The Monarch Mission

Empowering Students to Improve Habitat for Monarchs,
A Next Generation Science Standards-Based Curriculum, Grades PK-5

ECO-SCHOOLS USA
NATIONAL WILDLIFE FEDERATION
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LEGO Community Fund U.S.

National Wildlife Federation

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The mission of the National Wildlife Federation is to inspire Americans to protect wildlife and natural resources for our children's future. The National Wildlife Federation has been a leader in developing high quality educational program focused on the observation and study of nature, Earth systems and wildlife to advance science learning for nearly 50 years. Combined, our PK-12 programs reach 8,300 schools, approximately five million students and thousands of educators every year. For more about the National Wildlife Federation visit, www.nwf.org.

The LEGO Community Fund U.S. (LCFUS) mission is to inspire and develop builders of tomorrow to reach their potential by support programs benefitting children 0-14, primarily in the areas of learning, creativity or creative problem solving. We will support programs in the U.S. communities where the LEGO Group operates, and will give preferences to programs benefitting disadvantaged children.

Questions? **eco-schoolsusa@nwf.org**

INTRODUCTION

For many of us, one of our fondest memories of elementary school is observing monarch butterflies in the classroom and learning about metamorphosis as these remarkable creatures transformed from caterpillars to butterflies right in front of our eyes. As educators, many of you have probably used the monarch butterfly to teach about life cycles and migration. But this iconic species is in trouble and like many of our pollinator species is in decline.

These brilliant orange and black butterflies are among the most easily recognizable of the butterfly species. Their migration takes them as far north as Canada and, during the winter months, as far south as Mexico City. A single monarch can travel hundreds to thousands of miles. Monarchs are truly spectacular migrants, because the butterflies know the correct direction to migrate even though they have never made the journey before. They follow an internal "compass" that points them in the right direction each spring and fall. The monarch migration is one of the greatest natural phenomena in one of the greatest natural phenomena in the insect world.

But it is this migration and the habitat the monarch depends upon during this journey that has resulted in the species decline. It was in 2014, when biologists and the US Fish and Wildlife Service became concerned about the monarch butterfly's population numbers. According to scientists, the continent's monarch population has declined by more than 80 percent from its average during the past two decades—and by more than 90 percent from its peak of nearly one billion butterflies in the mid-1990s.

Why is the Monarch Butterfly in Decline?

The U.S. Fish and Wildlife Service is currently studying the status of the species to determine if it should be listed as a threatened species under the Endangered Species Act. The reason for the precipitous decline is primarily due to the loss of the monarch's exclusive larval host plant and a critical food source – native milkweed. These plants have been eradicated and/or severely degraded in many areas across the U.S. due to the overuse of pesticides by commercial agriculture and conventional gardening practices in suburban and urban areas. The accelerated conversion of the continent's native short and tall grass prairie habitat to crop production has had an adverse impact on the monarch, and climate change has intensified weather events which may also be impacting their populations. It is estimated that one million acres of milkweed must be planted annually simply to keep pace with new losses. Creating all of the habitat that monarchs need will require a massive habitat restoration program.

What is the National Wildlife Federation and our Partners Doing to Help?

The National Wildlife Federation (NWF) recognizes the increased need for native milkweed to restore monarch habitat across large landscapes, suburban and urban gardens. Because, the lack of native milkweed is a limiting factor for the monarch butterfly, localized efforts to increase the supply of native milkweed is critical. This is especially important in Texas where the butterflies make their first stop after overwintering in Mexico before starting the annual migration north. Without sufficient habitat and milkweed in this region, the migration of the monarch stops. On a national level, NWF and U.S. Fish and Wildlife Service and many other partners have joined forces to help protect the monarch by working to bring back native milkweed and nectar producing plants that the species rely upon for breeding and feeding along its migratory route.

How Can Schools Help Monarch Butterflies?

As monarchs lose more and more habitat on agricultural lands, backyards have become increasingly important. As part of a larger effort to protect pollinators, NWF and the U.S. Fish and Wildlife Service recently signed an agreement, calling on citizens to help monarchs by cultivating milkweed and native nectar plants. With a long history of creating habitat for wildlife, National Wildlife Federation believes that individuals, schools and whole communities can play a key role in helping monarchs recover.

Studying pollinators and the monarch butterfly gives students the opportunity to become engaged in and empowered to help solve a current and tangible 'real-life' environmental problem. The monarch butterfly is a species that students can have a direct positive impact on; a species they see in their schoolyards, backyards and at their local parks. The study of the monarch butterfly also lends itself beautifully to project-based learning. Students learn the importance of pollinators, develop plans, and implement effective solutions—such as creating monarch gardens with native nectar and milkweed (host) plants—that can make a concrete difference for the species.

Here's how your schools can play a role in this nationwide monarch-recovery effort:

Create a NWF Schoolyard Habitat®

Now with 5,000 participating schools, is the single largest school garden program in America. It supports school and educator efforts to develop wildlife and ecosystem education programs directly on the school grounds and provides children with opportunities to learn in outdoor classrooms. Schools can also participate in **NWF's Eco-schools USA program** and explore the Schoolyard Habitat pathway earning additional recognition and awards for your work. (www.eco-schoolsusa.org)

Plant milkweeds native to your region. Because they coevolved with your region's wildlife, native milkweeds are best. Sources of native milkweeds include Monarch Watch's Milkweed Market and the Xerces Society's Milkweed Seed Finder.

Cultivate native nectar plants. Nectar sources are especially important during spring and fall when monarchs migrate and need to fuel their flights, which can reach 2,000 miles during fall. Sources for native nectar plants include the Lady Bird Johnson Wildflower Center's Native Plant Database and regional planting guides published by the Pollinator Partnership.

Avoid pesticides use. In particular, steer clear of systemic insecticides such as neonicotinoids. These are taken up by plants' vascular systems, leaving caterpillars and butterflies that feed on leaves, nectar and pollen exposed to the poison long after it has been applied. A new study provides evidence that milkweed leaves treated with one neonicotinoid, Imidacloprid, kill monarch caterpillars that eat them.

Get your students involved in citizen science (see page the appendix, E-4). Biologists need volunteers to help study monarchs and students are great scientists. Programs such as Monarch Watch, the Monarch Larva Monitoring Project, and Journey North are great programs to involve your students in real science and support in helping monarchs.

ABOUT MONARCH MISSION

The lessons and activities that are part of ***The Monarch Mission, Empowering Students to Improve Monarch Habitat*** were created to complement your NWF Eco-Schools USA and Schoolyard Habitat® work and to accompany the construction of your school's Monarch Recovery Gardens and monarch observations. The curriculum is only one component to the overall experience. The Monarch Recovery Gardens project is not a short-term learning project. It is a long-term learning experience that will allow students to:

- Increase the available habitat needs of the monarch, subsequently leading to an increase in monarch numbers,
- Provide a variety of field experiences for students, allowing them to apply new learning and practice critical science, engineering and 21st century skills, and
- Build awareness in the community about a national environmental issue, while providing local solutions that can help bring them together, resulting in positive impacts for pollinator species, specifically the monarch butterfly.

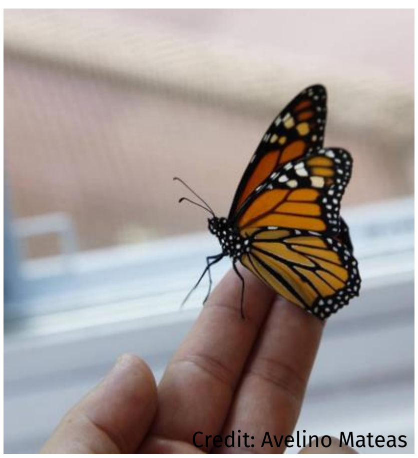
Each of the lessons and activites were designed starting with the Next Generation Science Standards (NGSS) for the following grade bands, K-2, 3-5, 6-8 and 9-12.

As lessons and activities were developed from the NGSS we focused on three key components,

- **Project-Based Learning:** using Monarch Recovery Gardens as the focus for place- and project-based, learning experiences.
- **Green STEM:** Using the natural world as the lens in which to integrate:
  - science content,
  - technology via web-based applications and online digital publishing tools,
  - engineering to create models, to demonstrate change over time and to solve design challenges to creating sustainable monarch habitat, and
  - Math to develop equations, measure plant growth, project progress, change over time and the rate of population growth/decline.
- **Interdisciplinary Instruction:** a scientifically literate student is able to communicate about topics in science and understand the historical value or nature of an issue and to use art to drive creativity and innovation.


Common Milkweed: Discovery Hill Austin
Credit: Marva Fowler


Credit: Harris Elementary


Credit: Avelino Mateas

WHAT IS CITIZEN SCIENCE?

Citizen Science is the collection and analysis of data relating to the natural world by members of the general public, typically as part of a collaborative project with professional scientists.

Goals and Objectives in the Classroom

The goal of Citizen Science in the classroom is to engage the student to not only learn about science but to be the scientist. Through discovering new things and increasing their own knowledge of the world students understand that science is not just memorizing a set of facts. By participating in citizen science they are now empowered to contribute to the ongoing process.

Students will make use of a number of skills such as collecting and analyzing data, interpreting results, making new discoveries, and developing and solving complex problems. According to the National Science Foundation, the constructs of citizen science are knowledge, engagement, skills, attitudes and behaviors. This creates a new science learning environment for students in the classroom.

Validity and Success

Citizen scientists collecting and reporting data to Monarch Butterfly projects provide information that contributes to the successful conservation of monarchs and their threatened migratory phenomenon.

For elementary grade level students Journey North's Monarch Butterfly Migration Project is a great place to start. According to its creators Journey North is "a global study of wildlife migration and seasonal change." Most students are familiar with this specie and the project is easy to participate in. With the appropriate building blocks even kindergartners can ask questions about data-another skill critical to building a scientific frame of mind. Students track the migration of the monarchs and learn about animal behavior and adaptations as well as the life cycle of the monarch butterfly representing key topics in life science. The project addresses content objectives through inquiry perspective which provides students with a way to build scientific skills and habits of mind.

One school in Brookshire, TX has taken their Citizen Science participation to new heights. With a new schoolyard Monarch Waystation garden in place they decided to embark on a sustained program where the students would be part of a world community. They would learn about science and conservation while helping the monarch population in their annual migration. They followed the suggested lessons from the Journey North website and shared their sightings of adult monarchs, eggs, chrysalides and caterpillars. Their students also participated in the Symbolic Migration and the school was plotted on the map of participating schools. One key element of their sustained inquiry was the Q/A with Dr. Karen Oberhauser where they learned important lessons about conservation and citizenship.

A more advanced Citizen Science project suitable for secondary grade level students is the Monarch Larval Monitoring Project (MLMP). The MLMP is a program in which volunteer citizen scientists collect and report real scientific data on monarch egg and larval distribution and abundance from their monarch breeding habitat(s).

The project involves youth and adult volunteers from across the United States and Canada in monarch research. It was developed in 1997 by researchers at the University of Minnesota. Students can begin the project by viewing the online training video series and the instructions provided on the activity datasheets.

Citizen Science helps students to understand that science is a way of thinking about the world that involves observing, questioning, analyzing, revising and collaborating. It exposes students to learning opportunities relevant to the real world and allows integration of inquiry into the teaching of content. Children learn science by actually doing science.

National Wildlife Federation, Journey North and the Monarch Larval Monitoring Project are partners of the Monarch Joint Venture (MJV). The (MJV) is “a partnership of federal and state agencies, non-governmental organizations, and academic programs that are working together to support and coordinate efforts to protect the monarch migration across the lower 48 United States”. The MJV is committed to a science-based approach to monarch conservation work, guided by the North American Monarch Conservation Plan (2008).

Cathy Downs
Monarch Watch Conservation Specialist
Chair – Bring Back the Monarchs to Texas

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PK: Gardens –Habitat for the Monarch Butterfly

BACKGROUND

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 play a critical role in the food supply for wildlife and people!

Brilliant orange-and-black monarchs are among the most easily recognizable of the butterfly species that call the Americas home. Monarchs, like all butterflies, change their diet as they develop. During the caterpillar stage, they live exclusively on milkweed plants. Milkweeds are wildflowers in the genus *Asclepias*.

THE PROBLEM

- The North American monarch population has declined by more than 90 percent in the past two decades. This is due to decline in summer breeding habitat in the U.S. and decline in winter habitat in Mexico.
- One-third of the monarch's summer breeding habitat has been destroyed, largely in the Midwest. Expansion of row crop agriculture and, to a less extent, development have destroyed 90 percent of our nation's native grassland ecosystems, on which monarchs depend. Milkweed, the only host plant for monarch caterpillars, has declined in the U.S. due to overuse of herbicides by commercial agriculture and conventional gardening practices in suburban and urban areas.
- Monarch overwintering sites are under threat, especially in Mexico where the forests used by monarchs are under logging pressure.
- Monarchs are being directly killed by insecticides both as adult butterflies and as caterpillars, in agricultural suburban and urban landscapes.

A TRANSFORMATIVE SOLUTION

- Instill a conservation ethic in students through stewardship and education.
- Find support in the school community and outside the school community, administrators, grounds and facilities staff, parents, academia, local non-profits and community businesses.
- Remove invasive plant species.
- Identify the four main elements of habitat.
- Create, build and maintain monarch habitat using native milkweed and nectar plants.

- Regional specific, native milkweed and nectar plant varieties, https://www.nwf.org/sitecore/content/Home/Garden-for-Wildlife/About/Native-Plants/Milkweed
- Use monarch habitat for interdisciplinary learning experiences and invite the community to engage in monarch citizen science, contributing to the pool of scientific data scientists use to draw conclusions about the species.

Activity 1 – Sorting in the Garden

PREPARATION

Either take students on a nature collection walk or you can collect natural items found in the schoolyard, items can include, rocks, soils, leaves, twigs, pine cones, tree bark, etc. Place items in a reusable box or plastic bag to use during the sorting activity.

MATERIALS

- Sorting trays – 1 per student or student pair
- Nature items – a collection per student or pair

WHAT TO DO

1. Take students outside, either to the garden area or another place in the schoolyard.
2. Pass out sorting trays and collected natural items.
3. Ask students to sort their objects by
    - Shape | Texture | Color

   After each sort talk about the "why" behind their sorting decisions, and provide students the opportunity to share their sort with the class.

Take pictures of the students while they are sorting and add them to your weekly student learning mural in the hall.

Activity 2 – Science Tools – Observing Plant Parts

MATERIALS

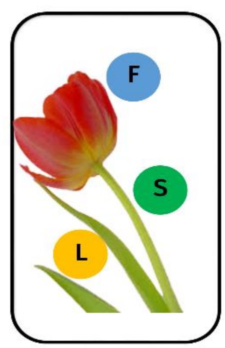
- Sorting trays – 1 per student or student pair
- magnifying loupes or glasses – 1 per student
- field scope (optional) – 1 per 4 students
- color dot stickers in 3 different colors – 1 set per student or student pair
- plant parts handout

PREPARATION

Gather enough flowering plants to supply one per student. You will also want to have an example plant, one that is not touched by the students.

WHAT TO DO

1. Pass out sorting tray with flower and hand lens/loupe to each student or pair.
2. Allow students a minute to explore.
3. Ask students if they can identify the stem, leaves and petals. Then together, identify the three parts.
4. Ask students to use their hand lens/loupe to look closely at each part. Focus on only one part at a time.
   - For example, let's look at the stem first. Ask students to identify the sound "stem" starts with and write that letter on their handout. Then ask them to draw the stem as they see it through their hand lens or fieldscope. Do this for the remaining plant parts.
5. Now conduct an informal assessment asking students to use the sticker to identify the plant part. Each student will receive three colored stickers, one with an "S" on it, one with a "L" on it and one with a "F" on it. One at a time ask students to place, for example the yellow sticker with an "F" on it next to the flower on their sorting tray. Do this for the remaining plant parts.



Take a picture of students with their completed trays and add them to your weekly student learning mural in the hall.

Activity 3 – How Does the Garden Feel? Observing Physical Properties

MATERIALS

- Sorting trays – 1 per student or student pair
- magnifying loupes or glasses – 1 per student

PREPARATION

Students will be looking more closely at natural items in the garden or on the school grounds, such as, rocks and pebbles, grasses, plants, trees, soil, etc. While not ideal, but in order to save time, you may want to collect some items for students to observe rather than allowing them to collect their own. Take this opportunity to go over field safety, such as not throwing objects and not eating putting any objects in the mouth, nose or ears.

WHAT TO DO

1. Take students outside to the garden and provide them with a sorting tray and a magnifying glass or loupe.
2. Students will be making observations of things found in nature. Explain we use our sense to make observations. We look at an object, we feel an object and so on. Start with something they know, such as their hand. Together, allow students to express what they see, feel, hear and smell.
3. Go through this same observation exercise with the as many of the items from the list below that time and attention span allow.
   - Soil
   - Grass
   - Leaves
   - Pebbles/rocks
   - Bark
   - Flowers
   - Twigs

Take candid pictures of students using their observation skills and add them to your weekly student learning mural in the hall.

Activity 4 – Color Mixing – What Makes Green?

MATERIALS

- Color mixing handout – 1 per student
- Pencil
- 3 paint brushes per student
- Blue and yellow paint

PREPARATION

Provide students with expectations during painting activities.

WHAT TO DO

1. Provide students with the color mixing handout.
2. Students will first trace the word green and then practice writing the word on their own.
3. Next students will use paintbrush 1 to color circle 1 blue, then paintbrush 2 to color circle 2 yellow and last use paintbrush 3 to add a little blue paint and a little yellow paint to circle 3, mixing the colors together to making green.
4. Take a walk to the garden or around the schoolyard and let students point out everything that is green. You can also take this opportunity to practice making observations and/or pointing out that students are making observations by looking for objects in nature that are green.

COLOR MIXING – WHAT MAKES GREEN?

green green

green green

blue + yellow = green

Science: Activity 5 – Soil Science - Temperature

MATERIALS

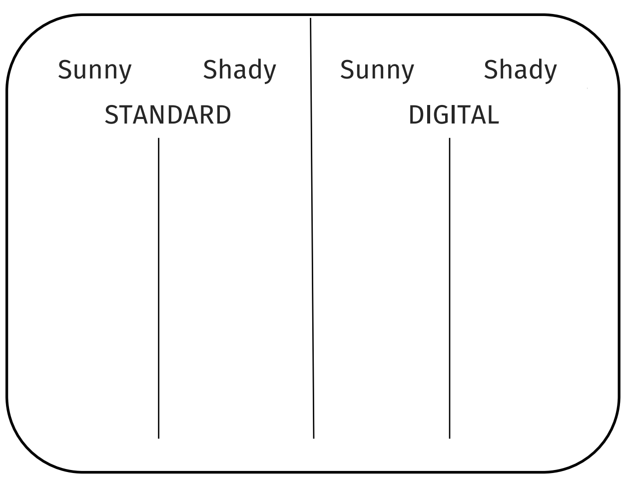
- Digital soil thermometer
- Standard soil thermometer
- Timer
- Hand-held white board with white board marker

PREPARATION

It's important each student get the opportunity to use the science equipment. While it is a privilege, it is necessary that students begin to build comfort with simple science equipment starting at a young age. To allow each student an opportunity to use the equipment it is recommended you go outside twice a day, morning and afternoon, with 2 sets of thermometers, 2 standard and 2 digital for as many days as is required for every student to use the thermometers.

Mark each standard soil thermometer five cm the dial, with a sharpie. The thermometer should not be inserted into the soil past this mark.

Set up your white board to take outside as seen below.



WHAT TO DO

1. Provide students with the expectations for handling both the standard and digital soil thermometers.
2. Take students out to the garden (having preselected a shady and sunny location) Insert one standard thermometer according to the specifications above, in a sunny location and the other in a shady location and start the timer for 5 minutes.
3. While the timer is going record the degrees in Fahrenheit, in the sun and in the shade with the digital thermometer. Record the numbers on your white board.
4. When the timer goes off, record the stand soil thermometer's temperature in Fahrenheit on your white board.
5. Sit with the students in a sandy(ish) area. Say the temperature aloud, asking your students to repeat, for example if the soil temperature is 55°F, students will repeat the entire phrase, "fifty-five degrees Fahrenheit". Next have the students practice writing 55 in the sandy around them. If there are no areas on the school grounds where students can have this tactile experience, go back to the classroom and practice writing the numbers another way.
6. Take with the students about why the degrees are different in the sun than they are in the shade. If they struggle with an answer, have some students stand in the sun and other stand in the shade and describe how they feel. This may help them begin to make a connection between the sun's rays and heat.
7. Next talk to students about why taking the soil temperature is important? The soil temperatures in the designated garden area must be of a certain temperature range to support the healthy establishment of the plants planted. If the ground is still too cold, then plants will not survive.

Take photos of students using the science tools and practicing writing their numbers and add them to your weekly student learning mural in the hall.

ENGINEERING OPTION

Students will be working to create a monarch garden in the schoolyard. Let them use LEGOs or natural materials from the schoolyard to make a model of the garden they would like to make for monarch butterflies.

PK: Getting to Know Monarch Butterflies

BACKGROUND

Students are building content knowledge so that they are better able to design, build, study and maintain a Monarch Recovery Garden. Monarchs are among the most easily recognizable of the butterfly species which call the Americas home. Monarch butterflies are bright orange with black and white markings. The body of the monarch is black. The head has a set of antennae. From the thorax come the wings, and are mostly orange with black veins running throughout. The outer edge of the wings has a thick black border. Within the black border are white spots. The white spots can range in size and they decorate the wings. At the upper corner of the top set of wings are orange spots. The underside of the monarch butterflies' wings can be seen when the butterfly is at rest or when it is feeding on a flower. Instead of bright orange, the underside is more drab and orange-brown.

Males and females can be told apart by looking at the top of their hind wings. Males have a black spot at the center of each hind wing, while the females do not. While the spots on males were once thought to be scent glands, they are actually vestigial and no longer serve that purpose. This is not the case for all butterfly species.

Size: Monarch butterflies have a wingspan of 3 ½ to 4 inches in length and weigh on average of 500 mg or 0.5g (about .02 oz.).

Lifespan: Most monarch butterflies do not live more than a few weeks. There are about four generations born each spring and summer and most of the offspring do not live beyond five weeks. The lone exception is the last generation born at the end of the summer.

The last generation of each year is the over-wintering generation that must make the journey back to Mexico. Rather than breeding immediately, the over-wintering monarchs fly back to Mexico and stay there until the following spring. In the early spring, they fly north to the southern United States and breed. Over-wintering monarch butterflies can live between 8 and 9 months.

Activity 1 – Parts of a Butterfly

PREPARATION

For this activity you will want to decide how you will have students create their butterfly. Here are some suggestions:

- Drawing
- Natural objects, like pebbles and small twigs
- Manipulatives
- Paper cut-outs that can be glued together

You may want to sort the parts into envelopes, trays, etc. to make for easier distribution.

MATERIALS

- Handout – Roll a Butterfly (consider laminating)
- Dice – 1 per student
- Green construction paper – ½ page per student

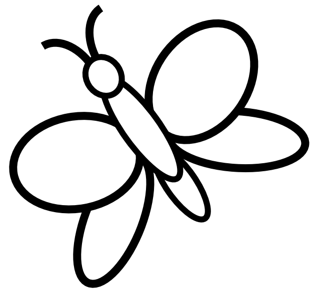
WHAT TO DO

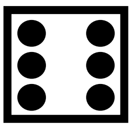
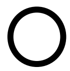
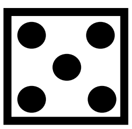
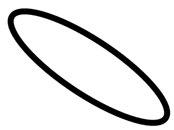
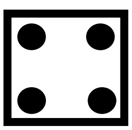
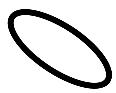
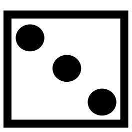
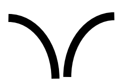
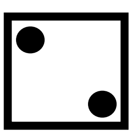
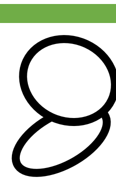
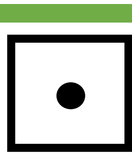
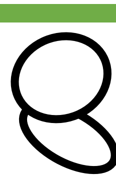
1. Give each student a dice and a copy of the *Roll a Butterfly* handout and a green half sheet of construction paper.
2. Explain they will be rolling the dice to get each of the parts of the butterfly, head, thorax, abdomen, antennae, and both wings.
3. After each roll you will give each student the part they rolled. Students are to place their butterfly part onto the green construction paper.
4. If a student rolls and lands on a part they already have they must wait till the next group roll to see if they get a part of the butterfly they need.
5. As students begin to complete their butterfly, have them help you give other students their butterfly parts.

Take pictures of the students while they work and add them to your weekly student learning mural in the hall.

Note: Be sure to say the name and encourage students to do the same, of each part of the butterfly as they are given out.

ROLL A BUTTERFLY

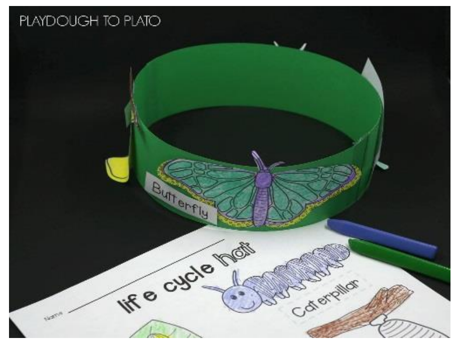


		**HEAD**
		**THORAX**
		**ABDOMEN**
		**ANTENNAE**
		**LEFT WINGS**
		**RIGHT WINGS**

For more creative learning ideas check out
www.makinglearningfun.com

Activity 2 – The Monarch Life Cycle

MATERIALS



- Life Cycle coloring sheet
- Crayons
- Scissors
- Glue stick
- Stapler
- 3 inches wide X 24 inches long strip of green construction paper

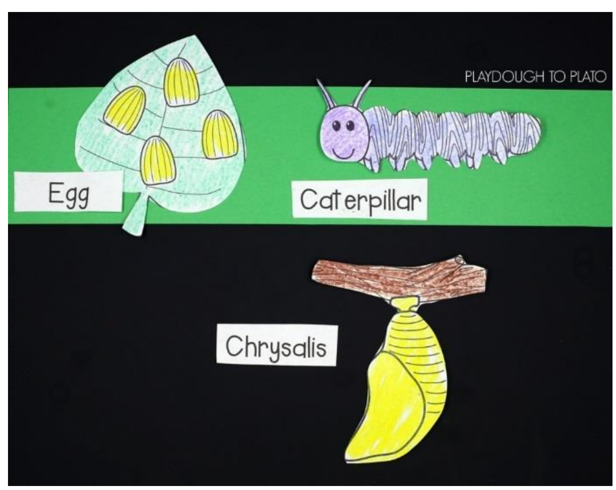
PREPARATION

This activity is adapted from Playdough to Plato,
The STEM Laboratory, https://www.playdoughtoplato.com/butterfly-life-cycle-hats/.

To make the headband, staple together the ends of two 3X12 strops to make it just the right length.

WHAT TO DO

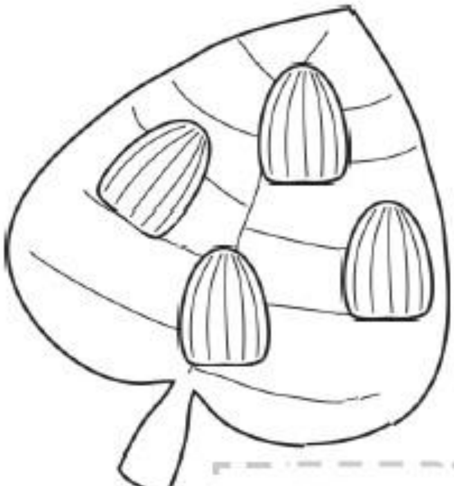
1. Read, Nation Geographic's easy reader, *Caterpillar to Butterfly,* or one of the other suggestions focused on the monarch butterfly's life cycle.
2. Pass out the green headband strips and have students write their names on one side.
3. Have students get out the following crayons, Green, Black, Orange, Yellow, then pass out the *Life Cycle coloring sheet.*
4. Students will then cut out the words and each colored image (the best they can).
5. Throw scraps in the recycle bin before continuing. Ask students to place their life cycle parts in the correct order. When students have their order correct, give them a glue stick to begin pasting each life cycle stage to their green headband strip.



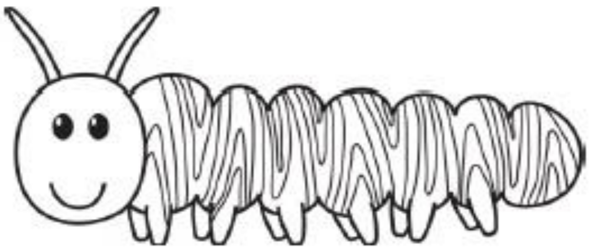
Take a group picture of the students with their hats on and add them to your weekly student learning mural in the hall.

Name ______________________________

life cycle hat

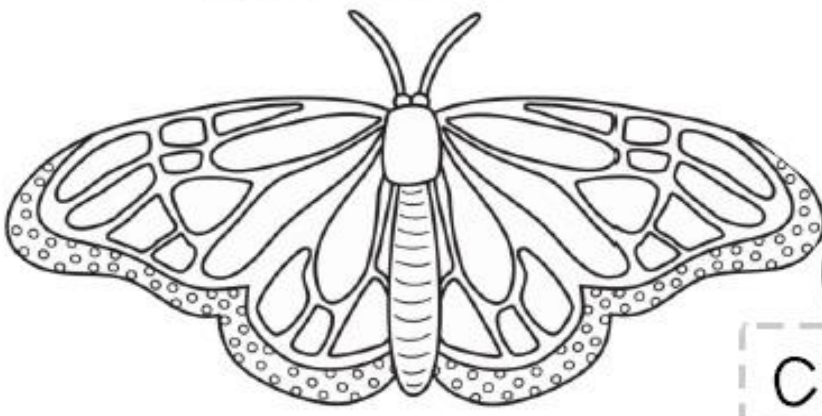


Egg



Caterpillar

Chrysalis



Butterfly

Activity 3 – Color Mixing – What Makes Orange?

MATERIALS

- Color mixing handout – 1 per student
- Pencil
- 3 paint brushes per student
- Blue and Yellow paint

PREPARATION

Provide students with expectations during painting activities.

WHAT TO DO

1. Provide students with the color mixing handout.
2. Students will first trace the word orange and then practice writing the word on their own.
3. Next students will use paintbrush 1 to color circle 1 red, then paintbrush 2 to color circle 2 yellow and last use paintbrush 3 to add a little red paint and a little yellow paint to circle 3, mixing the colors together to making orange.
4. Take a walk to the garden or around the schoolyard and let students hunt for orange objects. You can also take this opportunity to practice making observations and/or pointing out that students are making observations by looking for objects in nature that are orange.
5. Hang up dried student work on your weekly student learning mural in the hall.

COLOR MIXING – WHAT MAKES ORANGE?

orange

orange

orange

red + yellow = orange

Activity 4 – LEGO – Symmetry

MATERIALS

- Butterfly Symmetry handout
- LEGOs or other manipulatives
- Book, Looking at Nature: What is Symmetry in Nature?, Bobbie Kalman

PREPARATION

This activity is adapted from Fun at Home with Kids', Learning Symmetry with LEGOs and Butterflies, http://www.funathomewithkids.com/2014/06/learning-symmetry-with-legos-and.html

You may want to enlarge the symmetry handout and trace on to poster board, providing students with a larger surface area to work with.

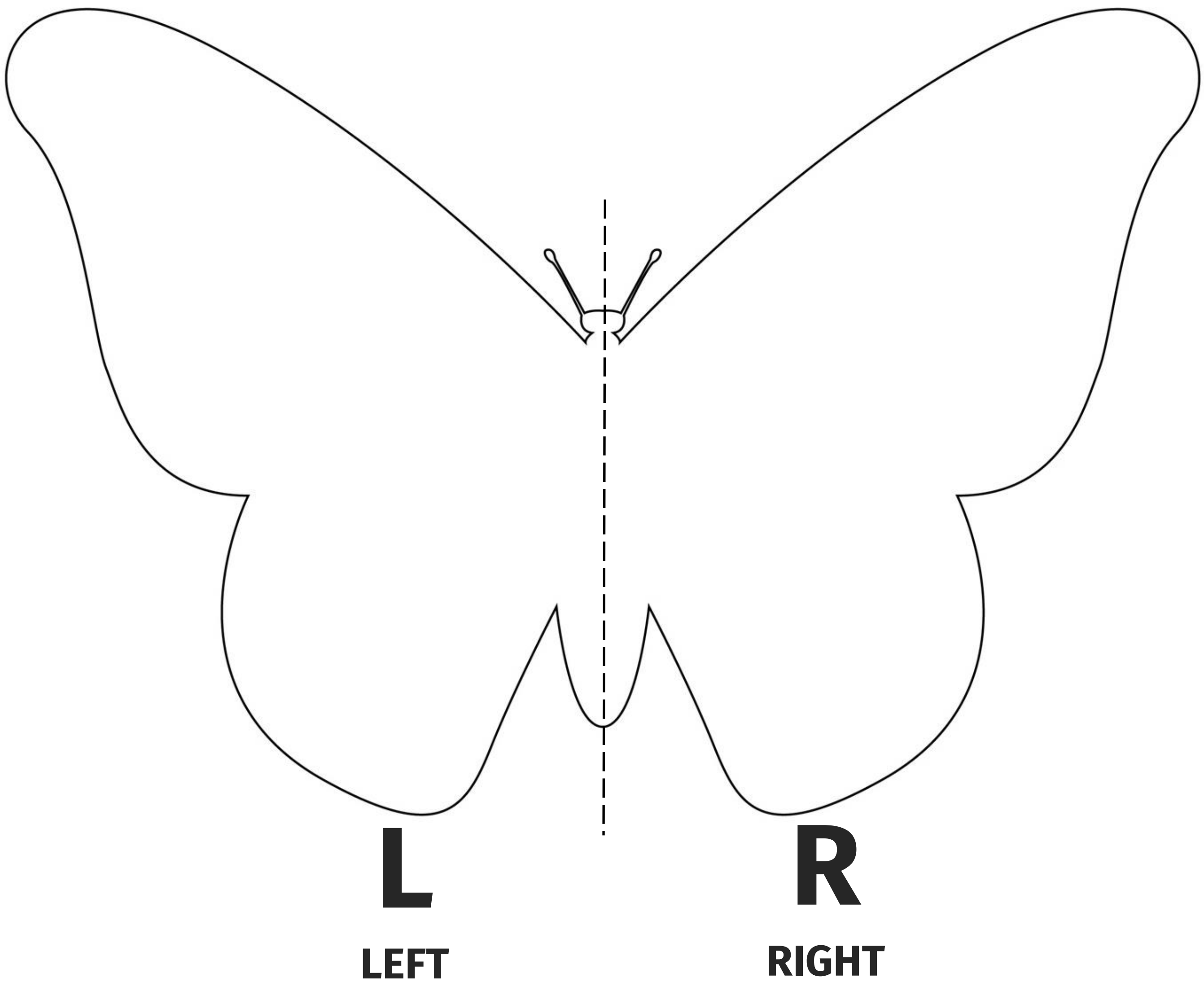
Organize 2 identical trays of LEGOs or manipulatives per student. This will help students process the activity.

WHAT TO DO

1. Read *Looking at Nature: What is Symmetry in Nature?*
2. Pass out the Butterfly Symmetry handout along with either two trays of LEGOs or manipulatives per student; one tray for the LEFT and one for the RIGHT
3. Ask students to only make a design on the LEFT side of the butterfly.
4. Once all students have completed the LEFT side, instruct students to fill in the RIGHT side making it look exactly the same as the LEFT, or symmetrical to the LEFT.

Take pictures of the students with their work and add them to your weekly student learning mural in the hall.

SYMMETRY



www.timvandevall.com

PK: Monarch Migration – A Unique Journey

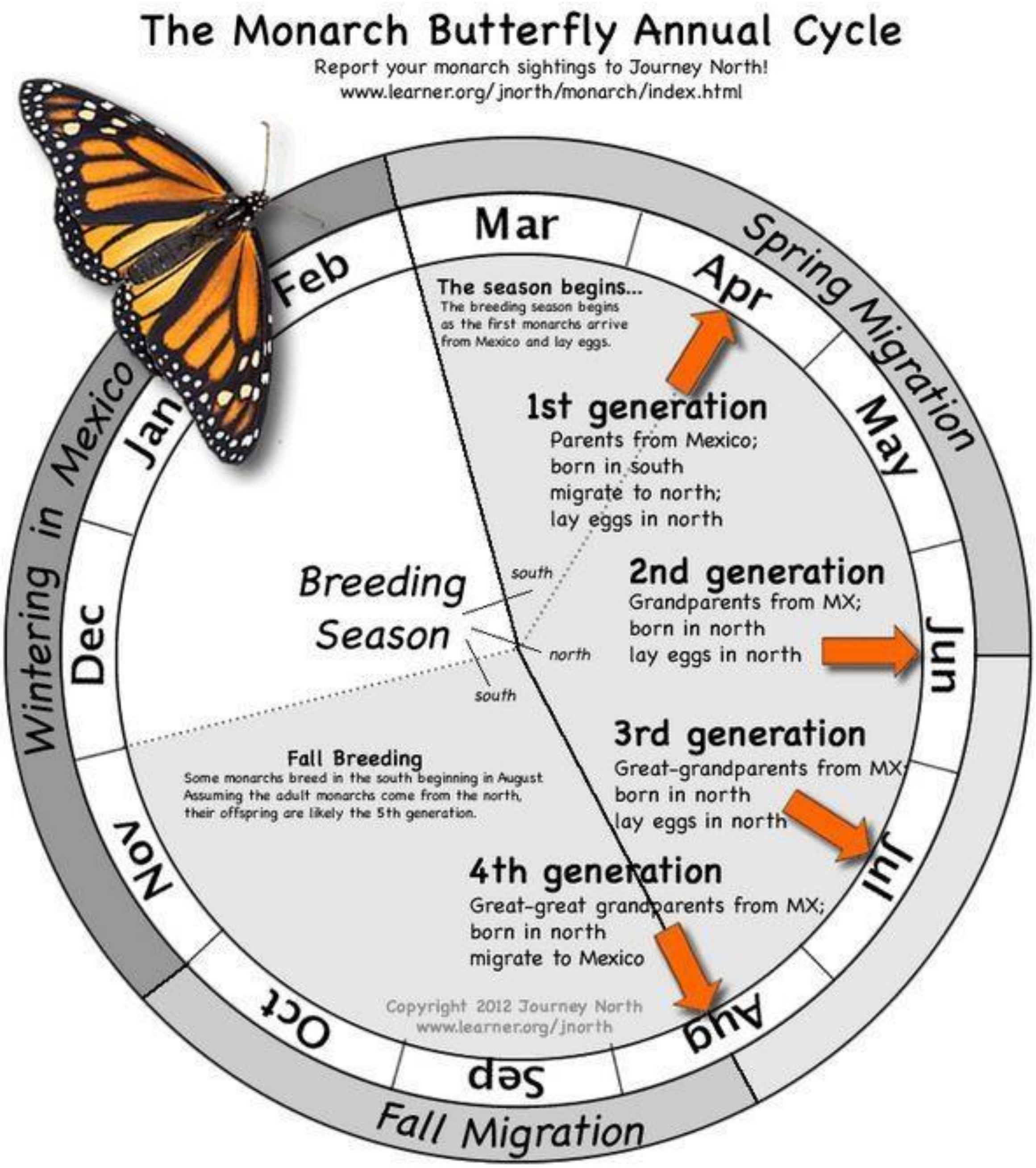
BACKGROUND

Over-wintering monarch butterflies in Mexico begin to make the journey north to the United States in early spring. Soon after they leave Mexico, pairs of monarchs mate. As they reach the southern United States, females will look for available milkweed plants to lay eggs.

The eggs hatch after approximately four days. The caterpillars are small, and they grow many times their initial size over a two-week period. The caterpillars feed on the available milkweed plant. When they get big enough, each caterpillar forms a chrysalis and goes through metamorphosis.
The chrysalis protects the monarch as it is going through the major developmental change of turning from a caterpillar to a butterfly. The chrysalis is green with yellow spots. After another two-week period, an adult butterfly will emerge from the chrysalis.

The adult monarchs continue the journey north that was left unfinished by their parents. Each year, about three to five generations will be born to continue migrating north. Most monarch butterflies do not live more than a few weeks. It is only the last generation, born in late summer that will live for several months and migrate back to Mexico to start the cycle over again.

The last generation of each year is the over-wintering generation. Rather than breeding immediately, the over-wintering monarchs stay in Mexico until the following spring. In the early spring, they fly north to the southern United States and breed. Over-wintering monarch butterflies can live upwards of eight months.


The Monarch Butterfly Annual Cycle
Report your monarch sightings to Journey North!
www.learner.org/jnorth/monarch/index.html
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Spring Migration
Fall Migration
Wintering in Mexico
The season begins...
The breeding season begins as the first monarchs arrive from Mexico and lay eggs.
1st generation
Parents from Mexico; born in south migrate to north; lay eggs in north
2nd generation
Grandparents from MX; born in north lay eggs in north
3rd generation
Great-grandparents from MX; born in north lay eggs in north
4th generation
Great-great grandparents from MX; born in north migrate to Mexico
Breeding Season
south
north
south
Fall Breeding
Some monarchs breed in the south beginning in August. Assuming the adult monarchs come from the north, their offspring are likely the 5th generation.
Copyright 2012 Journey North
www.learner.org/jnorth

Activity 1 – What's the Weather?
Observing weather during the monarch migration

PREPARATION

The following observations should be conducted during either fall or spring migration, or both. Make plans accordingly. Besides making daily observations during migration season, you can follow the migration at Journey North, http://www.learner.org/jnorth/maps/Maps.html

MATERIALS

- Daily access to Journey North's Monarch Migration maps for the current season, https://maps.journeynorth.org/maps
- Dailey access to your location's weather data, https://www.wunderground.com/
- Handout: Today's Clouds – 1 per student
- 1-Digital outdoor thermometer
- 1-Rain gauge – properly mounted in the schoolyard (use the directions from CoCoRaHS, https://www.ndsu.edu/fileadmin/ndsco/documents/Information_Packet.pdf), to purchase, https://goo.gl/vZKjWz
- Handout: This Week's Weather – 1 per student
- Large Cotton Balls – 5 per student
- Pencil
- Glue stick

WHAT TO DO

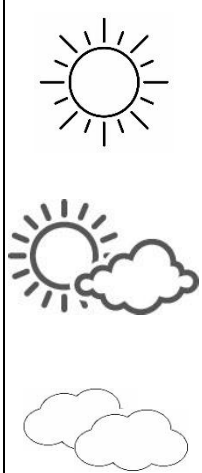
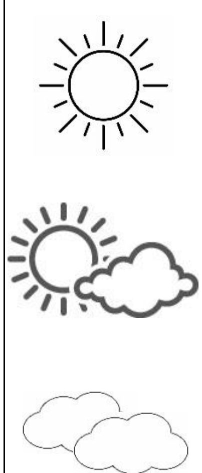
1. Students will have a data sheet to record temperature and precipitation for the week. At the same time every day, students will collect the following data:
    - Temperature in degrees Fahrenheit
    - Precipitation in inches
    - Circle other weather indicators as noted on the handout
2. Choose one day of the week to collect cloud data. Use the handout, *Today's Clouds* and let student's make observations of the clouds. Next use the cloud chart to choose which type of cloud they see. Then give students cotton balls and a glue stick to make the clouds they see in the sky on their data sheet.
3. Suggestion: keep student's work from the week and make a science notebook to share with parents/guardians during a conference, open house or other school event.

Take pictures of the students while they are collecting data and add them to your weekly student learning mural in the hall.

THIS WEEK'S WEATHER, PART 1

Name: ____

This week's dates: ____

	Monday	Tuesday	Wednesday	Thursday	Friday
Temperature	_______°F	_______°F	_______°F	_______°F	_______°F
Cloud Cover					
How Do You Feel Outside?	hot warm cool cold	hot warm cool cold	hot warm cool cold	hot warm cool cold	hot warm cool cold

THIS WEEK'S WEATHER, PART 2

Name: ____

This week's dates: ____

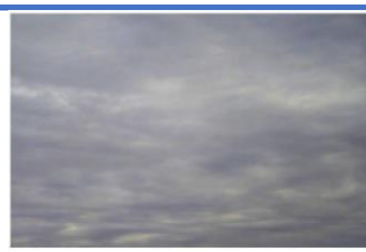
	Monday	Tuesday	Wednesday	Thursday	Friday
Precipitation	______°F	______°F	______°F	______°F	______°F
Precipitation Type					
How Does the Ground Feel?	wet dry	wet dry	wet dry	wet dry	wet dry

weather

weather

TODAY'S CLOUDS

Name: ____

 Stratocumulus	 Stratus
 Cumulus	 Cirrus
 Cirrostratus	 Cirrocumulus
 Altocumulus	 Altostratus

Color a blue circle ●, next to cloud types you see in the sky.

Using the space below, use your cotton balls to make the clouds you just observed outside.

Activity 2 – Migration Mapping

MATERIALS

- Handout: Where Do the Butterflies Go? 1 per student
- Pencil

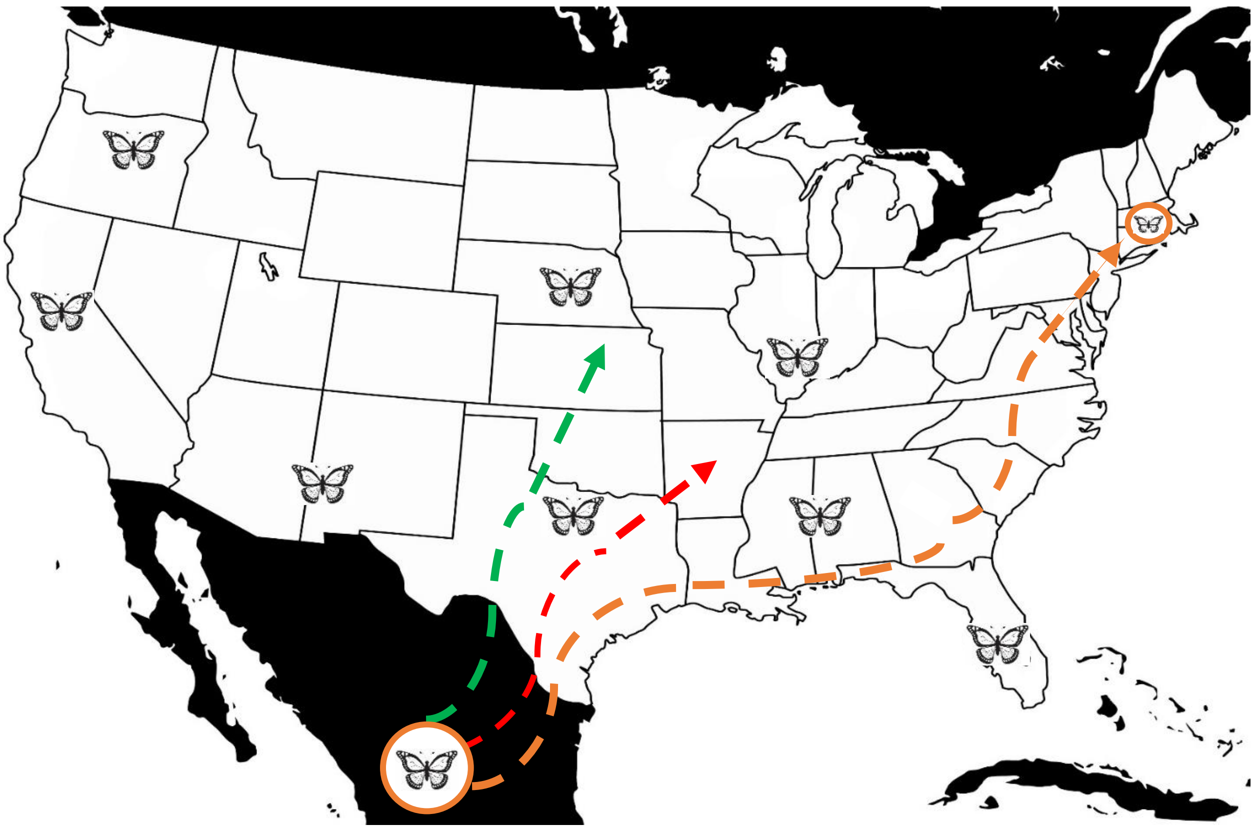
WHAT TO DO

1. Read, *Monarch Migration: Counting By 10*.
2. Explain the handout: *Where Do the Butterflies Go?* to each student. Help them follow each of the directions on the handout.

WHERE DO THE BUTTERFLIES GO?

Name: ____

First, find the orange line and trace the monarch's path from the Oyamel fir forests in Mexico to your school in Massachusetts. Next circle 10 monarch butterflies. Last practice writing the word *migration*.



Activity 3 – Graphing the Monarch Migration

MATERIALS

- Map of the North America or the United States and Mexico
- Handout: *Color and Cut Monarch Migration Mapping*, 1 per student

PREPARATION

Check out the fall peak migration by latitude chart below and plan to graph monarch numbers over a 2-4 week time period.

FALL			
Latitude	**Peak Monarch Abundance**	**Latitude**	**Peak Monarch Abundance**
49	August 18-30	31	October 4-16
47	August 24 – September 5	29	October 10-22
45	August 29 – September 10	27	October 15-27
43	September 3-15	25	October 20 – November 1
41	September 8-20	23	October 27 – November 8
39	September 14-26	21	November 3-15
37	September 19 – October 1	19.4*	November 10-22
35	September 24 – October 6		

*This latitude represents the general vicinity of the overwintering colonies.

WHAT TO DO

1. Replicate the graph, Monarch Migration Graphing, on poster board or butcher paper.
2. Have students color and cutout a set of four monarch butterflies using the handout below. If needed, students can color and cutout another set of monarchs if the first set is used.

3. Pick your 2-4 week observation window that coincides with peak migration dates. Check the peak migration dates for fall and spring, https://www.monarchwatch.org/tagmig/peak.html. Follow monarch migration progress using Journey North's monarch migration map, https://journeynorth.org/monarchs. Northern states may miss spring migration as "first sightings" above Virginia don't typically occur until the summer months. However, just briefly, those same schools may hit peak migration right as they return for a new school year.

4. Take students outside each school day, at the same time of day and for the same duration if possible, to sit near the butterfly garden. Have students raise their hand each time they see a monarch. You will record a tally mark on a scratch sheet of paper.
5. Once back in the class, allow each student to place a monarch on the graph for each monarch that was observed in the garden area. Call students to place a monarch in alphabetical order so everyone is sure to get the opportunity to place at least one monarch on the graph.
6. Optional: On Friday of each week, talk about the total number of observed butterflies and have students practice writing that number.

Take a candid photo of students with making monarch observations and add them to your weekly student learning mural in the hall.

ENGINEERING OPTION

The monarch butterfly does quite a bit of traveling and over the decades the journey has turned more perilous. One reason the journey is dangerous is because there are fewer native habitat for the monarch to rest, eat, and lay eggs.

Challenge your students to work together to design a safe monarch highway. Materials can be of your choice, but one suggestion is to use a long white piece of butcher paper to represent the highway. Next have students work together to design habitats between the two end points, the Oyamel fir forest in Mexico and their school.

Students can draw, use an assortment of classroom materials, such as blocks, LEGOs manipulatives, or natural objects found outside.

Allow each student to explain a part of their highway and why it will help the monarch.

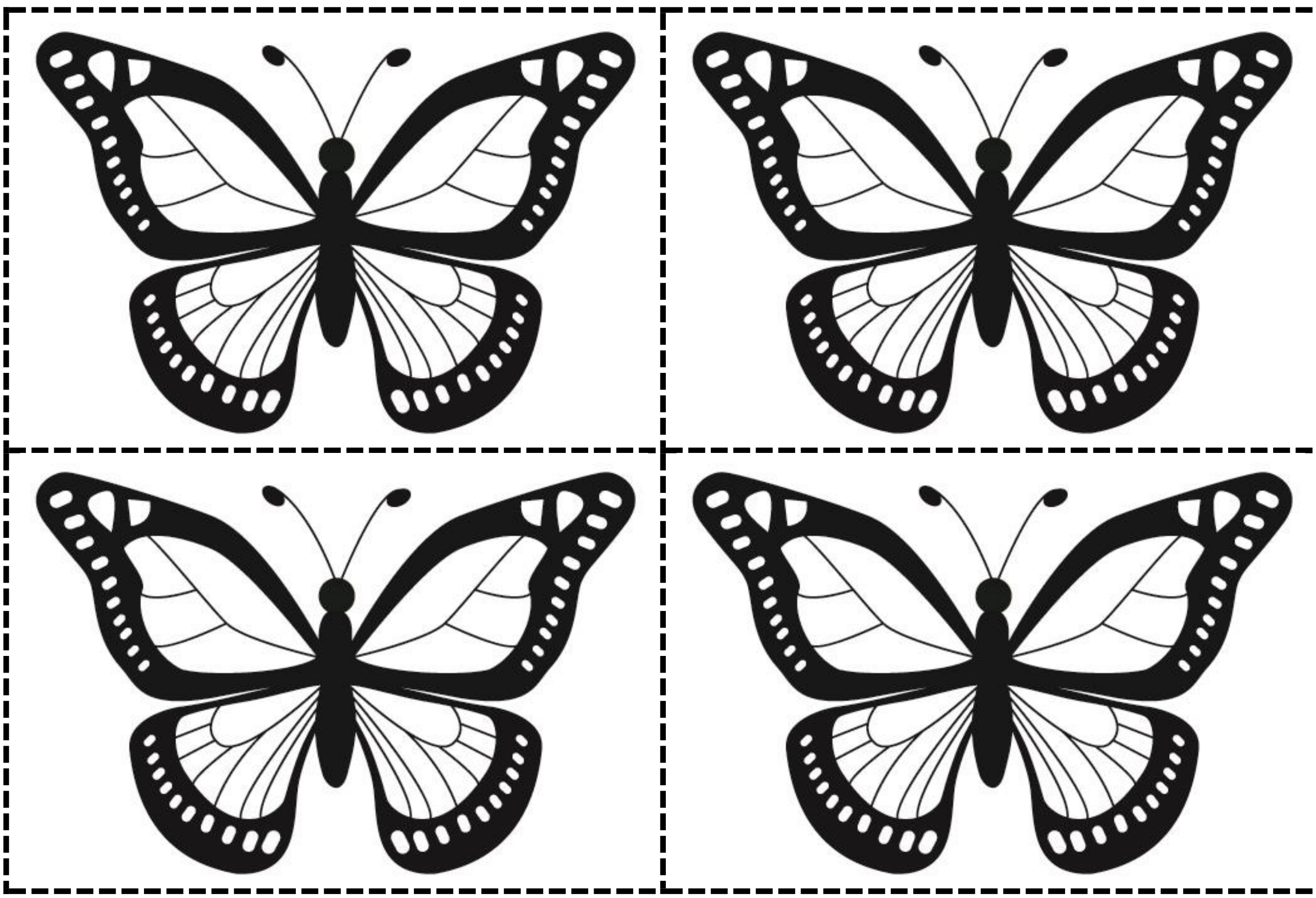
MONARCH MIGRATION GRAPH

Name: ______________________________________

Week: ______________________________________

Weeks	Number of Monarch Butterflies Sighted
WEEK 1	
WEEK 2	
WEEK 3	
WEEK 4	

Color and Cut: Monarch Migration Graphing



Credit: Adobe Stock, Leona

The Monarch Butterfly

K-2 | (3-4) 30 MINUTE CLASS PERIODS | SCIENCE, MATH, READING, ENGINEERING, WRITING

BACKGROUND

Students are building content knowledge so that they are better able to design, build, study and maintain a Monarch Recovery Garden. Monarchs are among the most easily recognizable of the butterfly species which call the Americas home. Monarch butterflies are bright orange with black and white markings. The body of the monarch is black. The head has a set of antennae. From the thorax come the wings, and are mostly orange with black veins running throughout. The outer edge of the wings has a thick black border. Within the black border are white spots. The white spots can range in size and they decorate the wings. At the upper corner of the top set of wings are orange spots. The underside of the monarch butterflies' wings can be seen when the butterfly is at rest or when it is feeding on a flower. Instead of bright orange, the underside is more drab and orange-brown.

Males and females can be told apart by looking at the top of their hind wings. Males have a black spot at the center of each hind wing, while the females do not. While the spots on males were once thought to be scent glands, they are actually vestigial and no longer serve that purpose. This is not the case for all butterfly species.

Left: Female monarch; note lack of hind wing patches (Photo: Candy Sarikonda) **Right:** Male monarch; note dark spot on each hind wing (Photo: Carrie Benham)

Monarch Lab

LESSON OBJECTIVES

Students will

- Identify and observe insects and their common characteristics.
- Build an insect.
- Construct the monarch butterfly life cycle.
- Act out the monarch butterfly life cycle.

Questions should be answered in the science notebooks and can be discussed in pairs, small groups and with the whole class. Building science literacy starts in Pre-K. Help students build their skills in reading, writing, listening and responding to science.

MATERIALS

- Science notebook
- Activity 2 Engineering Call-Out: A variety of consumable materials along with scissors and glue
- Pictures of common insects via magazines, online resources or the checklist at BugFacts.net.
- Book – *On Beyond Bugs: All About Insects*
- Copies of Evidence-Monarch Butterflies. Make one copy per pair or per group of four
- Life Cycle Cards: Make one set per student or pair of students
- Determine which of the life cycles you will make available to your students and gather the needed materials.
- Optional: slides of insects and insect parts – create a center where students can see insects in detail through microscope or detailed microscope images from the internet.

Size: Monarch butterflies have a wingspan of 3 ½ to 4 inches in length and weigh on average of 500 mg or 0.5g (about .02 oz.).

Lifespan: Most monarch butterflies do not live more than a few weeks. There are about four generations born each spring and summer and most of the offspring do not live beyond five weeks. The lone exception is the last generation born at the end of the summer.

The last generation of each year is the over-wintering generation that must make the journey back to Mexico. Rather than breeding immediately, the over-wintering monarchs fly back to Mexico and stay there until the following spring. In the early spring, they fly north to the southern United States and breed. Over-wintering monarch butterflies can live between 8 and 9 months.

Activity 1 – Insects I Know

1. **Investigating Question:** What is an insect? What insects live in our schoolyard? Have students write or help you write a list of every insect they can think of. Student can also make a picture list by drawing insects they are familiar with. Have students begin this list in their science notebook, listing the traits or characteristics that make insects, insects (for example: insects have eyes).
2. **Take a nature walk.** Go outside on a ten minute nature walk. (Provide students with your outside expectations and safety precautions.) **Define the boundaries for the investigation.** Generate ideas from the students about where they might find insects (where they live and eat) and model finding and observing the physical attributes and behavior of insects aloud. Instruct students to investigate what is living there and where they are in the schoolyard. Encourage students to take mental notes, make a list or sketches in their science notebook. After 5-10 minutes of independent or partner exploration, instruct students to pick an insect to carefully observe and draw (5 minutes). **Option:** Provide student with a temporary notebook they can wear outside. Just attach some note cards to their student lanyard and bring out a box of golf pencils for them to use on the walk.
3. **Debrief.** Have students compare the drawing they created to the list of characteristics of insects. Did everyone draw an insect or are some of them spiders, rolly pollies or centipedes?

NOTE: Students may have

pollies and/or centipedes and that is okay. Later they will understand why not all insects on their list are true insects.

Activity 2 – Is That Really An Insect?

Are insects and bugs the same thing? NO, a bug is a certain type of insect.

- Insects have three body parts. This is not always the case for bugs.
- Insects have a variety of different mouth parts, but true bugs have a "stylet" used to suck juices, typically plants, but some species feed on animals.
- Insects hatch from eggs and most go through complete metamorphosis, while true bugs go through incomplete metamorphosis; which means they hatch as nymphs from their egg. A nymph is a miniature version of the adult bug (https://askabiologist.asu.edu/explore/true-bugs)

Question 2-1: Do the insects in the images share the same characteristics from your first list? Are there new traits you want to add to the list or are there traits you want to take off your list?

Questions 2-2: How do you think scientists determined or came up with the one list all scientist would use to identify insects?

1. **Investigating Question:** What is an insect? Have students look through magazines, such as *Ranger Rick Jr.* or *Ranger Rick*. Your librarian may also have some field guides with pictures of insects and bugs found in your region or state. A very simple visual of insects can be found at, www.bugfacts.net/checklist.php. What similarities and differences do they notice?
2. **Have a class discussion** about the various traits students have found (this can come from a mental or written list). As a class determine 5 characteristics that help scientists identify insects. Then ask them to compare their list to an actual list of insect characteristics.
   - Exoskeleton
   - 3 body regions: head, thorax and abdomen
   - 3 pairs of segmented legs
   - 1 pair of antennae
   - Most have two pair of wings – **Note:** a few insects, such as ants don't usually have wings; some insects, such as flies only have one pair of wings.
3. Read, *On Beyond Bugs: All About Insects* by Tish Rabe, from Cat in the Hat's Learning Library.

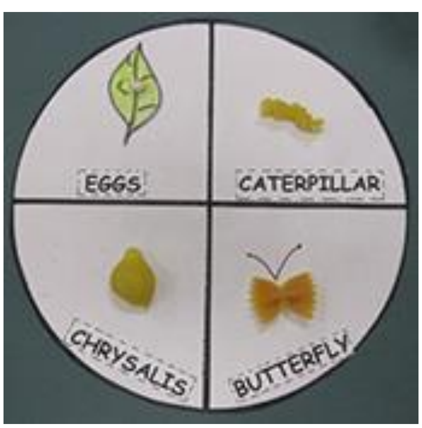
ENGINEERING OPTION: What purpose do wings serve on an insect? Provide students with a variety of consumable materials and have them construct an insect that has movable wings. Materials can include but are not limited to: pipe cleaners, egg cartons, paper (a variety of types), Wiki Stix, buttons, beans, pebbles, googly eyes, pom-poms, colored dots, straws, popsicle sticks, etc.

Activity 3 – Butterflies Are Insects

1. Investigating Question: How does a scientist prove a claim? (How do they prove what they are saying is true?) Have students Think-Pair-Share with a partner. Be ready to defend the claim that a monarch butterfly is an insect. Will they use their science notebook, books, photographs? Allow them to gather (within a reasonable amount of time) what they need to defend their claim. See page 1.8 for a set of monarch images students can use as a part of their evidence.

NOTE: There are limits to the evidence the photos can provide, for instance, students cannot tell from the photo whether or not the monarch has an exoskeleton.

2. Now that students are confident monarchs are insects it's time to look at them more closely. Pass out the sets of Life Cycle Cards, Activity 3-2 to students, p. 1.6-1.7. Have each student work alone to construct the cycle in the correct order. Next have them describe or tell their neighbor why they put the cycle in that particular order. When the student is ready check their work.
3. Students may now create the monarch butterfly life cycle using one of the methods below:
   - Draw the cycle in their science notebook.
   - Color, cut out, and put together the Monarch Life Cycle Wheel.
   - Color, cut out and glue into the science notebook, using the worksheet, *Life Cycle of the Monarch Butterfly*.



[Butterfly Life Cycle, Pinterest]

4. Sing, *The Butterfly Ballad* to the tune of "Mary Had A Little Lamb". After students learn the words teach students to act it out.

The Butterfly Ballad

by Guy Belleranti: Sing to the tune of "Mary Had a Little Lamb."

Butterfly starts as an egg,
As an egg, as an egg
Butterfly starts as an egg,
Let's see what happens next.

Caterpillar hatches out,
Hatches out, hatches out,
Caterpillar hatches out,
Let's see what happens next.

Caterpillar gobbles leaves,
Gobbles leaves, gobbles leaves,
Caterpillar gobbles leaves,
Let's see what happens next.

Caterpillar grows and sheds,
Grows and sheds, grows and sheds,
Caterpillar grows and sheds,
Let's see what happens next.

It becomes a chrysalis,
Chrysalis, chrysalis,
It becomes a chrysalis,
Let's see what happens next.

Butterfly comes out at last,
Out at last, out at last,
Butterfly comes out at last,
And then it flies away.

Act It Out

Verse 1
Roll up in a ball on the floor and cover your head.

Verse 2
Crawl like a caterpillar

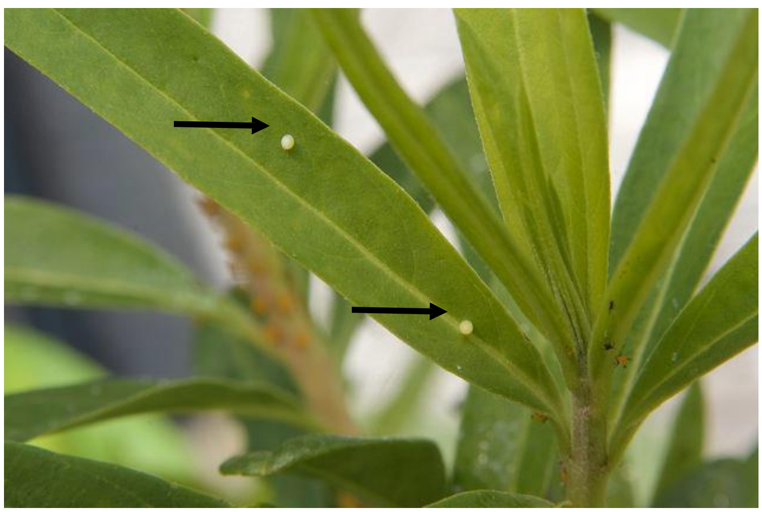
Verse 3
Act like you are eating and gobbling up as much food as possible

Verse 4
Act like you are growing, stretch long and tall

Verse 5
Pull your knees up to your chest and be as still as possible

Verse 6
Fly like a butterfly

LIFE CYCLE CARD 1



MONARCH BUTTERFLY EGGS

LIFE CYCLE CARD 2

MONARCH BUTTERFLY CHRYSALIS

LIFE CYCLE CARD 3

MONARCH BUTTERFLY LARVAE

LIFE CYCLE CARD 4

ADULT MONARCH BUTTERFLY

Images courtesy of the U.S. Fish and Wildlife Service Midwest Regional Center
unless otherwise noted

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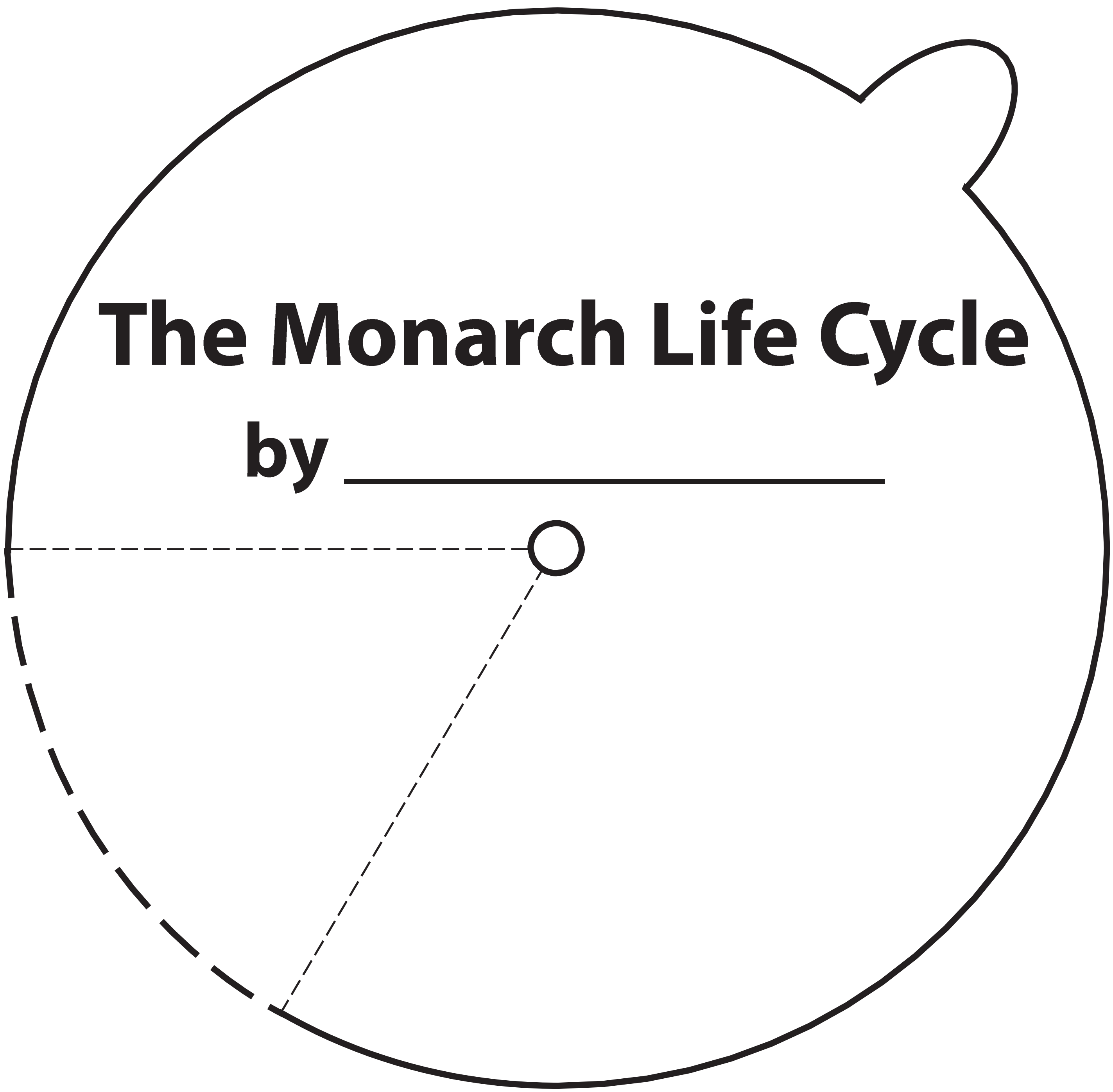
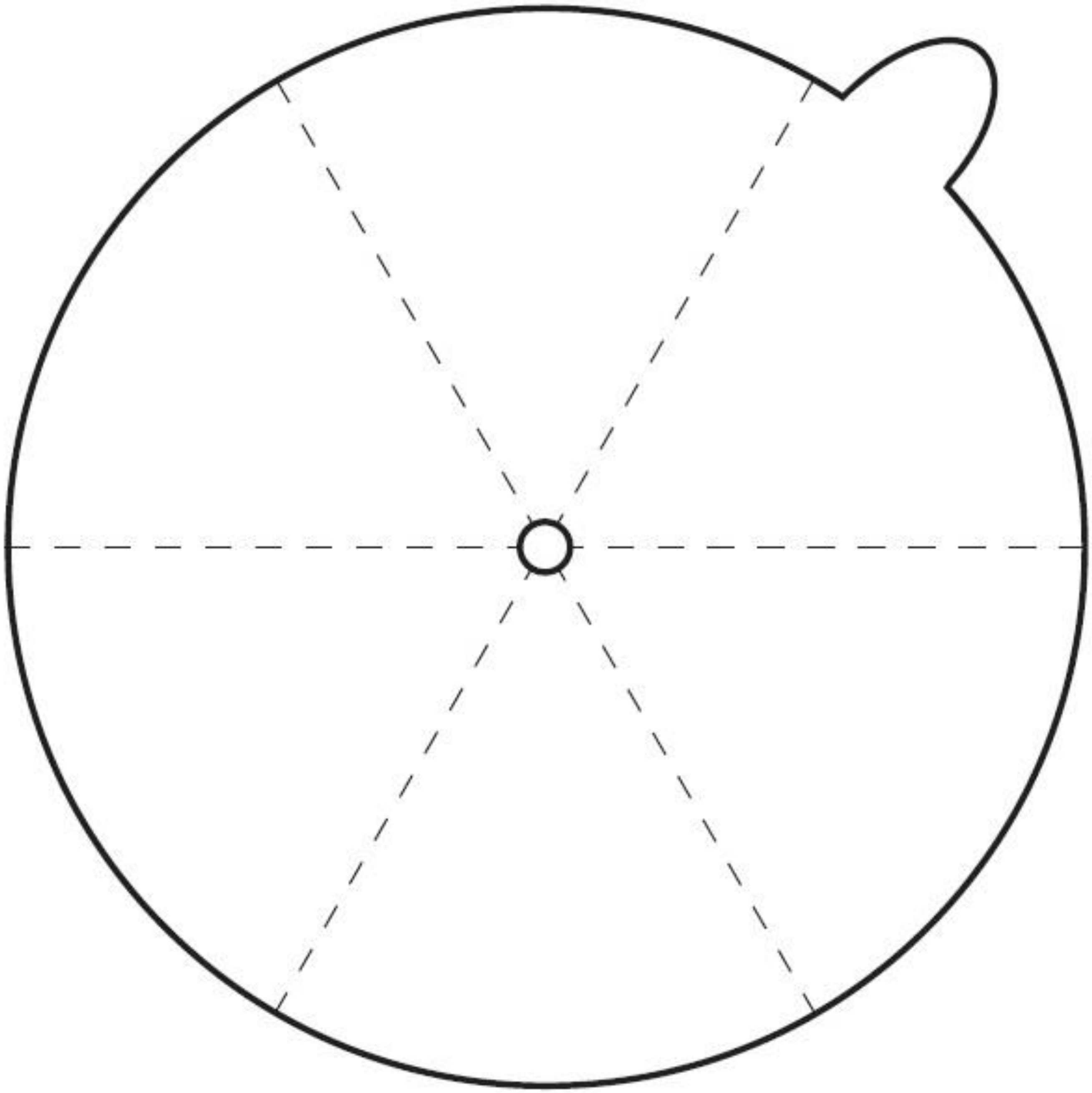
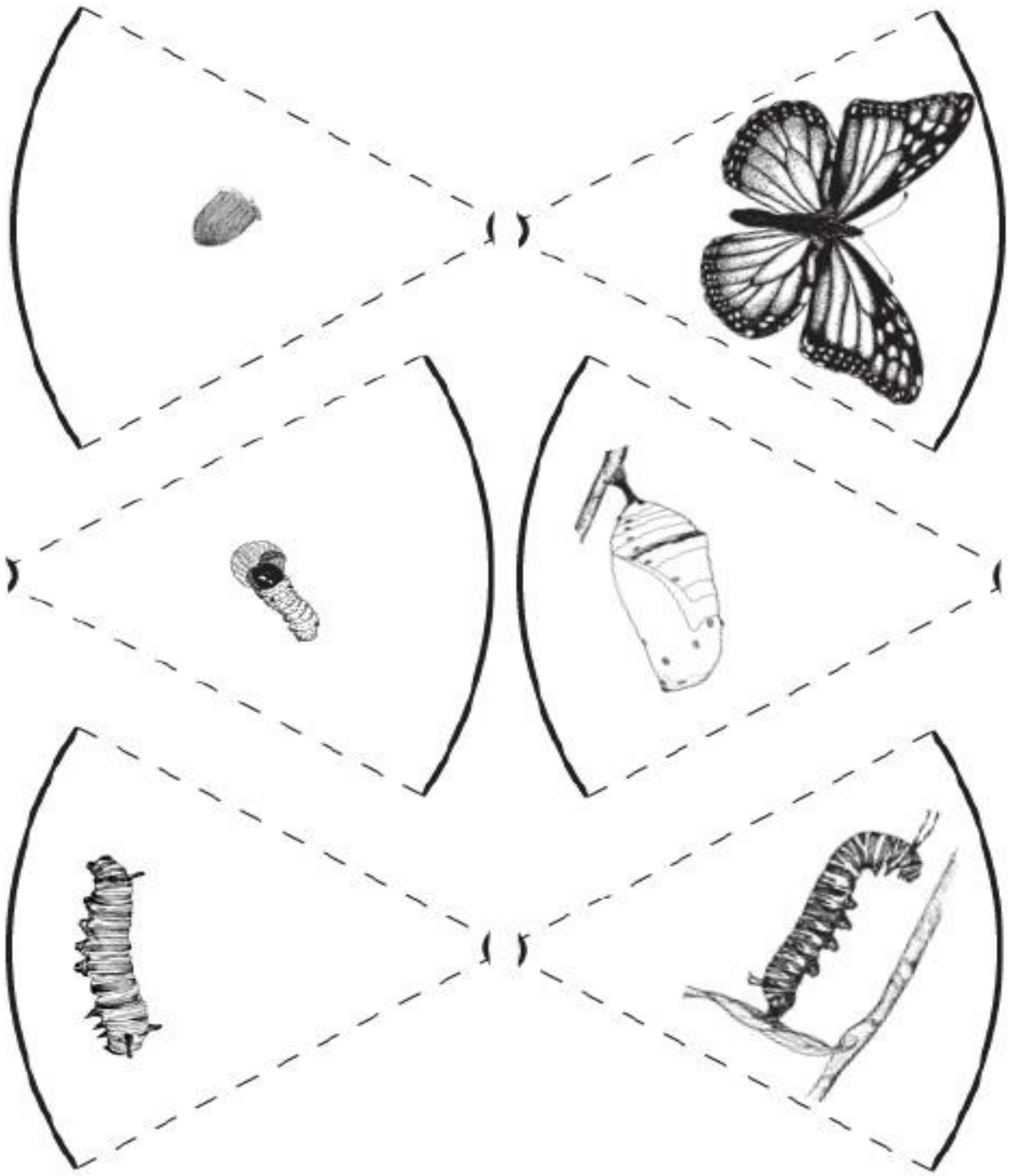
The Monarch Life Cycle

by ____________________







ECO-SCHOOLS USA
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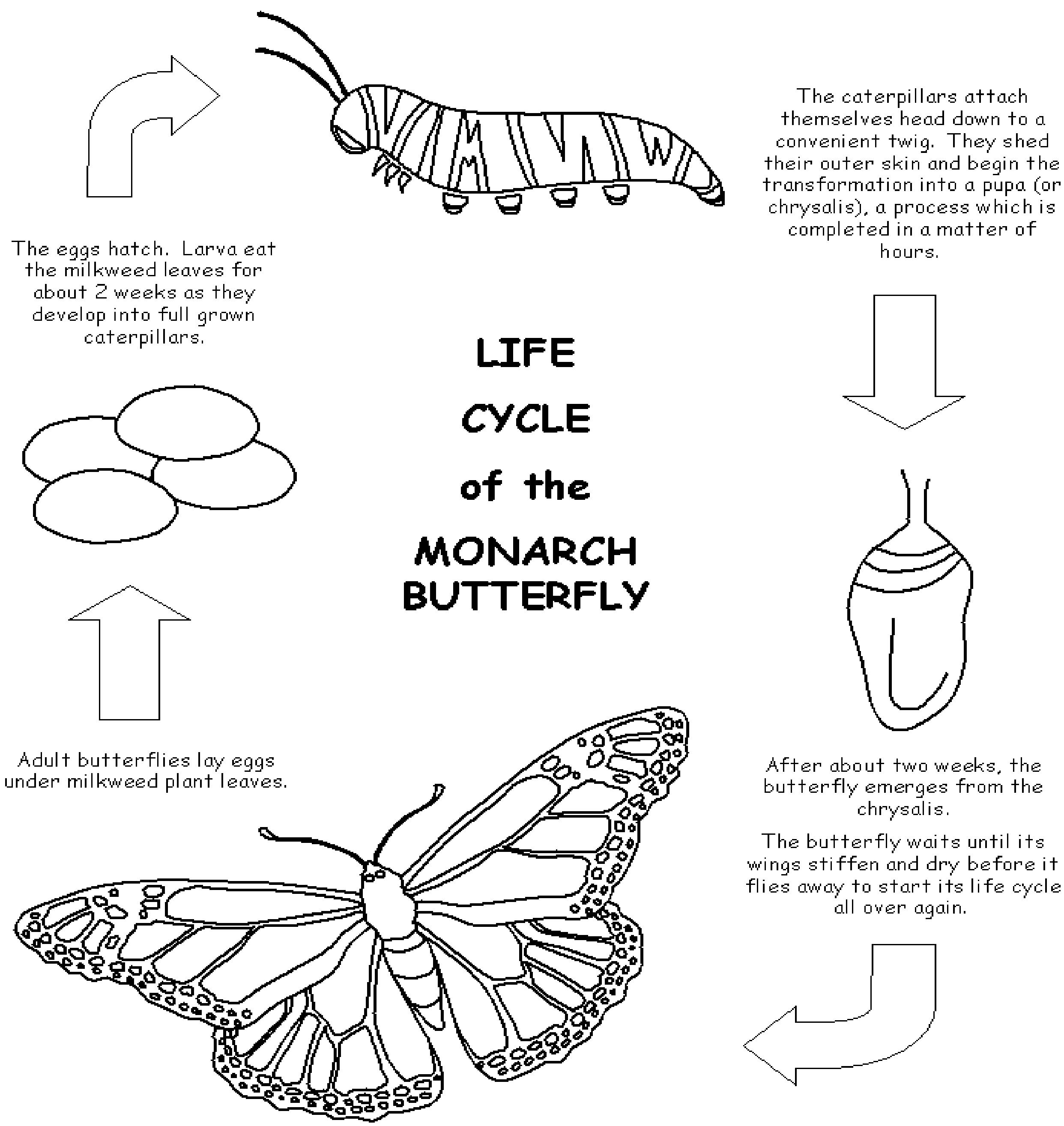
www.KidZone.ws
Butterflies

Name: ______________________________



www.kidzone.ws/animals/monarchlifecycle.htm Used with Permission.

What Do Plants Need To Survive

K-2 | (3-4) 30 MINUTE CLASS PERIODS | SCIENCE, MATH, READING, ENGINEERING, WRITING

BACKGROUND

Students are building background knowledge that will help them design, build, study and maintain a Monarch Recovery Garden. Plants and animals each have specific needs that must be met in order to survive. Some of those needs are similar and others are different. Building upon Lesson 1 where we made observations of insect life in the schoolyard, students will now make observations of plants species in the same location.

For something to be considered living it requires food to get energy to carry out all functions. All living things grow and follow a life cycle. All living things breathe; each plant or animal having specialized organs to complete this function. All living things reproduce and have sensory responses, such as animals to extremes in hot and cold and plants to the absence of light, water and air.[1] Plants, as living things require four specific elements to survive, food (in the form of nutrients found in the soil), water, air, and sun.

- **Air -** During the process of photosynthesis, plants use carbon dioxide to make food and release oxygen, as a result.
- **Water -** Roots carry water and nutrients to the plant. Water is also used during the process of photosynthesis by helping to release energy from stored food in the plant. Water pressure also helps to promote the growth of stems and leaves.
- **Nutrients -** Plants derive most nutrients from the soil. Nutrients can also come from fertilizers. Nutrients help plants grow and function properly and act similar to vitamins for humans.
- **Sunlight -** During photosynthesis, plants take energy from sunlight to produce sugars or food

LESSON OBJECTIVES

Students will

- Identify and categorize living and non-living elements in the schoolyard.
- Observe plant surroundings and look for patterns amongst a variety of plant life in the schoolyard.
- Identify the four basic needs of plants.

Questions should be answered in student science notebooks and can be discussed in pairs, small groups and with the whole class. Building science literacy starts in PK. Help students build their skills in reading, writing, listening and responding to science.

MATERIALS

- Science notebook
- Sticky notes – each student needs four
- Plant Needs' game cards - each student will receive one colored piece of paper for the game and then will receive one of each color for their science notebook. Create your own and laminate using construction paper or card stock. Colors needed: yellow, blue, white, brown. Size: 3x5 or smaller
- At least one of the three books is needed:
  - The Dandelion Seed by Joseph Anthony
  - Oh Say Can You Seed? All About Flowering Plants by Bonnie Worth
  - From Seed to Plant by Gail Gibbons

Activity 1 – Living and Non-Living Parts of a Habitat

Investigating Question: What do I see outside?

1. Take students outside, preferably to an outdoor learning space. Ask students to think back to their nature walk where they explored the schoolyard for insects. Reflect on what was seen while investigating. List all the things that students say in two columns on your whiteboard.

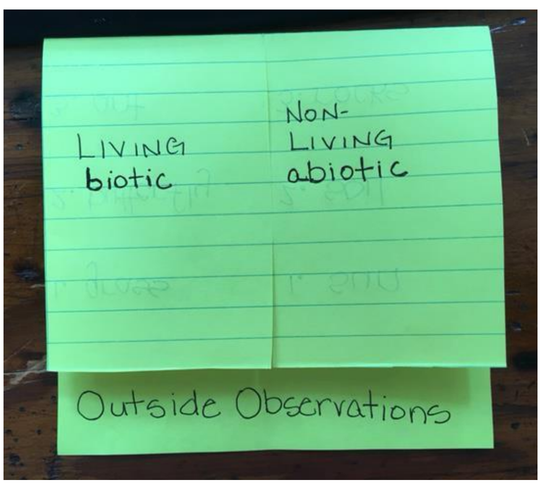
NOTE

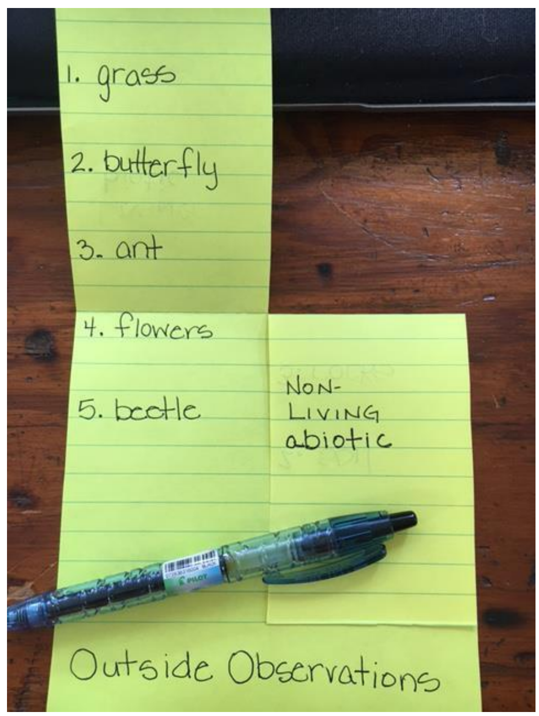
- Bring a whiteboard and marker outside with you.
- Be sure to use academic vocabulary with your students.

2. Ask the students the difference between the two columns. Add the labels to the two columns you've created. Explain by saying, a habitat provides all the things needed for life to exist. The ecosystem is the relationship between all the things that are living and nonliving.

LIVING (BIOTIC)	NON-LIVING (ABIOTIC)

3. Once back inside ask students to create their own chart in their science notebook or create a two-tab foldable. Ask students to include at least 5 biotic and 5 abiotic elements in their notebook/foldable.





Activity 2 – Observing Plant Life

Investigating Question: What is found around plants?

1. Take your students back outside, if possible to the same location and with their science notebook. Reflect with students about the last time they were here. They learned about how living and non-living elements are a part of a habitat. Now students are going to focus on one particular living aspect of a habitat, plants.
2. Ask students to make up-close observations of the plants, grasses, flowers and trees in the immediate area. Pick one and then ask them to make sketches in their notebook and answer the following questions.
3. Next have students talk in groups of four, sharing their sketches and answers to the questions. Make sure students know they can make changes to their original answers if they find they agree with someone else in the group.

Q1. How does it look and feel outside?

Q2. Where is the plant?

Q3. What is surrounding the plant?

Q4. What do you notice that is helping it grow?

Q5. Does how it looks and feels outside help plants grow?

Activity 3 – Plants' Needs

Investigating Question: What do plants need to survive?

1. After the student's recent plant observations, we want to focus on what plants actually require to survive. Put up four large sticky (chart paper size) notes. In the same groups as yesterday, ask one person from each group to place an answer on the sticky note. Once completed, ask the students to take another look at the charts, look for patterns. Now ask them what four things plants need to survive. See if the can come up with air, water, sun and soil.

What does it look and feel like outside?	What is surrounding the plants?	What do you notice that is helping the plants grow?	Does how it looks and feels outside help plants grow?
			YES | NO

NOTE
Add images and/or print out text to help younger students whose reading and written skills are not as well developed as students in older grades.

Two and three are encouraged to be completed outside.

2. Read: *Oh Say Can You Seed? All about Flowering Plants* by Bonnie Worth and/or *From Seed to Plant* by Gail Gibbons.
3. To reinforce the four elements that plants need to survive tell students they are going to play a quick game.
    - To play give each student 1 of the following pieces of colored paper (yellow, blue, white, and brown) no bigger than 3x5.
    - **Without making any sounds** they have to find the other three elements a plant needs to survive. For example, if student one has a yellow strip of paper, then they have to find, a student who has a blue, a student who has a white and a student who has a brown piece of paper.
    - Then as a group they must tell each other what element they are **without speaking.**
    - When the group feels they've completed the task they are to immediately sit down where they are, **remaining silent.**
    - Let one group member **whisper** to you the four elements plants need to survive.
    - Provide a reward for each group who is correct.
    - Optional: After confirming each group's correct answers they must act out each element for the rest of the class – all without talking. First ask all the "suns" to stand up, students will act out the sun, then ask all the "soils" to stand up, students will act out the soil. Do the same for water and air.
4. Once back in the class give each student one of each colored paper. Have them write what element the colored paper represents and then create a page titled, **What Plants Need to Survive**, in their science notebook. Students may cut the paper down and tape or glue them into their notebook.

ENGINEERING OPTION: Design a learning tool using LEGOs that teaches what plants need to survive. After they have a concept, provide student pairs with LEGOs. Once they have completed their first design ask them to test it on other students. Did it work as they planned? Allow them time to go back to the drawing board and redesign their model. Also allow students to take photos of their design. Print them off and display them in the class.

Properties of Matter in a Monarch Garden

K-2 | 120 MINUTES OVER A WEEK'S TIME | SCIENCE, MATH, READING, ENGINEERING, WRITING

BACKGROUND

Matter can be understood in terms of the types of atoms present and the interactions both between and within those atoms. The states, properties and reactions of matter can be described and predicted based on the types, interactions and motions of the atoms within it, both in living and nonliving systems.

By the end of grade two, students should be able to distinguish between different kinds of matter, and understand that matter exists in many forms. Matter can be described and classified by its observable properties, by its uses and by whether it occurs naturally or is manufactured. Also, by the end of grade two, students are expected to recognize that types of matter with different properties are suited to different purposes, e.g. soil can be used for planting plants or blocks are part of construction sets.

As students get ready to work on their Monarch Recovery Garden, it's important they have a basic understanding about how the sun warms the Earth. The sun' energy and how it flows through matter is an important concept that will be built upon now and through high school. K-2 students only need to know that the sun provides warmth and when the sun is not visible, whether due to the Earth's rotation or because it is covered by clouds, they do not feel as warm as they did before. This is also a good opportunity to identify patterns in seasonal and daily weather.

While the study of properties of matter is typically reserved for students' studies of physical science, it's essential they recognize matter exists all around us, even in a garden. Students will begin to identify properties of matter by observing objects found in their garden. They will observe color, state (solid, liquid gas), texture and flexibility of matter.

LESSON OBJECTIVES

Students will

- Make weather observations.
- Record data about the sun's impact on the Earth's surface.
- Record properties of matter found in the monarch garden.

MATERIALS

- Science notebook
- 2 outdoor thermometers
- Copies of the data collection sheets, *Sunlight Observations-Data Collection* and *Discovery Box Data*
- ***Book:*** *What Is It Made Of? Noticing Types of Materials,* by Marth E.H. Rustad (If you do not have this title in your library work with your librarian to find a suitable substitute.)
- Discovery Boxes with garden items. See Activity 2 notes for more information
- V-Model of Engineering Design, found in the appendix

Activity 1 – Observing the Weather

NOTE: This activity requires a 5-day observation period with at least one sunny day. In preparation for this activity do each of the following:

- Place two thermometers outside to measure temperature one in a location receiving full sun and another in a location that is shaded. Do not wait until you are outside with students to place the thermometers. Setting them up before school will allow the sun's energy to flow through them during the lunch hour before taking your students out to make observations.
- Cut out the data sheet or have students cut out the data sheet and glue it in their science notebook. Their data will serve as evidence for future discussions.

Investigating Question: What's the weather like outside?

1. Choose a time period over the next 5 days to take students outside with their science notebooks for 5-10 minutes. Once outside prompt students to collect their data on the *Sunlight Observations* data sheet in their science notebook. **Option:** You can cut out each data collection sheet and tape each page as a series, one underneath the other. This will ensure all the collection sheets will be on one notebook page and more easily flipped through.
2. In preparation for *Activity 2 – What's the Matter in the Garden?*, have students collect one item from the schoolyard each of the 5-days. These items can be placed into the discovery boxes and used a part of the activity. This discovery box items can be reused again in Activity 4.

ENGINEERING OPTION: Have students determine how they can use LEGOs to construct a bar graph showing the data they collected over their 5-days of weather observation. Use the *V-Model Engineering Design* as a model to guide students through the engineering design process.

SUNLIGHT OBSERVATION DATA COLLECTION

Name: ____

Date: ____

Circle the day of the week.

Monday **Tuesday** **Wednesday** **Thursday** **Friday**

Temperature in Full Sun:______________°F

Temperature in the Shade:_____________°F

Circle what it looks like outside.

Cloudy Partly Sunny Raining/Snowing Sunny

Circle how you feel when you stand in the SUN.

Hot Warm Cold Cool

Circle how you feel when you stand in the SHADE.

Hot Warm Cold Cool

SUNLIGHT OBSERVATION GRAPH

TEMPERATURE IN THE SHADE

TEMPERATURE IN FAHRENHEIT

100°					
95°					
90°					
85°					
80°					
75°					
70°					
65°					
60°					
55°					
50°					
45°					
40°					
35°					
30°					
25°					
20°					
15°					
10°					
5°					
0°					
	Monday	Tuesday	Wednesday	Thursday	Friday

SUNLIGHT OBSERVATION GRAPH

WHAT IT LOOKS LIKE OUTSIDE

Place an X in the chart box that shows what it looks like for each day you make observations.

TYPE OF WEATHER

Cloudy					
Partly Sunny					
Rainy/Snowy					
Sunny					
	1	2	3	4	5

Observation Day

Write 1-2 sentences summarizing your graph.

____

____

____

____

SUNLIGHT OBSERVATION GRAPH

How I Feel When I Stand Outside

AMOUNT OF SUN

Full Sun				
Shade				
	Hot	Warm	Cold	Cool

HOW MANY TOTAL STUDENTS FOR THE WEEK

When you think about the temperature outside during your week long observations, did the temperature feel different in the sun versus in the shade?

YES NO

Give a reason for your answer.

____

____

____

____

____

Which statement best describes the sun?

______ Provides warmth to humans, wildlife and plants.

______ Helps humans, wildlife and plants cool down.

DISCOVERY BOX

PROPERTIES OF MATTER

Name: ____________________

OBJECT NAME	USE	COLOR	SOLID, LIQUID OR GAS	TEXTURE	FLEXIBILITY

Activity 2 – What's the Matter In the Garden?

1. **Read:** *What Is It Made Of? Noticing Types of Materials* by Martha E. H. Rustad.
2. This activity is best suited for the outdoors. Provide each group of 2-4 students with a discovery box. Ask students to record their observations for each piece of matter in the box in their science notebook. **Option:** If your discovery boxes include several pieces of matter then you may ask students to pick 4-5 to observe.

   Explain: "There's a lot of 'matter' in a garden. When we work on our Monarch Recovery Garden, it will be important to have an understanding of the matter our monarchs and other wildlife will encounter."

NOTE: Soon students will be working on the creation, design, implementation and maintenance for the school's Monarch Recovery Garden(s). The properties of matter investigation is designed with the garden(s) in mind.

Depending on the ages of your students, either have your students create the data collection pages in their science notebook or use the data collection pages below. After collecting data students can cut it out and glue it into their science notebook.

Discovery Box – items listed are only suggestions and remember students may have collected discovery box items during their 5-day weather observations from Activity 1.

Suggested Box Size: shoe size

Include magnifying glass(es), variety of mulches (hardwoods of varying colors, recycled mulches), pebbles, soil, lava sand, dried molasses, moss, plant leaves, flowers, stems, sealed vials of water and air, etc.

Building a Monarch Habitat – A friend in need is a friend indeed

K-2 | (3-4) 30 MINUTE CLASS PERIODS | SCIENCE, MATH, READING, ENGINEERING, WRITING

BACKGROUND

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 vertebrates – including butterflies, moths, wasps, flies and beetles – and over 1,000 mammals, bird reptiles and amphibians, act as pollinators. The loss of any species weakens the ecosystem that all species rely on for survival, including humans. Monarch butterfly decline is an indicator that there is something wrong in our shared environment and a warning that we could be affected as well. Do we really want to live in a world where the next generation has no chance of seeing a monarch butterfly on a flower?

THE PROBLEM:

- The North American monarch population has declined by more than 90 percent in the past two decades. This is due to decline in summer breeding habitat in the U.S. and decline in winter habitat in Mexico.
- 1/3 of the monarch's summer breeding habitat has been destroyed, largely in the Midwest. Expansion of row crop agriculture and, to a lesser extent, development, has destroyed 90 percent of our nation's native grassland ecosystems, on which monarchs depend. Milkweed, the only host plant for monarch caterpillars, has declined in the U.S. due to overuse of herbicides by commercial agriculture and conventional gardening practices in suburban and urban areas.
- Monarch overwintering sites are under threat, especially in Mexico where the forests used by monarchs are under logging pressure.
- Monarchs are being directly killed by insecticides both as adult butterflies and as caterpillars, in agricultural, suburban and urban landscapes.

LESSON OBJECTIVES

Students will

- Identify elements of a habitat.
- Observe a variety of different habitats.
- Define diversity.
- Count the different types of plant and animal life in each habitat.
- Talk about monarch butterfly decline.
- Build a model of a Monarch Recovery Garden.

MATERIALS

- Science notebook
- Copies of Habitats and Diversity, 1 per student or pair of students
- National Geographic: How to Create Your Own Monarch Butterfly Rest Stop, 4:34 https://youtu.be/6JpLR2hpfSk
- Habitat Hunt, 1 per student pair
- Habitat Hunt Animal Cards, 1 per student pair (cards can be repeated or more cards can be developed)
- Monarch Recovery Model Boxes, 1 box per 2 students. To create the Monarch Recovery Garden Model boxes, see the Engineering Options in Activity 3.
- Copies of the Monarch Recovery Garden Model Guide, 1 per student pair

Activity 1 – Habitat Diversity

Investigating Question: What does "diversity" mean?

1. Gather three books and/or three images from the internet showing different ecosystems and the wildlife, plants and animals that are found there. Another option would be to work with your librarian and/or art teacher to locate similar books and photographs or paintings for this activity. Book choices include.

   AUTHOR: TONY FREDERICKS

   - *In One Tide Pool*
   - *Near One Cattail: Turtles, Logs and Leaping Frogs*
   - *Under One Rock*

   AUTHOR: MARY QUATTLEBAUM

   - *Jo MacDonald Hiked the Woods*
   - *Jo MacDonald Saw a Pond*

   AUTHOR: MARIANNE BERKES

   - *Over in a Forest: Come and Take a Peek*
   - *Over on a Mountain: Somewhere in the World*
   - *Over in the Ocean: In a Coral Reef*
   - *Over in a River: Flowing Out to Sea*

2. Students will use each of the three images or a page from three different books to take a closer look at the diversity or difference in plant and animal life in each habitat. Use the *Habitats and Diversity* data sheet. Then students will go outside to look at the diversity in plant and animal life in the schoolyard. Students will organize their observations using box 4 of the *Habitats and Diversity* data sheet.
3. Talk about what they think diversity means in a habitat based on the data they collected. Complete this activity by allowing students to share what they found and then write or draw in their science notebook what diversity means.

Activity 2 – Habitat Hunt

Investigating Question: What habitat elements are found in my schoolyard?

1. Review the four basic elements of habitat and the importance of each for an animal's survival.
2. The Habitat Hunt will be completed outside. Give each pair of students a Habitat Hunt data sheet, found on page 6, clipboard, and four different colored flags.
3. Then provide each student pair or allow students to choose a local/regional animal. Once they have their animal explain: "You are a ____, and in order to survive you need food, water, cover and places to raise your young. Take a look around you. Do you see all the necessary habitat elements for you to survive here?" Have students spend some time exploring the area of the schoolyard you have defined for them, looking for all the characteristics of habitat that meet their specific needs. Based on what they find, they will determine if the area could be considered "home" or if they need to continue looking.

NOTE

- It will be necessary for students to identify the habitat needs of their individual animals prior to going outside to complete their data sheet.
- When students return to the classroom, wrap up by allowing them to share with another pair of students our share out with the entire class.
- Optional: Allow students to take photos using their personal phones or school iPads of each habitat element they find. Print those images and have students place them on the back of this page, with tape, and label underneath the image what habitat element is pictured. Students may find they have anywhere from no elements to all four.

Habitats and Diversity

Q1. Look at each habitat. Why do you think it is important to have a variety of plants in a habitat?

Habitat Hunt

Q1. Will you stay and set up home for you and your family here? Why or why not?

Q2. What other habitat elements would you like to see here?

Q3. If habitat elements could be added to meet your survival needs could you stay and set up home here?

Activity 3 – Monarch Recovery Garden Model

Investigating Question: How can we design a model habitat suitable for monarch butterfly?

1. In preparation for making, designing and planning their Monarch Recovery Garden model, have the following discussion with your students.

   How would you feel if one of our friends in class left? What if someone in class left every week? What would our class eventually look like? (There'd be no more students.) What would you want to do? (I'd want to know why they were leaving, and if there was anything I could do to help or keep friends from leaving.) Well, this is what's happening to monarch butterflies and they need our help. In the last 20 years, when your parents were growing up, the monarch population in North America went down by 90 percent. Here's what 90 percent looks like. (Have 10 kids stand up – they are all monarchs. Now have 9 sit crisscross on the floor where they were previously standing – there is only one monarch left.) We know what will help their numbers go up; healthy diverse habitats that do not use pesticides or insecticides (no chemicals).

   (Stop for a moment and ask students what the class could do to help monarch butterflies. Based on prior learning, students should suggest a garden, a place to live, etc. Go with the garden idea and then watch this National Geographic Video: https://youtu.be/6JpLR2hpfSk. Continue the discussion below. Monarch butterflies need two kinds of plants, host plants and nectar plants. Host plants are considered the "nursery", while the nectar plants are where they "eat". Butterflies do not sleep like you and me, they only rest (butterflies are quiescent). When butterflies need to take shelter for the night they go to protected places called "roosts". Roosts may be tall grasses, perennial herbaceous plants, woody shrubs, and caves, and in some cases, man-made structures.

Diversity is the key to a successful Monarch Recover Garden (MRG). The MRG location on the school grounds will need to be in an area of full sun where it receives at least eight hours of direct sunlight. Also consider wet, sandy or muddy spots for butterflies to take in salts and other mineral nutrients. Using dark stones or tiles for butterflies to perch on to warm up on cool mornings adds to the butterfly activity in the garden.

2. Hand out the Monarch Recovery Garden model box (see *Engineering Option* below for instructions on creating these boxes) and Model Guide, found on page A4.9. This activity works best in pairs, as it's easier to have both students fully engaged working on their model. Go over your expectations for constructing the model and keep students updated on the time they have to complete the design and construction process.
3. Once students have completed their model and the MRG Model Guide, have each pair of students take a picture of their work. Provide students with an 8.5 x 11 piece of white cardstock or one-fourth of a white poster board to serve as their base (put their names in one corner). If your school is developing a pollinator garden this year, make sure to reference the students' work during the planning phases and ask for their suggestions. **Whatever your plans, make sure students are actively involved in the garden process so they take ownership and responsibility for its growth and success!**

ENGINEERING OPTION: Use a cardboard or clear plastic shoe box to store each group's model materials. Now it's time to reuse the natural items from Lesson 3 to help construct a more robust Discovery Box. You may want to raid your math manipulatives and consumables from the science lab. The following list is only a suggestion. When you have gathered what you feel are adequate supplies for your students to create their model of a Monarch Recovery Garden, be sure you keep an inventory and count of what each box includes. Sometimes objects sprout legs and disappear.

pattern blocks	sticks	colored wood blocks
leaves	base ten blocks	craft pom-poms
2-sided counters	cotton balls	pebbles
bark	tangrams	Cuisenaire rods
Grass	color tiles	tree seeds (acorns, pecans, etc.)

HABITATS AND DIVERSITY

Name ____

BOX 1

1. Circle the type of habitat do you see?

forest	pond	ocean
tide pool	meadow	prairie
schoolyard	river	stream
under a log	tree	mountains

2. How many different plants do you see? _____
3. How many different animals do you see? _____
4. Pick an animal you know. Place an X in the blank if you can point to the habitat elements the animal needs in the picture.

_____ food _____ water

_____ shelter _____ place to raise young

BOX 2

1. Circle the type of habitat do you see?

forest	pond	ocean
tide pool	meadow	prairie
schoolyard	river	stream
under a log	tree	mountains

2. How many different plants do you see? _____
3. How many different animals do you see? _____
4. Pick an animal you know. Place an X in the blank if you can point to the habitat elements the animal needs in the picture.

_____ food _____ water

_____ shelter _____ place to raise young

HABITATS AND DIVERSITY – PAGE 2

BOX 3

1. Circle the type of habitat do you see?

forest	pond	ocean
tide pool	meadow	prairie
schoolyard	river	stream
under a log	tree	mountains

2. How many different plants do you see? ______
3. How many different animals do you see? ______
4. Pick an animal you know. Place an X in the blank if you can point to the habitat elements the animal needs in the picture.

______ food ______ water

______ shelter ______ place to raise young

BOX 4

1. Circle the type of habitat do you see?

forest	pond	ocean
tide pool	meadow	prairie
schoolyard	river	stream
under a log	tree	mountains

2. How many different plants do you see? ______
3. How many different animals do you see? ______
4. Pick an animal you know. Place an X in the blank if you can point to the habitat elements the animal needs in the picture.

______ food ______ water

______ shelter ______ place to raise young

HABITAT HUNT

Name: ____

Directions

You are a ______________________________, and in order to survive you need food, water, cover and places to raise young. Take a look around you. Record the following information and decide whether or not you will stay here to set up your home.

food source: ____

water source: ____

cover: ____

places to raise young: ____

Questions

1. Could this be a home for you and your family? yes no
2. Using words or drawings, explain why or why not.
3. What other habitat elements do you need in order to build your home in the schoolyard?

CHIPMUNK

The eastern chipmunk is found in deciduous forests, shrub habitat, forest edges and suburban and urban areas where there is a lot of cover to protect it from predators.

Chipmunks are omnivores (they feed on both plants and animals). Their diet includes seeds, nuts, berries, fruits, flowers, mushrooms, insects, worms, snails, frogs, bird eggs and small birds.

They are most active in the early morning and late afternoon. Although they climb trees, they spend most of their lives on the ground or underground in burrows.

RING-NECKED PHEASANT

The "ring-neck" is a large bird with short rounded wings and a long, tapered tail. Ring-necked pheasants are usually found in fertile croplands and cultivated grain fields scattered with unplanted weed lots, pastures, small wetlands and occasional woody areas with underbrush.

Adult pheasants feed primarily on waste grains, weed seeds and insects which are located by scratching. Harsh winter conditions can make it difficult for these ground feeding birds to find food.

COMMON MUSK TURTLE

The common musk turtle is also known as a "stinkpot" because when it is captured or disturbed it secretes a smelly fluid from its top shell.

This is a small turtle, about 3-5 inches, with tan, brown, and gray or black top shell that may have dark flecks and be coated with algae.

These are aquatic turtles who love rivers, streams and reservoirs. Shallow, slow-moving streams and rivers with muddy bottoms and dense vegetation are preferred. Musk turtles are less common in ponds and lakes.

The diet of the musk turtle includes freshwater mussels, snails, crayfish, aquatic insects, worms, small fish, tadpoles, carrion and aquatic plants.

PRAYING MANTIS

The praying mantis became the state insect of Connecticut in 1977. It is about 2-3 inches in length and has shades of bright green to tan.

This insect can be found throughout the state from early May or June until the cold weather sets in.

Rarely found in hot humid or very dry climates, the praying mantis prefers sunny areas of green growth dominated by shrubbery or herbaceous plants.

They eat diurnal insects, including caterpillars, flies, butterflies, bees and some moths.

PENNSYLVANIA LEATHERWIND BEETLE

This beetle is the most common of the Goldenrod Solider Beetle family. Both the adults and larvae have the ability to produce “defensive chemicals from their abdomens.

Commonly seen in groups in late summer and early fall on goldenrod flowers where it feeds on nectar, pollen and insects. The beetle has a big appetite for aphids, so they are great to have in the garden – FREE organic pest control!

They can be found in meadows, fencerows, gardens and other areas with thick, sunlit vegetation.

MONARCH BUTTERFLY

Monarchs are native to North and South America.

These butterflies use different habitat in the warm months versus the cold months. They cannot survive freezing temperatures, so they over-winter in the cool high mountains of central Mexico and woodlands in central and southern California. In the spring, summer and fall they can be found wherever there are milkweeds. They are always searching for milkweed and suitable nectar plants.

These butterflies are like all butterflies, they change their diet as they develop. During the caterpillar stage they live only on milkweed plants. Adult monarchs feed on nectar from a wide range of flowers. All the monarch butterfly’s water needs are met through nectar feeding.

BUMBLEBEE

Bees are by far the most important pollinators of native plants, and the insects are essential to producing more than a third of the foods and drinks we consume.

Bumblebees are active during the day and are non-aggressive bees.

Their nests can be found underground in abandoned rodent burrows or mouse nests. Unlike honeybees, they do not store large amounts of honey.

Bumblebees feed on nectar and pollen. Worker bees collect the nectar and pollen and bring it to the hive to feed the colony. All honey-producing bees need access to water to cool the hive and help produce honey.

LITTLE BROWN BAT

This bat is very small ranging in size from 2.5 to 4 inches in length. They are brown in color and they have ears which are short and round. The Little Brown Bat is typically found living around swamp lands, but are also found in humid climates close to water. They have also been found in buildings and attics, in trees, under rocks and in wood piles.

They sleep and groom during the day and hunt by night. During the winter months they typically live in caves and abandoned mines.

The humid habitat offers them access to plenty of insects, such as mosquitos, moths, wasps, beetles, gnats and mayflies. In this environment they also have access to plenty of water for drinking.

MONARCH RECOVERY GARDEN MODEL GUIDE

Name: ____

What should be in the garden to help increase the monarch population?

1.	2.	3.
4.	5.	6.

What will each object in my model represent?

OBJECT	WHAT IT REPRESENTS
Example: an acorn	a tree
1.	
2.	
3.	
4.	
5.	
6.	
Extra:	
Extra:	

After the key is complete, come to me and I will give you a base for your model. When the model is complete take a picture of it, print it out and tape it to the back of this page.

Structure and Function: Plants vs. Animals

3-5 | 60 MINUTES | ENGINEERING, MATH, READING, SCIENCE, TECHNOLOGY, WRITING

BACKGROUND

Structure and function is a crosscutting concept within the NGSS and is explained as the way in which an object or living thing is shaped and its substructure determine many of its properties and functions. Structure and function are complementary properties. The functioning of natural and built systems alike depends on the shapes and relationships of certain key parts as well as on the properties of the materials from which they are made. By this age students have had a lot of experience with their own structures and functions, i.e. their five senses. What do they feel, hear, see, taste, and smell? What helps me feel, hear, see, taste and smell? In this lesson students will take that knowledge and apply new learning about the structure and function of basic plant parts. Students are not expected to memorize plant structures and the associated function, but are expected to apply their understanding that both plants and animals have structures with functions that aid them in survival.

A sense of scale is necessary in order to know what properties and what aspects of shape or material are relevant at a particular magnitude or in investigating particular phenomena – that is, the selection of an appropriate scale depends on the question being asked. For example, understanding how a bicycle works is best addressed by examining the structures and their functions at the scale of, say, the frame, wheels, and pedals. However, building a lighter bicycle may require knowledge of the properties of the materials needed for specific parts of the bicycles. Think about the scale to which your students will be exploring structure and function.

LESSON OBJECTIVES

Students will

1. Compare and contrast the basic structure and function between plants and animals.
2. Dissect two flowers, make observations and dialogue with peers, looking for similarities and differences.
3. Create a graphic organizer to demonstrate understanding.

MATERIALS

Flowers – (2) varieties per student pair for dissection
Flowers – (1) variety per student pair for observation only
Magnifying glass, hand lens or field microscope per student pair
Handout – *Name of a Flower System*
Notecards – 6 per pair of students

Activity 1 – What is Structure and Function?

Investigating Question: What is meant my structure and function of a living or non-living thing?

1. Ask students to make observations about the similarities and differences between themselves and their peers. Ask them to write down two similarities and two differences. Observations should be physically observed versus inferred, such as I am wearing blue tennis shoes and Peter is wearing black tennis shoes.
2. Discuss the fact that although each student in the class is a unique individual with his or her own special combination of characteristics, we all have certain features in common. Now ask students to write fingers, nose and knees in their science notebook and briefly explain their function. For example: fingers - I use them to grab, hold and pick up things and also to write and type (text).
3. Pose this question: "Could we make the same observations about plants and animals?" After a brief discussion explain that students will have an opportunity to make observations about a few plant species (Might want to use flowers from the garden – look at the plant parts prior to class to determine whether or not your garden's flowers would be a good fit for this activity).

NOTE: Best scenario would be to provide each pair or small group of students with two different flowers. This will allow them to find similarities and differences between their flowers and answer questions with greater understanding.

Simple Flowers to Dissect

- Tulips
- Lilies
- Magnolias
- Iris
- Rhododendrons and Azaleas

Complicated Flowers to Dissect

- Daisies
- Chrysanthemum
- Dandelions
- Sunflowers
- Black-eyed Susan

4. Have students work in pairs. Share your expectations and pass out the materials listed. Provide your students enough time to make observations, sketches, notes, etc. in their science notebook. See *Teacher Facilitation* below to help guide students through this part of the activity. *Optional:* Have students use their phones or school iPads to take pictures that can be printed and placed in their science notebook alongside their written notes.

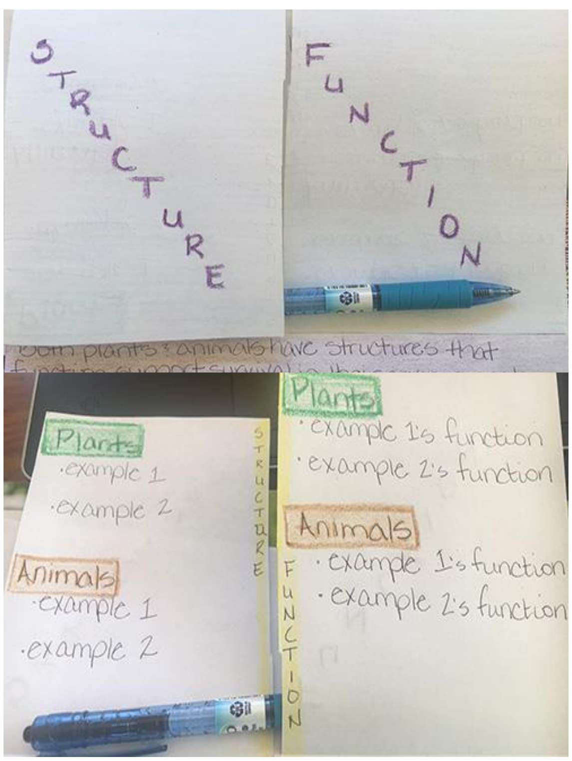
Teacher Facilitation

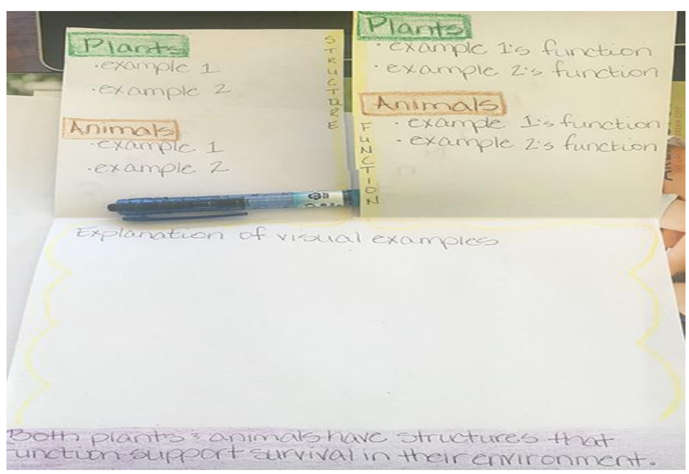
- Explain to students that they will carefully take each flower apart and group its similar parts together. Suggest that they begin by looking the flower over carefully to see how many different kinds of parts they can readily see. Caution them that toward the center of the flower the parts are smaller and harder to distinguish. Remind them to use their hand lenses/glasses/scopes to check for slight differences.
- Ask students to hold the flower upside down and carefully remove the parts, one at a time. Remind them to work with one flower at a time, working from the outside toward the inside. Have them place all the like parts together on one index card then count and record the number on the card. Do this for each flower.
- Next have students line these cards up in order from the outer most parts of the flower to the innermost parts. Have available several of the same type of flowers that are not to be dissected so students can refer to the original configuration of the parts.
- Have students compare their results by observing order, groupings of parts and the number of parts with other groups via a *Gallery Walk*. Do they notice a relationship between the numbers of parts?

Activity 2 – Examples of Structure and Function in Plants and Animals

Investigating Question: What are two examples of structure and function in plants and animals?

1. Have students create a two-tab foldable providing evidence that plants and animals have internal and external structures that function to support survival, growth and behavior and reproduction. Use the example below as a guide. The foldable can be finished for homework. Encourage students to provide:
    - 2 examples for both plants and animals
    - Structures: students may draw, get pictures from the internet, take their own photos, and/or cut out images from a magazine
    - Functions: students will neatly write or type, print out, copy and paste the function associated with the structure.
    - Students will briefly explain in words what their images show. (four complete sentences; one sentence for each example) (bottom strip-under the two- tabs)





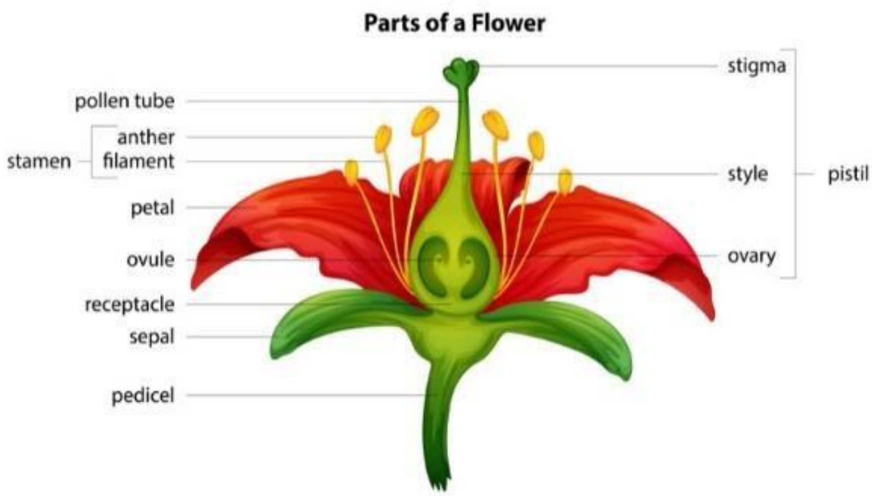
Activity 3 – Names in a Flower System

Investigating Question: Do flowers have structures and functions they need to survive just like humans?

1. Explain to the student that the different parts of the flower have names and specific functions in the plant. Give each group a copy of *Names of a Flower System*. Use an information text group reading strategy to review *Names of a Flower System* with students. Reminder: Students are not required to memorize or understand the function of the plant parts, only to see that there are differences in structures and functions for plants and animals. Optional: This text discusses parts of the flower. As you are reading with students also allow them to use their hand lens and a fresh flower to observe the parts you are reading about.

TECHNOLOGY & ENGINEERING OPTION: Student triads will use LEGOs to design 3 scenes showing a pollinator picking up pollen and dropping it off at another flower in the garden. Then students will use a smart phone to record a short "movie" of what's happening. Lastly, students will share their movie with the class.

NAMES OF FLOWERS



Flowers come in many different shapes, sizes, and colors. Although they may look very different, you have learned they share similar structures that help them function in the garden just like you have body parts that help you function and survive each and every day.

Turn over a flower that's not been dissected and you will see a little skirt of green leaves around the base (Instruct student pairs to make this observation). This lower outermost layer is composed of **SEPALS**. The whole group of them is called the **CALYX**. Before the flower opens, the sepals protect the more delicate flower parts inside. Sepals are usually green, but in lilies and tulips they are colorful and look just like petals.

The **PETALS** stand out in a flower because their major function is to attract specific animals to the flower for the purpose of pollination (Ask students what pollinators they know of). Petals have different adaptations, colors, shapes and smells to insure frequent visits by these specially invited guests, leading to pollination and ultimately the production of seeds.

Look closely inside the petals and you'll see a group of yellow, fuzzy containers on thin stalks. Don't look too closely or you may end up with yellow dust on your nose. That's **POLLEN** from the **STAMENS**. The stamens are made of a thin **FILAMENT** which holds up a bigger structure, called the **ANTHER**. The anthers are full of pollen and when open, they release dusty pollen to be picked up by various pollinators (or your nose). The pollinators take the pollen from flower to flower, usually on their legs.

Last but not least, hidden among the stamens is the **PISTIL**. There can be just one or many depending upon the flower type. The pistil is often divided into three parts. The enlarged base is the **OVARY** where the seeds develop. At the end of the pistil is the stigma. It is sticky making it easy for pollen to stick to it, and pollen on a stigma leads to seeds in fruits and vegetables!

The Sun: Feeding Ecosystems Everywhere

3-5 | 2 ½ HOURS | READING, SCIENCE, WRITING

BACKGROUND

The sun reigns as the supreme energy source in habitats around the world. From the sun plants gather energy needed to make their own food through the process of photosynthesis. Without the sun, the entire chain and subsequent webs could not exist. Many times we see food chains that start with the producer and not the sun. Leaving out this essential element can lead to student misconception at the very foundation of the food chain concept.

Along with understanding the sun's role in a food chain, it's also important for students to understand the symbols used to provide a visual model of these chains. Ask your students to explain what the arrows mean between the elements of a food chain. Usually students are unable to tell you or they say it represents "eats". "Eats" usually works until you get to the producer and the sun, because the grass doesn't eat the sun. Guiding students to understand the true meaning of the "arrows" will deepen their understanding of the concept. The arrows used in food chain models show how energy flows and how it is passed from one element to the next. Now when students get to the producer and the sun's energy within a food chain they will exchange the word "eat" with the words "energy flows from". For example, energy flows or is passed from the sun to the prairie grass and then energy flows or is passed from the prairie grasses to the insects, etc.

LESSON OBJECTIVES

Students will

- Connect prior knowledge on habitats and food chains with new observations from a children's book.
- Create a food chain, placing habitat elements in order as energy flows from one element to the next, placing strong emphasis on the sun's role in a food chain.
- Research the monarch butterfly food chain.
- Write their own food chain story, modeled after the story they read and focusing on the monarch butterfly food chain using native plants and natural predators.

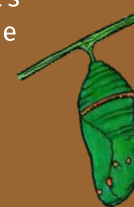
MATERIALS

- Book: Pass the Energy, Please! By Barbara Shaw McKinney
- Notecards cut in half, 7 halves per small group or pair of students
- 6 pennies or plastic markers per small groups or pair of students
- Books as student resources on butterfly habitat, specifically on monarch habitats, such as:
  - Monarch Butterfly, Gail Gibbons
  - National Geographic Readers: Great Migrations
  - Hurry and the Monarch, Antione O'Flatharta
  - Velma Gratch and the Way Cool Butterfly, Alan Madison
  - Monarch and Milkweed, Helen Frost
- Science Notebook

Activity 1 – Food Chains

Investigating Question: What is a food chain?

> **NOTE:** Create a word bank that's visible to the entire class, of the words used during your students. This can serve as a tool and reminders to use academic vocabulary while writing.



1. Write the food chain found in number five below, large on a piece of poster board. Roll it up and put a rubber band around it. You will use it when you go outside.
2. Take students outside and have them bring their science notebook and a pencil. Read, *Pass the Energy, Please!*, by Barbara Shaw McKinney. Before you start reading, ask your students to find the ecosystems file in their brain's life science filing cabinet and do a quick scan. Tell them, "Keep that content fresh in your mind as I read aloud."
3. Ask, "What was the main idea of the story?" Depending on the age of your students and where you are in your studies related to ecosystems, they will say things like, animals, food chains/webs, producers and consumers. Make note of these words in your notebook and add them to the class word bank/wall.
4. Unroll your poster board and ask students to copy the "list" in their science notebook and describe what they think it is.

Sun ⟶ Grass ⟶ Insect ⟶ Mouse ⟶ Snake

Ask the following questions to students. Students can work in pairs or small groups and then open it up to a class discussion.

Q1. What do you see? Describe it.

Q2. What words could be used in place of the arrows? Why do you think that (what is the reasoning)?

Q3. What would happen if the sun was taken out of the chain? Provide reasoning.

5. After discussing the questions, put a name to what students have been describing, if they do not already know it's a food chain. Encourage students to develop their own definition and then you can give them the "textbook" definition. "A food chain is a linear network of links in a food web starting from the sun and producer organisms such as, grass or trees and ending at top predators such as, grizzly bears or killer whales or decomposers." Along with their definition ask them to write a food chain they might find in their schoolyard. Give students the opportunity to Think-Pair-Share their definition and schoolyard food chain.

Activity 2 – Energy in a Food Chain

Investigating Question: Why is energy important to plants and animals?

1. Give student pairs or small groups seven halves of a notecard and six pennies (or any place holders). Ask them to write one of the food chains from the story, Pass the Energy, Please!, on the notecards. One food chain link per card, **for example**,

MOUSE	SUN	INSECT	SNAKE	GRASS

2. Next have students place their cards in the correct order. Use the coins to represent the passing or flow of energy. Student pairs also need to answer these questions, 1) "What role does the sun play in the food chain?" and 2) "Why is energy important to plants and animals?" Use a strategy that will allow students to check each other's food chains and discuss the answer to the question above.

PASS THE ENERGY, PLEASE! Food Chain options for students – feel free to add to or create your own

- Kelp and sea-weed, sun, fish, sea urchin, otter
- sun, grass, buffalo
- manatee, sea grasses, sun
- bamboo shoots, panda, sun
- grasses and tree leaves, cheetah, sun, gazelle
- milkweed pod (seeds), sun, snake, mouse, owl
- phytoplankton, Arctic seal, sun, zooplankton, polar bear
- dead animal carcass, sun, plants, vulture

3. Once students know their order is correct instruct them to write their food chain in their science notebook, along with the question and their answer found in part three.

Activity 3 – Author of your Own Food Chain Story

Investigating Question: What do I need to write my own food chain story?

1. It's time for your students to become the author of their own *Pass the Energy, Please!*, mini-story. See note for Activity 3 in the box above.
2. Explain: All authors have to do research for the books they write. We need to build our knowledge about the monarch butterfly and the ecosystem it lives in. Assign groups of students to find answers to the following questions or have students work together in small groups to answer the five questions below. Depending on the age of your students you may want to ask them to come up with the questions they need answers to in order to write their food chain story.

Note:
It will be helpful for students to have books, computers and/or other print and digital resources to do a research for their story. There are few selected titles found under the *Materials* section, but work with the librarian to find just what you'd like the students to access.

Q1. What is the life cycle of the monarch butterfly?

Q2. What do monarchs eat?

Q3. What does the monarch butterfly require to live; what are its habitat requirements?

Q4. What type of climate do they live in?

Q5. Where (geographically) can monarchs be found?

3. Review the writing style in the story, *Pass the Energy, Please!* Are there any patterns to the author's style? Will you copy her style or will you create your own (You might like to provide students with a monarch template/outline to write their final story in). As a class come with the expectations or use the ones listed below.
   - Main character: monarch butterflies
   - Demonstrate how energy flows through the monarch ecosystem
   - Show the sun's role in the monarch ecosystem
   - Use facts in your story, i.e., native plants and natural predators monarchs encounter
   - Age-appropriate grammar and academic vocabulary
4. Work with the Language Arts teacher to set up a writer's workshop, giving the students an opportunity to work through the writing process and illustrations. Students can use online digital storybook makers or even use PowerPoint to create their story and record themselves reading the story aloud. Provide students with the opportunity to read their stories aloud (this would be a great book buddy read aloud with younger students) and post them in the hallways for students to read while they are waiting or in the school library.

Cycling Matter and Habitat Loss

3-5 | (5) 50 MINUTE BLOCKS OF TIME PLUS OBSERVATION TIME | ENGINEERING, LANGUAGE ARTS, MATH, SCIENCE

BACKGROUND

Students are playing an active and important role as conservation stewards by constructing a schoolyard habitat specific to the needs of the monarch butterfly. The Monarch Recovery Garden is a large scale project with many small working systems. To help students grasp the important role these systems play, they will be creating a small scale biological ecosystem. This will allow them to examine and better comprehend how matter cycles through a habitat. The water, carbon and nitrogen cycle are all critically important in a healthy functioning habitat. It is important for students to have a basic knowledge of these biogeochemical cycles. For a review or basic introduction to each cycle use:

- USGS Interactive **Water Cycle** Diagram: http://water.usgs.gov/edu/watercycle-kids-beg.html. You can download a printable copy for student to cut out and put in their science notebook. http://pubs.usgs.gov/gip/146/pdf/gip_146_poster.pdf
- University of Climate and Atmospheric Research-**Carbon Cycle** Diagram: https://eo.ucar.edu/kids/green/images/carboncycle.jpg.

- An interactive game from Windows2theUniverse can be found at, http://www.windows2universe.org/earth/climate/carbon_cycle.html.
- And for the **Nitrogen Cycle** check out the video at https://youtu.be/oQohpVN20FI . A simple diagram can be found at https://www.coolaboo.com/earth-science/nitrogen-cycle/

Please note students' knowledge is basic and they are not required to understand all of the processes within each phase of the cycles. For example, students should understand that when water droplets evaporate from the undersides of leaves the droplets turn from a liquid to a gas through a process called transpiration and the gas is released into the atmosphere. They are not required to understand the chemical process, structure and function, and details associated with transpiration.

Another function of a healthy habitat is a place where multiple organisms get what they need to survive: food, water, cover and a place to raise young. In other words, a habitat is home to plants and animals. But, when we look closer, different living things have different and specific needs for food, water and cover. When two organisms (any kind of living things) have very similar habitats, their needs and how they meet these needs may be distinct, allowing them to live in close proximity to each other without competition. Two birds for instance, might live in the same tree but eat different foods, have different predators and have different tolerances to sunlight. The birds live in the same place, but do not fill the same role (called a niche). If organisms share the same niche, they may compete and limit the number of organisms that can live there. Competition, over a long time, may lead to greater animal and plant diversity as organisms carve out distinct niches. In the case of the monarch butterfly, they have very specific habitat needs to support their life cycle. If your school already has a pollinator garden in place without the specific host and nectar plants for the monarch, then students are unlikely to see monarchs in this garden.

As students go through the learning activities, work through the process of creating a Monarch Recovery Garden, conduct monarch citizen science investigations, students' thoughts and ideas will be challenged. One strategy to help students effectively discuss their analyses and conclusions is by constructing arguments from evidence. Constructing arguments from evidence is not a skill for older students. It's a skill that takes time to build and requires multiple learning opportunities with the same overarching core ideas. Without details to file through in long-term memory students will have difficulty formulating an argument to support what they are reading, writing or observing. Questions that require higher level thinking and push students beyond their comfort zone, lead to evidence. Having an understanding of specific content is a process that's rarely, if ever, linear and happens over time. Students must have multiple opportunities to inquire, observe, ponder, discuss and reflect. As students work through the learning activities, in the construction and monitoring of their garden they will have numerous opportunities to gather evidence and defend their thoughts and ideas.

LESSON OBJECTIVES

Students will

- Design a model of a closed ecosystem by constructing a three layer aquatic, terrestrial and decomposition biological column.
- Make observations, collect data and draw conclusions about the water, carbon and nitrogen cycles.
- Determine the relationship between biochemical cycles and living plants and animals.
- Construct arguments from evidence.

MATERIALS

- Science notebook
- Take a picture of one of your school gardens and print it out for each students.
- Materials for groups of 3-4 students to create a biological column – aquatic, terrestrial and decompostition systems – reference, http://goo.gl/SfMQyS - Please read through the options provided in Activity 1 and be prepared to carry out the terrarium project with your students.
- A copy per student: *Can You Back that Up? Preparing an Argument from Evidenve*.

Activity 1 – Building and Observing a Small Scale Ecosystem

Investigating Question: How can I build a terrarium that supports plant and animal life?

> Note:
> The terrarium project will take several days to complete. Set aside class time, recess and/or before/after school time to complete the terrariums.

1. After reading through the resources make modifications based on the needs of your students. Below is an investigative option:
   - Give your students the following resources. After reviewing these resources students are to provide you with a materials list based on the type of ecosystem they are wanting to build.
     - Pillbug Terrarium How To: https://www.youtube.com/watch?v=nqru5x3PP1I
     - Teacher Vision: Soda Bottle Terrarium: link to pdf.
     - Bottle Biology: http://www.bottlebiology.org/investigations/terraqua_main.html
     - 2 Liter Bottle Ecosystem Project: https://www.youtube.com/watch?v=4d6W_eLisQk
     - Indiana Expeditions: Bottle Biology: https://goo.gl/KiE08m
2. Instruct students to follow the directions on the method of terrarium instructions they have chosen. Encourage students (or assign) realistic cooperative groupings, for example, instead of using the term *Materials Manager* that student is instead the *Lab Manager* or instead of being the *Recorder/Reporter* that student is the *Communications Manager*.
3. Upon completion of their terrariums have students answer, *Questions Part A* below in their science notebooks.
4. Provide students with a regular and consistent time for them to continuing making observations and recording the terrariums health status. Use, Questions Part B throughout this time.

Questions Part A
Q1. List living and non-living types of matter, including solids, liquids and gasses.

Q2. How is your model ecosystem similar to and different from your school or home garden ecosystem?

Q3. What are the limitations of the model?

Questions Part B
Q1. How is water cycling in the terrarium? Explain.

Q2. How is carbon cycling in the terrarium? Explain.

Q3. How is nitrogen cycling in the terrarium? Explain.

Q4. Is the small scale ecosystem a suitable habitat for monarch butterflies? Explain your answer.

Q5. Using the terrarium as a model to visualize this scenario, choose one of the following events and explain three impacts it would have on systems in your habitat: extreme drought, hurricane, or wildfire.

Activity 2 – Cycles in the Garden

Investigating Question: How does matter cycle through the school garden?

1. Give each student one of the pictures you tool of the schoolyard habitat. Have them tape it to the top of a new page in their science notebook.
2. Take students outside to the garden with their science notebook and a pencil.
3. Remind students about the observations they made in their terrariums regarding the water, carbon and nitrogen cycle.
4. Remind students about the observations they made in their terrariums regarding the water, carbon and nitrogen cycle.

Q1. Why is the water cycle important to plants and animals that live in the garden?

Q2. Why is the carbon cycle important to plants and animals in the garden?

Q3. Why is the nitrogen cycle important to plants and animals in the garden?

Q4. What would happen if precipitation was taken out of the water cycle system?

Q5. What would happen to monarchs in our garden if the carbon cycle stopped working?

5. Underneath their picture, students will work in pairs to describe how water, carbon and nitrogen cycles through the garden. Help students by instructing them to focus on a specific part of the garden and not all the plants and animals in the garden. Provide students with an example if needed.
6. Now students will do an Inside-Outside Circle or Parallel Lines (also called Tea Party, Face to Face or Ladder).
   - Have one partner from each pair move and form a circle with students facing outward. This will be the inside circle.
   - Remaining students find and face their partners, forming the outer circle.
   - Pose question 1 from the box below. Inside partner will answer and outside partner will listen (Have students pause for "think time," then cue them to share).
   - Next, partners switch roles – outside partner talks, inside partner listens. Use the same question allowing for each partner to share their thoughts.
   - After that, outside circle will rotate clockwise, ending up with a new partner.
   - Now with a new partner, ask question 2.
   - Repeat this process for question 3 – 5.
7. Follow up back in the classroom by asking students to answer the questions in complete sentences in their science notebook.

TECHNOLOGY & ENGINEERING OPTION: Have students use LEGOs or natural items found outside to construct a model demonstrating how matter cycles through the garden habitat. Use the V Model of Systems Engineering to help students go through the design process with clear direction.

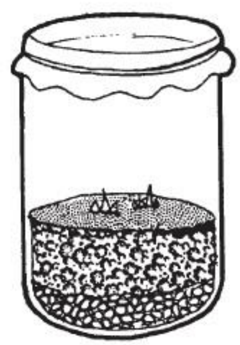
Soda Bottle Terrarium

Students can make their own mini-environments with plastic soda bottles, seeds, and small plants. Other materials and the directions are listed below. Small groups may work together on one terrarium or students can build their own individual gardens.

Note: The directions below can be copied and placed at a special center where all the necessary materials and equipment are available. Make a chart and assign center times to the students.

How to Make a Soda Bottle Terrarium

You will need:
- 1 plastic soda bottle with top cut off
- potting soil
- grass seed
- small plants
- gravel
- water
- spoon
- plastic wrap
- rubber band



What to do:
- Make a layer of gravel on the bottom of the bottle.
- Spoon the soil into the bottle; fill it about $^{1}/_{3}$ full (see picture above).
- Sprinkle the grass seed on top of the soil.
- Poke a hole in the soil with your finger.
- Put the roots of the plant into the hole.
- Smooth the dirt in and around the hole.
- Water the plants lightly.
- Cover the top of the bottle with plastic wrap.
- Place a rubber band around the plastic wrap to keep it in place.

Follow-up:
- Draw a picture of your terrarium. Label it Day One.
- Observe your garden every day of the week. Draw a picture of any changes you see. Label each change with the day. Use the Changes worksheet for your work.

CHANGES

Name ______________________________ Date ____________________

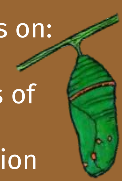
In each box draw a picture of the changes you observe. Be sure to write the day and date in each box.

Day 1 Date __________________	Day ____ Date __________________
Day ____ Date __________________	Day ____ Date __________________
Day ____ Date __________________	Day ____ Date __________________

Activity 3 – Arguing in Class

Investigating Question: How do I make a claim, supported by evidence that some species survive better in a habitat than others?

> Note:
> Students' arguments need to focus on:
> - the types of plants monarch butterflies need for all stages of their life cycle,
> - the school's geographic location along the monarch's migratory path, and
> - the time of year students are making observations.



1. As students become more involved with their schoolyard habitat and monitoring and evaluating the progress of their monarch numbers, students need to be able to effectively communicate what they know and what they want to happen. One skill that will help them is the capability to construct arguments from evidence.
2. Place students in groups of three or four. Provide students with the scenario below and the worksheet, *Can you Back that Up? Preparing My Argument from Evidence*. Eventually students and student groups should be able to come up with their own question, claims and evidence, but for this activity we are providing the scenario and the question they will write on their worksheet.
   Context: In habitats some organisms (like the hummingbird) can survive well, some survive less well (like the monarch), and some cannot survive at all.
   Question: Why are monarch butterflies not coming to our habitat? (This comes from the scenario below.)

SCENARIO – COMMUNITY AND SCHOOLYARD HABITATS

After learning about the importance of community habitats in class we wanted to investigate the types of plants and animals we had on our school grounds so we could provide habitat for our local wildlife, we were especially interested in what we could do to improve habitat for our local species.

During the next week we used the Eco-Schools USA Biodiversity Audit to identify the types and numbers of plant species we had. Next we split into groups to conduct biodiversity audits for the types and numbers of mammals, birds, reptiles and insects found around the school.

All the groups concluded that our school grounds are boring, very little biodiversity! We had very few trees, shrubs and other vegetation and since we learned that animals need food, water, shelter and a place to raise young, we knew we had a lot of work to do.

It was important to our class to provide these habitat elements at school. We wanted the local wildlife to return. The school is surrounded by concrete sidewalks and asphalt. We actually have very little green space. When we learned more about community and schoolyard habitats we discovered that lots of pollinators need our help. So we developed an action plan and set out to provide a schoolyard habitat for the local pollinators.

After more research and working with members of our community we had our National Wildlife Federation Schoolyard Habitat® built – a beautiful pollinator garden! Now we were ready and on the lookout for increasing numbers of certain pollinators, including the monarch butterfly and the ruby-throated hummingbird. After three weeks of observations we noticed an increase in the number of hummingbirds that were visiting the gardens. They were visiting several of our flowers including the Trumpet Creeper and Honeysuckle, Canada Lily and the Red Columbine. What we didn't notice were any monarch butterflies. We had a new question to investigate, "Why are monarch butterflies not coming to our habitat?"

CAN YOU BACK IT UP? PREPARING AN ARGUMENT FROM EVIDENCE

NAME:____DATE: ____________________

MY QUESTION IS?	WHAT DO I ALREADY KNOW?

WHAT TESTS AND/OR INVESTIGATIONS DID I CONDUCT RELATED TO MY QUESTION?

THIS IS WHAT I FOUND FROM MY TESTS AND/OR INVESTIGATIONS.

WHAT IS YOUR CLAIM? (Claims are made based on the results of your investigations.)

LEGO Community Fund U.S.
SPONSORED BY:

WHAT EVIDENCE DO YOU HAVE TO SUPPORT YOUR CLAIM?

PERSONAL:

INTERNAL RESOURCES (other students or groups)

EXTERNAL RESOURCES (any source that doesn't come from a member of the class, e.g. books, community experts, internet, videos, etc.)

REFLECTIONS

My ideas have changed because:

My ideas have not changed because:

Community Change

3-5 | (5) 50 MINUTE CLASS PERIODS | ENGINEERING, MATH, SCIENCE, SOCIAL STUDIES

BACKGROUND

Our land is changing. Land covered by forest is changing to farmland, land covered by farmland is changing to suburbs; cities are growing. Shorelines are shifting; glaciers are melting; and ecosystems boundaries are moving. As human population numbers have been rising, natural resource consumption has been increasing both in our country and elsewhere. We are altering the surface of the Earth on a grand scale. Nobel Prize recipient Paul J. Crutzen has said, "Humans have become a geologic agent comparable to erosion and volcanic eruptions..."

Land cover change has effects and consequences at all geographic scales: local, regional and global. These changes have enabled the human population to grow, but they also are affecting the capacity of ecosystems to produce food, maintain fresh water and forests, regulate climate and air quality and provide other essential functions necessary for life. As citizens, it is important for us to understand the changes we are bringing about to the earth system, and to understand the impacts of those changes for life on our planet. To learn more about the impacts associated with monarch habitat loss in the United States and Mexico refer to the introduction, NWF's numerous blogs on the monarch butterfly, http://blog.nwf.org/tags/monarch-butterfly/, and in the National Wildlife magazine article, Battle for Butterflies, https://www.nwf.org/Magazines/National-Wildlife/2015/AprilMay/Conservation/Battle-for-Butterflies.

Please note: Providing effective educational content related to climate change, including the loss of habitat and the peril or extinction of a species is best done in developmental stages that are grouped according to age levels. These stages are vitally important to environment based education because of the subject's deep underlying complexity. The National Wildlife Federation along with the North American Association for Environmental Education, NAAEE, recommend that content specific to climate change, habitat loss/destruction and species peril and extinction be carefully taught according to age level. This allows for cognitive and problem solving development of the human mind and also make sense because the subject inherently requires strong and effective building blocks of knowledge and skill. Also keep in mind that the size and extent of environmental problems can seem overwhelming to younger children who do not yet grasp all the possibilities for solutions. Younger children may have difficulty grasping the potential of collective societal scale and action or that individuals can make a useful contribution to such large scale challenges. The guidelines created by National Wildlife Federation and NAAEE are found in the appendix.

LESSON OBJECTIVES

Students will

- Analyze aerial photos to see how land use has changed over time.
- Make claims about the merit of a solution to address the decline in the monarch population.
- Explain how our extraction of natural resources impacts wildlife habitat.
- Develop a conceptual model that demonstrates monarch habitat today and what it can look like in the future with community-wide pollinator restoration habitats.
- Design a physical model to be presented to a variety of community members, both inside and outside the school building to build support for the project.

MATERIALS

- Science notebook
- One inch grid paper copied onto a transparency, one for the teacher to use and one per pair of students, http://www.math.kent.edu/~white/graphpaper/one-bold.pdf or http://www.math.kent.edu/~white/graphpaper/
- Thin dry-erase markers, two colors per student pair
- Color copies of the two San Antonio, Texas images – one set per pair – COLOR COPIES MUST BE USED for students to identify changes in land cover over time.
- Access to recyclable materials

Activity 1 – Changing Cities

Investigating Question: How do our needs and wants impact monarch butterflies?

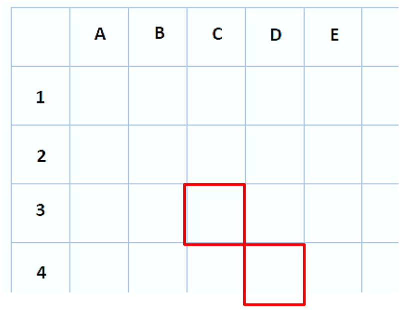
Note:
The goal of this activity is for students to see that as our communities grow we are making certain concessions. Some knowingly and others unknowingly. As a community grows so does its reliance on natural resources. It is critical students begin to see the cause and effect relationship between habitat loss and our use of energy resources, as well as an increase in air and water pollution and the increase reliance on pesticides and herbicides.

1. Ask student the questions found in the green box to the right. Have pairs of students come up with their ideas and write them in their science notebook. Students should be prepared to share with the whole class. Debrief as a class and write down student's ideas on chart paper or other space where students can view clearly.
2. For this activity you will need a two line per inch grid copied on a transparency. Students will be looking at change over time. You can do this as a whole class or if you have enough resources allow each pair of students to have their own photos and transparency grid. Share the pictures below.

Q1. **Why are monarch butterfly numbers decreasing?** (habitat loss and fragmentation, climate and weather changes, pollution, pesticides/herbicides-some of this was addressed in earlier lessons)

Q2. **What is the relationship between our natural energy resources and monarch butterflies?** (Students should struggle more with this question. Traditional instruction tends to separate the physical and life sciences. Here we begin to see that there are consequences, intended or not, to our actions (needs and wants)).

3. Create a grid on your transparency (refer to the materials section for a link to one inch grid paper). Label the X-axis A-O and Y-axis 1-18. Line up the transparency and the image and use a piece of tape to hold it in place. With a red marker choose 4 random squares to look at more closely. You will do the exact same thing and mark the exact same squares for both the 1991 and 2010 images. For example, if you mark A5, B2, D9 and E4 on the 1991 map, then you mark A5, B2, D9 and E4 on the 2010 map.



4. Explain to students that San Antonio is a major “highway” for monarch butterflies as they migrate into and out of Mexico. Ask, “What has changed in your squares?” “What could such a significant change in this city’s geography mean for the monarch”? [Habitat loss due to loss of green space, loss of biodiversity/**the plants the monarchs rely on (Remember without native milkweed, monarchs will not be able to make their migrations very far north)**. Monarchs are having to travel longer distances to reach safety because of the fragmentation of their habitat.]

Continue to the next page.

KEY

- **Greens:** green space of some type, like park systems, darker greens tend to be forested undisturbed natural areas.
- **Blues:** dark blue-deep waters, such as lakes, rivers and oceans out past the shore and drop offs, the lighter blues are streams, creeks and ponds or shallow areas of the larger water bodies above.
- W**hites:** represent clouds or smoke if irregularly shaped, but if white and symmetrical then it is an urban structure.
- **Grays:** on the ground represent urban areas, including highways, streets, schools, businesses, etc., but if in the sky above the surface the color represents haze and pollution.
- **Yellows/Browns:** represent soil, clear-cut forests and mountains and/or agriculture (crops)

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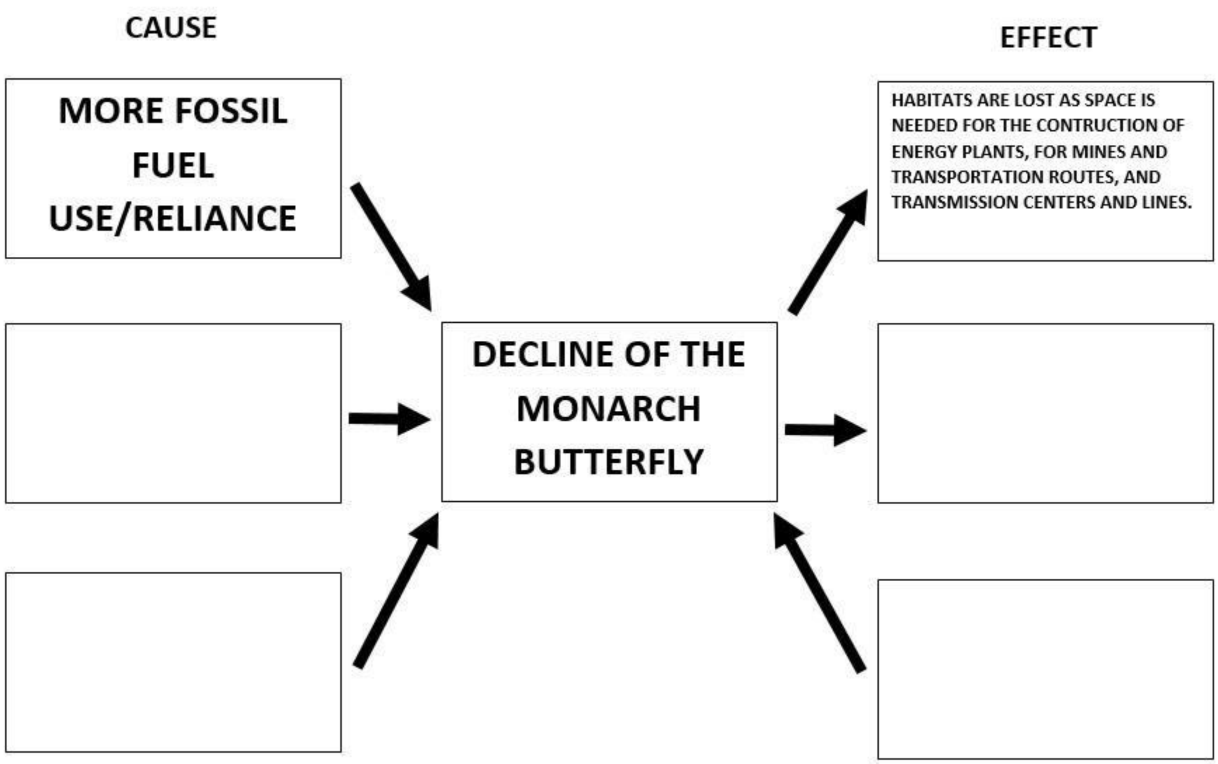
Activity 2 – The Oyamel Fir Forest

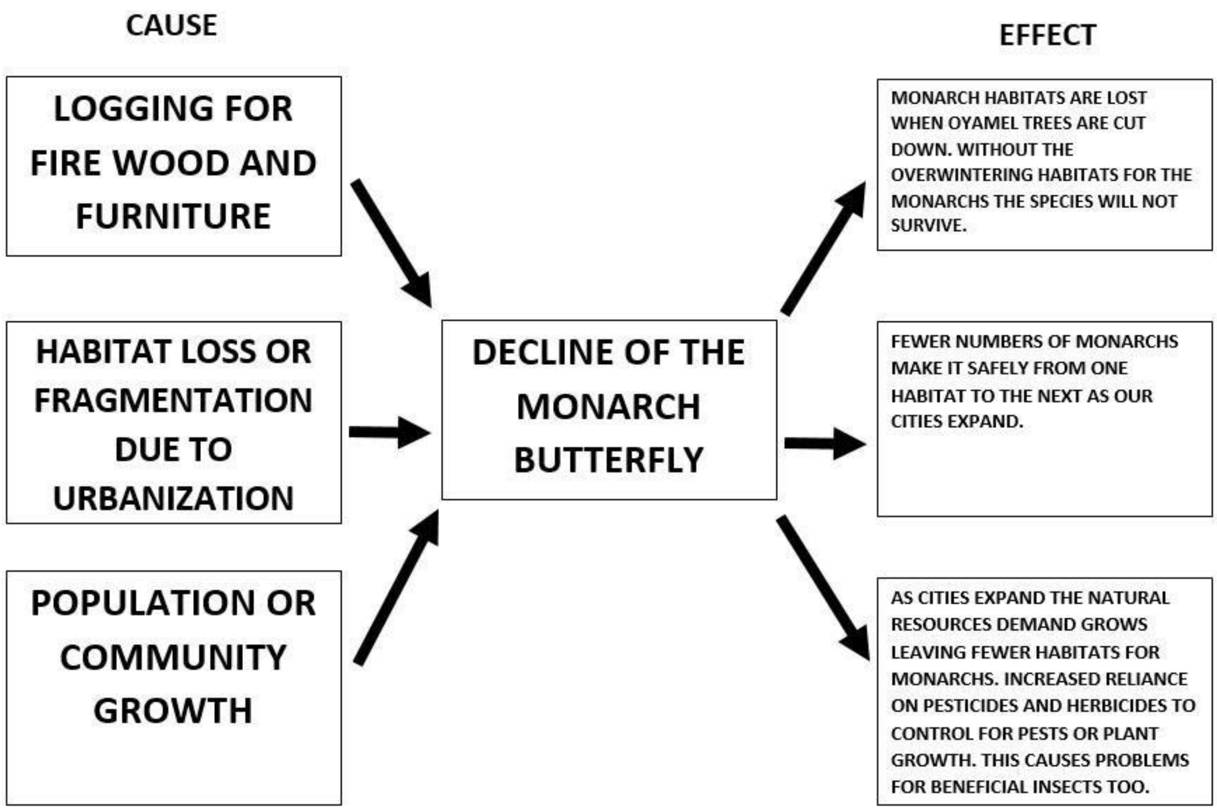
Investigating Question: What impact does logging have on the environment and how is logging impacting the monarch's where they overwinter? What role does logging play in the Mexican communities surrounding the Sierra Madre Mountains?

1. Another example for students to look at is the spread of logging operations, around the overwintering grounds for monarch butterflies overwinter. The Oyamel Fir Forests of the Mexican Sierra Madre Mountains are some of the rarest habitat in the world. Students can watch a ten minute video, https://youtu.be/Sw6Ug6RUPTQ, about the La Cruz Habitat Protection Project which highlights how the forest has changed overtime, how community leaders are working together to make change to preserve existing habitat and plans for the future in hopes of increasing monarch butterfly numbers all while preserving the way of life for the families who live there. While students will see the obvious changes to the landscape, the habitat loss and fragmentation along the monarch migratory path, what they don't see are the minute changes, such as in atmospheric pollution, pollution to waterways and ground water, etc.
2. Talk about the environmental impacts of logging. For background associated with logging impacts see, https://youtu.be/4x3jXRek4fY, VOA films illegal logging in Monarch butterfly's sanctuary in Mexico. Have students use a graphic organizer to show cause and effect related to the relationship between the monarch butterfly and our natural resources.
3. Ask students to reply again to the two questions asked on page 113. You could use this as a post-assessment to see how student understanding has changed.

Name ______________________________ Date ______________


CAUSE
EFFECT
MORE FOSSIL FUEL USE/RELIANCE
HABITATS ARE LOST AS SPACE IS NEEDED FOR THE CONTRUCTION OF ENERGY PLANTS, FOR MINES AND TRANSPORTATION ROUTES, AND TRANSMISSION CENTERS AND LINES.
DECLINE OF THE MONARCH BUTTERFLY

Answer Key


CAUSE
EFFECT
LOGGING FOR FIRE WOOD AND FURNITURE
HABITAT LOSS OR FRAGMENTATION DUE TO URBANIZATION
POPULATION OR COMMUNITY GROWTH
DECLINE OF THE MONARCH BUTTERFLY
MONARCH HABITATS ARE LOST WHEN OYAMEL TREES ARE CUT DOWN. WITHOUT THE OVERWINTERING HABITATS FOR THE MONARCHS THE SPECIES WILL NOT SURVIVE.
FEWER NUMBERS OF MONARCHS MAKE IT SAFELY FROM ONE HABITAT TO THE NEXT AS OUR CITIES EXPAND.
AS CITIES EXPAND THE NATURAL RESOURCES DEMAND GROWS LEAVING FEWER HABITATS FOR MONARCHS. INCREASED RELIANCE ON PESTICIDES AND HERBICIDES TO CONTROL FOR PESTS OR PLANT GROWTH. THIS CAUSES PROBLEMS FOR BENEFICIAL INSECTS TOO.

Activity 3 – Modeling Before and After

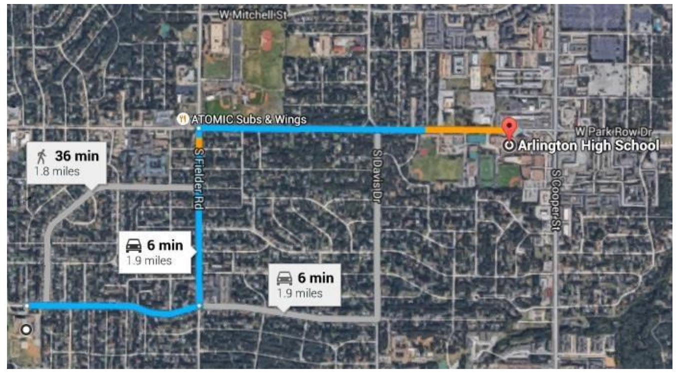
Investigating Question: What native plants need to be included in our Monarch Recovery Garden?

ENGINEERING OPTION: Have student groups create a today and tomorrow model demonstrating how habitat loss is contributing to the decline in monarch butterfly populations (today) and how engaging the community in habitat restoration could help to revers that decline (tomorrow).

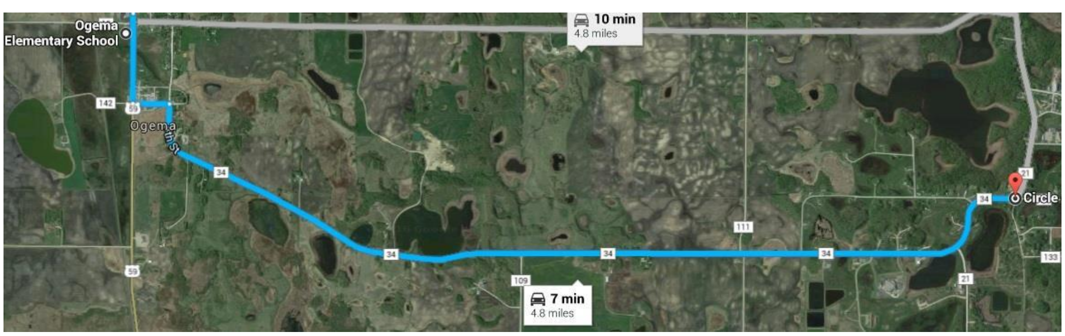
Student Question: You know what plants and other habitat elements are needed for the monarch to have the best change at survival. What does this look like in your community? In your neighborhood? From your school to the middle or high school?

1. Review with students if needed, what the needs are for the monarch butterfly.
2. Have student pairs or groups conduct a basic site inventory. Students will need their science notebook and a pencil, along with their smart phone or tablet to inventory their schoolyard.
3. Have student groups use Google Maps or Google Earth to pinpoint an area of the community they'd like to focus on for their today and tomorrow model. Below are three examples. Students can pinpoint their community or neighborhood focus and then dive in further for a more detailed look at specific points along their pathway of choice. For example, in the following communities where would the best habitat be located? What business or neighborhood associations could students engage in habitat restoration? For locations or areas with impervious surfaces, what solutions can students come up with to create habitat?
4. Resources:
    - Monarch Way Stations
      http://monarchwatch.org/waystations/
    - National Wildlife Federation Eco-Schools USA – The Monarch Butterfly
      https://www.nwf.org/Eco-Schools-USA/About/Take-Action/Monarch-Butterflies
    - Schoolyard Habitats
      https://www.nwf.org/schoolyard/
    - Community Wildlife Habitats
      https://www.nwf.org/sitecore/content/Home/Garden-for-Wildlife/Create/Communities
    - Pollinator Pathway
      http://www.pollinatorpathway.com/about/

Urban Texas community between a local elementary school and high school.
Community population: 383,000



Officially listed as an urban city, this local elementary and high school sit on the outskirts of Philadelphia, PA and could be considered more suburban.
Community Population: 1.57 million



Rural community housed on the Minnesota Chippewa Tribe Reservation.
Community Population: 580

5. Have student groups design a physical blueprint of their today and tomorrow model and develop a materials list. Use the sketch from their site inventory to develop their “today” blueprint. Encourage students to incorporate LEGO’s in their design as well as natural materials from the schoolyard and reuse recyclable materials.
6. Allow student groups to find materials they want to use for their model at home and school and allow time in class, before school and after school for students to have ample time to go through the design process and have meaningful discussions.
7. Display in the library or other common area(s). Allow students to present their projects and conclusions to a variety of audiences, such as at a staff meeting, PTA/PTO meeting, school and/or city board meeting.

Continue on to the next page.

Follow-Up Questions

Q1. What are the limitations of your model?

Q2. What can you do to make your model come to life?

Q3. What or who do you need to make your model come to life?

Q4. Besides restoring monarch butterfly habitat, what other positive impacts will your project have?

BASIC SITE INVENTORY: MONARCH BUTTERFLY GARDEN

School Name ____

Group Member's Names ____

Date Survey Conducted ________________

Latitude ______________________________Longitude ______________________________

Talk as a group and come up with a vision for the garden. My Group's Vision for the monarch garden...

____

____

____

Use this site to find your pollinator eco-region using your zip code, http://www.pollinator.org/guides.htm. Pages 18-20 list plants and habitat hints. Find the milkweed and nectar plants that are native to your region for inclusion in your Monarch Recovery Garden.

NATIVE MILKWEED FOR MY REGION

MILKWEED NAME	WE HAVE	WE DON'T HAVE
1.		
2.		
3.		
4.		
5.		

Why is it important to have more than one variety of milkweed?

____

____

____

NATIVE NECTAR PLANTS FOR MY REGION

NECTAR PLANT NAME	WE HAVE	WE DON'T HAVE
1.		
2.		
3.		
4.		
5.		

What month(s) is the best time to plant? ______________________________

Why? ______________________________

____

What is puddling and why is it important for monarchs? https://youtu.be/XN0tKUM4kTU. Attract butterflies to your garden with a butterfly puddle.

____

____

In your science notebook or on another sheet of paper, sketch the garden or selected site as it looks now. Include a compass rose and a key using symbols to represent trees, plants, walkways, rocks, etc. Why does the group think this is a good site for the Monarch Recovery Garden?

____

____

____

____

Appendix

Who's Who in the Study of the Monarch Butterfly ____ A-1
NSTA Statement on Early Childhood Education ____ B-1
A Field Guide to Monarch Caterpillars, Karen Oberhauser and Kristen Kuda Schoolyard Habitats® Action Plans ____ C-1
Journey North Citizen Science Data Collection Handout ____ D-1
Monarch Recovery Visioning Worksheet ____ E-1
Habitat Sheets ____ F-1
TEKS Alignment ____ G-1

Who's Who in the Study of the Monarch Butterfly

PROFESSOR DR. LINCOLN BROWER

Professor Dr. Lincoln Brower was an entomologist and research professor at Sweetbriar College in Virginia, who passed away in 2018 at the age of 86. He spent 6 decades studying the remarkable migratory lifecycle of the monarch butterfly and urging action to protect it. Dr. Brower's contributions include research on the overwintering, migration and conservation biology of the monarch butterfly. https://texasbutterflyranch.com/2015/02/16/q-a-dr-lincoln-brower-talks-ethics-endangered-species-milkweed-and-monarchs/

DR. KAREN OBERHAUSER

Dr. Karen Oberhouser currently serves as the Director of the University of Wisconsin – Madison Arboretum. She also serves as an adjunct Professor, Department of Fisheries, Wildlife and Conservation Biology at the University of Minnesota. Previously, she worked as a director at the Monarch Lab at the University of Minnesota. Karen has been studying monarch butterflies since 1984. She has worked with teachers and pre-college students in Minnesota and throughout the United States using monarchs to teach about biology, conservation and the process of science. **https://monarchjointventure.org/about-us/leadership-and-staff**

CHIP TAYLOR

Dr. Taylor is an insect ecologist, a Professor of Ecology and Evolutionary Biology at the University of Kansas and the Founder and Director of Monarch Watch, an outreach program focused on education, research and conservation relative to monarch butterflies. Watch this short documentary, *Saving the Migration* https://www.youtube.com/watch?v=maM2gl30cJc to learn more about his work and the plight of the Monarch.

CATALINA AGUADO TRAIL

Catalina Aguado trail was a citizen scientist from the state of Michoacán in México, and part of the original team who discovered the monarch's over-wintering grounds. Under the guidance of Dr. Urquhart, Catalina and her husband ken Brugger spent two years searching the mountains in central México for the monarch's winter destination. Their discovery graced the cover of the national geographic magazine in august 1976. http://texasbutterflyranch.com/2012/07/10/founder-of-the-monarch-butterfly-roosting-sites-in-mexico-lives-a-quiet-life-in-austin-texas

XERCES SOCIETY

The Xerces Society is a nonprofit organization that protects wildlife through the conservation of invertebrates and their habitat. For over 50 years, the Society has been at the forefront of invertebrate protection worldwide, harnessing the knowledge of scientists and the enthusiasm of citizens to implement conservation programs. View or download their comprehensive report on the Conservation and Ecology of the Monarch Butterfly in the United States. http://www.xerces.org

U.S. FISH AND WILDLIFE SERVICE

The U.S. Fish and Wildlife Service works to conserve, protect and enhance fish, wildlife and plants and their habitats for continuing benefit of the American people. USFWS has committed to work with its partners, including National Wildlife Federation to restore and enhance more than 200,000 acres of habitat for monarch whole supporting over 750 schoolyard habitats and pollinator gardens. https://www.fws.gov/savethemonarch

NATIONAL WILDIFE FEDERATION'S BUTTERFLY HEROS

This campaign is part of NWF's Garden for Wildlife program. Butterfly Heroes seeks to bring awareness to the declining population and connect gardeners, kids and families alike to help the monarch and other pollinators. To take the pledge and create new habitat for monarch butterflies submit your photo pledge and become a butterfly hero. https://www.nwf.org/butterfly-heroes

MILLION POLLINATOR GARDEN CHALLENGE

A campaign to register a million public and private gardens and landscapes to support pollinators. www.millionpollinatorgardens.org

MONARCH JOINT VENTURE

The **Monarch Joint Venture** (MJV), http://monarchjointventure.org/about-us, is a partnership of federal and state agencies, non-governmental organizations, and academic programs that are working together to support and coordinate efforts to protect the monarch migration across the lower 48 United States. The MJV is committed to a science-based approach to monarch conservation work, guided by the North American Monarch Conservation Plan (2008)

NSTA Position Statement:
Early Childhood Science Education

Introduction

At an early age, all children have the capacity and propensity to observe, explore, and discover the world around them (NRC 2012). These are basic abilities for science learning that can and should be encouraged and supported among children in the earliest years of their lives. The National Science Teachers Association (NSTA) affirms that learning science and engineering practices in the early years can foster children's curiosity and enjoyment in exploring the world around them and lay the foundation for a progression of science learning in K–12 settings and throughout their entire lives.

This statement focuses primarily on children from age 3 through preschool. NSTA recognizes, however, the importance of exploratory play and other forms of active engagement for younger children from birth to age 3 as they come to explore and understand the world around them. This document complements NSTA's position statement on elementary school science (NSTA 2002) that focuses on science learning from kindergarten until students enter middle or junior high.

Current research indicates that young children have the capacity for constructing conceptual learning and the ability to use the practices of reasoning and inquiry (NRC 2007, 2012). Many adults, including educators, tend to underestimate children's capacity to learn science core ideas and practices in the early years and fail to provide the opportunities and experiences for them to foster science skills and build conceptual understanding (NRC 2007, p. vii). Also underestimated is the length of time that young children are able to focus on science explorations. Effective science investigations can deeply engage young children for extended periods of time, beyond a single activity or session.

NSTA supports the learning of science among young children that will create a seamless transition for learning in elementary school.

Young Children and Science Learning

NSTA identifies the following key principles to guide the learning of science among young children.

- **Children have the capacity to engage in scientific practices and develop understanding at a conceptual level.**
  Current research shows that young children have the capacity for conceptual learning and the ability to use the skills of reasoning and inquiry as they investigate how the world works (NRC 2007, NRC 2012). For example, their play with blocks, water, and sand shares some science-relevant characteristics. Young children also can learn to organize and communicate what they learn, and know the difference between concrete and abstract ideas (Carey 1985). Adults who engage children in science inquiry through the process of asking questions, investigating, and constructing explanations can provide developmentally appropriate environments that take advantage of what children do as part of their everyday life prior to entering formal school settings (NAEYC 2013, p. 17; NRC 2007).These skills and abilities can provide helpful starting points for developing scientific reasoning (NRC 2007, p. 82).

- **Adults play a central and important role in helping young children learn science.**
  Everyday life is rich with science experiences, but these experiences can best contribute to science learning when an adult prepares the environment for science exploration, focuses children's observations, and provides time to talk about what was done and seen (NAEYC 2013, p. 18). It is important that adults support children's play and also direct their attention, structure their experiences, support their learning attempts, and regulate the complexity and difficulty of levels of information (NRC 2007, p. 3). It's equally important for adults to look for signs from children and adjust the learning experiences to support their curiosity, learning, and understanding.

- **Young children need multiple and varied opportunities to engage in science exploration and discovery** (NAEYC 2013).
  Young children develop science understanding best when given multiple opportunities to engage in science exploration and experiences through inquiry (Bosse, Jacobs, and Anderson 2009; Gelman, Brenneman, Macdonald, and Roman 2010). The range of experiences gives them the basis for seeing patterns, forming theories, considering alternate explanations, and building their knowledge. For example, engaging with natural environments in an outdoor learning center can provide opportunities for children to examine and duplicate the habitats of animals and insects, explore how things move, investigate the flow of water, recognize different textures that exist, make predictions about things they see, and test their knowledge.

- **Young children develop science skills and knowledge in both formal and informal settings.**
  Opportunities to explore, inquire, discover, and construct within the natural environment and with materials that are there need to be provided in formal education settings, such as preschool and early care and education programs through intentional lessons planned by knowledgeable adults. In addition, children need to have opportunities to engage in

science learning in informal settings, such as at home with cooking activities and outdoor play or in the community exploring and observing the environment.

- **Young children develop science skills and knowledge over time.**
  To effectively build science understanding, young children need opportunities for sustained engagement with materials and conversations that focus on the same set of ideas over weeks, months, and years (NRC 2007, p. 3). For example, investigating the concept of light and shadows over several weeks indoors and out with a variety of materials and multiple activities will allow children to re-visit and re-engage over time, building on observations and predictions from day to day.

- **Young children develop science skills and learning by engaging in experiential learning.**
  Young children engage in science activities when an adult intentionally prepares the environment and the experiences to allow children to fully engage with materials. The activities allow children to question, explore, investigate, make meaning, and construct explanations and organize knowledge by manipulating materials.

Declarations

NSTA recommends that teachers and other education providers who support children's learning in any early childhood setting should

- recognize the value and importance of nurturing young children's curiosity and provide experiences in the early years that focus on the content and practices of science with an understanding of how these experiences connect to the science content defined in the *Next Generation Science Standards (NGSS)* (NGSS Lead States 2013);

- understand that science experiences are already a part of what young children encounter every day through play and interactions with others, but that teachers and other education providers need to provide a learning environment that encourages children to ask questions, plan investigations, and record and discuss findings;

- tap into, guide, and focus children's natural interests and abilities through carefully planned open-ended, inquiry-based explorations;

- provide numerous opportunities every day for young children to engage in science inquiry and learning by intentionally designing a rich, positive, and safe environment for exploration and discovery;

- emphasize the learning of science and engineering practices, including asking questions and defining problems; developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; constructing explanations and designing solutions; engaging in argument from evidence; and obtaining, evaluating, and communicating information (NRC 2012, NGSS Lead States 2013);

- recognize that science provides a purposeful context for developing literacy skills and concepts, including speaking, listening, vocabulary development, and many others; and

- recognize that science provides a purposeful context for use of math skills and concepts.

NSTA recommends that teachers and other providers who support the learning of science in young children be given professional development experiences that

- engage them in learning science principles in an interactive, hands-on approach, enabling them to teach about science principles appropriately and knowledgeably;
- are ongoing and science-specific;
- help them understand how children learn science and engineering practices (NRC 2012, NGSS Lead States 2013);
- inform them about a range of strategies for teaching science effectively; and
- include the use of mentors to provide ongoing support for educators for the application of new learning.

NSTA recommends that those in a position to provide financial, policy, and other support for early childhood education should

- provide appropriate resources for teachers and children;
- ensure a positive and safe environment for exploration and discovery;
- ensure teachers receive sustained science-specific professional development that includes how children learn and how to teach science;
- provide mentoring; and
- establish a coherent system of science standards, instruction, appropriate assessment, and curriculum.

Parents and other caregivers can nurture children's natural curiosity about the world around them, creating a positive and safe environment at home for exploration and discovery. These recommendations can be found in NSTA's position statement, Parent Involvement in Science Learning (NSTA 2009), found at *www.nsta.org.*

—Adopted by the NSTA Board of Directors
January 2014

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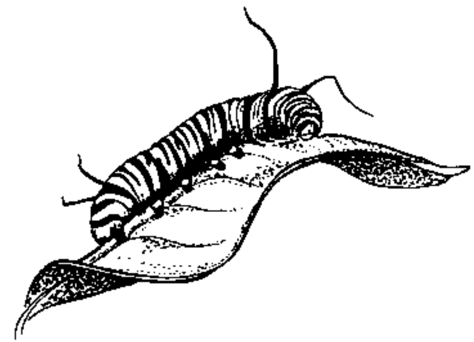
A Field Guide to Monarch Caterpillars (*Danaus plexippus*)



Karen Oberhauser and Kristen Kuda
Illustrations by Kristen Kuda

Produced with the support of the National Science Foundation. Opinions expressed are those of the authors and not necessarily those of the Foundation.

INTRODUCTION

This guide will aid in recognizing eggs and distinguishing larval (caterpillar) instars of monarch butterflies (*Danaus plexippus*) in the field. We assume that readers have some familiarity with monarch larvae already, and will recognize their bold yellow, white and black stripes on or near their host plants.

Several clues will help you find monarch eggs and larvae. Look for them on plants in the genus *Asclepias* (milkweeds), or on the closely-related *Cynanchum laeve* (Sand Vine) found in the central U.S. Females usually lay eggs on the underside of young milkweed plants, and this is often a productive location to search. A characteristic sign of a new larva is a minute hole in the middle of a leaf, while older larvae tend to eat on the margins of leaves. Learning to recognize "monarch-eaten" leaves will increase your success at finding larvae. They can also be located by the presence of their frass, or fecal matter. If you see adult monarchs (butterflies) in an area with milkweed, there is a good chance you'll find eggs or larvae as well.

Before going into the field to look at monarchs, we recommend reading the anatomy, molting, and distinguishing instars sections of this field guide. After these sections, there are detailed descriptions and drawings of eggs and each of the five instars.

Happy monarch hunting!

ANATOMY

The diagram below shows a generic butterfly larva, with three parts to its body—the *head, thorax* and *abdomen*. The thorax and abdomen each have several segments, which are numbered in the diagram. Many of these segments contain small holes called *spiracles*. The spiracles are connected to a network of airtubes called *tracheae*, which carry oxygen throughout the larva's body. Monarch larvae have two sets of *tentacles* or *filaments* (front and back); these are not antennae, and are not found on all butterfly larvae. They function as sense organs. The thoracic segments each have a pair of jointed *true legs*, and there are five pairs of false legs, or *prolegs*, on the abdomen.

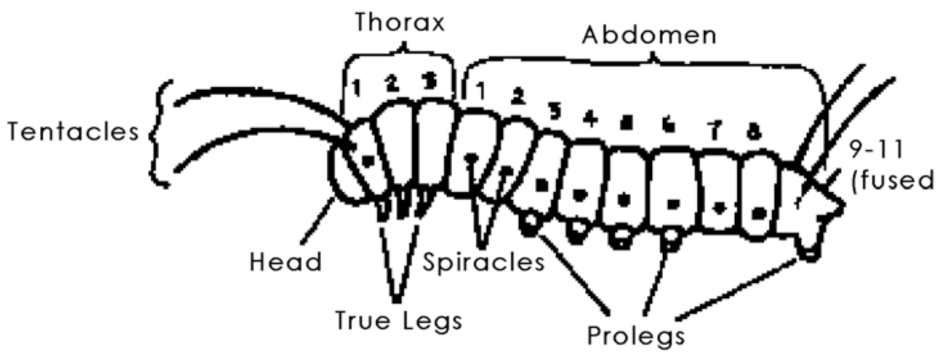


Figure 1. Larva anatomy

The head has a pair of short *antennae*, mouthparts, and six pairs of very simple eyes, called *ocelli*. The *spinneret* produces silk that small larvae use when they drop off a leaf and hang suspended in the air. Larvae in all instars use the silk to anchor themselves during molting, and fifth instar larvae make a “silk button” to which the pupa is attached. The *maxillary palps* are sensory, and also help direct food into the jaws. These features can be seen with the aid of a hand lens, but are difficult to see with the naked eye.

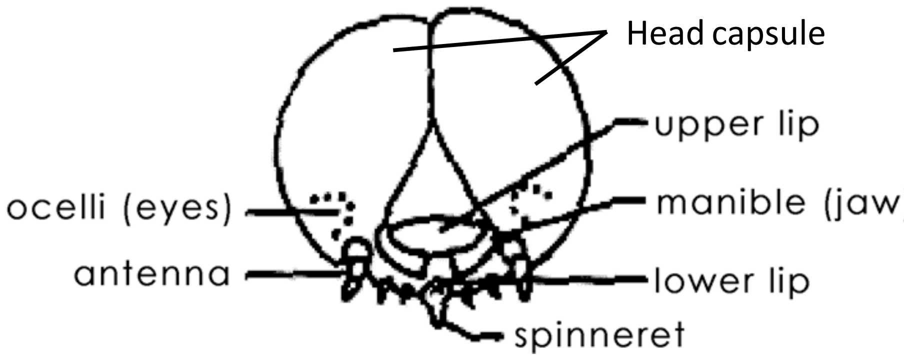


Figure 2. Butterfly Larva head

MOLTING

Monarchs have five larval *instars*, or stages between shedding their *cuticle* (outer layer of skin). The cuticle is made of long protein chains and chitin. It is rigid and hard, and serves to support and protect monarchs and other arthropods. It also restricts water loss. However, the cuticle limits growth and must thus be replaced periodically. The process of replacing the old cuticle is called *molting*. Molting is controlled by a hormone called *ecdysone* produced in glands in the thorax. It actually involves a whole sequence of events, beginning with the separation of the old cuticle from the epidermal (skin) cells that underlie it, a process called *apolysis*, and ending with the shedding of the old cuticle, a process called *ecdysis*. The old cuticle is partially broken down by enzymes, and some of its constituents recycled. When it is first secreted, the new cuticle is protected from these enzymes by a layer of wax. The new cuticle is soft and flexible, thus permitting expansion before it undergoes *sclerotization*, or hardening.

Table 1. Sequence of events in molting

1. apolysis (separation of old cuticle)
2. new cuticle production
3. wax secretion (protects new cuticle)
4. activation of molting enzymes
5. ecdysis (shedding of old cuticle)
6. expansion of the new cuticle
7. sclerotization (hardening of new cuticle)

Monarch larvae remain very still during all the steps of molting, the older instars often move off the milkweed at this time. The first thing that you will notice, besides their motionlessness, is the separation of the part of the cuticle that covers their head from the rest of the cuticle. This *head capsule* is the first part of the old cuticle to be shed, and the larva then crawls out of the rest of the skin. The shed skin is called the *exuvia*. After molting, monarch larvae (and the larvae of many other insects) usually eat the exuvia, thus recycling useful nutrients that it still contains.

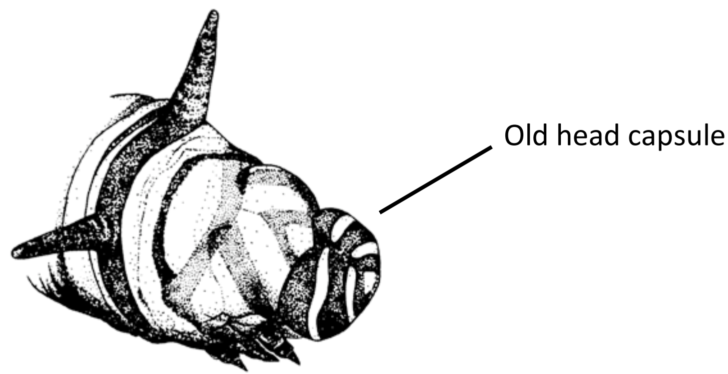


Figure 3. Third instar larva about to shed its head capsule.

DISTINGUISHING INSTARS

While most of the cuticle is quite hard, larvae still grow quite a bit within each instar. This is possible because of the flexibility of the new cuticle, and because parts of the cuticle contain a rubber-like protein which permits it to stretch. Therefore, distinguishing instars by size is not very accurate. Look at the drawings of a first instar larva, all drawn to the same scale, to see how much it changed in size within an instar!

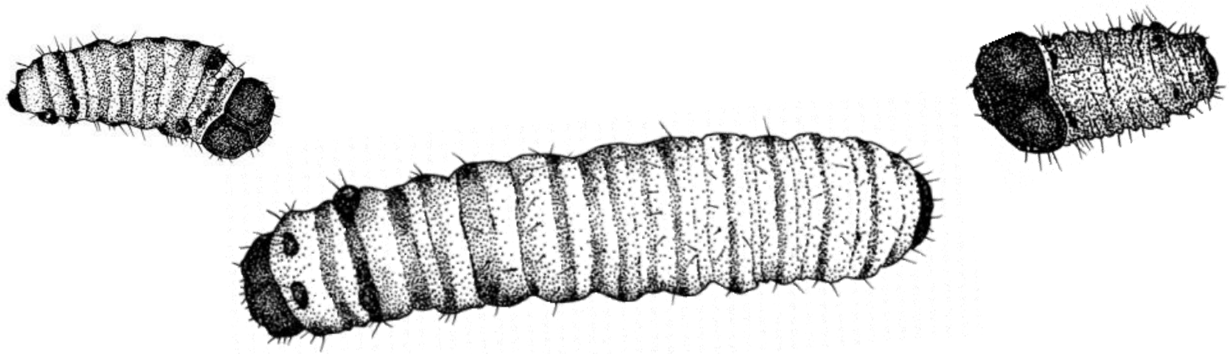


Figure 4. Three drawings of the same first instar larva over a period of 2 days (x25).

The easiest way to distinguish larval instars is by head capsule and tentacle size, since these do not grow during an instar. For example, the front tentacles on a fourth instar larva are about half the length of those on a fifth instar. Also, the size of the tentacles relative to the head capsule and the rest of the body increases with later instars. We have included estimates of the sizes of head capsules and tentacles for each instar in the table on the next page. However, individual monarchs vary in size just like humans do, so the larvae you find may not be exactly the sizes given.
The drawings below compare head capsule sizes in the five instars. Of course, real larvae have much smaller heads! The lines above each drawing give the actual measurement of the real heads. We measured several larvae with a calipers accurate to 0.1 mm, then took the average size, to get these measurements. Note that the head capsules increase in size by a factor of from 1.3 to 1.6 between each instar.

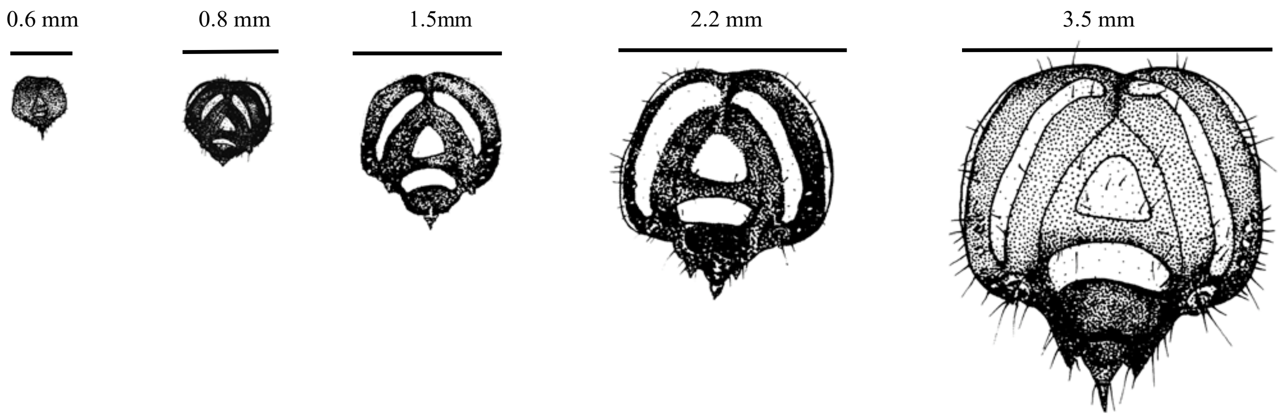


Figure 5. Head capsules, of the five larval instars (all drawn to the same scale, x12.5).

A note on measurement. We report the sizes of monarch eggs and larvae in millimeters (mm). There are 10 mm in a centimeter, so when something is 13 mm long, it is also 1.3 cm long. Sizes of body parts are most useful in distinguishing third and higher instars, since it is difficult to distinguish 0.6 from 0.8 mm (the sizes of head capsules on first and second instars) with the naked eye. It is best to use other characteristics described in the guide for the younger instars. The lines on the table below show the actual head widths and tentacle lengths for each instar. Whenever we show a drawing of a larva, we tell you how many times it has been magnified. For example, the heads shown on the previous page are 12.5 times larger than actual heads; we noted this by putting x12.5 in the figure caption.

Table 2. Comparison of head and tentacle sizes from the five instars. Lines show the actual length of these body parts, and numbers show how long the lines are (in mm). Starred spaces for the tentacles mean that these are too short to measure accurately.

	Instar				
	1	2	3	4	5
Head	(0.6)	(0.8)	(1.5)	(2.2)	(3.5)
Front tentacle	*	(0.3)	(1.7)	(5.0)	(11.0)
Back tentacle	*	*	(0.9)	(2.0)	(4.0)

EGG

Height: 1.2 mm

Width: 0.9 mm

Appearance: Monarch eggs are usually attached to the underside of young milkweed leaves. They are laid singly, and it is uncommon (though not unheard of) to find more than one on a single plant. The eggs look off-white or yellow, and are marked with a series of longitudinal ridges. The hard outer shell, or *chorion*, protects the developing larva.

Figure 6. Scanning electron microscope (SEM) image of a monarch egg

First Instar

Body Length: 2 to 6 mm

Body Width: 0.5 to 1.5 mm

Front Tentacles: Small bumps

Back Tentacles: Barely visible

Head Capsule: 0.6 mm in diameter

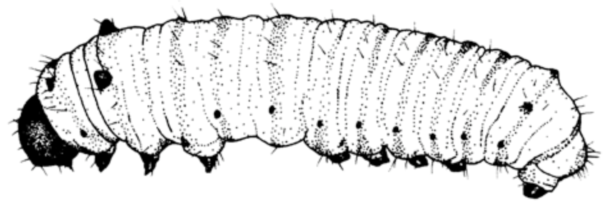


Figure 7. Body and head of first instar (x20)

Appearance: A newly-hatched monarch larva is pale green or grayish-white, shiny and almost translucent. It has no stripes or other markings. The head looks black, with lighter spots around the antennae and below the mouthparts, and may be wider than the body. There is a pair of dark triangular patches between the head and front tentacles which contain setae, or hairs. The body is covered with sparse setae. Older first instar larvae have dark stripes on a greenish background.

After hatching, the larva eats its eggshell (chorion). It then eats clusters of fine hairs on the bottom of the milkweed leaf before starting in on the leaf itself. It feeds in a circular motion, often leaving a characteristic, arc-shaped hole in the leaf. First (and second) instar larvae often respond to disturbance by dropping off the leaf on a silk thread, and hang suspended in the air.

SECOND INSTAR

Body Length: 6 mm to 9 mm

Body Width: 1 to 2 mm

Front Tentacles: 0.3 mm

Back Tentacles: Small knobs

Head Capsule: 0.8 mm diameter

Figure 8. Body and head of second instar (x12.5)

Appearance: Second instar larvae have a clear pattern of black (or dark brown), yellow and white bands, and the body no longer looks transparent and shiny. An excellent characteristic to use in distinguishing first and second instar larvae is a yellow triangle on the head and two sets of yellow bands around this central triangle. The triangular spots behind the head do not have the long setae present in the spots on the first instar larvae. The setae on the body are more abundant, and look shorter and more stubble-like than those on first instar larvae.

Third Instar

Body Length: 10 to 14 mm

Body Width: 2 to 3.5 mm

Front Tentacles: 1.7 mm

Back tentacles: 0.9 mm

Head Capsule: 1.5 mm in diameter

Figure 9. Body and head of third instar (x6)

Appearance: The black and yellow bands on the abdomen of a third instar larva are darker and more distinct than those of the second instar, but the bands on the thorax are still indistinct. The triangular patches behind the head are gone, and have become thin lines that extend below the spiracle. The yellow triangle on the head is larger, and the yellow stripes are more visible. The first set of thoracic legs are smaller than the other two, and are closer to the head.

Third instar larvae usually feed using a distinct cutting motion on leaf edges. Unlike first and second instar larvae, third (and later) instars respond to disturbance by dropping off the leaf and curling into a tight ball. Monarch biologist Fred Urquhart called this behavior “playing possum.”

Fourth Instar

Body Length: 13 to 25 mm

Body Width: 2.5 to 5 mm

Front Tentacles: 5 mm

Back Tentacles: 2 mm

Head Capsule: 2.2 mm in diameter

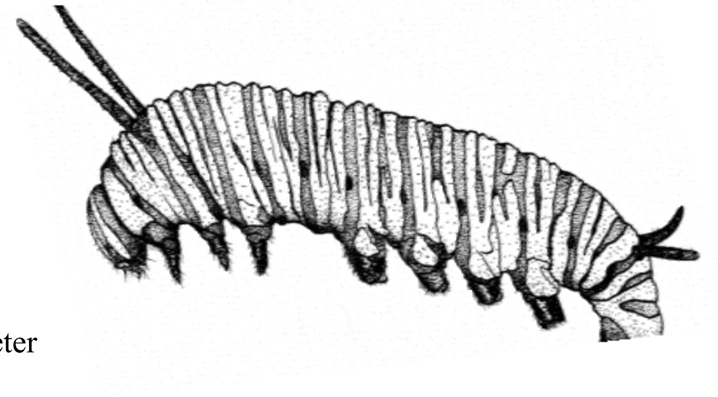
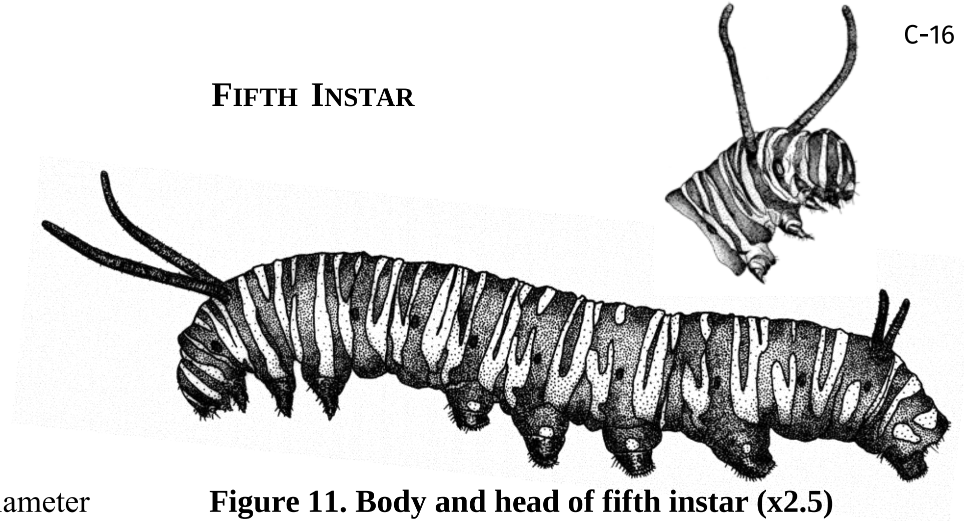


Figure 10. Body and head of fourth instar (x5)

Appearance: There is a distinct banding pattern on the thorax which is not present in the third instar larvae. The first pair of legs is even closer to the head, and there are white spots on the prolegs that were less conspicuous in the third instar.

Fifth Instar



Body Length: 25 to 45 mm

Body Width: 5 to 8 mm

Front Tentacles: 11 mm

Back Tentacles: 4 mm

Head Capsule: 3.5 mm in diameter

Figure 11. Body and head of fifth instar (x2.5)

Appearance: The body pattern and colors are even more vivid that they were in the fourth instar, and the black bands look wider and almost velvety. The front legs look much smaller than the other two pairs, and are even closer to the head. There are distinct white dots on the prolegs, and the body looks quite plump, especially just prior to pupating.

Fifth instar monarch larvae often chew a shallow notch in the petiole of the leaf they are eating, which causes the leaf to fall into a vertical position. They move much farther and faster than other instars, and are often found far from milkweed plants as they seek a site for pupating.

Schoolyard Habitats Action Plan

What is the issue?	What action will we take?	Who will do it?	When will it be done?	How will we monitor progress?	How will we know if we succeeded?	What will it cost?
K-2 Example We don't see many birds in our schoolyard.	We will find what the habitat needs of our local birds are and work with older grades to create the right habitat.	- Eco-Action Team - Master Naturalist - Master Gardeners - Interested school and volunteers	- Research in the fall and winter. - Take Junior Master Naturalist program in Winter - Bed prep in the spring - Build and plant in spring	We will use our Eco-Action Team meetings to learn, brainstorm and find ways to share our work with the school, our families and the community.	We will see an increase in the types and kinds of birds we see in our schoolyard.	We will look for donations of time and materials for the build of the garden. - student garden tools, plants/trees/shrubs, compost, feeders/seed, approx - $300-$500
3-5 Example We study a lot about ecosystems and we want to install a garden and plant trees and bushes so we can study ecosystems outside.	We will plan a garden and learning area using native plants and trees and natural elements.	- Eco-Action Team - Master Naturalist - Master Gardeners - City Parks Dept. - School/Community volunteers	- Research local flora and fauna in the fall - Secure approval for garden site in the fall - Take Junior Master Naturalist program in Winter. - Plant in the spring	We will use our Eco-Action Team meetings to check progress on our goals and create a project plant to help us stay on track.	Our school's students will be able to use the school gardens for learning no less than twice a year.	We will look for donations of time and materials for the build of the gardens. - student garden tools, plants, trees, shrubs, compost, field investigation tools - approx - $500
6-12 Example The principal at the CTE building has asked us to install gardens that their cullinary arts and horticulture program students can use.	We will develop a series of gardens that students can use for learning and as a way to engage the community in the education programs offered by the school district.	- Eco-Action Team - Master Gardeners - University/College horticulture dept. - Local chefs	- Schedule meetings early fall with stake-holders - secure approval for garden sites in winter - Bed prep in spring - Plant in the spring	We will rely on our Eco-Action Team meetings to check in on committee progress and our project plan timeline toward our goals.	Culinary and horticulture students will be able to use the gardens to deepen their learning by providing authentic learning experiences.	We will look for donations of time and materials for the guild of the gardens. - garden tools, plants, amendments and compost, building materials - $800

Remember these are just examples. Your Eco-Action Team may have one issue or you may have three. You may have one issue and three solutions. There is not a required number of issues to address or solutions to be completed. It is only required that the action plan be measurable and realistic.

Questions? **eco-schoolsusa@nwf.org**

ECO-SCHOOLS USA
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Schoolyard Habitats Action Plan

What is the issue?	What action will we take?	Who will do it?	When will it be done?	How will we monitor progress?	How will we know if we succeeded?	What will it cost?

Remember these are just examples. Your Eco-Action Team may have one issue or you may have three. You may have one issue and three solutions. There is not a required number of issues to address or solutions to be completed. It is only required that the action plan be measurable and realistic.

Questions? **eco-schoolsusa@nwf.org**

Journey North Citizen Science Data Collection

E-1

Download the Journey North app for Android or IOS from Annenberg Learner

Journey North Data Entry

1. Enter the number of monarch butterfly observed. ______________________

2. Comments: Here's what information is needed.

    a. Where are you? (Park, Schoolyard Habitat, Backyard, Walking Home)

    b. What time is it?

    c. What's the weather like? (Cloudy, Full Sun, In the high 90's)

3. Optional: If you have access, take a photo and use the photo editor to add the date and time.

4. What is the date for your observation? ________________________________

5. What is the location of your sighting?

    a. Country: ______________________
    b. State: ______________________
    c. City: ______________________
    d. Latitude: ______________________(round to the nearest hundredth)
    e. Longitude: ______________________(round to the nearest hundredth)

To find your current latitude and longitude use your phone's compass or go to https://www.latlong.net/ and insert your school's full address including zip code.

6. What is your first name?____

7. What is your last name?____

8. If instructed, go to the Journey North app, login and enter and submit your data.

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MONARCH RECOVERY VISIONING WORKSHEET

Group members and their role in the project:

Please respond briefly.

1. Describe how your schoolyard currently looks. Take pictures and attach to this page.

2. How is the schoolyard currently used?

3. Describe your ideal schoolyard – what would it look like? Sound like? How would it be use?

In working towards creating a wildlife habitat(s) on the school grounds, consider these questions.

4. Where on the schools grounds will the habitat be located and what evidence do you have to support this location?

5. What should the size and shape of the garden site be?

6. What will this habitat provide for the monarch butterfly?

7. What type of ecosystem are you restoring or recreating?

8. What will the source of water be in your habitat?

9. How will students be involved in the design and development of the habitat site?

10. How will classes use the completed site? What special features will the site need to accommodate these uses?

11. Which community members, businesses and organizations might be of assistance, labor or financial, with this project?

12. Sketch how the site will look after it is constructed. In the summer. In the winter. After a year.

IMMEDIATELY AFTER PLANTING	IN THE SUMMER
IN THE WINTER	AFTER ONE YEAR

13. Use the above ideas and information to form a vision statement for the Monarch Recovery Garden. This statement should include:
    - Wildlife for which the garden(s) is designed
    - Location and reason for selecting the area
    - Size of the habitat project
    - Other details that will help the school and community understand and "see" the project better

MONARCH RECOVERY GARDEN VISION

School ____Date ____________

Our Monarch Recovery Garden Vision is:

HABITAT TEAM PLANNING WORKSHEET

This form lists the members of our Monarch Recovery Garden Team. Each participant recognizes their role as a member of this team. Many others will be involved in the project, but those listed below take responsibility for the specific project areas listed below.

NAME	HABITAT TEAM	EMAIL
1. 2. 3.	**Habitat Team Leaders**	1. 2. 3.
1. 2. 3.	**Budget Coordinators**	1. 2. 3.
1. 2. 3.	**Curriculum Coordinators**	1. 2. 3.
1. 2. 3.	**Historians**	1. 2. 3.

HABITAT TEAM PLANNING WORKSHEET

1. 2. 3.	**Maintenance**	1. 2. 3.
1. 2. 3.	**Volunteer Coordinators**	1. 2. 3.
1. 2. 3.	**Communications and Marketing**	1. 2. 3.
1. 2. 3.	**Student Liaisons**	1. 2. 3.

I acknowledge and support the creation of the Monarch Recovery Garden, which will help guide the project along the way.

Principal/Director Signature ____Date______________

Habitat team Leaders

____Date_______________

____Date_______________

____Date_______________

NEXT GENERATION SCIENCE STANDARDS - THE MONARCH MISSION – K-5

Physical Science

K-PS 3-1 Make observations to determine the effect of sunlight on Earth's surface.
2-PS1-1 Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. Observations: color, texture, hardness, and flexibility. Patterns: similar and different properties.
2-PS1-2 Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose. Properties: strength, flexibility, hardness, texture, absorbency.
5-PS3-1 Use models to describe that energy in animals' food (used for body repair, growth and motion and to maintain body warmth) was once energy from the sun.

Earth and Space Science

K-ESS 3-3 Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

Life Science

K-LS-1-1 Use observations to describe patterns of what plants and animals (including humans) need to survive.
2-LS4-1 Make observations of plants and animals to compare the diversity of life in different habitats.
3-LS4-3 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 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 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. Limited to macroscopic structures.
5-LS2-1 Develop a model to describe the movement of matter among plants, animals, and the environment.

Engineering Design

K-2 ETS1-1 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.
K-2 ETS1-2 Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
4-ESS3-1 Obtain and combine information to describe that energy and fuels are derived from natural resources and that their uses affect the environment.
5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.