



Biodiversity & Pollinators Lesson Plan

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Partnership with Beyond
Pesticides

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OBJECTIVES

The objective of this lesson is for students to understand basic concepts surrounding the importance of biodiversity, the interconnectedness of ecosystems, and how pollination plays a key role in our food system. The lesson provides a contextual framework using the plight of pollinators to understand overarching elementary Next Generation Science Standards, a comprehensive list of which can be found at the end of this lesson plan.

STUDENTS TAKEAWAYS:

- Students will be able to define biodiversity and explain why it is important to them as well as all living organisms
- Students will be able to explain the interconnectedness of living organisms in providing each other with food, water and shelter.
- Students will be able to explain what happens when one or more organisms is removed from an ecosystem.
- Students will be able to understand the basic concept of pollination
- Students will be able to name several pollinators and explain that pollination is important because it provides us with food.
- Students will be able to express that bees are helpful organisms because of the ecosystem services they provide us with and that they should be appreciated, not feared, for the work they do.
- Students will be able to identify a threat to pollinators and express alternatives to the use of pesticides, such as organic food production practices.

LESSON PLAN

1. WHAT IS BIODIVERSITY?

5 minutes

Slides 2-4

Begin by bringing students' attention to the PowerPoint presentation. During this time they will receive background information necessary to participate in the activities later on in the lesson.

Defined as **variety of life**.

It is the variety of life on Earth and the **relationships between all life forms on Earth that support life**. It is the web of life, connecting all life on Earth in an interdependent web of function, purpose, and necessity.

Questions for student engagement throughout lesson, noted throughout lesson in green:

1. How can we figure out the meaning of the word “biodiversity?” (If you look at the word and separate it into two parts, then you get bio and diversity)
2. Bio means life, does anybody know what diversity means?
3. Does anybody know what variety means?
4. Do we have a lot of the same type of animals/plants on the Earth or do we have a lot of different types? (We have a very biodiverse planet!)

There are two different kinds of biodiversity that are important for keeping our planet healthy

Genetic biodiversity allows plants and animals within the same species to be different. Think about dogs, are they all the same? What are some differences between different kinds of dogs? Now, turn to the person sitting next to you. Do you look exactly the same? No, we do not, because there is a lot of genetic biodiversity within every species of animal. This is important because it increases the likelihood of survival. How do we get genetic biodiversity? From our Genes!

Genes, and not the type you are wearing, are what makes us all different! These kinds of genes are inside tiny little cells and tell your cells what you’re going to be like. Where do you get your genes? From your parents. Can you think of something you have in common with one of your parents? Or maybe a brother or sister? Genes also come into play with bees! There are over 20,000 different types of bees, not just honeybees!

Ecological Biodiversity is what allows us to have many different species living together in one place. It creates the diversity of ecosystems, natural communities and habitats. The composition of each ecosystem affects the ways that species living in that system interact with that system.

Let’s look at the Pollinator Poster to put all of this information together.

Show the students the **POLLINATOR POSTER**

1. How many different things do you see in these pictures? Do we have one living thing in these pictures or multiple? When lots of different species live together in one place, is that genetic or ecological biodiversity? (Ecological)
2. Now look at the butterflies, do you notice any differences between them? When two animals are the same, but look different, do we say they have genetic biodiversity, or ecological biodiversity? (genetic biodiversity)

3. Do you see any food in this picture? What type of plants provide food for you that you like to eat? What type of fruit do you like to eat? Plants provide a lot of food for us, and pollinators help plants grow that food. Plants and animals living and working together is made possible by what? (Biodiversity)

An ecosystem consists of many different habitats, which support many different living things that support each other in life. An ecosystem is complete when there is food, water, and shelter for all living creatures living within that system. Healthy soil, clean water, and diverse plant species are all elements of a basic ecosystem.

Think about your school. You have students, teachers, principals, janitors, a librarian, etc.

1. What would happen if you took away the teachers?
2. What if the janitors disappeared, what would happen then?

In an ecosystem, all the different pieces work together to survive. If one piece of the system is removed, the balance of the existing system shifts, and some things that were controlled, or supported, by that missing piece will begin to lose its proper balance, which will then affect other pieces of that system. We see this in nature, where big shifts in balance can cause groups to struggle or even die off permanently.

1. Do you know what it is called when a group of animals dies off completely? (extinction)
2. Can you name a group of animals that this has happened to?

Now, we are going to do an activity to show how changes in the environment can affect an ecosystem and the biodiversity within.

ACTIVITY I: BIODIVERSITY WEB

Slide 5

Background: The purpose of this exercise is to demonstrate the interdependence of different habitats within an ecosystem, and how adding or removing resources affects the balance of the entire system.

Supplies:

- 12 pieces of string, each two feet long
- 1 plastic cup or tin can
- 3-5 small rocks
- 1 thick rubber band
- 10 popsicle sticks with the following labels
 - Worms
 - Frogs

- Flies
- Trees
- Tall grasses
- Flowering plants
- Birds
- Butterflies
- Bees
- Beetles
- Small mammals
- Fish

Instructions:

Tie all the strings to the rubber band, and then put the rubber band around the cup or tin can (about 2/3 of the way up the cup/tin can). Put all the labeled sticks in the cup.

You will need six volunteers to each hold two strings. When all six are holding up all 12 strings at equal strength, all is well with the ecosystem.

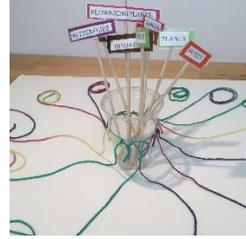
Have one person take a step back while everyone else stays put. Ask the students to observe what happens when he/she steps back. This is what happens when one living thing takes a little more resources from the system. Maybe this happens because this group doesn't have a healthy population of predators, or doesn't have enough pollinators to create food for everyone to eat. Have this student return to the starting position.

Have one student who is not holding any string, add the stones to the cup/tin can one at a time. This is what happens when many are relying on the same system for survival without adding more habitats. The stress on all the habitats becomes more. This could happen because a neighboring habitat or ecosystem has been destroyed, and all the inhabitants are forced to find new homes.

Have three students drop all of their strings. This is what happens when habitats or whole ecosystems are destroyed. What happened to the cup? Did it stay balanced? Did anything fall out of the cup? This is what happens when we build large developments of housing or plant large plots of grass for parks without adding back habitat.

Tell them the importance of adding back lost habitat by having the students who dropped the strings come back and pick up their strings.

Now imagine if we added more habitats to this system, what would happen to the heavy cup, would it rise or fall?



2. IMPORTANCE OF BIODIVERSITY

5 minutes

Slide 6

Return students' attention to the PowerPoint presentation, continue providing background information starting with slide.

Why is Biodiversity Important?

Provides a wide array of foods and materials, which contributes to the survival of all.

Defends against diseases and pests wiping out entire species.

Creates adaptability to changes, which is achieved by a concerted effort of many life forms repairing the damage done by a natural disaster, or another form of disturbance.

Provides ecological services, which are functions performed by many species that result in sustaining life on Earth. Within each ecological service there are many species at play.

- Decomposition of waste
- Water purification
- Pest control
- Flood moderation
- Soil fertility
- **Pollination (this is the focus of the presentation)**

Ask students questions as a group. For older students, you could also break them in to small groups and let them discuss the answer to each questions in order to provide more opportunity for participation.

1. How does one plant produce another plant? (Through pollination)
2. Can they do it alone or does something else have to help? (Something has to help, we call these pollinators)

3. What makes bees and other pollinators visit flowers? (the bright colors and they are looking for food, which we can nectar)
4. What is pollination? (Pollen mixes with a plant egg and makes a seed)
5. What do we usually do with seeds? (Plant them in the ground, give them sunlight and water)
6. What happens when a seed is planted in the ground? (Plants make more plants.)

3. THREATS TO BIODIVERSITY

5 minutes

Slide 7

Return students attention to PowerPoint, slides

Imbalance is the threat to biodiversity. Remember the cup? What happened when it was not balanced? This can be caused by change happening too quickly, often times by humans getting involved and taking too much of one resource.

Extinction can be a disruptor to life's balance because it is the permanent disappearance of life. It permanently removes a species from the planet, thus affecting whatever system it was part of. Extinction is part of the life cycle of Earth, and life's balance can adapt to those changes, if it occurs at a slow rate. As the planet changes, the species capable of inhabiting the Earth also shifts. These shifts are natural, and expected to occur on a small scale. But if it happens too fast, it threatens biodiversity in many ways.

Today, 1/3 of all known species are threatened with extinction. There are roughly 1.7 million identified species on Earth! 561,000 of those are endangered!

Extinction is occurring at a higher rate than normal, because of:

- Habitat loss or fragmentation
- Spread of non-native species and diseases
- Climate change
- Pollution

4. BIODIVERSITY AND POLLINATION

5 minutes

Slides 8-15

Pollination is the transfer of pollen from the stamen of a plant to the stigma of the same plant or a different plant. It unites pollen with a plant egg, which

results in a seed. It can produce only seeds or even food containing seeds. The seeds can grow into more plants like the ones they came from.

Pollination is an **ecological service** provided by pollinators, and results in the reproduction of flowering plants, which is equal to 90% of all plants on Earth; 80% of these flowering plants rely solely on pollinators to reproduce! Pollination provides food and other resources to many different living things on Earth.

Scientists estimate that **one out of every three bites of food you take** exist because of pollinators such as bees, moths, and butterflies. When the pollinator-plant relationship evolved, life on Earth became very diverse. Pollination supports biodiversity.

Pollinators include:

Wasps	Bees	Beetles
Birds	Butterflies	Ants
Flies	Bats	Moths

Pollination is a mutually beneficial relationship between the pollinator and the pollinated (plants). Some pollinators are very specialized and their relationship with a flowering plant is interdependent, meaning, if one disappears the other would disappear shortly thereafter. The effect doesn't end with this relationship; if this pair dies off, another organism suffers because it feeds on the food or other resources produced by this relationship, and so it goes across the web of life. Plants need pollinators to reproduce, pollination results in food, and that food feeds a wide variety of species.

1. Do you see my favorite type of pollinators? What are they? (Bees)
2. What's inside the flower that the bee likes? (Nectar, which is very sweet. Flowers use the sweetness to their advantage. Flowers are bright and showy, and they know bees like them because of that. They keep the nectar deep inside of them and then pollinators have to go through all of the pollen to drink their nectar.)
3. While the bees are drinking nectar, what else do they come in to contact with in the flower? (Pollen)
4. How do they transport that pollen to another flower? (It sticks to their body)
5. What is a honeybee? (A bee that makes honey AND pollinates plants)
6. Will someone share with us a time they saw a honeybee?

7. Can anyone tell me what you sometimes find inside of fruit? (Seeds)
Fruits make more fruit with the help of pollinators.

Pollinators contribute to biodiversity and life on Earth in ways that are significant to every ecosystem existing today. Roughly 90 % of all flowering plant species benefit from animal-assisted pollination, and 80% would cease to exist without pollinators!

Many of these flowering plants produce food as a result of pollinator-assisted pollination, and this food supports the lives of countless species, including humans!

1 in 3 bites we eat is dependent on pollinators!

1. How many of you like Fig Newton's? Did you guys know that figs have seeds in them?
2. Who likes raspberries? Do raspberries have only one seed or are there multiple seeds?
3. Did you know chocolate came from a plant? It requires pollination as well!
4. Did you know bumblebees are the best tomato pollinators? How many of you guys like pizza? Tomato sauce on your pizza? Without tomatoes there would be no tomato sauce.

90% of Earth's plants are flowering plants and they depend on pollination. The disappearance of pollinators would inflict catastrophic consequences on the entire planet.

Here's an example of the biodiversity pollinators bring:

There are 20,000 different bee species accounted for on Earth. These bee species are responsible for much of the 80% of the produce we depend on! Imagine all the food that might be lost if our bees went away. It's a scary thought, and awesome when you consider how many additional pollinator groups are providing food and other resources for us!

40% of the pollinators on Earth are endangered, which means many of the flowering plants that depend on them will also become endangered when these pollinators go extinct.

Pollinator populations are struggling to survive, and this fact threatens the balance of biodiversity on Earth, and life itself!

ACTIVITY II: POLLINATOR PUZZLE

Background: The purpose of this activity is to allow students to use their new found knowledge of pollinators and critical thinking skills to solve puzzles about the food system and how it relates to their everyday life.

Slide 16

Supplies:

- Print out the 'Pollinator Puzzle Pieces' document, each piece of paper should have one picture and one description
- Place the related cards in stacks

Instructions:

Pass out stacks of pictures, face down, to small groups of students to be solved from start to finish.

Start by explaining how fruit comes into existence from seed to flower to fruit, and that many things feed on the food produced by this pollination.

Give students 5 minutes to work as a team and arrange all the cards in order from start to finish and back again.

Ask them to imagine what might happen if the pollinator is removed.

Conclude by directing their attention to the interconnections each piece of the puzzle has, and the roll each piece plays in that cycle.

5. POLLINATORS, BIODIVERSITY, AND PESTICIDES

5 minutes

Slides 17-19

Pollinator populations are declining due to:

- ***Loss of natural habitat***
- ***Lack of food***
- ***Human use of poisonous chemicals***

Loss of habitat and food are disrupting the natural protection biodiversity offers. And then poisonous chemicals are added on top of lack of resources, killing the natural relationships designed to sustain healthy ecosystems.

Poisonous chemicals are used to protect an imbalanced system, such as grassy lawns and fields of single crops, such as corn, and these chemicals also harm the natural predators that may exist in that ecosystem.

1. When we spray something that kills insects, what do you think happens to the pollinators? (It kills them too because they are insects)
2. How does spraying pesticides on weeds above ground affect the soil and the bugs under the soil? (The chemicals go in to the ground and hurt the bugs and soil, many of which we need to produce food)
3. What does this do to biodiversity? (It reduces it, because it kills off certain species)

These chemicals are either sprayed or even built into seeds so every part of the plant carries the chemical. The chemicals become part of the plant, reaching into the nectar and pollen, and even the food the plant produces (we eat a lot of those foods). Pollinators who feed on these plants consume the poison and become very ill, or even die as a result.

Chemicals used include: insecticides (aimed at insect pests), herbicides (aimed at plant pests, otherwise known as weeds), and fungicides (aimed at fungal pests). Many of these chemicals are toxic to pollinators and other animals.

When used, pesticides build up in the ecosystem remaining in the soil, leaching into the drinking water, and food of the animals in the ecosystem inflicted with those toxic chemicals.

Pesticides disrupt the biodiversity of all systems indiscriminately by poisoning multiple species. The damage cannot be reversed without our help.

The list of struggling members on this planet will continue to grow unless we make big changes, starting with our own yards.

Bee populations of both honeybees and native bees are struggling to survive due to pesticide use.

Monarch butterflies are struggling to survive due to lack of nesting sites in the form of Milkweed, and this is due to herbicide use.

We could easily begin to solve these problems by stopping the use of toxic chemicals, followed by habitat restoration.

6. ORGANIC PRACTICES ASSIST IN RESTORING BIODIVERSITY

5 minutes

Slide 20

Harmful chemicals reduce biodiversity, but organic practices which do not allow the use of harmful pesticides, support biodiversity and a healthy food system. Toxic chemicals disrupt the natural balance, and perpetuate the use of toxic chemicals, making us dependent on them. **It's best not to ever start using chemicals in the first place, as they are often not needed.** Pests are hard to control without their natural predators present!

We can control the imbalance of pests by restoring and maintaining biodiverse ecosystems. Mother Nature has built-in systems to balance undesirable effects of individual species.

Monoculture crops (all the same across acres) are not diverse, genetically, and are susceptible to pests and disease, which is one reason why farmers of these crops are so dependent on chemicals to sustain crops. Variety in the soil and above the soil encourages natural pest control via predatory insects, birds, and other natural predators, and harnesses the protection that biodiversity brings.

7. NATURAL APPROACHES TO PEST CONTROL

5 Minutes

Slides 21-24

Feed the soil: diversity below ground

This approach takes advantage of the natural relationships in the soil and above ground to feed plants and promote successful growth.

- Disturb the soil less
- Plant with diverse crops
- Keep living roots in soil as much as possible
- Keep the soil covered

Habitat to support diversity above ground.

This tactic brings more diverse wildlife to the picture, which helps to control pests found above the soil.

- Plant bushes and trees for shelter provisions.
- Leave open soil for shelter provisions.
- Plant fruit-producing trees/bushes for food provision.
- Plant a variety of native wildflowers that bloom at a variety of times in the growing season for food provision.
- Place bee, bird, and bat houses.

1. Can someone explain to us how pesticides affect biodiversity? (They kill off insects, which reduces overall biodiversity)

2. What is an alternative for using pesticides? (Growing things organically, making sure there are bigger animals to eat little bugs, focusing on healthy soil)

ACTIVITY III: BUILD YOUR OWN NATIVE BEE HOUSE

15 Minutes

Slide 23

Objective: Students will construct a miniature bee house to take home for their garden or yard. Please download the “Summer Bee House Kit Instructions” document from our website for detailed instructions.

Supplies:

- One bottle of Elmer’s Wood Glue
- Four cups (to pour glue in and distribute on tables)
- Jumbo popsicle sticks, 12/student, extras to spread glue
- 1 7 inch 2x2 piece of wood with two 6-inche holes drilled in it **for each student**

Total: 35 minutes of talking without activities

CONCLUSION

At the end of the lesson, **students will be able to**

- Define biodiversity and explain why it is important to them as well as all living organisms
- Explain the interconnectedness of living organisms in providing each other with food, water and shelter. Explain what happens when one or more organisms is removed from an ecosystem.
- Understand the basic concept of pollination
- Name several pollinators and explain that pollination is important because it provides us with food.
- Name a threat to pollinators and express alternatives to the use of pesticides

APPENDIX I

NEXT GENERATION SCIENCE STANDARDS

This lesson was designed to meet several of the elementary level Next Generation Science Standards. Using the example of pollinators, this lesson illustrates the impacts that human action can have on an ecosystem, offering an opportunity to engage students at a variety of grade levels on the interconnectedness of living organisms and their ecosystems. It touches on many themes that span the course of elementary science education, and offers the opportunity to engage students in hands on demonstrations and activities that further increase their ability to master the curriculum. Specific examples of how this curriculum meets the Next Generation Standards are outlined below

KINDERGARTEN

STANDARD: EARTH AND HUMAN ACTIVITY

- K-ESS3-1.** Use a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live. [Examples of relationships could include that bees get nectar from plants to help them grow, other animals and humans then eat the plants and the foods that come from them, like fruit. Plants, animals, and their surroundings make up a system, focus on ecosystem and interconnectedness of all organisms.]
- K-ESS3-3.** Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment. [Examples of human impact on the land could include using pesticides to kill weeds, which in turn hurt bees and other pollinators, threatening our food supply. An example of a solution would be that humans could plant flowers to make more habitat for bees, giving them food and shelter, and that they don't use any harmful chemicals around their home.]

FIRST GRADE

STANDARD: HEREDITARY: INHERITANCE AND VARIATION OF TRAITS

- 1-LS3-1.** Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents. [Lesson touches on the topic of genetic diversity versus biological diversity. Uses examples from Pollinator Poster to explore the differences between animals of the same species that look different, and the occurrence of many different species living together in one place. Examples include comparing dogs of different sizes and shapes and butterflies that are different colors, as well as brainstorming traits one may have inherited from their parents or share with their siblings.]

SECOND GRADE

STANDARD: ECOSYSTEMS: INTERACTIONS, ENERGY AND DYNAMICS

- 2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.** [Students will learn about the process of pollination and then work in groups to solve puzzles that require putting the process of pollination in order from start to finish. Lesson also focuses heavily on ecosystems and importance of biodiversity.]
- 2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats.** [This is largely the focus of the lesson, focuses heavily on ecosystems and the importance of biodiversity. Students will perform a hands on “pollinator web” activity that demonstrates the importance of balance in an ecosystem, as well as what might happen if one or more of those elements was removed from the system.]

THIRD GRADE

STANDARD: ECOSYSTEMS: INTERACTIONS, ENERGY AND DYNAMICS

- 3-LS2-1. Construct an argument that some animals form groups that help members survive.** [Bees work in groups and live in hives in order to collect enough nectar to serve as food through the winter.]

STANDARD: HEREDITY: INHERITANCE AND VARIATION OF TRAITS

- 3-LS3-1. 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.** [Clarification Statement: Patterns are the similarities and differences in traits shared between offspring and their parents, or among siblings. Emphasis is on organisms other than humans. This lesson has an entire section on genetic and ecological biodiversity. Looks at the genetic diversity in animals that are the same species but look very different using dogs as an example, and then asks children to assess different genetic traits they share with family members or that differ from other members of the class. Lesson than explores biodiversity, the act of many different species living and working together in an ecosystem.]

STANDARD: BIOLOGICAL EVOLUTION: UNITY AND DIVERSITY

- 3-LS4-4. 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.** [Students should be able to draw conclusions between changes in biodiversity and the effects it can have on certain animals. Examples may be that certain species go extinct, or others take more resources than they should once other species disappear, creating imbalance as demonstrated by the biodiversity web activity.]

STANDARD: EARTH AND HUMAN ACTIVITY

- 3-ESS3-1. Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.** [Lesson discusses the fact that some changes happen as a result of natural occurrences, but the use of pesticides introduces a component to the environment that is not natural.]

FOURTH GRADE

STANDARD: FROM MOLECULES TO ORGANISMS: STRUCTURES AND PROCESSES

- 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.** [Flowers are bright colors and have nectar inside of them in order to attract bees and other pollinators. Pollination is crucial to their survival, and so these internal and external structures aid in their continued existence as a species. Without these adaptations, would not be able to reproduce.]

FIFTH GRADE

STANDARD: ECOSYSTEMS: INTERACTIONS, ENERGY AND DYNAMICS

- 5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.** [Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth. This lesson focuses extensively on the importance of ecosystems and the interconnectedness between organisms, soil, food webs, and pollination.]

STANDARD: EARTH AND HUMAN ACTIVITY

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. [Lesson explores the relationship between the human activity of pesticide use and the impact it has on biodiversity, which in turn can impact entire ecosystems. Without pollinators, our food supply would be threatened, and it is up to us to protect these important creatures from human actions that threaten their existence.]