar plants to provide nectar sources throughout the growing season.
- Do not use chemical pesticides on or around the plants in the garden, as these can be fatal to butterflies and their larvae. Order plants from nurseries that also do not use pesticides (see appendix for recommendations of local nurseries).
- Group plants according to their similar needs for sunlight and water to make maintenance easier.

Water

- Minerals are an essential part of a butterfly's diet and are readily available in water, especially water from puddles. The large surface area-to-volume ratio of shallow water allows for greater evaporation, which concentrates the dissolved minerals in the remaining water. Butterflies do not need a large amount of water; in fact they quickly expel most of the water they uptake but retain the dissolved minerals. Students can make one or more butterfly puddles by creating a small depression in the ground and

BACKGROUND

Schoolyard Habitat Action Plan (Continued)

allowing them to fill with rainwater. As part of ongoing site maintenance, students should check on the puddle during dry periods, and spray periodically with a hose. Another way to provide water is to dig a hole in the ground to accommodate a container. Place the container in the hole, level the ground to the top of the container, and fill with rocks and soil, as well as water.. Be sure to check for water periodically.

- For bees and hummingbirds, a simple bird bath can be filled with rocks for bees to land on.

Places for Cover and Sun

- To take refuge from the weather and from predators, bees and butterflies need plants of different heights. Consider this when selecting plants and incorporate a variety of trees, grasses, and shrubs.
- To provide sunning spots for butterflies, place large, flat stones in the schoolyard. If necessary, remove a little soil to stabilize the rock. Also make sure the selected vegetation is planted in an area that receives sun for most of the day.

Places to Raise Young

- For butterflies, this means having some host plants for caterpillars

to eat. You can use the planting guides listed in the appendix to find a list of these host plants.

- For bees, you ideally want to keep some bare ground available, or mulch with compost or leaves rather than wood chips which make it difficult for the ground nesting bees. For the cavity nesting bees and overwintering bees, you can leave your garden a bit messy at the end of the season. Leave some old tree stumps and dead twigs on the plants. See more tips on creating the nesting habitats for bees in the material section of Lesson 10.

Other Design Considerations

- When designing planting beds, place the tall plants in the back or center of the bed and the shorter plants toward the edges.
- Make sure planting beds and pathways are accessible to students and are clearly defined. Raised beds or planters can be installed to accommodate students who use wheelchairs.
- Make sure the habitat is at a safe distance from any ball play.
- Designate places for students to sit or classes to gather.
- Install signs to let people know that the twigs, leaves, branches, or mulch piles are bee habitats and not debris to be swept away.

Lesson 19

Summary

Students create a vision for their schoolyard habitat by reviewing the elements of a habitat and selecting plants that will provide nectar to pollinators across the seasons.

Materials

- Art materials for poster or diorama
- Online plant resources, 6–8 plant catalogs from the suggested list under “Resources”
- **19.1 Plants for the Schoolyard Habitat Worksheet**

Preparation

Activity 2

- Grades K–2
 - 6–8 plant catalogs from the suggested list under “Resources” (allow several weeks for these to arrive). Remove pages with pollinator plants.
- Grades 3–5
 - Print **19.1 Schoolyard Habitat Planning Worksheet** (one copy per group of 3–4 students)
 - 6–8 plant catalogs from the suggested list under “Resources”,

Objectives

Students will:

- review the habitat requirements for bees and butterflies.
- understand the importance of closing nectar gaps throughout the growing season (spring through fall) to support pollinators during their life cycle.
- plan a three season garden for pollinators.

ACTIVITY



Introduction

Review the [18.4 Schoolyard Habitat Audit](#). Is our schoolyard a good habitat for pollinators? Why or why not? What would make it better? Review the four elements of a habitat: food, water, cover, and places to raise young; ask students for examples of each for pollinators. As you review, you may want to create a chart during the class discussion with a list of animals

on one axis and the habitat needs (food, water, cover, places to raise young) on the other axis.

Tell the class that they will begin selecting some of the plants that will go in the garden. Review what part of the plant the pollinators visit and why? What are some things we need to think about when choosing plants for the garden?

ACTIVITY

Activity 2:
Discussion

1. Why did you choose some plants over others? Did you have your own selection criteria?
2. What was challenging?
3. What other considerations need to be made besides closing nectar gaps when planning a pollinator garden?

Explain to the class that just like the pollinators themselves, plants also have a life cycle. Some may flower in spring, some in summer, and some in fall before they are pollinated and make seeds. Ask them to think about flowers they have seen in early spring, in the summer, and in the fall. Why is it important to think about this when planning a pollinator garden? Why do we need to include plants that flower in different months in our pollinator garden?

Activity 1:
Designing a Pollinator Habitat

1. Students can draw or create a three dimensional diorama of what they imagine their schoolyard habitat for pollinators might look like.
2. Challenge them to include all factors of the habitat: food, water, cover, and a place to raise young. Older students might also create this on top of their baseline map.

Activity 2:
Closing Nectar Gaps

Grades K–2

1. Divide students into several groups. Give each group a poster and ask them to make three sections on the bottom of the poster: spring, summer, and fall.
2. Give each group one or more plant catalogs; sections of the catalogs can be pre-cut and divided among the group.
3. Students will cut out flowers and place them in their respective season by referring to their **bloom** period. If the plant blooms over several seasons, they can place it according to the beginning

of its bloom period. They should aim to find a few flowers for each season to create a vibrant and healthy pollinator habitat.

4. When the chart is complete, they can either draw or collage the rest of the poster, including pollinators visiting flowers if they choose.

Grades 3–5

1. Divide students into small groups.
2. Using plant catalogs and the online plant resources listed below, ask groups to complete the [19.1 Plants for the Schoolyard Habitat Worksheet](#).
3. Students will select plants according to their bloom times, flower color, and indicate the pollinator that it benefits. Their goal is to include plants in their chart so there are:
 - a. At least one type of flower in bloom during each season.
 - b. No more than 10 plants in total with a mix of trees, shrubs, or flowering perennials.
 - c. A variety of flower colors in each season.
 - d. Plants that attract your assigned pollinator.
4. Students use the reverse of Worksheet [19.1 Plants for the Schoolyard Habitat Worksheet](#) to award themselves points for each of the above criteria.

Extensions

1. Consider the other elements that are necessary in a pollinator habitat:
 - a. **Water:** Find out where bees and butterflies get their water. See www.nwf.org/Garden-For-Wildlife/Water.aspx. How can we provide additional water sources for them? What is the best design solution?

ACTIVITY



Resources

- NWF Schoolyard Habitats® How-to Guide www.nwf.org/Garden-for-Wildlife/Create/Schoolyards/Resources

Online Plant Resources

- National Wildlife Federation Native Plant Finder www.nwf.org/nativeplantfinder/
- Xerces Society: Pollinator Plants for the Northeast bit.ly/PlantsForPollinators

- Cover:** How can we provide extra cover for the pollinators to avoid predators and escape from wind and rain? For insects, this simply means dense plantings with different heights. Are there any types of grasses that are also host plants to butterfly larvae? Are there any trees and shrubs that also provide food or a host to butterflies?
 - Places to Raise Young:** Look at the host plants of common butterflies in your region using the NWF Native Plant Finder www.nwf.org/NativePlantFinder/Plants. Which ones support a variety of butterflies? Are any also nectar plants? Review [Lesson 10: Bee Homes](#); how can we make nesting sites available to native bees?
 - Other considerations:** Butterflies like warm sunny places to absorb warmth — like flat rocks in the sun.
- Consider adding fruits and vegetables to the garden such as squash, basil, and fruit trees, especially those listed on [4.1 List of Animal Pollinated Crops](#). This will reinforce how pollinators are part of our food system and also demonstrate the role they play in the plant life cycle.
 - Plants also have habitats. Once the final plant list is determined, assign students a plant and let them research its native habitat (meadow, wetland, forest edge, etc.). What is its tolerance for light (shade, part-shade, or sun) and water (dry, moist, or wet)? Find another plant that has a similar tolerance to help plan the garden beds.

Standards

K-ESS3-3 Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

K-2-ETS1-1 Engineering Design Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

3-LS4-4 Interdependent Relationships in Ecosystems Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

3-5-ETS1-1 Engineering Design Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2 Engineering Design Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Plant Catalogs

- www.americanmeadows.com/
- www.johnnyseeds.com/
- www.prairiemoon.com/
- www.prairienursery.com/
- www.selectseeds.com/

Community Science

- www.nyphenologyproject.org/
- www.usanpn.org/natures_notebook

PLANTS FOR THE SCHOOLYARD HABITAT

Name: _____

Date: _____



Using plant resources and catalogs, select plant species for each season of your schoolyard habitat. Write the plant type and plant name in the appropriate box and write a check mark for each pollinator it benefits.

Plant Type: Tree (T), Shrub (S), Flowering Perennial (F)	Plant Name	Flower Color	Bees	Butterflies	Humming- birds	Other Pollinators
Spring Blooms						
F	Wild Columbine	Red	X		X	
Summer Blooms						
Fall Blooms						

Name: _____ Date: _____



Schoolyard Habitat Scorecard Give your schoolyard habitat a score!
 You get points for making sure the schoolyard habitat has plants that bloom in spring, summer, and fall and benefit pollinators.

What's in the Habitat?	Points
At least one type of flower in bloom in each season. One point	
No more than 10 plants in total with a mix of trees, shrubs and flowering perennials. One point	
A variety of color in each season (more than one). One point	
Plants that benefit pollinators. One point	
Add one point for each plant that benefits more than one pollinator. Bonus	
Total Score	

PLANTS FOR THE SCHOOLYARD HABITAT

20 CELEBRATING HABITAT

Celebrating the Urban Schoolyard Habitat

Background

It's time to break ground on the schoolyard habitat and celebrate the community effort that helped create it!

Once you have created an action plan with the help of the Habitat Team and students, and once you have the resources and materials in place, it is time to put it all together and break ground to create the urban schoolyard habitat. Since the first step is to create the garden beds, pathways, and general infrastructure to house this habitat, it is essential to recruit experienced community members—parents, teachers, or custodians—who can help with the landscaping. The Appendix also offers a list under “Gardening Resources” of local organizations that can support schoolyard habitats by donating materials or offering design and build services.

Once the beds are ready for planting, involve the wider community, including students, teachers, parents, and staff. Students can get involved by adding compost to the soil, digging holes for trees and shrubs, planting bulbs, seeds, and seedlings and then adding mulch, watering, and making garden signs. The involvement of the wider community not only builds community but helps

everyone to feel invested and engaged in the project by encouraging pride of place and a larger sense of purpose.

This work day should be followed by an official ribbon cutting to develop broader community awareness of the project and to celebrate all the work and the individuals who made it happen! This event could include students sharing poems, songs, brochures, and artwork inspired by the urban schoolyard habitat project. We also encourage schools to invite elected officials, future potential funders, community partners, parents, custodians, and anyone who had a hand in creating—or will have a role in maintaining—the garden. National Pollinator Week, the third week of June, is a great opportunity to host a ribbon cutting event.

Once the urban schoolyard habitat provides at least a few types of food, water, cover and places to raise young on your school grounds, and when the site is being used for teaching, then you are ready to apply



BACKGROUND

Celebrating the Urban Schoolyard Habitat (Continued)

for National Wildlife Federation certification. You can find out more by visiting: www.nwf.org/Garden-for-Wildlife/Create/Schoolyards/Certify

Lastly, it's important to have a maintenance plan—including summer watering and harvesting—in place to ensure continued success of the urban schoolyard habitat.



ACTIVITY



Lesson 20

Summary

Students brainstorm activities for the opening ribbon cutting event and make preparations for those activities. They write letters to community members and organizations describing the purpose of their urban schoolyard habitat and design invitations to send for the event.

Objectives

Students will:

- think of creative ways to share their urban schoolyard habitat with the community.
- practice letter writing skills.
- gain awareness of the broader community outside of their school through community outreach.

Materials

- Bag of potting soil or compost, modeling clay, water, wildflower seeds, large tub, cardboard box, markers, pencils, paper, envelopes.

Preparation

Activity 1

- Purchase or order necessary materials to make seed balls.

Activity 2

- Brainstorm a list of community members you would like the class to contact and gather their addresses (or let students be involved in this).

Introduction

Ask the class to brainstorm some fun ways that they can celebrate the opening of their pollinator garden. How can they teach people about the purpose of the garden? How can they educate guests about the value of pollinators? Use their

ideas to plan activities and an agenda for the schoolyard habitat opening. Encourage creativity. Celebrate all of the hard work that went into creating the schoolyard habit and be sure to have fun! Additional ideas are listed under Extensions below.

ACTIVITY

Activity 1: Making Wildflower Seed Balls

This is a fun activity for children and adults. Seed balls can be created in advance or set up as an activity at the event. Seed balls (sometimes called “seed bombs”) are a mix of clay, soil or compost, and wildflower seeds. The seed balls can be tossed or planted in a garden, street median, or even in a vacant lot. Follow these steps:

Materials:

- 2 parts potting soil or compost
 - 5 parts clay from your local art store
 - 1–2 parts water
 - 1 part wildflower seeds
 - Large tub to mix ingredients
 - Cardboard box to dry and store seed balls
1. Mix the soil, clay, and 1 part water thoroughly. There should be no lumps. Slowly add more water until the mixture is the consistency of the toy store molding clay that comes in a can.
 2. Add seeds. Keep kneading the dough until the seeds are well mixed in. Add more water if necessary.
 3. Take small bits of the clay mixture and roll into a ball about one inch in diameter. The balls should hold together easily. If they’re crumbly, add more water.
 4. Dry seed balls for 24–48 hours in a shady place before sowing or storing. They store best in a cardboard box; do not use plastic bags.
 5. Plant or gently toss the seed balls on top of soil. They do not need to be buried or watered.
 6. Watch the wildflowers grow!

Source: www.gardeningknowhow.com/special/children/making-seed-balls.htm

Activity 2: Community Outreach

1. This is a good opportunity to review or introduce letter writing skills. Ask the students to create a list of members of the community to whom they would like to notify about their urban schoolyard habitat. They can include local elected officials, community boards, schools, libraries, parks departments, etc. Anyone who might have a vested interest or could be a potential partner in expanding the network of pollinator gardens in the neighborhood should be considered.
2. Students can choose one person from the list to send a letter. Discuss what might be important to include in the letter: the purpose of the habitat, why you are contacting them, and how they can support the project, etc. Once you have a date set for the ribbon cutting, you can include an invitation to the event in the letter.
3. Students may also make an impression by enclosing seed packets in the envelope or an illustration of the garden.



ACTIVITY

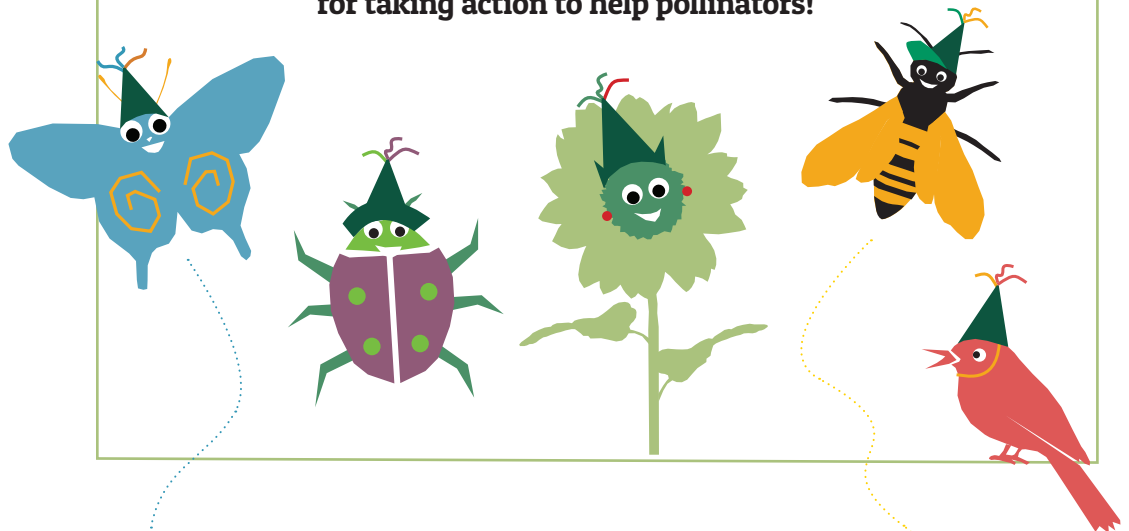
Extensions

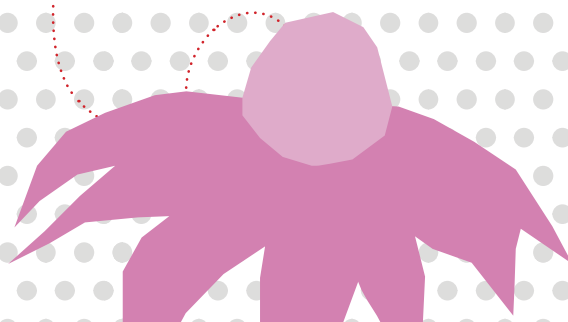
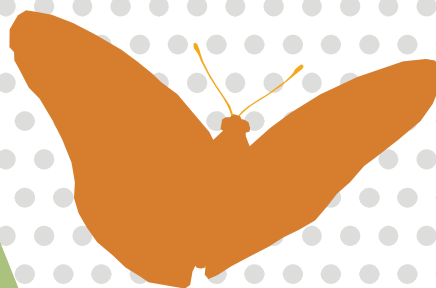
1. National Pollinator Week—scheduled during the third week of June—is a great way to build awareness and celebrate your project with some suggested activities below. Find out more by visiting: www.pollinator.org/pollinator-week.
2. Coordinate with GrowNYC or Greenbelt Nursery for plant give-aways.
3. Look for seed donations and let students design pollinator mixes and seed packets.
4. Students can offer tours of their urban schoolyard habitat, create their own scavenger hunts, or design plant and insect field guides.
5. Students can create brochures with information about the schoolyard habitat.
6. Students can perform skits, songs, or poems about pollinators or even organize a pollinator parade with pollinator costumes or small puppets.
7. Students can make recipes using ingredients that pollinators helped produce.

**Did you know?**

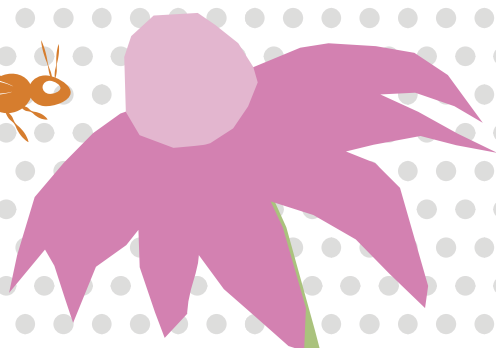
Make it official! If your schoolyard habitat provides wildlife and pollinators with food, water, cover, and places to raise their young, register it as a National Wildlife Federation Certified Wildlife Habitat®. Not only will this connect the garden to a network of thousands of certified habitats across the U.S., but it will provide the garden with official signage to help build awareness. To learn more about the benefits of certification and apply, visit: www.nwf.org/Garden-for-Wildlife/Create/Schoolyards/Certify.

**Congratulations and thank you
for taking action to help pollinators!**





Appendix



Curriculum Appendices

Community Science Projects

- Bumble Bee Watch
www.bumblebeewatch.org/
- Butterflies and Moths of North America
www.butterfliesandmoths.org/
- The Great Sunflower Project
www.greatsunflower.org/homepage
- iNaturalist
www.inaturalist.org/
- Monarch Watch
www.monarchwatch.org
- Nature's Notebook
www.usanpn.org/natures_notebook
- The New York Phenology Project
www.nyphenologyproject.org/

Curricula and Educator Resources

- Kids Gardening
www.kidsgardening.org/lesson-plans/
- NWF Monarch Mission
www.nwf.org/Eco-Schools-USA/Resources/Curriculum/Monarch-Mission
- Pollinator Partnership
www.pollinator.org/learning-center/education#cr

Field Journals

Field Journal Ideas

A field journal will help your students closely observe the natural world and translate their observations into words and drawings. At the same time, they will build communication skills, deepen their science understanding, and enjoy spending time outside.

- Choose a particular plant to observe through the seasons, or an animal home.

- Make observations within a designated amount of time (how many animals do we see in five minutes, how many sounds do we hear?).
- Make observations in a designated area—on a particular plant, part of the plant, or area of the garden.
- If an insect is moving quickly, take a photo and let students make a sketch from the photo.
- Use a guide to identify the animal or plant and label it next to the sketch.
- Press flowers or make leaf rubbings.

Field Equipment and Supplies

- Acorn Naturalists
www.acornnaturalists.com
- BioQuip Products
www.bioquip.com/

Field Journal Resources

- Make a Field Guide To Your Yard
www.blog.nwf.org/2010/06/make-a-field-guide-to-your-yard/
- Ranger Rick Nature Notebook
www.rangerrick.org/magazines/ranger-rick/classroom-resources/nature-notebook/
- *No Student Left Indoors: Creating a Field Guide to Your Schoolyard* by Jane Kirkland
- *How to Keep a Naturalist's Notebook* by Susan Leigh Tomlinson

Field Trips to New York City Pollinator Habitats

- The Battery
www.thebattery.org/
- Brooklyn Botanic Garden
www.bbg.org/learn/schools

Curriculum Appendices (Continued)

- Brooklyn Bridge Park
www.brooklynbridgepark.org/
- Central Park (North Meadow Butterfly Garden)
www.centralparknyc.org/attractions/north-meadow-butterfly-gardens
- City Growers
www.citygrowers.org/
- Greenbelt Native Plant Nursery
www.nycgovparks.org/greening/greenbelt-native-plant-center/education
- The High Line
www.thehighline.org/
- Jamaica Bay Wildlife Refuge
www.nps.gov/gate/planyourvisit/index.htm
- New York Botanical Garden
www.nybg.org/learn/schools-teachers/class-trips/
- Queens Botanical Garden
www.queensbotanical.org/group-programs-for-kids-and-schools/
- Snug Harbor Cultural Center and Botanical Garden
www.snug-harbor.org/

Gardening Resources**Grants for School Gardens**

- Annie's
www.annies.com/giving-back/grants-for-gardens
- Grow to Learn
www.growtolearn.org/grow-learn-mini-grant/
- Kids Gardening
www.kidsgardening.org/garden-grants/
- Lowe's
www.toolboxforeducation.com/
- NYC Youth and School Garden Network
www.nycschoolgardens.wordpress.com/

- Whole Kids Foundation
www.wholekidsfoundation.org/programs/school-gardens-grant
- Wild Ones
www.wildones.org/seeds-for-education/

Materials and Resources

- Big Reuse (lumber and building materials)
www.bigreuse.org/
- GrowNYC School Gardens (school garden resources)
www.grownyc.org/grow-to-learn
- McEnroe Farms (soil and compost)
www.mcenroeorganicfarm.com/composting
- NYC Compost Project (compost)
www1.nyc.gov/assets/dsny/site/our-work/reduce-reuse-recycle/community-composting
- NYC Parks GreenThumb (community gardens)
www.greenthumb.nycgovparks.org/
- New York Restoration Project (community gardens)
www.nyrp.org/
- Trees New York (tree care)
www.treesny.org/
- Urban Soil Labs at Brooklyn College (soil testing)
www.brooklyn.cuny.edu/web/academics/centers/esac/services/soil.php

Plant Nurseries

- Gowanus Nursery (Brooklyn)
www.gowanusnursery.biz/
- Greenbelt Native Plant Center (Staten Island)
www.nycgovparks.org/greening/greenbelt-native-plant-center
- Grow NYC Annual Plant Sale (multiple NYC locations)
www.grownyc.org/gardens/plant-sale

CURRICULUM APPENDICES

Curriculum Appendices (Continued)

- Long Island Natives (Long Island)
www.longislandnatives.com/
- Lowlands Nursery–Gowanus Canal Conservancy (Brooklyn)
www.gowanuscanalconservancy.org/nursery/
- North Creek Nursery (Pennsylvania)
www.northcreeknurseries.com/
- Sunset Farmstead (New Jersey)
www.sunsetfarmstead.com/

Wildlife, Insect, and Plant Guides**Field Guides Series****For Adults:**

- *Butterflies of New York City* by Jeff Fengler
- *Butterflies Through Binoculars* by Jeffrey Glassberg
- Golden Guide Series
- Kaufman
- National Audubon Society
- Peterson's

For Children:

- Peterson's First Guides
- Peterson's Young Naturalist Series
- Pocket Naturalist Guides (Waterford)

Insect Field Guides (Online)

- Animal Diversity Web
www.animaldiversity.org
- Bug Guide
www.bugguide.net
- Butterflies and Moths of North America
www.butterfliesandmoths.org/
- Discover Life
www.discoverlife.org/
- Insect Identification for the Casual Observer
www.insectidentification.org/

- Pollinator Partnership
www.pollinator.org/
- Wild Bees of New York
www.sharpeatmanguides.com/
- Xerces Society for Invertebrate Conservation
www.xerces.org/

Plant and Pollinator Habitat Guides

- Ecoregional Plant Guides
www.pollinator.org/guides
- National Wildlife Federation's Butterfly Heroes™
www.nwf.org/Butterfly-Heroes
- National Wildlife Federation Native Plant Finder
www.nwf.org/NativePlantFinder/Plants
- NYC Parks Wildlife Gardens Species List
www.nycgovparks.org/sub_about/parks_divisions/gnpc/garden_species_lists/garden_wildlife.html
- Pollinator-Friendly Native Plant Lists
www.xerces.org/pollinator-conservation/plant-lists/
- Pollinator Habitat Guide
www.earthpartnership.wisc.edu/2018/06/20/new-pollinator-habitat-guide-from-earth-partnership-available-now-online/
- Pollinator Nesting Resources
www.xerces.org/providing-nest-sites-for-pollinators/

Videos

- Disney's Wings of Life (2013)
- *Flight of the Butterflies* (IMAX, 2016)
- *The Incredible Journey of the Butterflies* (PBS, 2009)
- *The Incredible Story of the Monarch Butterfly: Four Wings and a Prayer* (Primitive Entertainment, 2007)

Name: _____ Date: _____

Location: _____ Weather: _____

MY NATURE JOURNAL
(GRADES K-2)

What I See:



What I Smell:



What I Hear:



What I Feel:



MY NATURE JOURNAL

(GRADES 3-5)

Name: _____ Date: _____

Location: _____

Temperature: _____ Time: _____

Plant Observation

Choose a plant to sketch:

Describe what you observed. What is something interesting you observed about this plant?

MY NATURE JOURNAL
(GRADES 3-5)

Name: _____ Date: _____

Location: _____

Temperature: _____ Time: _____

Animal Observation

List the animals you observed, and how many of each.

Animal	How many?	Animal	How many?

Choose an animal to sketch:

Describe what you observed. What is something interesting you observed about this animal?

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Lesson 16

Worksheet 16.1: Staci Antonelli, Teri Brennan, Brian Lensch, Karen Chase, Loi Ann Martin, Christian Holland, James Shrouds, Leponard Tompos

Lesson 19

NWF



Native Wildflowers for Pollinators

These plant species provide **nectar** for a variety of pollinators—native bees, flower flies, butterflies, and hummingbirds. Many species are also larval host plants for butterflies. Best suited for sunny locations, plant some of these wildflowers in your Schoolyard Habitat® to ensure a full season of blooms for pollinators.

WILDFLOWERS FOR POLLINATORS

SPRING BLOOMS



Wild Geranium
Geranium maculatum



Wild Columbine
Aquilegia canadensis



Golden Alexanders
Zizia aurea



Eastern Bluestar
Amsonia tabernaemontana



False Blue Indigo
Baptisia australis



Sundial Lupine
Lupinus perennis

LATE SPRING TO SUMMER BLOOMS



Beardtongue
Penstemon digitalis



Nodding Onion
Allium cernuum



Purple Coneflower
Echinacea purpurea

WILDFLOWERS FOR POLLINATORS

SUMMER BLOOMS



Wild Bergamot
Monarda fistulosa



Butterfly Milkweed
Asclepias tuberosa



Swamp Milkweed
Asclepias incarnata



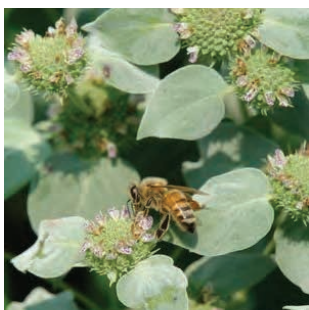
Garden Phlox
Phlox paniculata



Tickseed
Coreopsis tripteris



Pearly Everlasting
Anaphalis margaritacea



Mountain Mint
Pycnanthemum muticum

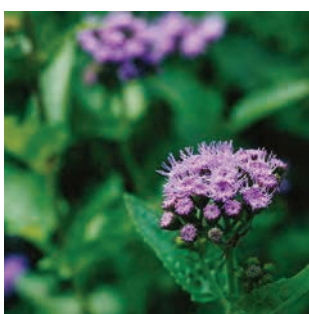


Anise Hyssop
Agastache foeniculum



Black-eyed Susan
Rudbeckia fulgida

FALL BLOOMS



Blue Mistflower
Conoclinium coelestinum



Goldenrods
Solidago spp.



Asters
Aster or Symphyotrichum spp.

POLLINATOR GARDENING



**GARDEN
FOR WILDLIFE™**

Pollinator Gardening

Pollinators are animals that move from plant to plant while searching for protein-rich pollen or high-energy nectar to eat. As they go, they are dusted by pollen and move it to the next flower, fertilizing the plant and allowing it to reproduce and form seeds, berries, fruits and other plant foods that form the foundation of the food chain for other species—including humans.

Pollinators are themselves important food sources for other wildlife. Countless birds, mammals, reptiles and amphibians eat the protein and fat-rich eggs, larvae, or adult forms of pollinators, or feed them to their young. Pollinators play a critical role in the food supply for wildlife and people!

Bees are well-known pollinators, but over 100,000 invertebrates—including butterflies, moths, wasps, flies, and beetles—and over 1,000 mammals, birds, reptiles and amphibians, act as pollinators.

**MORE THAN 85% OF
FLOWERING PLANTS
REQUIRE INSECT
POLLINATION WHICH
RESULTS IN FRUITS,
NUTS AND SEEDS THAT
25 PERCENT OF BIRDS
RELY ON FOR FOOD.
NATIVE BEES POLLINATE
15 PERCENT OF U.S
FRUIT, NUT, VEGETABLE
AND FIELD CROPS.**

**Learn
more**

NATIONAL WILDLIFE FEDERATION / 11100 WILDLIFE CENTER DRIVE, RESTON, VA 20190 / NWF.ORG/GARDENFORWILDLIFE

Tips & Info

Pollinators worldwide are in decline. Habitat loss, invasive species, parasites, and pesticides are largely to blame. Here's how to help.

Pollinator Gardens Tips

- 1. Plant native flowering plants in your garden.**
Get a list for your zip code at nwf.org/nativeplants.
- 2. Reduce the size of your lawn and replace with native blooming plants.**
- 3. Provide water for pollinators** by filling a shallow birdbath with gravel or creating a muddy patch in a corner of your yard.
- 4. Attract hummingbirds** by planting dense shrubs for nesting and native plants with bright red and orange tubular flowers for food. Supplement as needed with a nectar feeder.
- 5. Most native bees are solitary** and lay eggs in tiny tunnels in dead trees, fallen branches, hollow stems, or in sandy soil. Leave standing dead trees, fallen logs, and bare patches of sandy soil. You can even put out a bee house filled with nesting tubes.
- 6. Butterflies need special "host plants" as food** for their caterpillars. Monarchs, for example, rely on only one host plant, milkweed, so planting it will provide essential habitat. Find host plants for butterflies and moths native to your area at nwf.org/nativeplants.

Join the Garden for Wildlife Movement!

Join the growing movement of people making a difference for wildlife where they live, work, learn, worship, and play!

Get more tips on creating wildlife habitat gardens that benefit pollinators and how to get your garden recognized as a Certified Wildlife Habitat by the National Wildlife Federation. Every certified garden counts towards reaching the goal of the Million Pollinator Garden Challenge.

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Page 2: Tiger Swallowtail - Linda Matteo

Don't Use Pesticides

Insects are a sign of a healthy garden, and an important food source for birds. No need to spray!

Attract ladybugs, predatory wasps and other natural enemies of pests. Native plants attract these beneficial pest predators.

Hand-pick pests if you have an infestation or wash them off with a stream of water from a hose.

Use only use organic or natural pest deterrents such as soap, garlic and chili pepper.

Avoid chemical pesticides, especially neonicotinoid insecticides and "weed killers" that eliminate the pollen and nectar plants pollinators need.

Learn more at
nwf.org/organicpractices



**GARDEN
FOR WILDLIFE™**

For more information, visit
nwf.org/gardenforwildlife



**GARDEN
FOR WILDLIFE™**

Garden for Wildlife™

Attracting birds, butterflies and other wildlife is a wonderful way to make a difference right outside your door. It all starts with the things you plant.

When you create a wildlife-friendly garden, you'll be rewarded by knowing you're doing your part to help restore habitat. Imagine looking out the window into a landscape teeming with singing birds, colorful butterflies and beautiful plants and water features that attract wildlife.

It's easier than you might think.

National Wildlife Federation has been helping people restore wildlife habitat where they live, learn, work, play, and worship since 1973. Just provide the basic components of habitat and the birds and other wildlife will show up! It's that simple!

Visit our website for more expert tips on creating a wildlife habitat garden at nwf.org/garden.

5 SIMPLE TIPS TO GET STARTED

1. Plant a shrub that flowers for pollinators and produces berries for birds and other animals.
2. Put out a birdbath. Even small water features will be used by wildlife.
3. Provide cover with dense shrubs, wildflower gardens, rock walls and evergreens.
4. Mount a nesting box for birds, plant host plants for butterfly caterpillars or install a frog pond as places to raise young.
5. Put away the chemicals. Natural gardens are better for you and your family as well as the wildlife.

NATIONAL WILDLIFE FEDERATION / 11100 WILDLIFE CENTER DRIVE, RESTON, VA 20190

Get Certified!

Any place where you can create a wildlife-friendly garden can be recognized as a **Certified Wildlife Habitat®** by National Wildlife Federation. Your yard, a local park, a container garden, urban rooftop, a schoolyard or corporate landscape, regardless of size, can serve as important wildlife habitat.

Certifying is as simple as providing the four habitat components—food, water, cover, and places to raise young—and practicing **sustainable gardening techniques** such as eliminating pesticides, conserving water and planting native species.

Why Certify?

Aside from the rewards of offering wildlife a place to thrive, when you certify you get the following benefits:

- Inclusion in the National Wildlife Federation's **Certified Wildlife Habitat® national network**
- A **personalized certificate** for your wildlife habitat
- An optional **press release** to share with your local media about your achievement
- A subscription to the National Wildlife Federation's **Garden for Wildlife™ newsletter**
- A free one-year membership to the National Wildlife Federation which includes a subscription to **National Wildlife® magazine**
- A 10% discount on nesting boxes, feeders, birdbaths and other products from **National Wildlife® catalog**
- Eligibility to purchase and post an **attractive yard sign** to display your commitment to wildlife and the environment

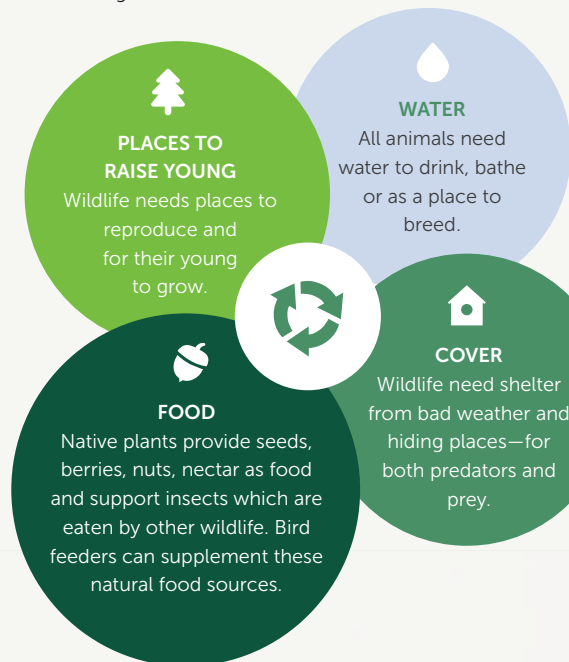
PHOTO CREDIT (from left to right):
 Certified Courtyard by Sally Vance (pg 1)
 Ruby Throated Hummingbird by George Brehm (pg 1)
 Monarch Butterfly by Marie Serrazina (pg 1)
 Bubble Bee by Robin Lee-Thorp (pg 1)



**GARDEN
FOR WILDLIFE**

Create a Sustainable Garden That Helps Wildlife

All wildlife need the following four things to survive:



Ready to Start?

Certify now with our new mobile friendly online application at nwf.org/garden.

There you'll find expert advice, tips, projects, videos, books and more that will tell you everything you need to know to create an amazing wildlife-friendly garden habitat and to get it certified.

Already Certified?

You're eligible to post one of our yard signs to share your accomplishment. To log in and purchase a sign, please visit nwf.org/yardsign.





Certified Wildlife Habitat® Application

Use this form to certify your wildlife-friendly habitat garden in your yard, school grounds, place of worship, or anywhere in your community. If the habitat meets the basic requirements, you'll join the growing movement of Wildlife Gardeners and receive a personalized certificate suitable for framing, a National Wildlife Federation membership, a subscription to the award-winning National Wildlife® magazine, a 10% discount on National Wildlife Federation catalog products, and opportunity to display a yard sign. You can also submit this application online at nwf.org/garden.

Property owner or organization _____

If you are filling out this application for someone else, please write their name in the space provided above.

If organization, contact person _____

Name(s) to Appear on Certificate _____

Maximum 30 characters, spaces included. (Personalized certificates are final, all future change requests will result in a \$5 change order fee. Please apply online to preview your personalized certificate)

Address of Habitat _____

City _____ State/Province _____ Zip Code _____

Telephone _____ Email Address _____

Mailing Address (if different from above) _____

Check the option that best describes your habitat.

☐ Home

☐ Pre-K-12 School

☐ Organization / Institute (Choose type below)

☐ Business / Corporation

☐ College / University

☐ Farm

☐ Roadside / Right-of-Way

☐ Community Garden

☐ Government Building / Property

☐ Place of Worship

☐ Museum

☐ Nature Center / Educational Setting

☐ Park / Forest / Refuge

☐ Other

BW17V2A

Food Sources

Plants provide the basic foods for wildlife. Feeders can be used as a supplemental source of food. Remember that some creatures will become food for others in a balanced habitat. Encourage a natural diversity of wildlife in your yard to ensure a healthy ecosystem. How do you provide food for wildlife? (Minimum requirement: 3)

PLANT FOODS:

- | | | |
|----------------------------------|---------------------------------|--|
| ☐ Seeds | ☐ Nuts | ☐ Pollen |
| ☐ Berries | ☐ Fruits | ☐ Foliage/Twigs |
| ☐ Nectar | ☐ Sap | |

SUPPLEMENTAL FEEDERS:

- | | | |
|------------------------------------|--------------------------------------|-----------------------------------|
| ☐ Seed | ☐ Suet | ☐ Squirrel |
| ☐ Butterfly | ☐ Hummingbird | |

Water Sources

Wildlife need a clean water source for drinking and bathing. How do you provide water for wildlife? (Minimum requirement: 1)

- | | |
|--|--|
| ☐ Birdbath | ☐ Water Garden/Pond |
| ☐ Shallow Dish | ☐ Butterfly Puddling Area |
| ☐ Lake | ☐ Rain Garden |
| ☐ Stream/River | ☐ Spring |
| ☐ Seasonal Pool | ☐ Ocean |

Places for Cover

Wildlife need shelter from bad weather and hiding places—for both predators and prey. How do you provide cover for wildlife? (Minimum requirement: 2)

- | | |
|---|---|
| ☐ Wooded Area | ☐ Dense Shrubs/Thicket |
| ☐ Bramble Patch | ☐ Evergreens |
| ☐ Ground Cover | ☐ Brush/Log Pile |
| ☐ Rock Pile/Wall | ☐ Burrow |
| ☐ Cave | ☐ Meadow/Prairie |
| ☐ Roosting Box | ☐ Water Garden/Pond |

Places to Raise Young

In order to provide complete habitat, you must provide places for wildlife to engage in courtship behavior and to mate, and then to bear and raise their young. How do you provide places to raise young for wildlife? (Minimum requirement: 2)

- | | |
|---|---|
| ☐ Mature Trees | ☐ Dead Trees/Snags |
| ☐ Meadow/Prairie | ☐ Dense Shrubs/Thicket |
| ☐ Nesting Box | ☐ Water Garden/Pond |
| ☐ Wetland | ☐ Burrow |
| ☐ Host Plants for Caterpillars | ☐ Cave |

Sustainable Gardening Practices

How you manage your garden or landscape can have an effect on the health of the soil, air, water and habitat for wildlife—as well as for the people. Some practices are more environmentally-friendly and sustainable. How do you garden sustainably?

(You need to employ practices from at least two of the three categories below to help manage your habitat in a sustainable way—to better help wildlife, we advocate employing one or more practices from each category.)

SOIL AND WATER CONSERVATION

- ☐ Limit Water Use
- ☐ Collect Rain Water
- ☐ Rain Garden
- ☐ Plant Buffer Around Bodies of Water
- ☐ Xeriscape (water-wise landscaping)
- ☐ Drip or Soaker Hose for Irrigation
- ☐ Use Mulch or Ground Cover to Retain Soil Moisture and Limit Erosion
- ☐ Reduce or Eliminate Lawn

CONTROLLING EXOTIC SPECIES

- ☐ Practice Integrated Pest Management
- ☐ Remove Invasive Exotic Species
- ☐ Keep Cats Indoors
- ☐ Use Native Plants

ORGANIC PRACTICES

- ☐ Eliminate Chemical Pesticides
- ☐ Eliminate Chemical Fertilizers
- ☐ Create Compost Pile

To apply, please send:

- ☐ This Completed Application - REQUIRED
 - ☐ \$20 Application Fee* (non-refundable) - REQUIRED
- *Applications Fee Waived for Pre-K-12 School Habitats

National Wildlife Federation • P.O. Box 1583 • Merrifield, VA 22116-1583

Allow 4-6 weeks for processing. Please keep a copy of this application for your records.





Garden Certification Walk-through Checklist

It's easier than you think to create your own wildlife garden! Use this walk through checklist to confirm you have all the elements necessary to be certified:

***Note:** this checklist is only a tool to prepare your garden, please certify online at www.nwf.org/certifiedwildlifehabitat

FOOD: Your habitat needs three of the following types of plants or supplemental feeders:

- | | | | |
|---|---------------------------------|---|---|
| ☐ Seeds from a plant | ☐ Fruits | ☐ Bird Feeder | ☐ Butterfly Feeder |
| ☐ Berries | ☐ Sap | ☐ Squirrel Feeder | ☐ Nuts |
| ☐ Nectar | ☐ Pollen | ☐ Hummingbird Feeder | |
| ☐ Foliage/Twigs | ☐ Suet | | |

WATER: Your habitat needs one of the following sources to provide clean water for wildlife to drink and bathe:

- | | | | |
|-----------------------------------|--|--|--|
| ☐ Birdbath | ☐ Seasonal Pool | ☐ River | ☐ Rain Garden |
| ☐ Lake | ☐ Ocean | ☐ Butterfly Puddling Area | ☐ Water Garden/Pond |
| ☐ Stream | ☐ Spring | | |

COVER: Wildlife needs at least two places to find shelter from the weather and predators:

- | | | | |
|--|---------------------------------------|--|---|
| ☐ Wooded Area | ☐ Cave | ☐ Brush or Log Pile | ☐ Dense Shrubs/Thicket |
| ☐ Bramble Patch | ☐ Roosting Box | ☐ Burrow | ☐ Water Garden or Pond |
| ☐ Ground Cover | ☐ Evergreens | ☐ Meadow or Prairie | |
| ☐ Rock Pile or Wall | | | |

PLACES TO RAISE YOUNG: You need at least two places for wildlife to engage in courtship behavior, mate and then bear and raise their young:

- | | | | |
|--|----------------------------------|---|---|
| ☐ Mature Trees | ☐ Wetland | ☐ Dead Trees or Snags | ☐ Water Garden/Pond |
| ☐ Meadow or Prairie | ☐ Cave | ☐ Dense Shrubs/Thicket | ☐ Host Plants for Caterpillars |
| ☐ Nesting Box | ☐ Burrow | | |

SUSTAINABLE PRACTICES: You need to employ practices from at least two of the three categories below to help manage your habitat in a sustainable way *to better help wildlife, we advocate employing one or more practices from each category:*

- | | |
|---|---|
| ☐ Soil and Water Conservation: | |
| <ul style="list-style-type: none"> • <i>Riparian Buffer</i> • <i>Capture Rain Water from Roof</i> • <i>Xeriscape (water-wise landscaping)</i> • <i>Drip or Soaker Hose for Irrigation</i> | <ul style="list-style-type: none"> • <i>Limit Water Use</i> • <i>Reduce Erosion</i> • <i>Use Mulch</i> • <i>Rain Garden</i> |
| ☐ Controlling Exotic Species: | |
| <ul style="list-style-type: none"> • <i>Practice Integrated Pest Management</i> • <i>Remove Non-Native Plants and Animals</i> | <ul style="list-style-type: none"> • <i>Use Native Plants</i> • <i>Reduce Lawn Areas</i> |
| Organic Practices: | |
| <ul style="list-style-type: none"> • <i>Eliminate Chemical Pesticides</i> • <i>Eliminate Chemical Fertilizers</i> | <ul style="list-style-type: none"> • <i>Compost</i> |

GARDEN FOR WILDLIFE™
(CERTIFICATION CHECKLIST)



Visit
**NWF.org/
SchoolyardHabitats**
to learn how
your school can create
habitat for wildlife
and take learning
outside!

