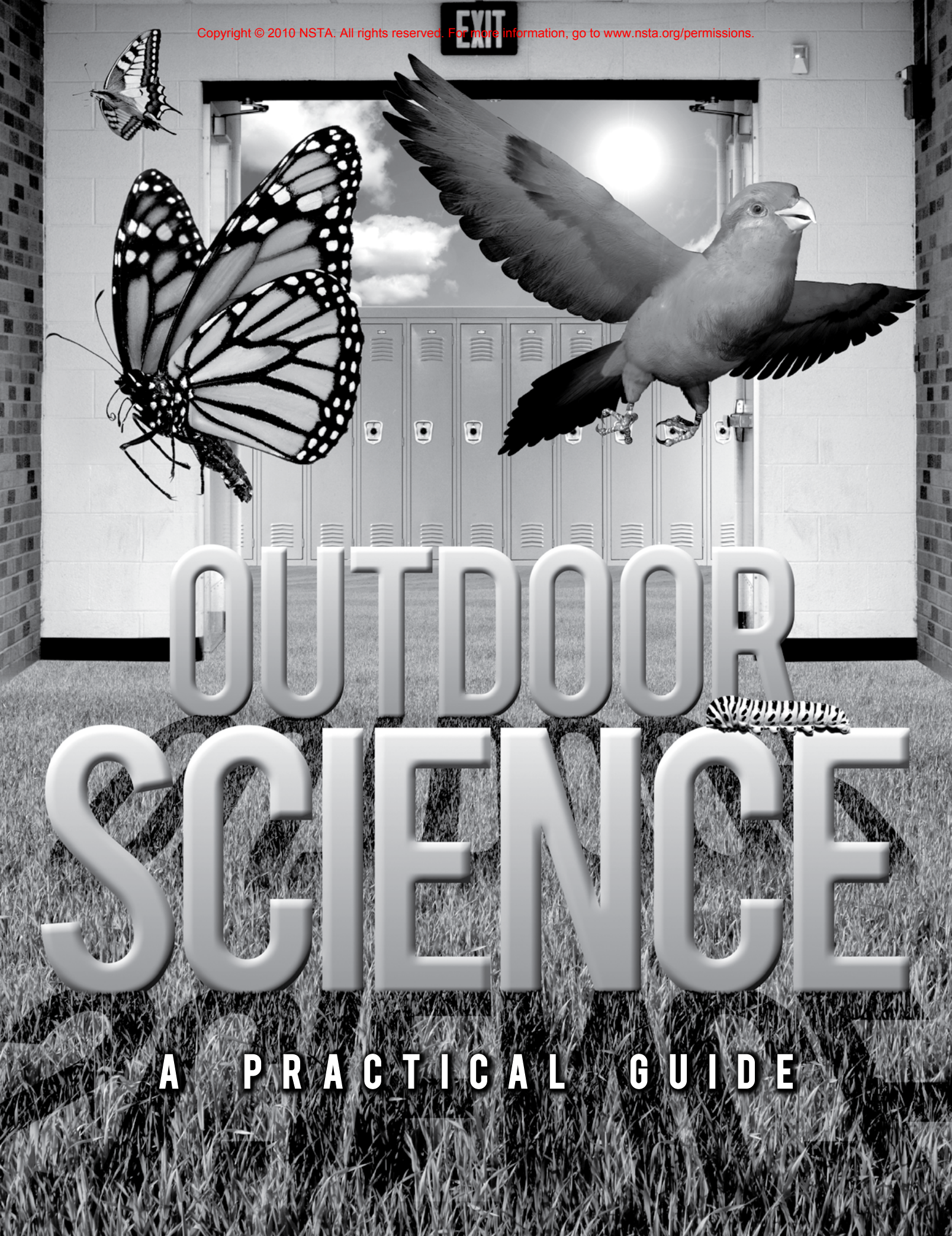

OUTDOOR SCIENCE

A PRACTICAL GUIDE

STEVE RICH

OUTDOOR SCIENCE

A PRACTICAL GUIDE

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Dedication

Outdoor Science: A Practical Guide is dedicated with love to my son, Spencer Anthony Rich, who as a young boy helped me rediscover the outdoors through his eyes, and as a young man continues to help me see the world in new ways.

As Maya Angelou said, "My son is my monument."

Foreword

Science teaching offers a realm of possibilities for creating new kinds of classrooms and learning communities that fit the needs of today's students. Following the 2005 release of Richard Louv's *Last Child in the Woods* and the No Child Left Inside national initiative, more attention has been focused on the need for increased opportunities for children to interact with nature during the school day. Louv coined the term *nature-deficit disorder* to describe children's disconnections from the natural environment as a result of spending more time in front of televisions and video games. This disconnection has led to serious, troubling trends among today's schoolchildren: a rise in obesity, a lack of empathy for living things, more attention disorders, and social isolation, among other concerns. Furthermore, in addition to health and behavioral problems, serious learning problems result when students do not have opportunities early on and throughout their educations—both in school and during play—to interact with the outdoor world.

Many of us recall a childhood in which we spent most of the day playing outdoors. Whether it was the backyard, woods, fields, ponds, or streams in our rural or suburban neighborhoods or inner-city parks, playgrounds, harbors, empty lots, sidewalks, or alleys—we could explore, interact with, and come to know our natural world through play while simultaneously building social skills. Digging in the soil, watching ants, catching frogs, collecting seeds, floating sticks, making "dams and rivers," skipping rocks, observing butterflies and bees—all of these experiences contribute to children's early understanding of the living and physical worlds. Sadly, the "outside school" lives of today's children are much more structured and supervised, with few opportunities to interact in outdoor play spaces. When children do have free time, it often is spent in front of a computer, the television, or video games. Likewise, the school day is spent primarily indoors with few opportunities to interact in a naturalized outdoor setting. The once-a-year field trip may be the only time some children ever experience learning in an outdoor setting.

But there is a way to not only bring nature to our students but also bring our students to nature. This book offers a practical, effective solution for dealing with the nature-deficit disorder epidemic by creating a special kind of classroom environment and collaborative community that makes it possible for every child to participate in outdoor exploration and discovery that bring science and other subjects to life. As today's students prepare to be the adults of tomorrow's society, we need to transform

Foreword

the traditional four-wall, "contrived" learning environment into one in which students can participate in practical projects and activities that are not restricted by the physical boundaries of the classroom or limitations of bringing the outside world inside.

Outdoor Science: A Practical Guide describes how teachers can change the physical environment for learning to an outdoor classroom where students can feel successful as they interact with the natural world; in addition, Steve Rich presents innovative ideas for transforming curriculum and instruction to meet the needs of today's learners. The suggestions in this powerful book are consistent with the recommendations from the National Science Foundation's report "Environmental Science and Engineering for the 21st Century," which confirms the importance of environmental education for building knowledge, critical- and creative-thinking skills, and basic life skills such as problem solving, consensus building, information management, and strong verbal and written communication skills (NSF 2000). The outdoor classroom offers an ideal setting in which students can delve into important environmental issues and develop an appreciation of their natural surroundings, which offer an authentic vehicle for creating an enhanced sense of stewardship and appreciation for the natural world.

Our nation's future depends on educating the next generation of students to be wise and responsible stewards of the environment. To prepare students, we need to design effective instruction and develop innovative rigorous curriculum, and offer new types of learning spaces that provide opportunities for student-driven, inquiry-based, and interdisciplinary learning that values school-community partnerships. Now you too can learn how to engage your students, school, and community in designing the types of classrooms that the author has developed successfully during his accomplished teaching career. From simple outdoor spaces to extensive habitat areas, every school can find a way to design an outdoor learning space using the practical suggestions in this comprehensive guide.

Thank you, Steve, for sharing your tremendous wisdom, insights on science teaching and learning, and innovative and practical ideas for moving education outside, where children can truly engage in authentic learning in natural surroundings. In an era of standards and accountability, we need to think outside the box for new ways to make learning accessible to students. What better way to do that than to take "the box" outside!

Page Keeley
Maine Mathematics and Science Alliance
NSTA President 2008–09

Correlation to National Science Education Standards

	Content Standards	Chapter 3 Activities	Chapter 4 Activities	Chapter 5 Activities	Chapter 6 Activities
Physical Science	K–4 Properties of objects and materials		p. 62		p. 124
	5–8 Properties and changes of properties in matter				
	K–4 Position and motion of objects		p. 84		
	5–8 Motions and forces				
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Life Science	K–4 Characteristics of organisms			p. 90	
	5–8 Structure and function in living systems	pp. 44, 46, 48		p. 98	
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Earth and Space Science	K–4 Properties of Earth materials				p. 124
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	K–4 Changes in Earth and sky		pp. 74, 80	p. 92	
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	K–4/5–8 Understanding about science and technology				
Science in Personal and Social Perspectives	K–4/5–8 Personal health				
	K–4 Characteristics and changes in populations	pp. 32, 36, 40		p. 100	pp. 130, 132
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	K–4 Types of resources			p. 104	
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	K–4 Changes in environments			p. 104	p. 126
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	5–8 Nature of science				
	5–8 History of science				

3

Birds, Bugs, and Butterflies

Science Lessons for Your Outdoor Classroom

Outdoor classes give teachers the chance to share nature's wonders with students firsthand. From the smallest insect to the largest flying predator, children will retain far more knowledge if they watch animals in natural settings instead of simply reading about them.

One of the most important concepts to share with students is that animals have four basic needs: sources for food, a water source, shelter, and space to bring up their young. When planning an outdoor learning experience, think about how many of these resources are already available on the school grounds and what you can add to make the environment more hospitable for wildlife.

Among the wild animals that may travel through a school yard, birds, bugs, and butterflies are the most common—the focus of most of the lessons in this chapter. There is an abundance of information for teaching about these animals available through the internet, books, and nature centers.

As you develop your outdoor-teaching skills, you may want to bring a wider variety of wildlife into your lessons. You must take into consideration the safety of your students and the location of your school when thinking about attracting wildlife. Animals that move through the air are less of a nuisance and therefore more acceptable in the

3 Birds, Bugs, and Butterflies

school yard and surrounding area, regardless if the school is located in an urban or rural setting.

For many birds, shelter could be as simple as trees that already live in your school yard. Water might be available in a stream or ditch, or you could easily set up a birdbath. Depending on the species, a food source might be insects living naturally in the area, seeds from flowering plants, or several bird feeders that can be viewed from your classroom window.

Butterflies need flowers for their food sources as adults and host plants as a food source for caterpillars (and a place to raise their young). They also need shallow pans of sand and water for "puddling" and shrubs, fence posts, or trees on which they may climb to form their chrysalides.

Finally, space or a place to raise young must not be overlooked. The more space you have, the more area is available for animals to establish their own territories, which is particularly important so that students can compare the habits of various species. You can increase the school yard's appeal to certain birds by adding birdhouses. Many students will enjoy building and placing the houses as well.

The following activities may lead to establishing permanent additions to your school yard or having your school yard certified by the National Wildlife Federation as a Certified Wildlife Habitat (*www.nwf.org*). Even if this does not become a permanent addition, however, sharing these close-up views of animal environments will teach students valuable lessons about being informed citizens in the natural world and make science concepts more meaningful, fun, and easy to recall.

This chapter offers a variety of activities to allow you to "tame" the wildlife to help you teach. Instructions for each lesson are presented first to help you make the most of each handout. Handouts for the activities start on page 33.

Don't Forget!

- Communicate with the school office. Make sure other teachers (next door to your classroom or across the hall) know that you are taking your class outside in case anyone is looking for you.
- Be aware of student allergies to plants or insect stings.
- Choose materials carefully. Working with concrete objects such as patio blocks, birdbaths, or benches puts heavy objects around little fingers and toes.
- Play is for the playground. The outdoor classroom is a space for learning.

For a full list of safety tips, see pages 15 through 16.

3

Animal Habitat Survey

Teaching Objectives: to identify the basic needs of food, water, shelter, and space required by animals to raise their young; to identify resources to meet the basic needs of animals living on the school grounds

Why/How to Use This Lesson: In any study of populations and ecosystems (NRC 1996, p. 140), an activity such as this study of the local environment helps students form a local perspective on a global concept. Use this lesson to help students sharpen their observation skills and gain a greater understanding of how local organisms fit into their ecosystems.

SCILINKS
THE WORLD'S A CLICK AWAY

Topic: What Is a Habitat?

Go to: *www.scilinks.org*

Code: OS001

Materials: handout, clipboard, pencil

Procedures and Tips: For this lesson, it would be helpful for you to take a walk through the school yard before taking your students outside. Look for specific examples that meet the needs of animals. Make notes about possible animal habitats.

Before leading the class outdoors, engage students in a discussion of animals' basic needs. Animals need food, water, shelter, and space to raise young. Discuss these needs and relate them to the resources on the school grounds.

First, talk about what animals eat and drink. Some examples to mention might be that squirrels eat nuts and seeds from trees, spiders eat insects, and caterpillars eat leaves. Water sources for animals can include mud puddles, water dripping from a gutter on the building, streams, or birdbaths.

Shelter for animals can be trees, the eaves of the school building, and rocks or underbrush. Space for raising young connects to shelter and can include trees for some animals and open fields for others.

Assessment/Next Steps: After students have had a chance to explore outdoors and identify a number of resources that animals need, gather students back into a group to discuss the results of their school yard survey. If you are still planning your outdoor classroom, this activity will allow students to help you adjust and improve the plans. What have they found that meets animals' basic needs, and what can they identify that is lacking? If they have answered this question adequately, then they have mastered the intended concept.

Animal Habitat Survey
Basic Needs of Animals—Resources in Our School Yard

Name: _____ **Date:** _____

Directions

Take a walk on the school grounds with your teacher. Complete this form to show what resources are available to animals.

1. What sights and sounds do you see or hear that tell you animals are here?

   _____
   _____
   _____

2. What proof can you find that animals have been here? (e.g., footprints, anthills, droppings, feathers, etc.)

   _____
   _____
   _____

3. What animals may have lived here before there was a school building? What was taken away from the environment that may have made them leave?

   _____
   _____
   _____

4. Compare your findings with a partner's findings and talk about the basic needs of the animals you wish to attract. Then check your findings with those of the rest of the class before filling in the chart below.

Basic Needs	Resources in Our School Yard

3

How Birds React to Environmental Changes

Teaching Objective: to make predictions and inferences regarding the responses of birds (and other animals) to changes in their environment

Why/How to Use This Lesson: Use this lesson to support units of study on the traits and behaviors of organisms (NRC 1996, p. 129). You can also use this lesson to support the fact that individual animals do react to environmental changes but adaptation and natural selection occur over generations. This lesson should help students define adaptation as "variations organisms are born with that can lead to an individual's survival and reproduction" (Keeley, Eberle, and Tugel 2007, p. 144).

SCILINKS
THE WORLD'S A CLICK AWAY

Topic: Behaviors and Adaptations

Go to: *www.scilinks.org*

Code: OS002

Materials: handout, clipboard, pencil, binoculars (optional, for bird watching), "Habitat Change" assessment probe (Keeley, Eberle, and Tugel 2007, p. 143)

Procedures and Tips: Discuss animals and how they react to changes in their environments before you take students outdoors. You may wish to read out loud from a resource book or show a video from the internet to offer students background information. Consider using the formative assessment probe listed in the Materials section above.

When going outdoors to observe birds, remind students to be quiet and still. Birds will frequently be scared away by noise and movement. One way to view birds with an active class is to sit far away from the spot where birds gather. You will need binoculars for conducting the activity this way. If you do not have bird feeders, search the school yard for trees where birds live. You may be able to spot nests ahead of time and find the best place on school grounds to take your students.

If you have little luck with natural attraction of birds to the school grounds, try scattering mixed birdseed in a field or along the edge of a wooded area. If you see that this works, make it part of the observation by letting your students in on the strategy. Compare what happens when the seed is scattered to when it is not.

Assessment/Next Steps: Evaluate students' answers to questions on the handouts to assess understanding. Consider taking this lesson to the next level by introducing adaptation and natural selection.

How Birds React to Environmental Changes

Name: _____ **Date:** _____

Directions

Animals have to make adjustments to survive changes in their environments. Birds often have to react to changes such as new buildings, trees being chopped down, or less food in the area. Think about birds that live in your area. Watch the birds that live on the school grounds and then fill in the blanks below.

1. Write down three changes that these birds have made to survive.

   a. _____ b. _____ c. _____

2. Compare your list with a partner. Add something from his or her list. If your lists are the same, brainstorm one more change.

   _____

3. Next, think about animals' four basic needs. Complete the chart below to show birds' needs and reactions to their surroundings. A few examples are provided.

Think About It!

Is migration an option when the habitat changes? Why or why not? Explain your answer on the back of this page.

Basic Need	Source That Meets Need	Reaction When Need Is Not Met
Food	(e.g., hunts for seeds in fields or woods)	(e.g., gets seeds from bird feeders)
Water		
Shelter	(e.g., builds nests in trees)	(e.g., trees are cut down; lives in birdhouse)
Space		

3

The Great American Backyard Bird Count

Teaching Objectives: to engage students in a wildlife counting activity; to connect students with the scientific community

Why/How to Use This Lesson: In a unit on regulation and behavior of organisms (NRC 1996), it may be helpful for students to gather information in much the same way that scientists do. This activity would fit into units on migration, animal habitats, food webs, or food chains.

Materials: handout, clipboard, pencil, binoculars, internet access (visit *www.birds.cornell.edu*)

Procedures and Tips: If your school has a computer lab, have your class visit the website for Cornell's ornithology lab (see Materials section). Even if you do not have internet access for your students, visit the Cornell University's website yourself for additional background information before you teach this lesson.

Counting birds and other animals is an activity that scientists have conducted throughout modern times and students will find simple and engaging. This activity will also benefit from your scoping out the bird populations in your school yard ahead of time. A preview will give you an idea of some reasonable numbers to expect from your students when they do their counts.

If possible, place a number of bird feeders on your school grounds to increase your chances of seeing a variety of birds. Consider offering sunflower seeds in one feeder, thistle seed in another, and mixed seed in a third feeder. You may even spread seed on the ground if feeders are not in your budget. Actually, certain kinds of songbirds are ground feeders. As with the activity "How Birds React to Environmental Changes," involve the students in attracting the birds to the school yard. Let students formulate a plan for what kind of seed to spread based on research in field guides and on the internet.

You can make a temporary bird feeder by rolling a pinecone first in peanut butter and then in birdseed. Tie it to a tree branch with string.

Assessment/Next Steps: After your students have conducted their observations and compared them in small groups, facilitate a class discussion about their discoveries. Ask students if the results might be different in another season. (Migration would affect fall and spring numbers in many areas.) If you plan to conduct the activity again, save the handouts and compare students' results the next time. This will yield an opportunity to graph results if students observe differences.

The Great American Backyard Bird Count

Name: _____ **Date:** _____

Scientists at universities all over the world study animals. Some of the scientists at Cornell University study ornithology, the science of birds. (Visit *www.birds.cornell.edu* to find out more.) You can participate in the bird-counting programs that Cornell University offers on its website or conduct a count of your own.

Directions

Take a trip outside or watch birds from inside the classroom. Look for different kinds of birds. Then answer the questions below.

Tip: It is helpful to sit near bird feeders for this activity. Check to see if the feeders are filled with various kinds of seeds. If you do not have bird feeders on your school grounds, try sitting near some trees. Be still and quiet so that you do not scare the birds.

1. In a 10-minute period, how many birds did you see? _____ birds

2. How many different species of birds did you see? (You do not have to know the names to answer this question. Just observe that they are different types.)
   _____

3. Which bird species did you see most often? (If you do not know the name, describe it now and check in a field guide later.) _____
   _____
   _____

   How many of this species did you see?_____

   Form groups of three students and compare your answers.

   Who saw the greatest number of birds? _____

   How many? _____

4. Would adding your numbers together be an effective way to get the total number of birds in the school yard? Why or why not?
   _____
   _____
   _____
   _____
   _____
   _____
   _____
   _____
   _____

3

Do You Hear What I Hear?

Teaching Objectives: to identify the role of animal sounds in nature; to compare and contrast the sounds made by various animals

Why/How to Use This Lesson: A lesson on animal sounds fits into the study of animal regulation and behavior (NRC 1996), particularly behavior as it relates to environmental stimuli and communication. Animals may use sounds to warn of predators or find a mate. When planning a lesson on animal sounds, consider ways to develop the students' understandings of how the sounds help animals survive.

SCILINKS
THE WORLD'S A CLICK AWAY

Topic: Animal Communication

Go to: *www.scilinks.org*

Code: OS003

Materials: CD or tape of nature sounds, CD player or stereo, handout, clipboard, timer or watch with a second hand

Procedures and Tips: Shop around for CDs or recordings of animal sounds that you can play for your class. Some of these recordings have themes such as rain forest or ocean. Listen to the recording ahead of time and choose the part that has the most distinct animal sounds. If possible, use a recording that has sounds native to your area.

To set the mood when you play the sounds for the class, turn the lights low and have students close their eyes. Ask students to listen for at least two minutes (more if possible). Ask them to write down as many different animals as they can identify. Ask them to be specific about animals (for example, students should not say "birds," but instead specify owls, seagulls, hawks, and so on).

As in other lessons, preview the school yard to determine if there are sounds that are audible and plentiful. (If there are no audible sounds, try listening outdoors at home at night, and consider making this a homework assignment.) After students have listened to recorded and real animal sounds, have them discuss why animals make sounds. Research the topic with books from your media center or on the internet. If you have access to a recording device (such as a cell phone, laptop computer, or graphing calculator sound probe), you can try recording nature sounds at night to share with the class.

Assessment/Next Steps: Assess students' understanding by evaluating the paragraphs they have written from the Reflect section on the student handout. After this lesson there are numerous possible extensions, such as comparing the sounds of nature in different biomes, at different times of day, or in various places in your community.

Do You Hear What I Hear?

Name: _____ **Date:** _____

Evidence of animals in the wild comes in many forms. Have you ever thought of sounds as evidence? Even though you cannot hold the sounds in your hands, you can record them electronically. You can also keep a written record of what you hear. Go outdoors with a partner. One person will close his or her eyes while the other person takes notes. The student who has his or her eyes closed will listen first for bird sounds and then for frog sounds. The writing partner will write what sounds the partner hears. Work together for 15 minutes, taking turns. Fill in the chart below. Be sure to talk quietly so you do not scare your test subjects!

Directions

Use a clock, timer, or stopwatch to time yourself. Every time you hear a bird or frog sound, tell your partner. The partner who is writing should make a mark in the correct column below. If you do not have birds or frogs on your school grounds, your teacher may let you choose other animal sounds to observe.

Time Interval	Bird Count	Other Animal	Frog Count	Total Sounds

Reflect

Think about the different sounds you heard on the recording your teacher played for you. Think about the sounds you heard when you listened outside. Think about the other animals you have heard, too. Why do animals make sounds? Do they respond to one another? Imagine animal sounds from another biome, such as the rain forest or ocean. What would they sound like? Write a paragraph to answer these questions on the back of this page.

Internet Connection

Find animal sounds on the internet. For frog sounds, search for the species spring peepers. See if you can find the sounds of at least three different animals to share with your class.

3

The Migration Sensation

Teaching Objectives: to identify animals that migrate through the local area; to provide an understanding of the advantages of migration

Why/How to Use This Lesson: In a unit on animal behavior or perhaps an integrated unit on migration, this lesson puts into perspective the advantages and disadvantages of migration. If you introduce natural selection, students can begin to realize that animals with the instinct and ability to migrate have survived over time.

SCILINKS
THE WORLD'S A CLICK AWAY
Topic: Migration
Go to: *www.scilinks.org*
Code: OS004

Materials: handout, pencil, clipboard, resources for research, paper for brochure, bird feeders for migrating birds (optional), flowers for migrating butterflies (optional), digital camera for brochure pictures (optional)

Procedures and Tips: If your students have completed the activity "How Birds React to Environmental Changes," then they will have a head start on this lesson because migration can be taught from the perspective of being the ultimate response to environmental change. In other words, migrating animals move to a new environment when the current one becomes difficult. However, it is important to note that migration has occurred across generations. Entire species migrate—not just one bird who "decides" it is too cold and therefore flies south for the winter. After discussing this concept with the class, take a walk through your school yard or outdoor classroom. Have your students take their handouts on clipboards to answer questions 1 and 3. Question 2 can be done after you go inside. As you walk through the school yard, tell students to think about how they might make a travel brochure for migrating animals. If you have access to a digital camera, students may take pictures to use in their brochures.

Discuss the answers in cooperative groups or as a whole class, then have students work on their brochures. Some computer software programs have templates for brochures, which may help students with design ideas.

Assessment/Next Steps: To assess understanding, evaluate students' brochures to determine if they include several advantages of migration. To take this further, use the internet (*www.learner.org/jnorth*) to find target animal species that students can study in-depth.

The Migration Sensation

Name: _____ **Date:** _____

Migration is the seasonal movement of animals to a completely different location. They migrate to survive and meet their basic needs. Among the animals that migrate are salmon, whales, monarch butterflies, and many different kinds of birds.

Directions

Answer the questions.

Migration Through the School Grounds

1. Find out what animals migrate through your area. Spend 10 to 15 minutes making observations. Write down what you see and hear. What animals do you think might migrate through your school yard? What makes you think so? (Hint: Look for evidence! Do you see some birds only at certain times of the year? Do you see animals gathering to migrate? Are there animals in your school yard that might not want to spend the winter in your area?)

   _____
   _____
   _____
   _____

2. Back up your theory above with facts. Research migration in your media center. Look up the Journey North website (*www.learner.org/jnorth*). Check to see if you were right. What are some animals that actually migrate through your area?

   _____
   _____
   _____
   _____

3. How do the school grounds meet the needs of migrating animals? What can you and your classmates do to make the area a better place for migrating animals?

   _____
   _____
   _____
   _____

Show What You Know

Pretend you are a travel agent. Make a brochure that shows your school yard as a travel destination for migrating animals. What can you offer these animals? Read the travel section of a newspaper, a travel site on the internet, or brochures from a local travel agent for ideas and phrases. Use these to talk about your school yard's best travel features. Be creative! Attract nature's "tourists" to your school!

3

Monarch Butterfly Life Cycle

Teaching Objective: to identify by sight the stages of the monarch butterfly and its host plant

Why/How to Use This Lesson: This activity would be a good first lesson for a monarch unit, whether you decide to raise monarch caterpillars in your classroom or search for the adult butterflies and their offspring on milkweed plants. It could also fit into a general unit on life cycles.

SCILINKS
THE WORLD'S A CLICK AWAY
Topic: Butterflies
Go to: *www.scilinks.org*
Code: OS005

Materials: handout; crayons, colored pencils, or water-based markers; internet access (visit *www.monarchwatch.org*); "Does It Have a Life Cycle?" assessment probe (Keeley, Eberle, and Dorsey 2008, p. 111)

Procedures and Tips: Consider using the assessment probe listed in the Materials section to start a unit or discussion about life cycles.

There are about two dozen species of milkweed, including common milkweed, tropical, swamp, sand vine, and narrow leaf. A complete guide to milkweed, including photographs and information about various species, can be found on the Monarch Watch website (*www.monarchwatch.org/milkweed/guide/index.htm*).

More than just a coloring exercise, the handout can be used to show the monarch and the host plant as they appear in nature. Use the multimedia gallery on the Monarch Watch website to make sure all of the stages depicted on the handout are colored correctly. There are various shades of orange in the monarch wings, and it may be a good time to mix in a lesson about creating different shades of paint colors. Provide students with crayons, water-based markers, and colored pencils instead of limiting them to one medium.

Explain to the students that the adult butterfly drinks the nectar from the flowers and lays eggs on the underside of the milkweed leaves—only one egg per leaf. The caterpillar eats the leaves. Emphasize that milkweed plants provide food, shelter, and a place to raise monarch young.

Assessment/Next Steps: To assess learning, answer this question: Did students correctly label the stages and closely match the colors from photographs of the monarch life cycle? To take it further, have students compare and contrast the stages with those of other butterflies or living things.

Monarch Butterfly Life Cycle

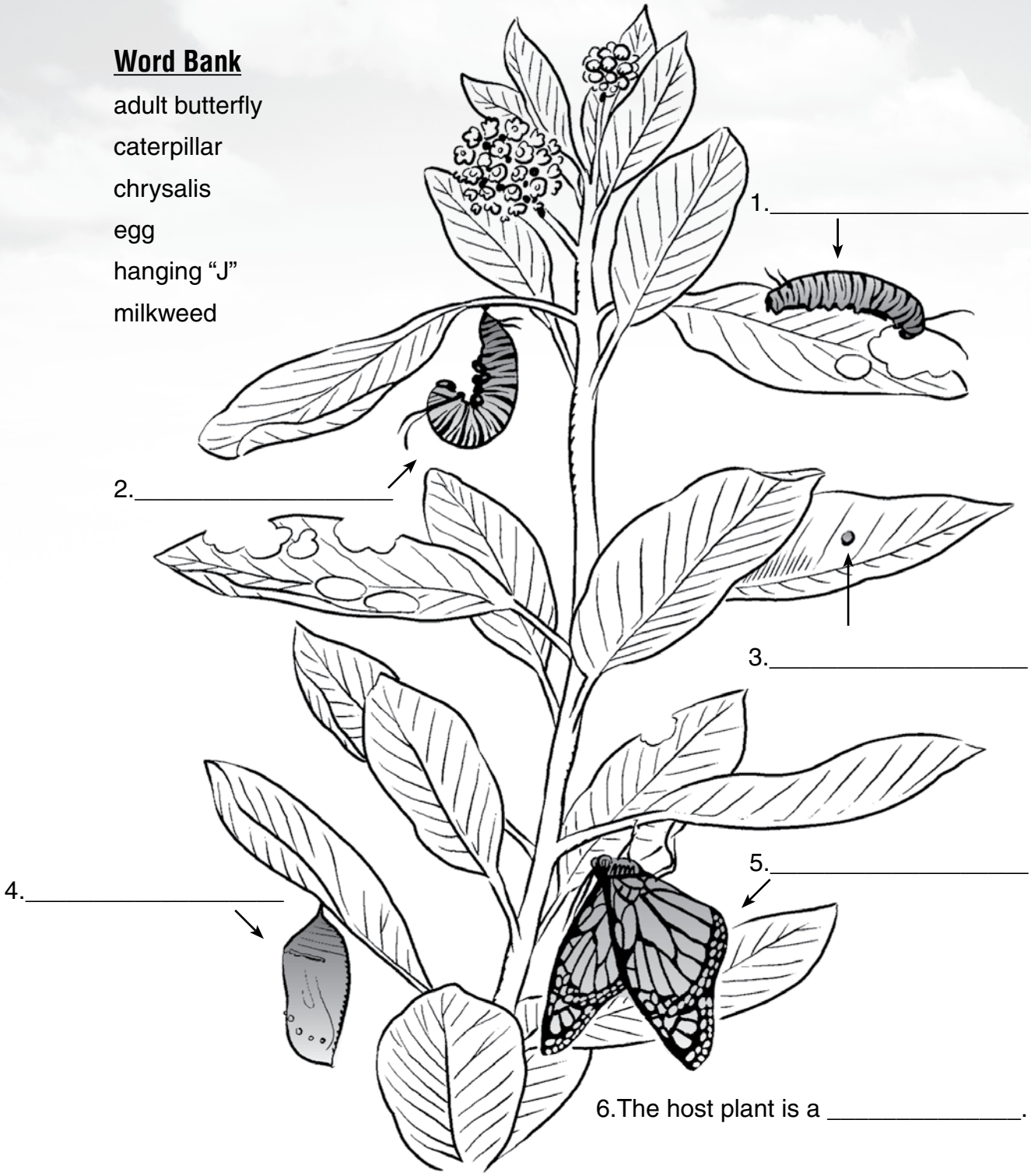
Name: _____ **Date:** _____

Directions

Fill in the blanks to label the stages of a monarch butterfly's life.

Word Bank

adult butterfly
caterpillar
chrysalis
egg
hanging "J"
milkweed



6. The host plant is a _____.

3

What Do Swallowtail Caterpillars Swallow?

Teaching Objectives: to identify host plants of caterpillars; to make observations and inferences about caterpillars' preferences for certain plants

Why/How to Use This Lesson: This lesson fits into the study of animal habitats. When students help teachers plan animal habitats for the school yard, a comparison of which plants attract more animals can help determine future plantings. This is another opportunity for students to gather and analyze data, which are everyday activities for scientists in the field.

Materials: fennel, dill, and parsley plants; swallowtail caterpillars; handout; clipboard; pencil

Procedures and Tips: Swallowtail butterflies are one of the most common in North America. There are many varieties. Most prefer one of three herbs as host plants: fennel, dill, or parsley. With these plants, you can test the preferences of swallowtails in your area. It may even help you determine the variety of swallowtail that is native to your state.

Have students complete the following steps:

- Germinate seeds to establish plants in the garden area or purchase plants.
- Put plants in a sunny area along with some flowers for the adult butterflies. (To do this activity indoors, purchase swallowtail chrysalides from your favorite science vendor and put the mature plants inside an insect cage.)
- Observe the area until swallowtails are spotted. If none are seen, check the leaves of the plants for small white specks, which are the butterfly eggs.
- When the eggs hatch, keep a record of which plant is eaten. If more than one plant type displays eggs, compare the amount and the rate at which caterpillars eat the leaves of each plant after they hatch.
- Use the chart on page 45 to record the results. Analyze the data on the chart to determine what the swallowtails in your area prefer.

If your experiment is not successful (no butterflies were attracted and no eggs laid), research additional species of butterflies native to your area. Check a butterfly field guide, or use the internet (*www.butterflywebsite.com*) for ideas.

Assessment/Next Steps: Evaluate the student answers to questions below the data chart on page 45. Did students support answers with valid reasoning? To take this further, compare the eating habits of various species of caterpillars or follow up with the lesson on adult swallowtail butterflies (What Do Adult Swallowtail Butterflies Swallow?).

What Do Swallowtail Caterpillars Swallow?

Name: _____ **Date:** _____

Directions

Look carefully at swallowtail host plants. Record your observations on the chart below.

Plant	Date planted or date seeds sprout	Date eggs are laid / number of eggs	Date eggs hatched & number of larvae	Estimate of percentage of plants eaten in one week
Fennel		/		
Parsley		/		
Dill		/		

Note: One way that scientists measure the amount of food that a caterpillar (larva) has eaten is by collecting and weighing frass, or caterpillar waste. You may not want to do this, but you can look for green pellets under the plant. If you see frass underneath it, then that is what the caterpillar has been eating.

What can you learn from the data in the chart?

1. The caterpillars preferred to eat _____ because _____
   _____
   _____
   _____

2. If the caterpillars preferred one plant over the others, what does this mean about the other two plants? Support your answer. _____
   _____
   _____
   _____

3. Fennel and dill are more likely to flower than parsley, but did you notice any butterflies drinking nectar from any of these plants? _____
   Why do you think they did or did not? _____
   _____
   _____

3

What Do Adult Swallowtail Butterflies Swallow?

Teaching Objectives: to make observations and inferences about animal feeding habits using butterflies as an example; to identify the feeding preferences of certain butterflies

Why/How to Use This Lesson: Teachers may use this lesson as part of a unit on structure and function of living things. The butterfly's proboscis is unique and often sparks student interest in how various animals eat. This lesson pairs nicely with another lesson on how birds use their beaks to pick up various types of food. Teachers may consider including this lesson idea as part of the study of food webs and food chains because the plant is a producer and the butterfly is a consumer.

Materials: three varieties of flowering plants, butterflies, handout, clipboard, pencil

Procedures and Tips: Use a container, school yard flower garden, or space in an outdoor classroom to plant three or more types of flowers. Then have your students observe the flowers to determine which ones are visited by butterflies most frequently.

Prepare students for this activity by watching a video of a butterfly using its proboscis (feeding tube) to drink from a flower. Students will then know what to look for while making their observations in the garden.

This activity will work best if done over a period of time, with students gathering information at various times over several days or weeks. Weather and luck will play a part in this activity, so you will have to be flexible enough to make time for observations on sunny days when butterflies are active in the school yard. If you would rather teach this lesson indoors, a butterfly habitat with three types of flowers inside will serve the same purpose and perhaps offer simpler observation and more predictable results.

Assessment/Next Steps: To evaluate understanding, read students' responses in the Butterfly Visits section above the data chart. Did students support their reasoning for their observations? To take it further, have students illustrate or model a food web or food chain, including the swallowtail and flowers in the study they conducted.

What Do Adult Swallowtail Butterflies Swallow?

Name: _____ **Date:** _____

Directions

Adult butterflies drink flower nectar for their food. See if there is one type of flower that the butterflies like better than others. Observe swallowtail butterflies and complete the chart.

- Record the types of flowers in the first column. Make a mark for each time a butterfly lands on the flower.
- If you see the butterfly's proboscis unfurl, highlight the tally mark using a water-based marker.

Butterfly Visits

Put yourself in the butterfly's place. Write in the first person (or first insect, to be exact!) to explain the reasons for why you made the choices. (*Example:* I preferred the nectar of the purple coneflower because . . .) Continue on the back of this page.

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Flower	Day 1	Day 2	Day 3	Day 4	Day 5
A					
B					
C					
Example: Marigold	I I I	I I	I I I I I I I	I I I I I I I I I	I I I I I I

3

Milk a Weed for All It's Worth!

Teaching Objectives: to identify various types of host plants for monarch butterflies; to gather and graph quantifiable data from observations in an experiment

Why/How to Use This Lesson: This activity may help students understand how plants and animals interact. It would be helpful in a unit on food webs or an integrated unit on monarch butterflies.

Materials: three varieties of milkweed seeds or plants, monarch butterflies or caterpillars, flowerpots, potting soil, water, trowel, handout, pencil (Safety note: Potting soil may contain venmiculite, which has asbestos fibers. Keeping potting soil moist significantly reduces exposure to asbestos fibers.)

Procedures and Tips: Order three varieties of milkweed seeds from Monarch Watch (*www.monarchwatch.org*). Germinate the seed indoors and transplant the plants outdoors when they are about 20 cm tall. Have students create a chart to gather data. Make sure the data are quantifiable (able to be translated into numbers for comparison). Students may choose one variety of milkweed as a comparison and keep it indoors in a cage with a butterfly raised from larva to adult. You may wish to conduct the entire activity indoors by placing pots of all three milkweed types in the insect cage with monarch butterflies.

Assessment/Next Steps: Evaluate students based on their interpretations of the quantitative data they have collected. Can students explain their reasoning about conclusions they made using the data? For additional studies, have students research what other insects call milkweed home. There are additional food chains involving aphids, ladybugs, and ants.

Milk a Weed for All It's Worth!

Name: _____ **Date:** _____

On most milkweed plants, adult monarch butterflies drink the nectar of the flower. Meanwhile, the caterpillars eat only the leaves on a host plant. This makes for "one-stop shopping" when the monarch is on the go!

Directions

Compare the varieties of milkweed available in your area to find out if monarch butterflies have one they like better than others. Locate three different kinds of milkweed plants if possible. Create a pictograph to track how many times the monarchs visit the plants. Draw a butterfly shape on your graph for every five times the monarchs drink nectar from each kind of milkweed. Observe the milkweed plants over several days.

Note: The plant that is most eaten is the favorite variety of the caterpillars.

Draw one butterfly shape to represent 5 visits to the plant.

Plant A	
Plant B	
Plant C	

Results

Which kind of milkweed should you plant in the school garden? Why?

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

3

Raising My Caterpillar

Teaching Objectives: to practice making predictions based on evidence; to observe the life cycle of a butterfly; to care for a living being

Why/How to Use This Lesson: Raising a caterpillar helps students develop conceptual understanding of life cycles by giving them a concrete example to follow. It is a good way to start a unit on insects, life cycles, butterflies, or even the needs of living things.

SCILINKS
THE WORLD'S A CLICK AWAY
Topic: Life Cycle
Go to: *www.scilinks.org*
Code: OS006

Materials: caterpillars, small plastic container, insect cage, food source (the correct host plant leaves) for caterpillars, paper towel, stick, ruler, handout, pencil

Procedures and Tips: The easiest way to get started is to order a butterfly life cycle kit from a reputable science supply company. One of the most common butterflies sold as larvae is the painted lady. These caterpillars are hearty, and students can care for them easily. They come with their food medium, containers, and directions. However, if you find caterpillars that you can identify reliably by species and correct food source, you can raise them without a kit. Be sure to provide students with small containers. A small plastic peanut butter jar is just about the right size. Punch holes in the top and cut a piece of paper towel to put between the lid and the lip of the jar so the caterpillar will not hurt itself trying to get out of the holes. The paper towel also makes a convenient place for the caterpillar to make its chrysalis.

Have students clean the waste out of the bottom of the jars each day and replace uneaten food with fresh leaves. (Safety note: Try to keep the insides of the jars dry to prevent mold growth.) Each student should observe his or her caterpillar each day and record the caterpillar's size. Keeping a science journal to describe the changes is an important step. Students can measure caterpillars through the sides of the jars most easily when the caterpillars walk up the inside of the jars.

When each caterpillar makes its chrysalis on the paper, take the paper out and wrap it around a stick. Place the stick in an insect cage. When the butterfly emerges, usually a week or so later, observe it for one day and then release it outdoors. (*Note:* Make sure when you order butterfly larvae from a science supplier that the species is native to your area.) After all the native butterflies are released, have students compile their data and represent it on graphs.

Assessment/Next Steps: The data should represent reasonable findings and be recorded accurately in graphs. To extend the experiences in this lesson, you could provide opportunities to compare the caterpillar and butterfly life cycles with those of other animals that go through metamorphosis, such as frogs or mealworms and beetles. You could also have students research particular caterpillars. There is a great deal of information available on the monarch caterpillar, for example, on the Monarch Watch website (*www.monarchwatch.org*).

Raising My Caterpillar

Name: _____ **Date:** _____

Directions

Take care of a caterpillar that is given to you. Caterpillars only need a small container. There should be tiny pinholes in the lid for air, and you must keep the container clean. Clean the caterpillar's home every day. Put in fresh host-plant leaves each day. Complete the sentences below.

1. My caterpillar is the larval stage of a _____ butterfly.
(species)

2. I got my caterpillar on _____ when it was _____ centimeters long.
(date)

3. The host plant for this type of caterpillar is _____ .

4. The color of the caterpillar on the first day is _____ .

5. Make a drawing to show how the caterpillar looked on the first day.

6. I predict that the caterpillar will make its chrysalis on _____ .
(date)

7. After three days, the length of my caterpillar is _____ centimeters.

8. I have made these three observations of my caterpillar in the first three days.

   a. _____

   b. _____

   c. _____

9. I predict my caterpillar will be _____ centimeters long in three more days.

Show What You Know

After measuring the growth of your caterpillar every day, make a graph of the growth on the back of this page. Remember to label all parts of the graph.

3

Animals Living on the School Grounds

Teaching Objective: to compare and contrast animal adaptations in the local environment

Why/How to Use This Lesson: This activity is the culmination of those earlier in this chapter. Conduct at least three or four other school yard activities first (such as Animal Habitat Survey, How Birds React to Environmental Changes, The Great American Backyard Bird Count, and Do You Hear What I Hear?).

SCILINKS
THE WORLD'S A CLICK AWAY

Topic: Adaptations of Animals

Go to: *www.scilinks.org*

Code: OS007

Materials: handout, clipboard, pencil, digital camera for photographs of animals in school yard (optional), binoculars (optional)

Procedures and Tips: Students should use data from other activities: charts, handouts, graphs, or any other data from a science journal or notebook. Then have students compile the information into the chart on page 53.

Even though the handout uses the word *best*, discuss with your students that there really is not actually a best animal. They are looking for an animal that moves with ease through the school yard, finds food with no trouble, and faces few predators. That animal may be the one that has adapted over generations to survive in your local area.

Assessment/Next Steps: Evaluate students' charts for reasonable data collection. After compiling their individual chart information, students can work in groups with others who picked the same animal to create presentations for the class. Encourage the use of computer slide shows, posters, or even role-playing as each student attempts to persuade others in the class that his or her animal is best suited for life in your school yard.

Animals Living on the School Grounds

Name: _____ **Date:** _____

Directions

Find four animals to study. Use this chart to get started.

Animal Characteristics or Adaptations	Animal A _____	Animal B _____	Animal C _____	Animal D _____
Lives in trees				
Able to fly				
Exoskeleton				
Metamorphosis				
Lays eggs				
Cares for young				
Migrates				
Predatory				
Eats only plants				
Humans provide its food				
Swims				
Number of legs				

1. Refer to the chart to sum up what you have learned about animals that live in your area. What do they all have in common? Why? _____
   _____
   _____

2. Which animal do you think is best suited to life in your school yard? Why?
   _____
   _____

Put It All Together

Divide into groups. Students in each group decide which animal is best adapted for life in the school yard. Within your group, work on a presentation for the class. Convince other students that your animal is the best fit for life in your school yard. After the presentations have been given, conduct a survey to see if your classmates have changed their opinions.

3

School Yard Food Chain

Teaching Objective: to identify a food chain in the local environment

Why/How to Use This Lesson: This is a good culminating exercise for any unit on animals. If you have conducted several activities in this chapter, the food chain chart information can be taken from information that your students have already gathered.

SCILINKS
THE WORLD'S A CLICK AWAY
Topic: Food Chains
Go to: *www.scilinks.org*
Code: OS008

Materials: handout, clipboard, pencil, binoculars (optional), hand lenses (optional)

Procedures and Tips: For outdoor observation prior to filling out the food chain chart, students may use binoculars to get a good look at animals in trees or use a hand lens to look at smaller creatures under rocks and in crevices.

If students cannot find animals, they should find evidence of their existence. Explain to the students that for them to use animals in the chart, they need to see at least one of the animals in the chain or at least see evidence of its existence. Some examples of a school yard food chain might be as follows:

1. parsley, caterpillar, spider, bird
2. wild onions, crickets, lizard, box turtle

Your students will surely discover many other examples. Check to make sure that student choices are conceivable for the environment on your school grounds.

Assessment/Next Steps: Evaluate the food chain for accuracy. In short, does it have a producer and at least three consumers? As an extension, have students use large sheets of drawing paper or bulletin board paper to complete food webs using their school yard food chains.

School Yard Food Chain

Name: _____ **Date:** _____

A *food chain* represents how energy is passed from plants to animals. In the chain, some animals (called *herbivores*) feed on plants. Other animals (called *carnivores*) feed on other animals. Some animals (called *omnivores*) feed on plants and other small animals. One animal eats another to survive. For example, a food chain in a pond might include a fish that eats algae, a turtle that eats the fish, and a raccoon that eats the turtle. The sun supplies energy to help new algae grow. Then the chain starts all over again.

Directions

Create a diagram in the space below to show a food chain you have seen in the school yard. Draw pictures and arrows to show the links in the food chain. Include one plant and three animals. Be sure you have seen at least one of the animals or at least be able to prove there is evidence of that animal living in the area. Label the food chain parts as either producers or consumers. Label the consumers as carnivores, herbivores, or omnivores.

Your Food Chain

3

Tag, You're It!

Teaching Objectives: to practice methods used by scientists to track migration of monarch butterflies; to participate in genuine scientific research as part of the international scientific community

Why/How to Use This Lesson: In the study of life science, this lesson fits into units on regulations and behavior or populations and ecosystems (NRC 1996). The activity allows teachers to illustrate for students how scientists gather information on the behavior of wild animals in context rather than through simple discussion or reading.

Materials: monarch butterflies (raised from caterpillars or captured wild), tags from Monarch Watch, butterfly nets, containers for butterflies, handout, clipboard, internet access (visit *www.monarchwatch.org*)

Procedures and Tips: Visit the Monarch Watch website well in advance of this lesson to order tags. If you do not have internet access, you can call Monarch Watch (1-888-TAGGING) for information on ordering tags. This is a fall activity, so plan to conduct this lesson between August and October. Once you receive the tags, you may wish to practice tagging a live butterfly on your own before you do so with your class. You may also consider doing this as a demonstration. Students should research the Monarch Watch website thoroughly before attempting this activity.

In addition to the instructions online, you will also receive tagging instructions with your tags. The main tip to emphasize for students is to be gentle with the butterflies. If you capture the butterflies wild, they tend to be far more active than if you raise them from caterpillars. Therefore, you may want to consider raising caterpillars if this is your first time working with monarchs. (Note to schools located west of the Rocky Mountains: Contact the Oregon Department of Agriculture, 635 Capitol St. NE, Salem, OR 97310, for information on tagging the western population of monarchs. Monarch Watch only tags monarchs located east of the Rockies.)

Assessment/Next Steps: Answers on the student handout allow teachers to assess understanding of the concepts in the lesson. After this lesson, students may engage in further studies of migrating animals through websites such as Monarch Watch or Journey North (*www.learner.org/jnorth*).

Tag, You're It!

Name: _____ **Date:** _____

You may have heard of scientists tagging birds or other animals. But have you ever heard of tagging an insect? The tagging of monarch butterflies takes place every year, and you can help. You can raise monarchs from caterpillars that your teacher provides, or you can locate milkweed plants and use a net to catch the monarch butterflies that come to feed there. For complete tagging instructions, look on the Monarch Watch website (*www.monarchwatch.org*) and study the pictures.

Directions

Think about the questions as you tag your butterfly. Record your answers below.

1. Why would scientists want to tag butterflies?

   _____

   _____

2. What problems might there be in designing a tag for such a small animal?

   _____

   _____

3. How is the information from a tagged butterfly used?

   _____

   _____

4. How can we help the monarchs along their journey?

   _____

   _____

5. How can the Canadian, U.S., and Mexican governments work together to help the migration of the monarch butterfly?

   _____

   _____

Helpful Hints

Tagging a monarch butterfly is tricky, to say the least! To tag it, you have to touch the butterfly's wings. This has to be done carefully so that the butterfly is not hurt. The trick is to hold the butterfly from the underside. This will keep the scales on the wings from rubbing off on your fingers. Be gentle. Make sure the tag is in the middle of the lower wing. The tag will not hurt the butterfly or keep it from flying.

3

Tag, You're It!

Name: _____ **Date:** _____

Show What You Know

Use this activity to spark your imagination! Write a newspaper article announcing the coming of monarchs to your community. Your teacher can even help you send the article to the editor of your local newspaper.

Read the information about butterflies. What butterflies might visit your school grounds? How can you find out what each type of butterfly likes to eat or drink? You can use exploration and experimentation to discover a butterfly's food preferences.

Think about what you would do if you wanted to find out (without asking them) if your friends like hamburgers or pizza best. How would you conduct the experiment? You might buy some hamburgers and a pizza. You could put everything on a table and see which food your friends choose to eat. In the same way, we can "set a table" for caterpillars and butterflies. Think about how you might do this. To gather the most accurate information possible, you would need to repeat the experiment several times. Repeating an experiment is good scientific practice and would take into account your friends who like both foods.

Directions

Design an experiment that answers the question "What do butterflies like to eat?" Use the scientific method: Select the type of butterflies that is native to your area. Form a hypothesis. Research and plan your experiment. Record your observations. Analyze your data and draw a conclusion on the basis of your results.

What Do Butterflies Eat?

Butterflies have one of nature's unique adaptations: metamorphosis. This means they completely change in form at different stages of their lives.

One of the most important results of metamorphosis relates to eating and food sources. Because of metamorphosis, adult butterflies do not compete for the same food sources as their young.

How Does This Work?

Young butterflies are larvae, but we usually call them caterpillars. Caterpillars eat leaves. Each species of butterfly has a special "host" plant. The female butterfly lays her eggs only on the leaves of this special plant, so when the caterpillars hatch and need to eat, their food source is right there for them.

Adult butterflies do not eat solids; they only drink their food. Sometimes the adult butterflies will puddle or gather on moist, sandy soil to drink water. More often, each butterfly drinks nectar through a proboscis, the slender "straw" that unfurls from its head.

Index

*Page numbers in **boldface** type refer to tables or figures.*