Outdoor Science Adventures for Elementary Students
A Field-Based Science Curriculum

Developed by
The SMILE Program
Oregon State University
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Developed by

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Goals

**Goal 1**
To create an enjoyable, yet challenging, camp within which students experience field-based scientific research into the ecology of three communities. The students are engaged in a variety of activities that teach them to use scientists' tools of the trade, to evaluate data, and to select tools and methods to be used at their final project study site. While operating in a hands-on, skills-based environment, the students are encouraged to take ownership of their learning.

**Goal 2**
To teach students responsibility: environmental responsibility as they collect data and biotic samples at the field study and final project sites; academic responsibility as they use their new skills and findings and present the results of their work; and personal responsibility as they enter into a cooperative group learning experience and work for personal and group success.

**Goal 3**
To surround each student with a community within which she/he can have a positive learning experience through interactions with the other campers, teachers, parents, and camp staff. Students are met with the expectation of building community. Each student participates and shares in the work; brings a voice to the group that is welcomed and respected; has a clearly defined role and understands what that role is in each activity; is expected to succeed in the roles of group member and scientist; and operates in a diversity of communities (cabin groups, research teams, and SMILE clubs) to gain experience in risk-taking and community-building.

**Goal 4**
To provide a real world context for learning and research. The students make application of their foundational knowledge and skills by researching a new site using the scientists' tools of the trade. They are encouraged to develop a scientist's respect for data and are helped to realize the importance of this data. The students engage in site-specific challenge problems to gain a deeper understanding of the connectedness of the various factors under investigation.

**Goal 5**
To encourage the students along a path of lifelong learning through higher education. Students connect with successful adults who take a genuine interest in them. The staff members are involved in all aspects of the campers’ day, as cabin counselors and camp instructors. Staff members reflect the ethnic diversity of the students, when possible, and serve as college-student role models. Staff members receive training in multicultural teaching, as well as science content areas. At the final campfire, staff members share their hopes and aspirations, as well as the joys and challenges of being a college student. These individuals make conscious efforts to bond with and encourage attending students in their educational ambitions.
Structure

The camp structure provides each student an array of opportunities and experiences in which the students are the keys to successful and healthy communities. Each student should nourish personal reasons to support individual and group success.

Foundation Studies
The foundational studies at the camp take place in three ecological communities. In each community the students engage in hands-on activities that address the overlying theme using two research strategies. Before studying their final project sites, students have gone through three iterations of the same strategy, with specific application to each of the communities. By moving through the different iterations, students are able to see the similar and distinctive aspects of the communities and the work that scientists do in investigating them. Having made site-specific studies, they are better prepared to investigate a new site which is similar in nature to one or a more of the field study sites.

Topic Areas
The topic of ecology is separated into two parts, to be taught at two sessions of the camp: Part One, Investigation of Relationships Within and Between Ecological Communities and Part Two, Integration of Biotic and Abiotic Factors to Create Ecological Communities.

In each part, the four subjects addressed are: living organisms, ecological connections, physical features and characteristics of communities, and community surveys. In Part One the themes are Plant and Animal Survey and Ecological Connections. The themes for Part Two are Community Mapping and Maintaining Life in the Community.

Field Notebook
Each student has a field study notebook which serves as a resource and learning tool. A section containing a template for a field notebook follows each final project. One way the students use this notebook is to record notes about the specific activities and respond to questions at each of the field study stations. The students make basic observations and work to answer questions designed to focus their attention on the application of the theme to a given community. Additionally, the notebooks can serve as a journal of their trip, an autograph and address book, and as an organizer for the campers’ cabin and field study groups.

Final Project
The final project study allows students the opportunity to be the “experts” and to take the lead in investigating an unfamiliar site, using the knowledge, tools, and techniques gained through the previous field studies. The students work in their SMILE clubs at the final study site. An underlying reason for this grouping is so that students may take their final project and presentations back to their schools and communities to share with others.
A Note to Teachers

While this curriculum packet was developed for a specific location, there are things you can do to make it usable at your location.

Pond Community
The studies in both parts of the curriculum use two ponds of very distinct characteristics. If you choose, you may use the activities at one pond. However, if you want to do comparative studies with two ponds, here are the characteristics of the ponds at the camp site. Lower Pond is very shallow and in the late stages of succession. The vegetation growing across the surface of the pond leaves little area for open water. Typical marsh grasses are found along the banks and pond edge. Water is turbid. Little aquatic vertebrate life is found in this pond. Pagoda Pond is young. The entire surface of the pond is open water. Much vertebrate life is found in this pond. Water clarity is higher.

Staging Area
The staging area serves as the meeting place for introducing and, often, concluding, activities. In this area you need to be able to gather the students in a circle or some other grouping, set up an easel with chart pad, display background and references materials, facilitate student interaction and discussion, and engage students in writing in field notebooks. Portable camping tables that unfold to provide a working surface and seats for four are helpful, if you have access to such.

Order of Activities
With one or two exceptions, the activities in this curriculum will stand alone in any order you choose. The activity scripts were written for the order used during the SMILE camp. The scripts, of course, can be adjusted to fit your students and needs.

Materials Lists
Each activity has a materials list. Additionally, there are lists in Appendix C. Items in italics are activity sheets or charts that have been included in this curriculum.

Field Notebook
A template for the field notebook used at camp is included in a section after each final project. You can use these pages to assemble a notebook or develop your own pages. If you intend to do a series of outdoor investigations, we strongly recommend that you use a some type of field notebook. For durability, use heavier paper for the cover.
Alignment of OSA Activities with National Science Education Standards

All of the Outdoor Science Adventure activities are based on sound structural guidelines which correlate with the National Science Education standards. Specifically, all of the activities are constructed within the national standards framework for unifying concepts and processes, science as inquiry, science and technology, science in personal and social perspective, and the history and nature of science. The standards for physical science, life science, and earth and space science are more activity specific and are noted as such. The following is a comprehensive correlation between the activities of SMILE’s Outdoor Science Adventures for Elementary Students and the National Science Education Standards.

Unifying Concepts and Processes Standards
All of the Outdoor Science Adventure activities meet the following Unifying Concepts and Processes Standards.

Systems, Order, and Organization
• Students compare and contrast objects according to a variety of characteristics. They classify a set of objects or organisms using a classification scheme. They give examples of the concepts of change, force, and population.

Evidence, Models, and Explanation
• Students recognize that scientific facts are based on evidence. Using data, students construct charts and simple bar and line graphs.

Change, Constancy, and Measurement
• Students use math concepts and tools in science. They observe and record data about objects, events, and changes. They estimate and measure length, temperature, volume and mass in metric and English units.

Evolution and Equilibrium
• Students predict simple cause and effect relationships. They understand that individuals of the same kind differ in their characteristics, and sometimes the differences give individuals an advantage in surviving and reproducing.

Form and Function
• Students design an object that has a specific function. They collect data using the appropriate tools. They draw conclusions based on data collected.

Science as Inquiry Standards
All of the Outdoor Science Adventure activities meet the following Science as Inquiry Standards.

Abilities Necessary to do Scientific Inquiry
• Students recognize and explain that scientific knowledge is changeable. They describe the steps in scientific inquiry. They repeat a simple experiment. Students identify the variables in a controlled situation. They create models or drawings to scale. They identify common scientific equipment (i.e. microscope, meter stick).
Understanding about Scientific Inquiry
• Students expect similar results when science experiments are repeated. They understand that science investigations work the same way in different places. They understand that describing things as accurately as possible is important in science. Students practice safe behavior in science activities. They use mathematics in all aspects of scientific inquiry.

Physical Science, Life Science, and Earth and Space Science Standards
The following are some specific examples of how the Outdoor Science Adventure activities meet these standards.

Physical Science Standards
• Students identify the difference between a physical and chemical change. Part Two activities meet this standard.
• Students identify forms of energy (i.e. thermal, mechanical, radiant, and nuclear.) Part Two activities meet this standard.

Life Science Standards
• Students identify basic life processes (i.e. growth, reproduction, and responding to environmental factors.) Both Part One and Part Two activities meet this standard.
• Students identify characteristics of plants and animals. Part One activities meet this standard.
• Students identify the developmental stages, or life cycles, of plants and animals. Part One activities meet this standard.
• Students describe how environmental changes effect organisms. Both Part One and Part Two activities meet this standard.

• Students describe the interdependence of animals, plants, and their environments. Both Part One and Part Two activities meet this standard.
• Students recognize that the major source of energy is sunlight and that radiant energy is converted to usable form. Both Part One and Part Two activities meet this standard.
• Students draw food webs and describe how energy is transferred from organism to organism. Both Part One and Part Two activities meet this standard.
• Students understand that in nature, many materials are recycled to be used again. Both Part One and Part Two activities meet this standard.
• Students describe how beneficial adaptations help organisms survive over time. Both Part One and Part Two activities meet this standard.

Earth and Space Science Standards
• Students identify and give examples of physical features of the land, such as rivers, lakes, mountains, and valleys. Part Two activities meet this standard.
• Students identify forces that change the earth’s surfaces and create new soil (i.e. wind, water, volcanoes, glaciers.) Part Two activities meet this standard.
• Students observe, record, and describe weather. Part Two activities meet this standard.
• Students estimate and measure temperature using the metric system. Part Two activities meet this standard.
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Science and Technology Standards
All of the Outdoor Science Adventure activities meet the following Science and Technology Standards.

Abilities of Technological Design
• Students apply the scientific method.
  They design and implement a solution or product. They understand that one solution to a problem may create another problem. Students recognize that even a good design may fail and there is no perfect design.

Understandings about Science and Technology
• Students use a variety of ways to learn about science (i.e. books, graphs, field studies.) They are able to recognize and identify examples of technology. They are able to interact with technology-based businesses via guest speakers, field trips, and correspondence.

Science in Personal and Social Perspectives Standards
All of the Outdoor Science Adventure activities meet the following Science in Personal and Social Perspectives Standards.

Personal Health
• Students show confidence in themselves as learners. They act safely to prevent personal injury.

Populations, Resources, and Environments
• Students identify effects of a population on their environment. They list a variety of ways to conserve resources. They explain how people or natural events can cause changes in the environment.

Science and Technology in Society
• Students learn how to locate and use information to answer questions about science. They use current technology to assist in locating information. They recognize and use common science vocabulary.

History and Nature of Science Standards
All of the Outdoor Science Adventure activities meet the following History and Nature of Science Standards.

Science as a Human Endeavor
• Students identify occupations where scientific and/or technological training would be useful. They can identify scientific problems present in the everyday world. When given specific circumstances, they are able to list types of data that could be used to help solve the problem. They work cooperatively to generate solutions to everyday problems.

Nature of Science
• Students recognize that scientific knowledge changes slowly.
Alignment of OSA Activities with the Excellence in Environmental Education Guidelines for Learning (K-12)

All of the Outdoor Science Adventure activities are based on sound structural guidelines. These activities have been designed to address the widely accepted goal of environmental education (as stated in the Belgrade Charter of the United Nations)

The goal of environmental education is to develop a world population that is aware of, and concerned about, the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations, and commitment to work individually and collectively toward solutions of current problems and the prevention of new ones.

The activities in this curriculum address the essential underpinnings or key principles of environmental education, as they as given in the Guidelines for Learning. These underpinnings are systems, interdependence, the importance of where one lives, integration and infusion, roots in the real world, and lifelong learning. The following is a comprehensive correlation between the OSA activities and the Guidelines for Learning from the North American Association for Environmental Education.

**Questioning and Analysis Skills**

All of the Outdoor Science Adventure activities meet the following Questioning and Analysis Skills Guidelines.

**Questioning**

- Learners are able to develop, focus, and explain questions that help them learn about the environment and do environmental investigations.

**Designing Investigations**

- Learners are able to design environmental investigations to answer particular questions - often their own questions.

**Collecting Information**

- Learners are able to locate and collect reliable information about the environment or environmental topics using a variety of methods and sources.

**Evaluating Accuracy and Reliability**

- Students are able to judge the weaknesses and strengths of the information they are using.

**Organizing Information**

- Learners are able to classify and order data, and to organize and display information in ways that help analysis and interpretation.

**Working with Models and Simulations**

- Learners understand many of the uses and limitations of models.

**Developing Proposed Explanations**

- Learners are able to synthesize their observations and findings into coherent explanations.
Knowledge of Environmental Processes and Systems

All of the part one activities and most of the part two Outdoor Science Activities meet the following Knowledge of Environmental Processes and Systems Guidelines.

Organisms, Populations, and Communities
• Learners understand that biotic communities are made up of plants and animals that are adapted to live in particular environments.

Systems and Connections
• Learners understand major kinds of interactions among organisms or populations of organisms.

Flow of Matter and Energy
• Learners understand now energy and matter flow among the abiotic and biotic components of the environment.

Human/Environment Interactions
• Learners understand that human-caused changes have consequences for the immediate environment as well as for other places and future times.

Personal and Civic Responsibility

All of the Outdoor Science Adventure activities meet the following the Personal and Civic and Personal Responsibility Guideline.

Accepting Personal Responsibility
• Learners understand that their actions can have broad consequences and that they are responsible for those consequences.
Part One
An Investigation of Relationships Within and Between Ecological Communities
**Part One/Introduction:**

**Overview**

**Focus**
Part One focuses on the relationships of organisms to their environments and the interactions within and between different communities. The students will investigate these topics in forest, meadow, and pond communities by conducting a “Plant and Animal Survey” and tracing out “Ecological Connections” in each of these communities. Specifically, for each community, the students will look at community characteristics, plant and animal characteristics, populations and adaptations, food chains and webs, energy and nutrient cycling, and environmental and human impact on the communities.

**Final Project**
In the final project, students investigate one of four new sites, with each SMILE club conducting a habitat study of a different site. In each community, the students will inventory the various kinds of plant and animal life found, describe the interdependence of organisms, look for evidence of human impact, and design model animal(s) perfectly suited for various niches.

**Goals**
By the end of Part One, students will be able to identify three living communities by the distinguishing features and plant and animal populations of each; understand the basic life needs of plants and animals; have an awareness of the interactions of organisms with their environments; be able to use scientific tools for ecological studies; and finally, understand that communities are an integration of several pieces.
The goals of the Plant and Animal Survey studies are for students to discover the answers to a set of questions about each community and to gain an awareness of the diversity of life in each community. The questions to be answered are:

- What makes a pond a pond (forest) [meadow]?
- Where do organisms live in a pond (forest) [meadow]?
- What are the types and relative numbers of plants found in the community?
- What is the distribution of one type of plant relative to others in the community?
- What adaptations allow these plants to grow in the community?
- What are the types and relative numbers of animals found in the community?
- What adaptations allow these animals to live in the community?
- Are there special constraints in this community with which plants and/or animals must contend?

**Science Process Skills**
- observe
- measure
- classify
- categorize
- infer
- predict
- hypothesize
- use numbers
- communicate
- collect and handle data
- interpret data
- draw conclusions

**Vocabulary**
- abiotic
- adaptations
- bacteria
- biological diversity
- biotic
- cambium
- canopy
- change
- characteristics
- community
- conifer
- cross section
- deciduous
- density
- distribution
- ecosystem
- environment
- evergreen
- fungi
- groundcover
- habitat
- hardwood
- heartwood
- invertebrates
- leaf
- needles
- organism
- parallel
- phloem
- sapwood
- scales
- softwood
- transpiration
- understory
- vertebrates
- weed
- xylem
The goals of the Ecological Connections studies are for students to explore ways in which organisms interact with one another, to develop an awareness of the ways in which humans impact the communities of life around them, to investigate the flow of energy and nutrients in a community, and to gain an understanding of communities as the integration of all life found therein. Questions to be answered include:

- Where or what is the source of energy for the living community?
- Who eats whom in a given community?
- How are the different food chains connected into a food web in a community?
- How does energy move through and dissipate in a community?
- What evidence of changes in environmental conditions are found in a community? What evidence of adaptations to these changes by the plants and animals are found?
- What evidence can be found of human activity in or around the community? How have these activities impacted the community?
- What are some specific examples of the interdependence of plant and animal life in a community?
- What are the roles of the individual organisms in a community?
- How does the community meet the needs of its inhabitants?

**Science Process Skills**
- observe
- compare
- hypothesize
- gather evidence
- communicate
- collect and handle data
- analyze data
- draw conclusions

**Vocabulary**
- adaptations
- carnivore
- competition
- cycle
- decomposition
- energy production
- environment
- food chain
- food web
- habitat
- herbivore
- humus
- limiting factors
- niche
- organism
- photosynthesis
- predator
- prey
- scavengers
Part One/Introduction:
Activity Overviews

Pond Plant and Animal Survey

What is a Pond?
Students examine their individual ideas of what a pond is, develop a basis for their investigations of a pond, get an overview of the ponds to be studied, and see how well the group definition fits the particular pond.

What Lives Here?
This activity allows the students to explore the pond, identify the plant life found there, and record their relative number and distribution. Students also observe animal life, the different ways they move, different kinds of eyes and mouth parts they have, adaptations for catching food and breathing, and the way they interact with one another. The students also study the pond habitat.

A Bowl of Mud
This activity develops the concept of biological diversity. It provides concrete experiences for understanding invertebrates, basic classification, and adaptations. Additionally, this activity allows students to further explore and to better understand a habitat at a different level.

Pond Ecological Connections

Fitting In
One of the ways to study the relationships of an organism to the environment it occupies is to examine the niche of that organism. In this activity, students “create” organisms to fill specific roles in the pond environment by recognizing the characteristics that make aquatic creatures distinct from one another and relating these characteristics to the organisms’ requirements for survival.

Weaving the Web
One way the various kinds of plants and animals interact is as links in a food web. While food webs in a pond can be very complex, this activity allows students the chance to identify a few of the links in the web of pond life.

Change Detective
Change is a constant process. The students do each of their field studies in a ninety-minute period. At other times of day and in another season, they might find conditions very different. To help the students get a more complete understanding of the pond, they look for evidence of changes and how these changes affect life in the pond.

Forest Plant and Animal Survey

What is a Forest?
This activity enables students to explore the components of a forest and develop an operational definition of forest.

Tree Growth
Students investigate tree growth using wood cookies from two tree species.

Tree Study
Students describe a chosen tree by using personal observation and sensory investigation.

Animal Detective
The forest is home to a variety of animal life. Students collect information about different animals living in the forest and look for signs of animal life.
Forest Ecological Connections

Stumpin’ Around
One might be amazed by the number of things found in or on a stump or rotten log. Students gain an awareness of some of the different plants and animals that may be found in this particular habitat.

Forest Cycles
Using the data collected in Stumpin’ Around, the students draw a simple cycle of the interactions among plants and animals on a stump to show how plants and animals depend on each other in many ways.

Beaks, Feet, and Adaptations
The diversity of plant and animal life on this planet provides a showcase for the many different ways these organisms are adapted to survive in their environments. In this activity, students examine some of the differences in beaks, feet, and other adaptations of birds and other forest organisms.

Home, Home in a Tree
From their leafy branches to their tangled roots, trees provide a habitat for a host of plants and animals. In this activity, students discover how plants and animals depend on trees.

Meadow Plant and Animal Survey
A Field of Dreams
Students explore a meadow environment and define those features that distinguish this ecological community from others.

Plant Neighbors
This activity develops the concept of plant diversity. In this activity, students inventory a plot in a meadow community and map the distribution of selected plants in their environment.

Outcast
When is a weed not a weed? This activity gives students a chance to study common “pest” plants in a setting where these plants are valued members of the community.

An Ant’s Eye View
A ground-level inspection of a meadow can reveal an amazing amount of animal presence and activity. Through this activity, students explore the meadow habitat at ground level, while looking for signs of animal life.

Meadow Ecological Connections

Influence, Influence All Around
Organisms affect and are affected by their environment. In this activity the students explore ways plants impact their environment.

Grazin’
How long does it take a deer, grazing in a meadow, to eat a specific amount of grass? This activity gives students the chance to be deer, charged with “eating” for a period of ten minutes, as a tool for exploring predation and the competition among animals for resources.
Meadow Banquet
In this activity students take a close look at a meadow community to observe feeding cycles that connect plants and animals.

As the Meadow Changes
Change is a constant process. To help the students gain a better understanding of the meadow, they look for evidence of change and how these changes affect life in the meadow.

Final Project: Habitat Study
In this culminating project students work in SMILE Club groups. The groups apply the study skills developed previously to an unfamiliar site. The students in each group share the results of their investigations with the rest of the camp by presenting a display of the new site.
Pond Plant & Animal Survey
An Investigation of Relationships
Within and Between
Ecological Communities
What is a Pond?
(adapted from “Describe a Pond,” USDA Forest Service)

(25 minutes)

Activity Overview
Students examine their individual ideas of what a pond is; develop a base for their investigations of a pond; get an overview of the ponds to be studied; and see how well the group definition fits the particular pond.

Learning Objectives
To successfully complete this activity each student will:
• define a pond in their own words
• list some characteristics of a pond
• observe a pond and its surroundings
• compare a “real” pond with the group definition of a pond
• communicate what natural features are found at a pond

Science Process Skills
The students will engage in scientific inquiry through: observing, predicting, communicating, operationally defining

Background for Teachers
Ecologists usually describe a pond as a quiet body of water which is shallow enough, usually 3 to 7 feet deep, that plants often grow all the way across it. This happens because sunlight penetrates to the full depth of a pond, permitting growth of rooted plants. A lake is usually larger and deeper than a pond. This definition is not precise; what some people call a pond, others may call a lake, a wetland, or a marsh. The water temperature of a pond is fairly uniform from top to bottom. There is little wave action and a pond usually will have a sand or mud bottom. A pond is an ever-changing and dynamic community that encompasses the lives and deaths of many different types of plants and animals. The pond as a habitat must provide for the needs of the organisms living in it. What are those features that distinguish a pond from other habitats?

The pond is a diverse community. The distinct habitats that can be found in or by a pond contribute to this diversity. These four habitats are open water, surface film, water’s edge, and the pond bottom. The open water area is in the center of the pond. The surface film provides a home for a number of floating plants and animals and animals that walk upon and hang underneath the film. The water’s edge includes the inner edge of the plant growth into the water and about one foot upon the land. The pond bottom is a sandy, muddy, or silty area, home to a variety of plants, animals, and bacteria.
What is a Pond?
(25 minutes)

Materials
field notebook, paper, pencil, chart pad, chart pens

Preparation
• Find a spot, away from the ponds, suitable for gathering with the students to open this activity.
• Make a scouting trip to Pagoda Pond to map out all available access points, to plan the logistics of the activities at the pond, and to cover needed safety considerations.
• Check also the Lower Pond area to find a gathering spot and places for the students to do their collecting of plant and animal life.

Activity Outline
Introduction (Step 1, 1 minute)
Describing a Pond (Steps 2-3, 4-5 minutes)
Defining a Pond (Steps 4-6, 3-4 minutes)
Observing Ponds (Steps 7-11, 9-11 minutes)
Closure (Step 12, 3-4 minutes)

Procedural Steps
1. Gather with the students in the predetermined site away from the ponds. Have the students sit in a circle. Set the stage for the activity by saying: “We will be spending the next 90 minutes doing a field study involving a pond. To make sure we are all talking about the same thing, we will spend some time thinking about and developing a common understanding of what a pond is.”

2. Distribute the half-sheet of paper to the students. Tell the students to take 3-4 minutes to write in as much detail as possible a description of a pond. Move among the students as they work. Be ready to assist any students who are struggling to get started. You may ask these students:

   “Have you ever seen a pond?”
   “What was it like?”
   “Can a pond be a pond without water?”
   “How deep would the water be in a pond?”
   “Is pond water standing or moving?”
   “What is the area around the pond like?”
   “What things might be found in a pond?”
   “What natural features might you find in or around a pond?”

3. When the allotted time has passed, tell the students to form groups of up to 3. (Allow for no more than 4 in any group, depending on the size of the field study group.) Say: “Compare your descriptions and write a one sentence definition of a pond, one your whole group agrees upon. When you have this definition, each of you should record your group’s definition on page 7 in your field notebook.”

4. Have the groups read their definitions. As they read them, list on the chart paper the kinds of things they use to describe the pond: depth, size, plants and animals, etc. When all groups have shared their definitions, ask:

   “What are some of the similarities and differences in your definitions?”
   “What are some of the things that seem to be common to all your definitions?”

5. To close, share the ecologists’ definition of a pond: “Ecologists usually describe a pond as a quiet body of water shallow enough that plants often grow all the way across it.” It is important that the students understand that this definition is not precise and that people have differing ideas of what a pond is, as demonstrated when they compared their own descriptions of a pond.

6. Discuss with the students this definition and develop a working definition that will be used throughout the field study.
7. Transition to the next part of this activity by saying: “We now have a definition of a pond with which we can all agree. We have also listed a number of characteristics of a pond. Now we will look at a particular pond and see the components that make a pond a pond.” Lead the group to Lower Pond, with the SMILE teacher and adult chaperone walking halfway back and at the end of the line. Be sure to collect the half sheets of paper before heading to the pond.

8. Stop along the way to Lower Pond and have the students gather around for these instructions:

“This next part of the activity will give you an overview of a pond environment and provide an opportunity for you to see how well this pond fits the definition of a pond that you just developed.”

“As we approach the pond you should make observations about the pond and the things surrounding it. Record these in your field notebooks.”

“For this part work alone while making the observations.”

“Let’s move to the pond. Remember to make careful observations and to record what you see.”

9. After reaching the pond, allow the students 5-7 minutes to finish recording their observations. Then say:

“What are some of the things you listed?”
(encourage each child to respond.)

“Where were these features found?”

“Are there ways for us to classify the features we have seen?” (living (biotic) and nonliving (abiotic) would be a simple classification.)

“Are there things about a pond you may not be able to see?”

“What might some of these things be?”

“What can these things tell you about this pond?”

10. Ask the group:

“How well does this pond fit the definition we developed earlier?”

“Do we need to change our definition?”

“Do you think you know what a pond is?”

“Who would like to summarize what we have found out about what makes a pond a pond?”

“Will every pond have the same features we have found at this one?”

“Now we will look at a second pond, the one near the cabins. As we walk there think about how the second pond might compare to Lower Pond and to our definition of a pond.”

11. As you walk to the Pagoda Pond, lead a discussion of what the students might expect to see at the next site. Ask why they would expect to find these things. As you approach Pagoda Pond, remind the students to make careful observations of the pond and the surrounding area. These observations should be recorded in the students’ field notebooks.

12. At Pagoda Pond, ask the students to think about and compare their observations of the two ponds. “Do you think the same types of plants and animals could survive and thrive in each of these ponds? Why? Does our definition of a pond still hold?”

13. Transition to the next activity with: “You have observed some of the particular components of two different ponds. Now we will move on to some activities that focus on how these components fit together. Specifically, we will look at the plant and animal life of a pond and discover where the plants and animals live in each of the two ponds we have observed.”
**Activity Overview**

Students explore the pond. They will identify the plant life found there and record their relative number and distribution. Students will observe the different ways animals move, different kinds of eyes and mouth parts they have, adaptations for catching food and breathing, and the way animals interact with one another. Also, the students will study the habitats of the plant and animal life in the pond.

**Learning Objectives**

To successfully complete this study each student will:
- collect plants and animals from a pond
- identify some of the pond organisms collected
- describe the habitats of the pond organisms collected
- relate how pond animals are suited for their environment
- communicate what plants and animals are found at a pond

**Science Process Skills**

The students will engage in scientific inquiry through: observing, predicting, inferring, hypothesizing, classifying, communicating

**Background for Teachers**

The pond is a diverse community. This diversity contributes to the distinct habitats that can be found in or around a pond. These four habitats are: open water, surface film, water’s edge, and the pond bottom. The open water area is in the center of the pond. Both large and small free-swimming animals and plants can be found here. The surface film is home to floating plants and animals, animals that walk on the surface and those which hang underneath the film. The water’s edge includes the inner edge of the plant growth into the water and about one foot up on the land. Many aquatic plants and animals may be found here, especially those who visit the pond to drink water or find food. The pond bottom is a sandy, muddy, or silty area which is inhabited by a variety of plants, animals, bacteria, and other organisms.

Plants grow in the habitat where their needs are provided for. There are two classes of plants that grow from the bottom of the pond: submergent and emergent. Submergent plants grow completely underwater except for the flowers and seeds. These plants usually have long, bushy, very branched leaves. Emergent plants are rooted on the bottom and have stems and leaves above the surface of the water. Additionally, plants may be found along the edge of a pond (shoreline), floating on the surface of the pond (floating leaf), as well as floating in the water or on the surface, attached to the bottom, or attached to other plants (algae). The distribution and abundance of plant types in the pond is determined in large measure by the availability of suitable habitat. The habitat for a particular species of plant is characterized by the presence of needed physical, chemical, and biological conditions: water, nutrients, carbon dioxide, space, and light.

The animal life of the pond is grouped as vertebrate or invertebrate. Vertebrates are often considered the most important animals found in a pond. Their presence is often seen as an indicator of pond health. In some instances, the evidence of an animal’s presence is more easily found than the animal itself. The habitats of animals must provide for the basic needs of animals: food, water, shelter, air, space.
What Lives Here?
(45 minutes)

Materials
buckets, plankton nets, baby food jars, petri dishes, dish pans, magnifiers, dissecting microscopes, field notebook, pencil, pond life books, aquatic life charts, chart paper, markers

Preparation
• Scout each of the ponds to be certain of the availability of plant and animal life.
• Be prepared to demonstrate proper collecting techniques at each of the ponds and to show the acceptable distance for moving out into the pond, if this is to be allowed.
• It is important to minimize the environmental impact of this study. Be certain to establish a routine by which the students will be able to return animals and plants, if possible, to each of the ponds when the study is completed.
• Start at Pagoda Pond and end at Lower Pond.

Activity Outline
Introduction (Steps 1-2, 1-2 minutes)
Searching for Life I (Steps 3-4, 6-8 minutes)
Examining Findings (Steps 5-6, 6-8 minutes)
Discussion/Recording (Step 7, 4-5 minutes)
Searching for Life II (Steps 8-9, 6-8 minutes)
Examining Findings (Step 10, 6-8 minutes)
Discussion/Recording (Step 11, 4-5 minutes)
Closure/Transition (Step 12, 1 minute)

Procedural Steps
1. To set the stage for this activity gather the students in a sharing circle and ask them:
   “What can we find out about the pond?”
   “What might be important things to look for?”
Invite student responses, then add:
   “Life in a pond can tell us many things about the water it contains. In this activity we will find out what lives here in Pagoda and Lower Pond.”

   “We will start with Pagoda Pond.”
   “What kind of life would you expect to find in this pond?”
   “Where in the pond would you expect to find this life?”

2. Tell the students that they will look at both the plant and animal life in and around Pagoda Pond. Say:
   “What are some of the guidelines we need to consider when collecting plants and animals to have the least impact on the environment?”
   “What are some guidelines we need to consider for this to be a safe activity?”
Solicit student responses to each of these questions and then stress the following:
   “We will need to return as many of the living things we collect back to their environments as possible.”
Share with the students if and how they will be able to venture out into the pond, what gear to wear, and other appropriate safety guidelines.

3. Present a lesson on the distribution of pond plants and remind them to take note of the locations they are taking the plants from.

4. Divide the students into groups of 4 to 5. Have some of the students in each group collect plant life from and around the pond. The remaining members of each group should collect animal life from the pond. When the collecting is complete, have the group members come together to share their findings.

5. Have reference charts and books about pond life available for each group to use as they examine their findings.
6. Lead the students in exploring their findings by asking the following:

“What kinds of plants and animals did you find?” “Where did you find them?”

“Did you find many of the same kinds of living things?”

“Are there other kinds of things that might live in or around this pond that you did not collect?”

“What might be reasons you did not find these?”

“What does the life in this pond tell you about the pond itself?”

“Are there any relationships between the life found and where it was found?”

7. Have on hand a sample of each of the tables from the field notebooks (page 7) and make an entry into each so that the students will see what information is being solicited. Tell them to select two different plants and two different animals from their collections and complete the tables in their field notebooks. Have the reference materials available for the students as they complete the tables. Encourage students to return their samples to the place from which each was collected. When this is completed, prepare to move to Lower Pond.

(**If time becomes a factor, use only samples from Pagoda Pond and skip the trip to the Lower Pond. Have the students detail four plants and four animals from Pagoda Pond, instead of two.)

8. Lead the students to the Lower Pond. On the way, ask:

“Would you expect to find the same plants and animals at the Lower Pond as those found at Pagoda Pond?” “Why?”

“What might be some things you will find?”

“What things from your earlier observations influenced your answers?”

“Let’s see what we will find.”

9. Be sure to add any additional safety precautions if needed for this particular pond, as well as reinforcing those given earlier. Have students repeat the collecting and exploring procedures used at Pagoda Pond.

10. Again, lead the students in their exploration of the samples with questions similar to those in step 6.

11. Tell the students to complete the tables in their field notebooks with two samples each of the plant and animal life from the Lower Pond.

12. Conclude this study with the following:

“We have learned some things about where the various kinds of plants in and around a pond grow. What can we say in general about where plants grow?”

Accept student responses and summarize with:

“Plants grow in habitats that provide for their needs.”

Restate what the needs of plants are. Finish with:

“We have also collected animals and looked at the special features of some of these animals. The habitats of animals must provide for the basic needs of the animals.”

“We’ve looked at where different types of plants and animals are found in a pond. Now we want to take a closer look at what lives in the mud along the edge and at the bottom of a pond.”
Activity Overview
This activity helps to develop the concept of biological diversity. It provides concrete experiences for understanding invertebrates, basic classification, and adaptations. Additionally, students further explore and better understand a habitat at a different level from their own.

Learning Objectives
To successfully complete this activity each student will:
• observe the variety of animal life found in a bowl of mud
• observe the adaptations of animals for moving, getting food, and breathing
• gather data about the variety of animal types found in a bowl of mud
• analyze the data about the variety of animal life in a bowl of mud
• communicate ideas around the concept of biological diversity

Science Process Skills
The students will engage in scientific inquiry through: observing, predicting, collecting data, analyzing data, classifying, communicating

Background for Teachers
By collecting and recording data about plants and animals and their environment, students are often able to see relationships that are obvious. This activity gives students the opportunity to explore the mud of a pond and begin to draw some conclusions about the way the environment affects the organisms living there. Although the animals to be studied during this activity have their home in the mud of a pond, this habitat must still be one that provides for the basic needs of animals: food, shelter, air, water, and growing room. As the variety of life found in the mud may be surprising to some, the adaptations the various animals have for obtaining life’s basics are also varied. Different movement, food-gathering, and breathing structures will provide a means by which the students can classify the types of animals found.

A Bowl of Mud
(adapted from “A Bowl of Mud,” Massachusetts Audubon Society)
(20 minutes)
A Bowl of Mud
(20 minutes)

**Materials**
field notebooks, pencils, chart paper, easel, assorted colors of markers, petri dishes (plastic egg cartons or ice cube trays work well also), plastic spoons, plastic bowls, hand lenses, bucket(s) with rope attached, aquatic life charts

**Preparation**
- Decide if Pagoda or Lower Pond will be used for this activity, as the mud will be collected from one pond only. Lower Pond is the one recommended for this activity.
- If the student groups are to collect the mud from the pond, scout out areas around the pond that will provide access for them to do this. Otherwise, be prepared to collect a fresh mud sample in a bucket and allow each student group to get their bowl of mud from the bucket. In all cases, at the end of the activity, return all animals and unused mud to the pond.
- Examine a bowl of mud from the selected pond as a help in preparing the class bar graph at the end of this activity. It is important for you to know the variety and number of organisms to be found.

**Activity Outline**
Introduction (Step 1, 1 minute)
Sorting through Mud (Steps 2-3, 3-4 minutes)
Observing and Counting Organisms (Steps 4-5, 6-8 minutes)
Compiling Group Data (Steps 6-8, 5-6 minutes)
Closure (Steps 9-10, 1 minute)

**Procedural Steps**
1. In a sharing circle introduce the activity by asking the students the following:
   “What’s good about mud?”
   “Would anything live in mud?”
   Remind the students of the different places plants and animals were found previously.
   “In this activity, we will explore the variety of animals that live in the mud.”
   “How many different kinds of living things do you think will be found in the mud of this pond?”
   Tell the students to record their guess on page 8 of their field notebooks.
2. Divide the students into groups of 2 to 3.
   Have each group collect a bowl of mud from the pond or from the bucket of mud you collected.
3. Have the students sort through their bowls of mud and remove each creature they find with a plastic spoon. Have them put each creature of the same kind in a petri dish with several spoonfuls of water or in one partition of an egg carton, again with several spoonfuls of water.
4. Once sorting through the mud is completed, tell the students to observe each type of creature, using a hand lens if needed. They should pay particular attention to the structural features of each type of animal that help it to: a) breathe, b) move about, and c) get its food. Remind students to complete the table on page 8 of the field notebook as they make their observations. For the descriptive name, have the students invent a name for each animal that is descriptive of it in some way. Move among the students during this time to see what creatures have been found and to help them in determining the adaptive structures.
5. When all the groups have completed the table for three of the organism types found in their bowls of mud, have each group make a count of the total number of different kinds of organisms found in their bowls. This number should be recorded on page 8 for the number of different living things found in their bowl.
6. Help the students to shift their attention by asking:
   “How many of you think you all found the same types of organisms in your bowls?”
   “Why would you expect this?”
   “We will now find out what types of organisms each group found.”

7. Distribute an aquatic life chart to each group so that the students will be able to identify their creatures as you call for them. Make a class tally of the number of each different kind of creature, calling out the name of each organism and asking each group to respond with the number of that type they found in their bowl. Place this tally on the chart. When you have gone through the list of all organisms found, ask the students how many different kinds of animals were found in all the bowls of mud. Have the students record this number on page 8.

8. Use the numbers from the class tally to create a bar graph that shows the diversity of kinds and the number of each kind. Call on different students to fill in the graph for each type of organism. When the bar graph is complete, ask:
   “Are you surprised by what you see?”
   “Did you expect there to be so many different animals in the mud?”
   “What things, if any, do these animals have in common?”
   “Why are the numbers of organisms of each type different?”
   “Would you expect them to be the same?”
   “Why? or Why not?”

9. Conclude this study with: “The pond is a very diverse community. Many different types of plants and animals live here. Their presence gives us information about the pond and its ability to support the life found in it. No matter what plants and animals are found there, a pond must be able to meet the basic needs of each type of life.”

10. Say to the students, “We've encountered a number of new vocabulary words as we've studied the pond. What are some of those words?” As the students share, have each student record four or five of these words on page 7 of the field notebook under “Vocabulary Acquired.”
Pond Ecological Connections
An Investigation of Relationships Within and Between Ecological Communities
Activity Overview
One of the ways to study the relationships between an organism and its environment is to examine the niche of that organism. Students “create” organisms to fill specific roles in the pond environment by recognizing the characteristics that make aquatic creatures distinct from one another and relating these characteristics to the organisms’ requirements for survival.

Learning Objectives
To successfully complete this activity each student will:
• gain a greater awareness of the aquatic environment
• recognize the characteristics that make aquatic creatures distinct from one another
• identify the special features of aquatic animals that enable them to move, breathe, get food, and protect themselves
• create a critter with particular adaptations for an aquatic environment
• communicate what constitutes the niche for their created critter

Science Process Skills
The students will engage in scientific inquiry through: observing, inferring, communicating

Background for Teachers
The earth provides different kinds of homes for living things: seas, lakes, ponds, streams, deserts, forest, fields, etc. The plants and animals living in each are well suited for their environment. The inhabitants often provide food and shelter for one another.

The pond environment is of particular interest. Besides sunlight, a pond contains or produces everything necessary for the plants and animals that live there. All green plants become food for the plant-eaters such as nymphs and tadpoles, these animals are in turn preyed upon by flesh-eaters. Scavengers such as water striders and sludge worms eat dead leaves, animals, and animal droppings. They help keep the pond clean. If not eaten, every plant and animal eventually dies and becomes soil. Thus each pond member is useful within the pond community.

The role an organism, population, or species plays in a community is its niche. An organism’s niche encompasses all of the effects it has on other life and its response to nonliving things. In investigating the niche of an organism, one looks for a set of relationships of that organism to the environment in which it lives, biotic and abiotic factors, as well as at the adaptations of the organism to survive in its habitat.

Aquatic invertebrates face many challenges to survive. Depending on the specific conditions of their habitat, each animal has adapted ways to get oxygen, to hide from predators, to move away if their habitat is threatened, and to get food. These adaptations help an organism function in its community and to be part of the web of pond life.

In a given environment, an organism must be able to have its basic needs met. For a plant these needs are water, nutrients, air (carbon dioxide and oxygen), growing room, and light. For animals these are food, water, shelter (protection), air, and space.

Four distinct habitats which can be found in or around a pond contribute to the diversity of pond life. These habitats are: open water (OW), surface film (SF), the water’s edge (WE), and the pond bottom (PB). These habitats provide an environment where the inhabitants interact and are linked together.

Fitting In
(adapted from “Create a Critter,” Cornell University Cooperative Extension Service)
(30 minutes)
Materials
field notebook, pencil, chart papers, chart markers, preserved samples of aquatic life, compound microscopes, magnifying lenses, weighted bucket with rope attached, petri dishes, Observing Adaptations sheet, Create-a-Critter cards for students, Create-a-Critter cards for the leader, ten plastic tubs to make two sets of the five groups of cards, colored pencils, crayons, markers

Preparation
• Just before the start of the study, collect a bucket of pond water so students will be able to observe the adaptations of microscopic pond animals.
• Be certain the preserved specimens are available and in appropriate containers for the students to view.
• If the students will be handling some of the specimens, have ready a procedure for the students to use in removing the specimens, handling them, and returning them to the right containers.
• Be familiar with the operation of the compound microscope and be prepared to demonstrate its operation to the students.
• Label the tubs for the create-a-critter cards; two tubs for each of the following categories: Body, Breathing, Eating, Movement, Other Behaviors. Cut the clue cards and place them in their appropriate tubs, making certain to divide the cards in a given category between the two tubs equally. Set aside until needed.

Activity Outline
Introduction (Step 1, 4-5 minutes)
Observation of Aquatic Critters (Steps 2-5, 8-10 minutes)
Critter Creation (Steps 6-8, 8-10 minutes)
Closure (Step 9, 4-5 minutes)

Procedural Steps
1. Open this study in a sharing circle by helping the students to focus on the needs of plants and animals. Use the following to prompt student input and discussion:
   “What do animals need in order to live? What do plants need to live?”
   “How and where do plants and animals obtain the things they need for survival?”
Prepare the students for this activity with the following:
   “The habitat of an organism must provide for its needs. An organism's niche is its relationship with the environment it occupies.”
   “Adaptations are features of organisms that help them survive in their habitats.”
   “We will spend some time looking at different adaptations that help aquatic animals survive. We will use preserved specimens of larger pond animals and fresh pond water for microscopic pond animals. As you observe each organism, think about where in the pond that animal might be found and how the observed features make that animal suited to live in that particular environment. Record your observations on the Observing Adaptations sheet, not in your field notebooks. You may use words or a sketch as a means of recording.”
2. Direct students on how to handle specimens and show them how to obtain a sample from the bucket of pond water that you collected earlier. Demonstrate the use of the microscope for viewing the organisms in the pond water. For some organisms, magnifying lenses or the unaided eye may be adequate to allow the students to see the details of the animal’s features.
3. Walk among the students as they look at the animals and ask about what they see.
“What does the animal use to move about?”

“How does the animal eat?”

“Do you think this animal is a predator, prey, or scavenger?” “What causes you to think this?”

“How does the animal breathe?”

“Are there other interesting features you have observed?” “What do you think they are used for?” “Why?”

“Where in the pond would this animal live?”

4. Encourage each student to observe three to four different pond animals and to record their observations on the Observing Adaptations sheet. (This sheet will help the students create their pond critters.)

5. Bring the students back together to shift into the next phase of the activity, creating a critter based on a set of five clues. Say:

“What were some of the features you found on the organisms you viewed?”

“How do these help the organisms function and survive in their environments?”

“Now that you have seen some of the adaptations of pond animals, you will use that information to create a critter to live in a particular part of the pond.”

6. Explain to the students that they will receive five Create-a-Critter cards. Each card gives a brief description of a physical characteristic, a behavior, or an aquatic adaptation. The cards are labeled in one of five categories: Body, Breathing, Eating, Movement, and Other Behaviors. Each student draws one card from each category. To speed the process, place the two sets of tubs in two rows and have the students form two lines. Tell them to take a card from each tub and find a spot (within your teaching arena) for thinking and drawing. Allow all students a chance to get their five cards before moving on.

7. Tell the students they are to record the information about the critter they are to create on page 9 in their field notebooks. While the students are entering this information, distribute the colored pencils, crayons, and markers for the students to use in drawing. After students have entered their information, tell them that they should draw an imaginary aquatic animal that would fit the clues they received. In addition to drawing the critter, the students need to give it a name and label its features and what the features are used for. Do this drawing in the field notebook. Allow the students 5-6 minutes to complete their drawings. After students have drawn a large version of the critter, have them do a second drawing that places their critters in their pond habitat.

8. When everyone is finished, have the students share their critter in groups of 2-3. Tell them they should explain how their critter has adapted to survive in the pond and where in the pond their critters would live.

9. When everyone has shared, gain the attention of all the students. To wrap up the activity, use four or five of the leader’s Create-a-Critter cards to show what the adaptations the students used to create their critters look like on real pond animals. Say: “Just as some of you had the same adaptations and showed them in different ways, real pond animals have different ways to survive in their habitats. Each of these organisms has a niche in its habitat, a role in the community, and special features for fulfilling that role and surviving. Our next study will help us see how plants and animals are connected through different food webs in a pond.”
## Fitting In: Observing Adaptations

Describe or sketch your observations about the following:

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<th>Animal</th>
<th>What Its Body is Like</th>
<th>How It Breathes</th>
<th>How It Eats and Gets Its Food</th>
<th>How It Moves</th>
<th>Other Behaviors</th>
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</tr>
</tbody>
</table>
### Breathing
- Carries its own air for underwater breathing
- Breathes through the surface of its body
- Creates a current to direct more oxygen toward its body

### Movement
- Has three tails at the end of its abdomen that help it swim
- Moves by expelling water from its body
- Has paddle-shaped legs that help it move through water
- Uses parts of its body other than legs to swim
- Can fly through water

### Eating
- Prefers to eat other living things, using its big jaws
- Can eat an animal fifty times bigger than itself
- Has a mouth designed to collect tiny food particles
<table>
<thead>
<tr>
<th>Body</th>
<th>Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is camouflaged</td>
<td>Has special attachments to hold onto slippery rocks</td>
</tr>
<tr>
<td>Looks like a stick</td>
<td>Has a hard armor</td>
</tr>
<tr>
<td>Is soft and vulnerable</td>
<td>Has a flat shape</td>
</tr>
<tr>
<td>Has a streamlined shape</td>
<td>Can live where there is little oxygen</td>
</tr>
<tr>
<td>Breathes through gills located outside its body</td>
<td>Must live where there is a lot of oxygen</td>
</tr>
<tr>
<td>Uses a breathing tube to reach air</td>
<td>Has breathing gills that look like tails</td>
</tr>
</tbody>
</table>
Fitting In: Create-a-Critter Cards for Leaders

Is camouflaged

Body

Has special attachments to hold onto slippery rocks

Body

Dragonfly nymph  Stonefly nymph  Mayfly nymph

Black fly larva

Looks like a stick

Body

Has a hard armor

Body

Water scorpion

Caddisfly larva

Is soft and vulnerable

Body

Has a flat shape

Body

Deer fly larva  Midge larvae  Mosquito larva

Crane fly larva  Black fly larva

Water penny leettle larva  Mayfly nymph
**Part One/Pond Ecological Connections**

---

**Fitting In: Create-a-Critter Cards for Leaders**


---

**Body**

- Has a streamlined shape
  - Mayfly nymph
  - Water penny beetle larva
  - Black fly larva

**Breathing**

- Can live where there is little oxygen
  - Tubifex worm
  - Mosquito larva
  - Rat-tailed maggot

- Must live where there is a lot of oxygen
  - Stonefly nymph
  - Black fly larva
  - Caddisfly larva
  - Mayfly larva

- Uses a breathing tube to reach air
  - Water scorpion
  - Rat-tailed maggot
  - Mosquito larva

- Has breathing gills that look like tails
  - Damselfly nymph

---

---
Fitting In: Create-a-Critter Cards for Leaders

Carries its own air for underwater breathing

Breathing

Breathing

Diving beetle

Backswimmer

Crane fly larva

Breathes through the surface of its skin

Has three tails at the end of its abdomen that help it swim

Movement

Movement

Has feet that feel the vibrations of other creatures in the water

Movement

Moves by expelling water from its body

“Jet-propelled” dragonfly nymph

Mayfly nymph

Mayfly nymph

Stonefly nymph

Caddisfly larva

Water strider

Deschutes Flyshop

Stonefly nymph

Caddisfly larva

Water strider

Deschutes Flyshop

Stonefly nymph

Caddisfly larva

Water strider
Has paddle-shaped legs that help it move through water  **Movement**

Has a mouth designed to collect tiny food particles  **Eating**

Preferences to eat other living things using its big jaws  **Eating**

Backswimmer  

Water boatman

Can fly through water  **Movement**

Emerging stonefly adult

Predominantly aquatic larvae include:

- Backswimmer
- Water boatman
- "Jet-propelled" dragonfly nymph
- Damselfly nymph
- Mayfly nymph

Eats animals 50 times bigger than itself  **Eating**

- Giant water bug
- Damselfly nymph
- Dragonfly nymph
- Dobson fly larva (hellgrammite)
- Black fly larva

Prefers to eat decaying things

**Eating**

- Caddisfly larva
- Crayfish
- Aquatic sowbug

Infects chemicals that dissolve the internal body parts of its prey

**Eating**

- Giant water bug
- Water strider
- Backswimmer

Hides from other animals

**Other Behaviors**

- Dobsonfly larva (hellgrammite)

Has a LARGE appetite

**Eating**

- Dragonfly nymph
- Dobsonfly larva (hellgrammite)

Sees above and below the water at the same time

**Other Behaviors**

- Whirligig beetle adult

-- Burrows into the bottom of a stream or pond

**Other Behaviors**

- Tubifex worm
Hides its head inside its body

Other Behaviors
Gives off stinky chemicals to ward off attaches

Other Behaviors

Lives on the surface of water

Other Behaviors

Attaches to rocks with a safety line

Other Behaviors

Crane fly larva

Whirligig beetle adult

Stonefly nymph

Scud

Caddisfly larva

Water strider

Whirligig beetle adult

Caddisfly larva

Black fly larva

Avoids bright light

Other Behaviors

Lives in a protective structure it builds

Other Behaviors
Weaving the Web
(adapted from “Weaving the Web,” Cornell University Cooperative Extension Service)
(35 minutes)

Activity Overview
One way the various kinds of plants and animals interact is as links in a food web. While food webs in a pond can be very complex, this activity allows students the chance to identify a few of the links in a web of pond life.

Learning Objectives
To successfully complete this activity, each student will:
• construct a food web of pond life
• describe the predator-prey relationship and its place in the pond community
• communicate the importance of a food web within a pond community

Science Process Skills
The students will engage in scientific inquiry through: inferring, investigating, classifying, questioning, constructing models, interpreting data

Background for Teachers
All creatures that live in ponds rely on other plants and animals for their food. Food is a link between all animals, large and small. Most animals eat plants, and those animals in turn are eaten by other animals. These animals are eaten by their predators, and so on. These links through eating make up what is called a food chain. In real life, however, connections are not so simple. One animal may eat a variety of foods, including plants and smaller animals. Other animals may eat plants, animals, and decaying matter. The chain becomes complicated and is more accurately depicted as a food web. All the inhabitants of the pond are connected together by their needs in the pond web of life.

All animals need food to survive. Every animal shares a common challenge of finding enough nourishment to stay alive and healthy. In the pond some animals get food as passive feeders and filter feeders. Other animals are more active predators. Some disguise their predatory natures, i.e. some can remain motionless until suitable prey passes by; others have physical features they can put out of the way until needed. Some of the surface-living animals have special structures that permit them to breathe without exposing themselves to peril.

Pond animals have adapted defense mechanisms to survive the many pond predators. An obvious example is color. Protection is also provided by stinging and biting, by shells or hard body coverings, and by the ability to swim rapidly to escape. It seems that water animals in general are well adapted and that few species have disappeared throughout history. The pond is a dynamic environment that contains everything except the sunlight needed to sustain the variety of life found in it.

A basic feature of a food web is a system of checks and balances, that prevents populations of one type of organism from dominating others. For example, algae overgrowth is prevented by a variety of algae-eating invertebrates (such as stoneflies and hellgrammites) and vertebrates (such as small fish). Large fish eat small fish, keeping the number of small fish in check. In order for a predator to live, a prey animal must die. Predation is critical to keeping animals populations diverse and in equilibrium with each other. Adaptations of both predator and prey are only successful if adequate numbers of their population survive.

If there are many connections at each level of the food web, the web is strong and less likely to be damaged by disruptions in the environment. For an analogy, consider a structure made of children’s building blocks. If the structure is made of many blocks at each level, it is less likely to collapse when one block is removed. If the structure is made of just a few vertical blocks, the
building will collapse when one block is pulled out. This building analogy corresponds to an food pyramid, which is another way of showing the intricacy of supply and demand for food within a given community. The food pyramid illustrates the differences in the size and numbers of different forms of life at the different parts of a food web. It helps to show relationships between producers and consumers. The producers take solar energy and convert it to food for primary consumers and secondary consumers. The base of the pyramid consists of microorganisms and plants. The next level consists of organisms that eat these plants and animals. The final levels are predators that eat other animals. As is the case with the structure of blocks, the broader the base of the food pyramid, the more stable it is. All large predators tend to be at the top of a food pyramid. People are usually at the top of a food pyramid.

Food webs and pyramids are also useful to illustrate the transfer of energy from one species to another. Energy is transferred from the sun to the producers (green plants such as microscopic algae); from the green plants to a primary consumer (e.g., a water flea); from the primary consumer to the secondary consumer (e.g., a minnow). Scientists call this transfer of energy from one species to another a transfer between trophic levels. Thus, the algae, water flea (herbivores), and minnow (carnivores) represent three trophic levels. Ultimately, the algae, water fleas, and minnows die and become food for the decomposers, the microorganisms that break down living things into raw materials.

**Weaving the Web**

(35 minutes)

**Preparation**
- Scout out locations near the pond that would be appropriate for having the sharing circle and suitable for having the students work in groups as they weave the web.

**Activity Outline**
- Introduction (Steps 1-3, 4-5 minutes)
- Weave the Webs (Steps 4-8, 12-15 minutes)
- Sharing the Webs (Steps 9-11, 6-8 minutes)
- Closure (Step 12, 5-7 minutes)

**Procedural Steps**
1. Have the students stand in a sharing circle. Ask them what are the occupations of people living in their communities (e.g., mail carriers, secretaries, doctors, teachers, grocers, school children, librarians, ministers, etc.) Talk about how these people depend on each other for their survival and well-being.
2. Then ask:
   - “What would happen to plants and animals if a disease killed all the grass on the earth?”
Discuss the elements of an ecological community (nonliving or abiotic matter, plants, consumers, and decomposers).
   - “What organisms live in a pond community?”
   - “Can any of the pond community’s members live without each other?”
3. After soliciting student responses, say: “The
plants and animals living in and around the pond interact with each other in a variety of ways. One of the most important interactions is as links in a food web. A food web shows which animals eat other plants and animals. In this activity you will construct a food web for the plants and animals found in a pond community.” Lead the students in a discussion of producers and consumers and how these are connected in a food web.

4. Have the students form groups of 2-3. Distribute to each group a sheet of newsprint, Weaving the Web activity sheet, tape, two pairs of scissors, and markers.

5. Have the group members cut out the organisms from the activity worksheet.

6. Ask each group to arrange the pictures in a realistic order on the sheet of newsprint, so that there are levels of organisms. Tell them there should be at least four levels of organisms. Allow the groups time to discuss and decide.

7. After they decide where everything should be placed, have the students tape each picture onto the newsprint.

8. Ask them to draw arrows connecting each organism to the food it eats. For example, arrows could go from the algae to the mayfly and from the large fish to the fish hook. Some arrows may skip between levels of the food web. An example is that of mayflies, which can be eaten by stoneflies and by trout.

9. Have each small group share its food web with the entire field study group.

10. After all groups have shared, have the students record their food webs (with arrows) on page 10 in their field notebooks.

11. When all have finished, ask the students how their food webs differed. Ask them to think about what might cause the differences.

12. To close the study ask the students:

“How can you say about the food web in the pond?”

“What would we need to do to complete the web?” (Add in the sun and decomposers. Have students add these to page 10 of their field notebooks.)

“Are there other kinds of interactions between the various plants and animals in the pond?”

“What would happen to the pond web if some change caused one link in the web to be removed?”

“Next we will look for evidence of the changes that are taking place or have taken place in this pond community.”
**Weaving the Web**


<table>
<thead>
<tr>
<th>Bacteria and fungi</th>
<th>Algae and plankton</th>
<th>Mayfly nymph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water penny larva</td>
<td>Caddisfly larva</td>
<td>Hellgrammite (dobsonfly larva)</td>
</tr>
<tr>
<td>Stonefly nymph</td>
<td>Dragonfly nymph</td>
<td>Minnow</td>
</tr>
<tr>
<td>Catfish</td>
<td>Bluegill</td>
<td>Trout</td>
</tr>
<tr>
<td>Largemouth Bass</td>
<td>Osprey</td>
<td></td>
</tr>
</tbody>
</table>
Change is a constant process. The observations students make are for one time in one day. At another time of day and in a different season, they might find conditions very different. To help the students get a more complete understanding of the pond, they will look for evidence of changes and infer how these changes affect pond life.

Learning Objectives
To successfully complete this activity the student will:
- identify evidence of change in their lives
- use various senses to read the environment and look for evidence of change
- categorize evidence of change
- explore cause and effect relationships
- draw inferences about conditions in the pond at other times
- communicate how change affects pond life

Science Process Skills
The students will engage in scientific inquiry through: observing, inferring, categorizing, hypothesizing, communicating

Background for Teachers
Our world is constantly changing, sometimes quickly and sometimes slowly. A change can be as small as the falling of a leaf or as large as the movement of mountains. Our ability to recognize these changes and understand what causes them can provide us with valuable information about our environment.

Some types of changes are familiar and readily apparent. For example, we can watch a car drive through a puddle and splash us on the sidewalk. We see the location of the car change while we hear the engine and the splash of the water. We feel wetness where we were dry before, and we see the spattered mud where previously there was none.

Not all change occurs this quickly or can be observed to be taking place. Frequently, what we observe is the result of the change. Examples of less obvious processes of change include the growth of students or the fading of jeans after months of wear and laundering. Still, we can observe evidence that these changes have occurred or are taking place. We know growth has occurred when students can reach shelves that used to be too high. We can look inside the jeans pockets to see fabric that is darker than that at the knees.

Frequently, the recognition of conditions after a change has occurred is the only evidence we have of the change. Making observations that lead us to question previous conditions is the first step in exploring change. We combine experiential evidence, that which we perceive with our senses, with previous experience and research into the experiences of others to make inferences about what conditions were before the change. We can then conclude what change took place. With this conclusion, one may move even further to predict how that change is affecting or has affected the life in a particular community.

Inferences about the causes of change and predictions about what may happen in response to those changes are supported by the same sources of information. It is important to be able to distinguish the evidence of change from the change itself. Likewise, it is important to be able to distinguish the change from the cause of the change. Birth and death are two ever-present processes in a community that bring about changes. Any evidence of these processes is evidence of change in a community.
Change Detective
(25 minutes)

Materials
field notebooks, pencils, poster of immature and adult aquatic organisms, Change Scavenger Hunt cards

Preparation
• Scout areas around the ponds to find one that will allow students to find adequate evidence for the changes taking place in and around the pond community.
• Have in mind clear parameters for the hunt and be prepared to share these with the students.
• Preview each of the hunt cards to be sure that two to three of the four items on each card can be “detected.”
• Decide if the environment will support the collecting of the items from the hunt cards. If not, choose a method by which the students will be able to share their findings.
• Select a location in the field study area for placing the poster of immature and adult aquatic organisms.
• Plan a subtle change you can make in your appearance to demonstrate detecting change for the large group.

Activity Outline
Introduction (Step 1, 2-3 minutes)
Detecting Change (Steps 2-4, 4-5 minutes)
Change Scavenger Hunt (Steps 5-7, 9-11 minutes)
Closure (Steps 8-9, 2-3 minutes)

Procedural Steps
1. Gather the students in a sharing circle. Ask:
   “What is a change?”
   “How do you know a change has taken place.”
   (introduce the idea of evidence here.)
   “What things cause change to happen?”

   “What are some of the changes that have taken place in your lives?”
   “What is the evidence of these changes?”
   “What caused these changes?”

   Encourage the students to share and when they have finished doing so, add:
   “Just as you have experienced change, so does the pond. The pond community is a very dynamic, ever-changing environment. For the next few minutes we will be change detectives. We will be engaged in an activity that will allow us to look for evidence of changes in the pond community and to gain an awareness of the many different ways these changes take place.”

2. Have the students form groups of 3-4 members. Tell them that each group will stand in front of the rest of the field study group and be observed. Then that group will have a chance to huddle together off to the side to make one or more changes in the appearance of the group. They will then face the remainder of the large group so that the large group members will have a chance to detect the changes that have taken place. You should demonstrate: allow the students to observe you for a few seconds; turn away from the group (move out of sight if necessary) to effect the change you decided on earlier; turn back to the group and again allow yourself to be observed by the students. If the students have difficulty detecting the change(s) you made, direct with hints about where they might look, how the change affects your appearance, etc.

3. When the students have detected the change(s) you made, lead them in a quick
discussion of how they knew a change had occurred and the importance for looking for evidence.

4. Group by group, allow the students to work through the detecting change portion of this activity. After each group, reinforce the distinctions among change, evidence of change, and the cause(s) of change using the specific from each group.

5. As you move into this part be certain you are positioned by the aquatic organism poster. You will need to refer to the poster during this transition. When all groups have illustrated a change, say:

   “We have been able to practice our detecting skills by looking for changes we made in our appearances. Now we want to use our observational skills to look for evidence of changes in and around the pond. What are some of the things you could find that show there are changes here? What could be some things causing the changes?”

   “An example of change is the life of an animal, animals are born, they grow into adults, and they die. Let’s look at this poster to see some examples of immature and adult aquatic organisms. What are some of the changes you see?”

Allow students to share their ideas and then move on by saying: “This poster shows one kind of change; but as your examples earlier showed, there are many others. We are going to search for evidence of change. We will look for signs of change by having a Change Scavenger Hunt.”

6. Have students form groups of 2-3. Tell them that each group will get a card for the scavenger hunt and that as a group they should search the area around the pond to find an example for each of the four items on the card. Issue any needed safety precautions, distribute the Change Scavenger Hunt cards, and send the students off to hunt. You will need to move among the groups as they work to assist them, if needed, in their efforts.

7. Allow 7-8 minutes for the hunt and then call the students back together for closure. Ask:

   “What kinds of things did you find?”

   “What changes do these things represent?”

   “What caused these changes?”

   “How is the pond and its organisms affected by these changes?”

8. Have the students select two of their hunt items for which they found evidence and record the information on page 10 of their field notebooks. When all have had a chance to record, say: “Change is a part of life and happens all the time: sometimes slowly; other times more quickly. The changes in one place or group of living things can impact what happens some place else or with another group of living things. The changes can be natural ones or can be caused by people. The changes you have detected have been natural ones. How do people cause changes in the pond environment? Are all these changes good? Bad? What changes might you be causing in a pond? What could be the effects of these changes? Who decides if a change is good or bad? These are a lot a questions with a lot of answers. I hope you will think about them.”

9. To conclude the field study say, “We have looked at different ecological connections in a pond community. What are some of these? What are some of the special vocabulary words we’ve used?” As students respond, encourage them to write four or five of these terms on page 9 in their field notebook under “Vocabulary Amassed.”
Change Detective Scavenger Hunt

Look for something that:

1. is becoming smaller.
2. started out as an egg.
3. is usually found outside of the pond.
4. changes with day and night.

Change Detective Scavenger Hunt

Look for something that:

1. is changing into something else.
2. commutes to the pond.
3. started out as a seed.
4. can grow a new body part.

Change Detective Scavenger Hunt

Look for something that:

1. is becoming bigger.
2. is no longer living, but once was.
3. is usually found outside of the pond.
4. changes color.
Change Detective Scavenger Hunt

Look for something that:

1. is becoming smaller.
2. changes color.
3. started out as a seed.
4. molts or sheds its exoskeleton.

Change Detective Scavenger Hunt

Look for something that:

1. is changing into something else.
2. changes with day and night.
3. is no longer living, but once was.
4. started out as an egg.

Change Detective Scavenger Hunt

Look for something that:

1. is becoming bigger.
2. is usually found outside of the pond.
3. started out as a seed.
4. molts or sheds its exoskeleton.
Forest Plant & Animal Survey
An Investigation of Relationships Within and Between Ecological Communities
**What is a Forest?**
(adapted from “Cross Sections,” USDA Forest Service)
(25 minutes)

**Activity Overview**
What makes an area a forest? What are characteristics of a forest? This activity provides students the opportunity to identify and explore the components of and develop an operational definition for a forest.

**Learning Objectives**
To successfully complete this activity the student will:
- identify components of a forest community
- develop an operational definition for a forest
- describe the layering in a forest community
- communicate the characteristics of a forest

**Science Process Skills**
The students will engage in scientific inquiry through: observing, collecting data, classifying, drawing conclusions

**Background for Teachers**
All ecosystems share the same basic categories of biotic and abiotic components. All have plants, animals, air, soil, water, etc. The nature of these general categories of components varies depending on the type of ecosystem. The forest is a complex community where trees and other plants and animals live in delicate balance. A fundamental difference between forests and non-forested ecosystems is that the dominant plant type in forests is trees. The presence of trees is caused by a number of abiotic factors, including moisture availability, soil type, and general climate. Conversely, the trees themselves influence the character of many biotic and abiotic factors. Local weather conditions, soil fertility, and animal species may all be dramatically different where trees are growing when compared with an adjacent grassland or shrub ecosystem. A simple definition of a forest is an ecosystem whose main vegetation is large groups of trees that provide a canopy over the vegetation below.

The most dominant tree species in a forest usually determines the forest’s appearance and suitability as a habitat for plants and animals. For example, in some forests, large, dominant trees reduce sunlight and monopolize soil moisture and nutrients, thus limiting the types of plants that can grow beneath them.

Layering in the forest community is very important. The topmost branches and leaves of the tallest trees create a living awning that protects the life below it. Forest managers consider trees over thirty feet tall to be part of the canopy. The specific effects of this canopy vary with the degree of openness. A closed canopy is one that largely blocks direct sunlight from reaching the floor of the forest. An open canopy allows more sunlight to penetrate to the forest floor. In either case, some of the general effects of the canopy are shading; protecting small trees, shrubs, and other living things from winds and rains; preventing the escape of the water vapor released from plants; and providing a variety of habitats for many animals, insects, and birds. Many organisms live in the canopy but forage for food on the forest floor.

Below the canopy is the understory, made up of smaller trees (fifteen to thirty feet) and the largest shrubs. The difference between a tree and a shrub is that shrubs grow from several stalks coming out of the ground, whereas trees grow from a single trunk. Squirrels and birds might be found at this level in the forest. The plants found at this level are adapted to grow in the shade of the larger trees.
The third level from the top of the forest is the shrub layer. This layer is sometimes referred to as the undergrowth. Some larger, browsing animals (such as deer) find both protection and food here. Shrubs are the main vegetation at this level.

Ground cover is the layer at the forest floor. Here you find plants that do not have woody stems. Below the ground cover is a layer sometimes referred to as the herb layer. Here you find mosses and other small, moisture-loving plants. These plants are involved in the decomposition of dead plant and animal life into raw materials, making nutrients available to other plants.

Forests are important for many reasons. They provide wood products important to our daily lives. They provide habitats for a wide variety of living organisms. They are valuable to humans as recreation areas for hiking or camping. Forests provide oxygen as a product of photosynthesis. There is a need for people to understand what forests are, how they work, and what affects them. By doing so, we are better able to understand what is needed to maintain this valuable resource.

**Materials**

- field notebooks, pencils, *Guidelines for Collecting*, laminated *Forest Scavenger Hunt* cards, permanent transparency markers, small plastic sample bags for collected hunt items (if the students physically collect any items), chart paper, chart markers, easel, stopwatch

**Preparation**

- Scout the forest area to be sure most of the items on each of the *Forest Scavenger Hunt* cards can be readily found.
- Decide the boundaries for the hunt and settle on a plan for marking these and making them known to the students.
- Decide also if the site can support the collecting of samples or if the students will need to draw, make a rubbing, or write a description for each “collected” item.
- If you decide that the students should not collect their items, make available the materials needed for them to share their findings (paper, crayons, colored pencils.)
- Select an area for gathering with the students at the end of the scavenger hunt for listening to the sounds of the forest. Each student should be able to lean against the trunk of a tree while sitting on the ground.
- Select a location near the forest where you will be able to gather with the students and have a good view of the layering in a forest as you lead them in a discussion of the distinct characteristics of a forest.

### Activity Outline

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction (Step 1, 2-3 minutes)</td>
</tr>
<tr>
<td>2-4</td>
<td>Forest Scavenger Hunt (Steps 2-4, 6-7 minutes)</td>
</tr>
<tr>
<td>5-6</td>
<td>Sounds of the Forest (Steps 5-6, 2-3 minutes)</td>
</tr>
<tr>
<td>7-10</td>
<td>Transition (Steps 7-10, 2-3 minutes)</td>
</tr>
<tr>
<td>11-15</td>
<td>Defining a Forest (Steps 11-15, 5-6 minutes)</td>
</tr>
<tr>
<td>16</td>
<td>Closure (Step 16, 2-3 minutes)</td>
</tr>
</tbody>
</table>

### Procedural Steps

1. Gather the students in a sharing circle and ask: “How many of you have done a field study at the pond or in the meadow? If you have done a study in another community, I am sure you have noticed that there are some obvious differences between those areas and where you are now. We will consider those differences as we try to answer the question: What is a forest? This activity will help us to discover what makes an area a forest. Before we try to develop a definition, you will spend some time exploring a forest and looking at some of its parts.”

2. Have students separate into pairs. Tell them they will be going on a Forest Scavenger Hunt. Share with them the guidelines for and boundaries of the hunt. Caution them that they
are to do nothing to harm the living plants and animals in the environment!

3. Distribute one *Forest Scavenger Hunt* card to each pair of students. Ask the pairs to look over their list to see if they understand what they are being asked to find. After addressing their questions, let them know that you have checked out the site and know that most, or all, of the items can be found. Tell the students how to collect their items. Distribute the materials they need for collecting. Send the students out.

4. Be prepared to move among the students as they work through the lists. Offer assistance if needed.

5. At the end of the allowed time, call the students together in the area you selected for listening. Tell the students that to finish the hunt they need to “find” the sounds of a forest. Lay out the rules for the activity: Each person will sit on the ground with their back against a tree trunk and listen for any sounds coming from the forest. As they hear various sounds, they are to record these on page 11 of their field notebooks. For a period of **two minutes** everyone listens and records the sounds they hear without talking.

6. After each student is seated at a tree with field notebook open to page 11 and pencil in hand, tell them the listening period has started and start the timer.

7. When two minutes have passed, call the students together to discuss the findings from the hunt. (You should have the students gather in the area you selected earlier for viewing the layering in the forest. This will facilitate your move into the last part of the activity.) Ask: “What are some of the things you found on your hunt?” Tell the students to select three of the found items on their scavenger lists to record on page 11 in their notebooks.

8. Next ask: “Why are these things important to the forest?” Solicit student responses and tell the students to record one importance for each found item on page 11.

9. Continue, asking:
   “What were some of the sounds you heard?”
   “What were the sources for these sounds?”

10. Ask:
   “How do the sounds and scavenger items fit together to form a forest?”
Solicit student responses and transition with:
   “Who knows what makes a forest?”

11. After allowing students to share their thoughts, ask them to look at the forest, noting any patterns, and describe what things they see. As the students share, record their ideas on the chart paper.
12. After a list is generated, say: “One of the distinguishing features of a forest is the presence of trees as the main vegetation. Their presence allows a forest community to be layered. Can you identify layers in this forest? How many layers do you see? What are the characteristics that describe each layer?”

13. Say:
   “Let’s start at the top and see what we can discover about this forest.”

**Canopy**
   “How high do you think the tallest trees are?”
   “How high do you think the lowest branches are?”

Share with the students a working definition of canopy.

**Understory**
   “What do you notice about the next layer of trees?”
   “Can you think of a reason to explain what you see?”
   “How is this layer affected by the one above?”

Share a working definition of understory.

**Shrubs**
   “Do you notice any differences between this layer and the two above it?”
   “Do the plants at this layer have the same growth pattern as the taller trees?”

Define shrubs.

**Ground cover**
   “What do you see below the shrubs (bushes)?”
   “Do you observe any general characteristics among the plants at this layer?”

Define ground cover.

14. Say: “We have made a lot of observations about the forest. Considering all that you have observed and learned, how would you like to define forest?” Solicit student responses and guide them toward a definition that includes the following: a community (ecosystem, environment, etc.); trees are main vegetation; layering (present in natural forests); interactions among plants, animals, and nonliving factors.

15. Write the final definition on the chart paper and have students record it on page 11 in their notebooks.

16. To provide transition to the next activity say:
   “We now have a definition of a forest, what other things could we find out about a forest?”
   “Since trees are the dominant plants in a forest, next we will spend some time studying the growth characteristics of trees.”
Guidelines for Collecting in Nature

There are several reasons to limit the collection of organisms during out-of-doors activities:

• To model respect for all living things.
• To model that all organisms are best studied in their natural environment without interference from observers.
• To keep from impacting the organisms in an area, especially if many classes visit the same site.
• To avoid making the main focus of the activity collecting animals and/or plants instead of understanding ecological concepts.

If it has been determined that you will have the students collect some organisms for closer observation, several recommendations for this process are listed below:

• Never collect material from an area unless you have permission from the person or organization who owns the land. You may not collect any material from a national or state park.
• Never collect rare or endangered species. Someone at the Department of Natural Resources or a local extension service in your state should be able to tell you if there are any such species in your area. Numbers for these agencies can be found in your phone book.
• Never collect a plant if it is the only one growing in a particular area. Instead, collect plants that are growing in groups or stands.
• Take care when keeping living organisms in a container. Make the animal as comfortable as possible and provide for its basic needs.
• Place all containers away from direct sunlight.
• Provide items in the container under which the organisms can hide.
• If it is necessary to handle organisms, be gentle. Be aware that some animals might bite to protect themselves.
• If aquatic animals are collected, use water (from the area where the organisms were found) in the containers. If the water in the containers with aquatic animals becomes warm, replenish with cool fresh water.
• Return all organisms to the spot they were found as soon as the observations are complete.
**Forest Scavenger Hunt**

If permitted, collect the following things from within the given boundaries. **Remember:** Please do not harm the living plants and animals in our environment.

1. A seed that travels by wind.
2. A leaf with parallel veins.
3. Food for a squirrel.
4. Food for an insect.
5. A leaf with two or more colors.
6. A hairy leaf.
7. A feather.
8. A circle in nature.
9. A wrapper of any kind (candy, gum, etc.)
10. A square in nature.

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**Forest Scavenger Hunt**

If permitted, collect the following things from within the given boundaries. **Remember:** Please do not harm the living plants and animals in our environment.

1. A nut.
2. Evidence of animal life.
3. A seed that will stick to an animal’s fur.
4. A bone.
5. A rock with two or more colors.
6. A pine cone that has been nibbled by a squirrel.
7. A piece of bark or a bark rubbing from a tree.
8. The biggest leaf you can find.
9. A wrapper of any kind (candy, gum, etc.)
10. A circle in nature.
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may grow slowly or die. Growth rings show this graphically. In general, wide rings indicate good conditions for growth (plenty of nutrients, water, sunlight, and adequate space) while narrow rings often indicate less favorable conditions for growth (drought, insect damage, lack of nutrients, competition).

A common sight in some countryside areas is a fence embedded in a tree. This illustrates an important aspect of tree growth. Tree growth in height and length occurs at twig and root tips. If it were otherwise, the fence would be over our heads. A good analogy for the growth of a tree is the following: Each year’s new layer of cells forms a hollow tube. Growth in length occurs through this tube’s telescoping over the previous year’s growth. A tree, then, is made up of numerous hollow tubes of cells. These cell layers build up over the life of the tree.

The bark on a tree has two layers. The outer layer is called bark while the inner, moist, greenish layer is called phloem. The woody stem (trunk), forming the bulk of the tree, is xylem. The cells between the phloem and the wood (xylem) is called cambium. The cambium layer is the outermost growth ring. It is in this layer that cell division occurs. The cambium covers the entire body of the tree except the very tips of twigs and roots. Each growing season, the cambium layer, through cell division, adds a new layer on the wood. It also adds a new layer to the inner bark (phloem) on the cambium’s outer face.

By counting a tree’s growth rings, you can tell its age. Every growth season, a tree adds a new layer of wood to its trunk. Each ring has two parts: a wide, light part (early wood) and a narrow, dark part (late wood). The early wood grows during the wet, spring growing season.

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**Activity Overview**
This activity allows students to investigate tree growth using cross sections (wood cookies) from two tree species.

**Learning Objectives**
To successfully complete this activity the student will:
- demonstrate an understanding of growth rings
- contrast growth rates of trees using growth rings
- formulate hypotheses on environmental conditions affecting tree growth
- communicate factors affecting tree growth

**Science Process Skills**
The students will engage in scientific inquiry through: observing, using numbers, contrasting, interpreting data, hypothesizing, inferring, communicating

**Background for Teachers**
There are over 50,000 different tree species in the world. Some trees tower more than 360 feet (110 m), like coastal redwoods, and some reach only 15 feet (5 m), like bluejack oaks. Tree leaves may be needle-shaped, broad and flat, or made of little scales. Tree bark may be smooth, rough, shaggy, or deeply furrowed. Branches may spread out to form a huge, broad crown or may rise narrowly like a column.

A tree is a living system. What do they need so they can grow? Some of their needs are the same as those of people and animals. Trees need plenty of water and nutrients, which they get from food. The way that trees get their food is very different from the way people do. Plants make their own food by using energy from the sun.

If trees don’t get enough water, nutrients, or sunlight or have adequate space for growing they
During the transition from the drier summer to fall and winter, growth slows and the late wood forms. The rings provide clues about the climate of the area over time and evidence of disturbance around the tree, such as fire and flood.

The shape and width of the annual rings often differ from year to year because of varying annual growth conditions. During a moist growing season, a tree in a temperate region may produce a particularly wide ring. During a drought, a colder-than-average winter, or an unseasonable frost, a tree will produce a particularly narrow ring. In a science called dendrochronology (which literally means “the study of tree time”), scientists have found that they can learn about past climates by studying the ring patterns of very old trees.

Many factors besides weather can affect a tree’s growth. Accordingly, tree rings reflect a tree’s response to such stressors as root damage, disease, and competition from other plants. Sometimes a disturbance will occur after the growth season, producing a narrow or misshapen ring the following year. Embedded branches (knots) often create beautiful patterns. Differential suppression caused by physical proximity to an object can shift the growth pattern to one side. Environmental factors including light, soil moisture, available nutrients, defoliation from insects, summer temperatures, fire, etc. can suppress overall growth, causing tight ring patterns. To study a tree’s growth rings without harming the trees, scientists use a technique called coring. By drilling into the center of a tree trunk with a hollow instrument called an increment borer, they can remove a long, narrow cylinder of wood (called a core sample.) The growth rings appear as lines on the core sample.

### Materials
Large demo wood cookie, laminated Wood Cookie picture (one for each student), hardwood wood cookie for each group of 2-3 students, softwood wood cookie for each group of 2-3 students, pencils, field notebooks, chart paper, chart pens, easel, labels for wood cookies

### Preparation
- Make and attach a label to each smaller wood cookie that identifies the tree source for the cookies and whether the tree is hardwood or softwood.
- Select an area for this activity that will allow the groups of 2-3 students to be separated enough that they are working independently during the wood cookie study.
- Practice counting rings on the demo wood cookie and the wood cookie picture. Be ready to demonstrate ring counting to the students using the demo cookie.

### Activity Outline
- Introduction (Step 1, 4-5 minutes)
- Wood Cookie Study (Steps 2-3, 5-6 minutes)
- Closure (Steps 6-7, 3-4 minutes)

### Procedural Steps
1. Have the students sit in a semicircle so that they are all facing you and are able to see your wood cookie and pictures. Hold up the large wood cookie. Ask the following questions:
   
   “Describe what you see as you look over the surface of this wood cookie.”

   Allow the students to brainstorm descriptors. As they share their ideas, write them on the chart paper. You may use this list to remind the students what they have said already. When the ideas run out, focus back on the ones that relate to the growth rings. Retrieve the wood cookie and again hold it up to the students.
   
   “Can anyone give a possible explanation for how these rings were formed?”
“Does a tree grow vertically or horizontally?”

“In this cross-section (a cut across the tree to show growth layer), exactly where is growth occurring?”

“Do the color variations in the rings signify anything?”

(You could use an analogy of waves rippling out from the point in a pond where a thrown pebble enters the water. Be careful that the students understand where the growth is actually occurring.)

“What story do these rings tell us about the tree this wood cookie was taken from?”

(age of tree, years of rapid growth, years of slow growth, stressors affecting the tree such as fire, disease, competition, root damage, dead branches, etc.)

“What could you look for in a wood cookie that would be an indication of any of the things just mentioned?”

(As an example: “If a tree had been affected by a forest fire, what might you see on its cookie that would show that?”)

Show students how to count the rings. Give a Wood Cookie picture to each student and allow them to practice counting rings.

2. Divide the students into groups of 2-3. Each group will receive a small hardwood and softwood wood cookie sample. Before sending the students off to study the samples, tell them they should turn to page 11 in their notebooks to record their observations for each of the cookies. Tell them that they can draw a picture or use words to describe the ring pattern and to complete the last row of their table by trying to answer the question: “Why might the tree have grown this way?”

3. Send the groups off to their study areas.

4. Move among the groups as they make their observations and develop hypotheses to explain the ring patterns they observe.

5. At the end of the allowed time, bring the groups back together. With groups remaining intact, sit in such a way that everyone can see each other and the wood cookies.

6. Have each group explain what they found and why it might have occurred. As they share, create on chart paper a list of environmental factors that might cause differences in tree growth. (If needed, highlight any of the factors that can be seen in the demo cookie.)

7. Say: “You have made some excellent observations while looking at tree growth and factors that affect it. What other tree characteristics can we study? We are now ready to move to the next activity in which you will each have your own tree to study.”
Tree Growth: Wood Cookie
(Ranger Rick’s Naturescope, Trees are Terrific, Copycat Page: Reading the Rings Part 2, National Wildlife Federation, 1988)
Activity Overview
Students describe a chosen tree by using personal observation and investigation.

Learning Objectives
To successfully complete this activity the students will:
• observe characteristics that distinguish different trees
• draw conclusions about the factors that affect tree survival
• communicate ideas about the role and importance of trees

Science Process Skills
The students will engage in scientific inquiry through: observing, identifying, drawing conclusions, reasoning, composing, communicating

Background for Teachers
There’s a lot of variety in the more than 50,000 kinds of trees in the world. For example, some trees tower more than 360 feet (110 m) high and some reach only 15 feet (5 m), like the bluejack oaks. Tree leaves may be needle-shaped, broad and flat, or made of little scales. Tree bark may be smooth, rough, shaggy, or deeply furrowed. Branches may spread out to form a huge, broad crown or may rise narrowly as a column. From a tree’s tiny root hairs buried in the ground to the highest leaves in its crown, each part of the tree plays a role in helping it to function.

A tree’s roots help anchor the tree in the ground. They also absorb water and minerals and carry them to the leaves, where these materials come into contact with chlorophyll (the green pigment in leaves and stems) Sunlight passes into a leaf, strikes the chlorophyll, and gives it energy to break water molecules apart. The hydrogen from the water molecule combines with carbon dioxide from the air. The resulting carbohydrates (starches and sugars) are the plant’s food. The leaf releases or “exhales” oxygen from the broken water molecule.

The trunk provides support for branches, which in turn support the tree’s leaves. The trunk and branches contain the tree’s “pipes,” the tubes that transport water and nutrients to the leaves, and sugar from the leaves to the rest of the tree. They also contain the growing layer of the tree that makes the trunk, branches, and rest of the tree thicker each year. From the inside to the outside, the layers are:

Heartwood forms the central core of the tree, is made up of dense dead wood, and provides strength for the tree.

Sapwood, also called the xylem, brings water and nutrients from the roots to the leaves; older xylem cells become part of the heartwood.

Cambium, a very thin layer of growing tissue, makes cells that become new xylem, phloem, or cambium.

Phloem, also called the inner bark, carries sap (sugar and nutrients dissolved in water) from the leaves to the rest of the tree; at certain times of the year, phloem may also transport stored sugars from the roots up to the rest of the tree (for example, in the springtime, the sap of sugar maple rises from the roots and is tapped by people to make maple syrup.

Bark is a very important part of a tree. The outer bark acts as a suit of armor against the outer world. It wards off insects and disease, and it protects the inner tissues against damage from storms or extreme temperatures. The bark of certain species also protects the tree from fire. Bark descriptions are based on color, texture, thickness, shagginess, and other relevant details (spongy, covered with spines, etc.) The bark of some species changes significantly with age.

Tree Study
(adapted from “Adopt a Tree,” Project Learning Tree)
(20 minutes)
Leaves (or needles) are the food factories of a tree. Using energy from the sun, which they capture with a pigment called “chlorophyll,” leaves convert carbon dioxide and water into oxygen and sugar (food!) through the process called photosynthesis. The gases needed for and generated by photosynthesis enter and exit through tiny holes called “stomata,” on the surface of the leaves. Water vapor also exits through stomata in the process called transpiration.

The overall shape of a leaf, texture of it, number of its parts, leaf arrangement, and margin design give clues to the tree’s identity. The shape of the leaves differ in many ways. The tips of leaves may be notched, pointed, rounded, tapered, and so on. The bases of the leaves may be squared, rounded, heart-shaped, and so on. Some leaves have teeth (serrated) along their margins, some leaves are lobed, and some leaf margins are smooth (entire). Some leaves are completely hairy, other have hairs on only one side, and others are completely smooth. Leaves also may be thick or thin, rough or waxy. Leaves with only one piece to them are called simple. Compound leaves, on the other hand, are made up of several leaflets. Many trees have alternate leaves that are staggered along the twig. Other trees have opposite leaves that grow in pairs on the twigs.

Materials
pencils, field notebooks, hand lenses, chart paper, easel, chart pens, Guidelines for Collecting in Nature, p. 61

Preparation
• This activity works best in a mixed-species forest.
• In the area where this activity will take place, collect from the ground underneath some trees several kinds of objects that represent the characteristics of trees. Be sure you have included some objects for the characteristics the students will be studying. Examples of objects to collect would be leaves or needles (pointy edges, fuzzy underside, pine-needle clusters); bark (rough, smooth, crumbly); and nuts, seeds, or fruits (acorns, walnuts, cones).

• Find an area in the forest that would work well for the study, each student needs his/her own tree within the boundaries you set. Be prepared to identify the different trees in the study area.

Activity Outline
Introduction (Steps 1-3, 2-3 minutes)
Observation of Tree (Steps 4-9, 6-8 minutes)
Acrostic Poetry Writing (Steps 10-12, 3-4 minutes)
Closure (Step 13, 4-5 minutes)

Procedural Steps
1. Ask the students to name something that is their very own or is special to them in some way. Listen to students’ responses and when all who want to have shared, move on.

2. Explain that each person will get to study his/her own tree for the next few minutes. Ask them:
   “Are all the trees in this area the same?”
   “What are some of the things that might be different about the trees?”
   “What are some of the things you can look for as you study your individual trees?”

As the students share these responses make a list of their ideas on the chart paper.

3. Ask the students to turn to page 12 in their notebooks. Go over the table and the two questions for this activity. Point out any of the ideas from the students’ list that are found in the table. Focus specifically on the last row of the table. Ask the students:
   “Which of your ideas would be good ones for
My Tree is...?

“What types of things could you observe about a tree that would help you complete this sentence?”

4. Explain to the students that they will need to complete the table and the two questions as they study their own trees. Encourage the students to use hand lenses as they look at the bark and leaves/needles of the trees; to look at the tree from different viewpoints: lying down on the ground, sitting with back to tree and looking up, stepping back from the tree (at three to four different distances) and looking up, etc. Remind students to use complete sentences in the table.

5. Caution the students not to do anything that would damage the trees. Tell them they should not tear living parts off the trees. Summarize the Guidelines for Collecting in Nature.

6. Have the students form a circle around you. (Depending on the spot you selected, the circle may enclose some trees as well. This is all right.) The students should be facing outward. They should extend both arms and move outward in this circle until the fingertips on each hand just touch those of the person on either side. When all students are set, tell them that the tree each of them will study will be first one that they touch with either hand (or arm) as they walk in a straight line away from the circle.

7. When you are sure all students understand, tell them to start walking out from the circle to find their tree and start their observations.

8. Circulate among the students as they work. Be prepared to redirect students if they are struggling to focus on the activity or finding ways to express their observations within the framework of the table.

9. When the allotted time has passed, call students together. Ask them to share some of their observations. Encourage each student to share one or two observations about his/her tree. Ask several students to tell how they knew if their tree was alive.

10. When all have shared, tell the students that they will finish this activity by writing a poem about their trees. This poem will be an acrostic, a poetry form in which the first letter in each line, when read vertically, spells out the name of something, in this case, TREE. You may cite this as an example:

   Towering
   Reaching
   Extending
   Embracing the sky

The students should use the observations in their tables to form their own acrostic poems.

11. Tell the students to return and sit under their trees to compose their poems.

12. When the writing is completed, call the students back in and have them share their poems.

13. To transition to the final activity of this field study say: “While the forest is a living community dominated by trees, the forest ecosystem depends on animals as well. Our next activity will allow us to look for some of the animal life found in a forest.”
Animal Detective
(20 minutes)

Activity Overview
The forest is home to a variety of animal life. Students collect information about different animals living in the forest and look for signs of animal life.

Learning Objectives
To successfully complete this activity the students will:
- find and identify signs of animals living in the forest
- describe animals that live in the forest
- communicate the importance of these animals to the forest

Science Process Skills
The students will engage in scientific inquiry through: observing, identifying, interpreting, concluding, communicating

Background for Teachers
While trees and plants are usually the most conspicuous elements in the forest, the forest community also depends on animals. Animals are vital to most plants because they help pollinate flowers and disperse seeds. At the same time, animals may eat certain plants, greatly reducing their numbers. Some insects can substantially damage a forest ecosystem if their numbers get too high. Insect-eating birds play an important role in keeping insect populations in check.

A tree can be the entire habitat for many tiny animals that live in its bark and among its leaves. A shrub may be a food source for a deer. While the animals themselves are not readily available for one to observe, one can search for and find signs of animal life. Even in the most sterile-looking environment, you can usually find some signs of animal life. These signs include: gnawings, scratches, tracks, scat, litter, dust baths, burrows, feathers, mud nests, paper nests, ground nests, bark tunnels, galls, leaf mines, insect egg-masses, runways, uneaten or partially eaten food, webs, songs, sounds, rolled leaves, nibbled leaves, etc. The animals leaving these signs could be mammal, insect, spider, bird, reptile, or amphibian.
Material
Laminated Signs of Animal Life charts, pencils, field notebooks, forest animals reference books, pictures of forest animals, chart paper, chart pens, easel

Preparation
- Survey the study site for any potential hazards and risks. Be ready to caution students about these before they are sent out into the study area.
- Find an area in the study site that has various types of trees and shrubs.
- Decide how the activity will be conducted: each study group free to roam over the entire sight or each study group having a designated area in which to search for signs of animal life.
- Collect fallen leaves, twigs, bark, fruit or nuts that show signs of animal life (chewed holes, tunnels, scrapings, egg cases, webs, galls, etc.) Try to collect 4-5 different signs of animal life.
- Search the area in greater detail to determine the number of different signs to be found. If too few signs are available, allow students more time to use reference books about forest animals to find out about animals that live in the forest and any signs that might be found of their presence.
- Determine the strategy for the activity. Will the students be allowed to collect any of the signs? What cautions might be needed in this effort? What will be a good spot for the students to use the reference books?

Activity Outline
Introduction (Steps 1-2, 2-3 minutes)
Search for Animal Signs (Steps 3-6, 6-8 minutes)
Use of Reference Books (Steps 7-8, 4-6 minutes)
Closure (Steps 9-11, 2-3 minutes)

Procedural Steps
1. Ask the students:
   “Have you seen many animals in this forest?”
   “Do you think animals live here?”
   “What kinds of things could you look for to show that different animals do live in this forest?”
   “Where in the forest might you find these signs?”

On the chart paper, make a list of the students’ ideas for life signs and where they might be found.

2. After the students have completed their lists, show them the signs of animal life you collected earlier. Lead the students in a discussion of these signs. Tell the students how these are examples of animal life in the forest. If you collected life signs that are not on the students’ list, please add these items to that list.

3. Tell the students they will search for their own signs of animal life. Have the students form groups of 3-4. Distribute a Signs of Animal Life chart to each group. Tell them the chart describes some of the different signs of animal life they could look for on their search. Encourage students to ask questions about any of the items on the charts.

4. State the boundaries of the search and whether all groups can roam freely and search the entire area or search in a specified area only. Encourage the students to look for (and collect, if possible) as many signs as they can find. If the students are not allowed to collect the signs, tell them to write on the chart where they found each sign (on the ground, on tree bark, on a shrub leaf, on a twig, etc.)

5. Send the groups off on their searches.
6. After the allotted time, call the groups back in. Have the students share some of the signs they found on their searches. Ask them to share their ideas about the animals that left each sign. Ask them to give the reasons for their responses.

7. When each group has shared, tell each group to select three or four of the signs they found. They should record these signs and where they were found on page 12 in their notebooks. Tell them they will spend the next few minutes trying to find out what animals may be responsible for leaving the signs they chose. Tell them to include an item of information about the forest animal in column 4 of the “Animal Detective” chart in their field notebook.

8. When the time has passed, ask the students to share what they discovered about the animals that may have caused the signs they selected. After the groups have responded, ask:

“What general statement can you make about the kinds of animals that live in the forest?”

“Do you think a forest could survive without any animal life?” “Why?”

9. Close the activity by saying: “Both plants and animals are needed in the forest. How they interact with each other is the subject of another field study.”

10. Close the field study by saying: “During this field study, we have looked at the variety of plant life in the forest, explored plant growth, studied individual trees, and found signs of forest animal life. What we have accomplished is answering the questions: ‘What makes a forest a forest?’ ‘What and who lives in the forest?’”

11. Add: “Also during this field study we’ve encountered some new vocabulary. What are some of these words? What do they mean?” Have students record four or five of these terms on page 11 of the field notebook under “Vocabulary Gained.”
## Signs of Animal Life

<table>
<thead>
<tr>
<th>Sign</th>
<th>Where Found</th>
<th>Animal Who Made It</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Galls</strong>&lt;br&gt;(abnormal swellings on plants)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rolled Leaves</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Leaf Mines</strong>&lt;br&gt;(blotches or tunnels on leaves)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mud Nests</strong>&lt;br&gt;(side-by-side tubes)</td>
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<td><strong>Paper Nests</strong>&lt;br&gt;(gray, paper-like nests)</td>
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<td><strong>Scat</strong>&lt;br&gt;(solid animal waste)</td>
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<td><strong>Feathers</strong></td>
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<td><strong>Nibbled Leaves</strong></td>
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Forest Ecological Connections
An Investigation of Relationships Within and Between Ecological Communities
Stumpin’ Around
(adapted from “The Fallen Log,” Project Learning Tree)
(15 minutes)

**Activity Overview**
One might be amazed by the number of things found in or on a stump or rotten log. This activity allows the students to gain an awareness of some of the different plants and animals that have homes in this habitat.

**Learning Objectives**
To successfully complete this activity the students will:
- observe the living things on a stump or rotten log
- draw conclusions about and record the effects of these things on the stump or log
- describe the process of decomposition
- demonstrate an understanding of the importance of a stump or rotten log by not tearing it apart as they explore it
- communicate their conclusions about the ecological interactions occurring on a stump or rotten log

**Science Process Skills**
The students will engage in scientific inquiry through: observing, inferring, interpreting data, communicating

**Background for Teachers**
Trees collect minerals and other nutrients from the environment (the soil and air around them) and use them to build bark, wood, branches, leaves, and roots. When a tree dies, its nutrients become available for animals and other plants to use. As the nutrients are used, the tree is slowly broken down into **humus**, a dark rich layer of soil. This breaking down process is called **decomposition**.

Wood-eating insects, such as bark beetles, as well as fungi and bacteria, invade a dead or dying tree, paving the way for other invaders. A rotten log or stump is often called a “nurse” log because it acts as a nursery for young forests plants.

Decaying wood is sure to have fungi, moss, and lichens growing on it. Wildflower, tree, and other plant seeds that land on the soft wood of decomposed log or stump may sprout and grow. Plants and fungi penetrate the wood and break it apart as they grow. Lichens release a weak acid that breaks down the wood. Moss holds in moisture, making the log a suitable habitat for many plants and animals.

Termites, sow bugs, carpenter ants, and wood roaches are all examples of creatures that eat or tunnel through wood. As they chew their way through the wood, they help break down the log or stump. Bark beetles eat through the living tissue just under the tree’s bark. Evidence of their work is easy to find on most dead logs or stumps. The tunnels of those tiny insects create intricate patterns in the wood underneath the bark.

Some animals, such as centipedes and spiders, feed on sowbugs, millipedes, and other insects that feed on the decaying wood. The predators, and the scavengers, become meals for birds, skunks, and other animals that reach into a log or stump to find food.

Many creatures depend on decaying wood as shelter. Patent leather beetles, click beetles, and other animals may winter there. Some beetles, wasps, slugs, and other animals lay eggs in decomposing wood. Salamanders may wait in the cool dampness of a stump or rotting log during the day and hunt for food at night. As these animals burrow into the log, breaking it apart, they add to the decomposition.
Stumpin’ Around
(15 minutes)

Materials
field notebooks, pencils, hand lenses, field guides to: insects, spiders, and nonflowering plants

Preparation
• Locate a stump or rotting log on which the effects of living and nonliving things can be observed. If possible locate an area with more than one stump or rotting log so that each small group of 3-4 students will be able to work on its own. (Large fallen limbs and rotting pieces of lumber can work also.)
• Prepare a chart-sized version of the table on page 13 in the field notebook to write the students’ discoveries.
• Collect leaves, twigs, bark, etc. as examples of animal habitats.

Activity Outline
Introduction (Steps 1-2, 2-3 minutes)
Observing the Stump (Steps 3-5, 6-8 minutes)  
Closure (Step 6, 3-4 minutes)

Procedural Steps
1. With the students gathered around you, show them the leaves, twigs, etc. you collected. Ask:
   “What living things might you find on these objects?”
   “Why would these living things be there?”
   “If I put these objects back on the ground where I found them, what would eventually happen to them?”
2. Say:
   “This activity will let us look at a much smaller habitat than any of the others you may have investigated—a stump (or rotting log).”
   “What living things would you expect to find on a stump (or rotting log)?”
   “What happens to stumps in a forest?”
3. Have the students form groups of three to four. Explain that each group will study a stump (or log.) Students need to record, on page 13 in their notebooks, each different kind of plant or animal found, where it was found (on top of the stump, on the side near the top, on the side near the base, under the bark of the stump, on the ground), what it was doing, and what effect it might have on the stump.
4. Discuss with the students the need to carefully examine their stumps without tearing the stumps apart. They may gently lift pieces of bark to look under them, but should not pull bark off the stump. When the students finish examining the stump, they should study areas around it, leaf litter, under rocks, etc. Have them write their findings in the “Stumpin’ Around” table on page 13. Have the groups go study the stumps.
5. When the time has elapsed, call the students back together. Have the students share their discoveries by posing the following questions:
   “What kinds of plants were on the stumps?”
   “What kinds of animals were found on the stumps? Where were these animals found?”
   “How do the animals you found on the stump interact with it?”
   “What living things did you find in the areas around the stumps? Were some of these the same as you found on the stumps? What do these areas and the stumps have in common?”
   “Was the tree from your stump removed a long time ago or a short time ago? Why do you think so?”
   “How does the forest benefit from a stump?”
6. Transition to the next activity (that uses this data) by saying: “Now that you have found the plants and animals that live on a stump, you have a chance to tie these organisms together.”
**Forest Cycles**  
(adapted from “Nature’s Recyclers,” Project Learning Tree)  
(10 minutes)

**Activity Overview**
Using the data collected in the previous activity, the students will draw a simple cycle of the interactions among plants and animals living on a stump to show how plants and animals depend on each other.

**Learning Objectives**
To successfully complete this activity the students will:
- identify ways plants and animals interact in the microhabitat of a stump
- infer relationships among these plants and animals
- communicate the meanings of their cycles

**Science Process Skills**
The students will engage in scientific inquiry through: interpreting data, inferring, communicating

**Background for Teachers**
A forest is a living community dominated by trees. Each plant in the forest, from tiny mosses to giant trees, has its own specific needs for sunlight and moisture. Because environments vary tremendously, a specific location will be better for certain plant species than for another, and those species will grow more abundantly as a result. The most dominant tree species in a forest usually determines the forest’s appearance and suitability as a habitat for other plants and animals. For example, in some forests, large, dominant trees may reduce sunlight and monopolize soil moisture and nutrients, thus limiting the types of plants that can grow beneath them.

While trees and plants are usually its most conspicuous elements, the forest ecosystem also depends on animals. Animals are vital to most plants because they help pollinate flowers and disperse seeds. At the same time, animals, such as deer, rabbits, and insects, can substantially damage a forest if their numbers get too high. Insect-eating birds and other predators play an important role in keeping insect populations in check.

Another way that forest plants and animals are connected is through a web of eating relationships. One primary function of an ecosystem like a forest, is the production and distribution of energy. All life depends on the ability of green plants to use sunlight to synthesize simple sugars from carbon dioxide and water. Through this process, called photosynthesis, plants take energy from sunlight and make it available to animals. Plant eaters, or herbivores, eat the plants directly; flesh eaters or carnivores, in turn eat herbivores or other carnivores, thus forming a food chain. A food chain is a simplified way of showing energy relationships between plants and animals in an ecosystem. For example, the food chain: sun → sunflower seed → mouse → owl, follows the energy exchanged as a seed is eaten by a mouse, which in turn is eaten by an owl. However, rarely does an animal eat only one type of food. A food web describes the interconnection of the food chains and gives a clear picture of the relationships between plants and animals in an ecosystem.

All parts of the environment form an interactive community. Animals acquire energy for life by eating plants and other animals. In turn, these animal will become food for scavengers such as maggots or vultures, or decomposers such as fungi and bacteria.
Trees have many different roles in the forest community depending on their age and size. Their leaves, bark, seeds, flowers, fruit, and roots provide food for many kinds of animals. Trees also provide roosts, shade, and shelter to many living things. For example, holes in older trees and around their roots provide shelter for animal's nests and dens.

Like all living things, trees are subject to disease and injury. Physical damage may not kill the tree, but may provide holes and openings in which animals and insects can live and feed. Eventually, trees weakened by injury and disease will die, fall down, and decompose. When they die, trees return their nutrients and other elements back into the soil and are recycled throughout the forest ecosystem.

The cycles in the forest are numerous. A tree life cycle, from seed to rotting log or stump to seed, is one example. Food webs represent other cycles. Social and economic cycles affecting forests would also be possibilities.

Many living things depend on dead trees for food, shelter, and/or nesting sites. Fungi, bacteria, and wood-eating insects such as termites and some beetles are usually the first to “move into” a dead tree. As they feed on the tree, they help soften the wood. The tunnels of the wood-eating insects provide access routes through which water, fungi, and bacteria enter the tree. Small animals lay their eggs in the soft wood and the larvae feed on the wood when they hatch. Others feed on the fungi or animals already living in the dead tree. And some animals make their nests or seek shelter inside decaying trees. As all of these animals excavate, eat, and burrow through trees, they help to break them down. It takes a long time to turn a tree back into the humus that nourished it as a seedling.
**Forest Cycles**
(10 minutes)

**Materials**
field notebooks, pencils, colored pencils, crayons, chart paper, chart pens

**Preparation**
- Find an area suited for this activity, one where the students can sit with their backs to trees as they study their data and draw their cycles.
- Brainstorm closure ideas that allow the students to maximize their drawn cycles.

**Activity Outline**
Introduction (Step 1, 1-2 minutes)
Drawing the Cycles (Steps 2-5, 3-4 minutes)
Sharing/Closure (Steps 6-7, 3-4 minutes)

**Procedural Steps**
1. Ask:
   “What are some words or phrases that contain ‘cycle’?”
   “Does ‘cycle’ have the same meaning in each of these words or phrases?”

   Continue with:
   “We all have our own ideas about the meaning(s) for the word cycle. In this activity you will use your definition of cycle to making a drawing of what you think is a cycle taking place among the plants and animals you ‘discovered’ on the stump. You will work alone and have 3-4 minutes to think about and complete your drawing. Place your drawing under Forest Cycles on page 13 in your notebooks.”

2. Send the students off to work.

3. When the time has elapsed, call everyone back together. Ask for volunteers to share their diagrams or cycles. If appropriate, comment on how people defined and illustrated “cycle” differently.

4. Ask:
   “What cycles did you identify?”
   “What roles do these cycles play in the forest environment?”
   “What caused the stump to die?”
   “Can this be part of a cycle?”

5. Discuss the events that may have created the stump.

6. For closure choose an idea you like. If many of the cycles drawn by the students are similar, have those individuals draw on the chart paper one cycle, combining the elements of the various cycles. If enough of the cycles are different, have all students (in 2-3 groups) involved in drawing a diagram on the chart paper that combines all the elements into one cycle. Ask the students, in groups of 3-4, to illustrate the life cycle of a tree from birth to death. Consider any other possibilities you developed during the preparation phase.

7. Transition to the next activity with: “Just as the organisms found on and around the stump were suited to live there, other organisms are suited for their habitats as well. In our next activity, we will study some of the adaptations of birds that equip them to survive in their environments.”
Beaks, Feet, and Adaptations
(adapted from “Birds, Beaks, and Adaptations,” Minnesota Valley National Wildlife Refuge)
(30 minutes)

**Activity Overview**
The diversity of plant and animal life provides a showcase for the many different ways these organisms are adapted to survive in their environments. This activity allows students to examine some of the many differences in beaks, feet, and other adaptations of birds and other organisms.

**Learning Objectives**
To successfully complete this activity the students will:

- observe and compare different kinds of beaks, feet, teeth, and pelts, as well as the locations of the eyes in different animals
- draw conclusions about how the different adaptations equip each organism to survive in its habitat
- infer the habitat for which each organism is best suited
- communicate the ways adaptations in animals can be associated with an animal’s environment

**Science Process Skills**
The students will engage in scientific inquiry through: observing, comparing, hypothesizing, drawing conclusions, inferring, communicating

**Background for Teachers**
A habitat is the place where a plant or animal gets all the things it needs to survive: food, water, shelter, and space. A habitat may be as vast as a grassland that is hundreds of square miles or as tiny as a leaf. In either case, the organisms calling this habitat home would need to have their life needs met within this area.

All living things grow and change, as do their environments. Adaptations allow a plant or an animal to change to fit into its environment so it can survive. If an organism cannot change and adapt to its changing environment, the organism will die. The more versatile and flexible a plant or animal is, the more likely it will survive.

The variety of structural and behavioral adaptations of animals are particularly interesting to study. Animals have specialized body parts for protection: claws, teeth, beaks, armor, feet with hooves, horns, shells, antlers, and many others. Some animals are able to mimic other animals (coral snake and king snake; viceroy and monarch butterfly.) Others have behaviors that protect them. Some birds migrate; an opossum and a hognose snake play dead; bears and snails hibernate; some are able to withdraw into a shell. Many animal species employ camouflage (protective coloration) as a means of hiding from their enemies.

A bird’s beak is a unique, multifunctional tool. The shape of a bird’s beak gives clues to the bird’s main food source. Each beak has a shape designed for eating a certain type of food. A woodpecker’s beak is useful for drilling to obtain insects in the wood, and the duck’s beak is useful in the water as a shovel to find food in the mud.

Feet provide clues to the bird’s habitat. Bird’s feet are adapted for wading, climbing, perching, and grasping. Birds that swim and live near water have webbed feet (like the duck.) Birds that live in trees and need to perch on branches have feet with three toes in front and one long toe in back. Birds that climb trees (like the woodpecker) have two toes in front and two toes in back. Owls and hawks are animals that hunt prey. They have claw-like talons on their feet for attacking animals that they eat. Birds can be divided into groups according to how their bodies look, their size, where they live, whether they migrate, or what they eat.

The location of the eyes of an animal can also give clues about the role of the animal in the community, its habitat, and its protective mechanisms. Most birds have eyes located on the
sides of their heads. They can look at something with one eye at a time. This helps them look for food on the ground, as well as making it easier to see a predator approaching.

Sharp teeth are needed by carnivores for tearing into the flesh of their prey. Flat-surfaced teeth serve herbivores well in grinding the plants they consume. Pelts can be indicators of the ability of an organism to tolerate heat/cold and accommodate heat exchange. While these are just some of the many adaptations by animals, they all have one thing in common. Adaptations are necessary for species survival.

Most adaptations evolve over long periods of time and help a species better fit into its slowly changing environment. People can cause sudden environmental changes that are difficult for animals to adapt to in a short period of time. One of the greatest threats to animal life is the destruction of habitat by human intrusion. For example, if an animal is dependent on a food source, and that food source disappears, they cannot suddenly change their structures and behaviors and find another food source.
Beaks, Feet, and Adaptations
(30 minutes)

Materials
mounted birds, deer skull, dog skull, skulls of other animals, pelts, tweezers, meat tongs, spaghetti tongs, needle-nosed pliers, nutcracker, pencils, field notebooks, chart paper, chart pens, pictures of animals showing different adaptations (enough for each group of 2-3 students to have two or three different pictures), Beaks, Feet, and Adaptations laminated sheet for each student, water-soluble transparency markers

Preparation
• Survey the room containing the materials to develop a plan for displaying the birds, skulls, and pelts that would allow students to study the different objects and be able to move with ease through the display of items.
• Select a mounted bird, animal skull, and pelt to be used introducing the activity. The selected items should not be placed out again for the students to use in their observations.
• Be familiar with the household and kitchen tools so that you can share how each one represents an animal adaptation for survival.
• Write on the chart paper the names of the tools, leaving room to write student responses as they share their ideas about the adaptations represented by each tool. Prepare a sample chart from page 14 to use to illustrate the types of entries students should make. Be ready to complete this chart for the samples you use to introduce the activity.

Activity Outline
Introduction (Steps 1-2, 6-8 minutes)
Observation of Adaptations (Steps 3-6, 10-12 minutes)
Sharing and Recording (Steps 7-8, 5-7 minutes)
Closure/Transition (Steps 9-10, 2-3 minutes)

Procedural Steps
1. Ask:
   “Have you ever changed?”
   “What caused your change?”
   “What would have happened if you had not changed?”

   After listening to the students’ responses, say:
   “All living things grow and change. These changes most often occur in response to what is happening in the surrounding environment.”
   “If living things are to survive, they must change.”
   “In this study, we will look at some of the many ways animals have changed (adapted) in response to changes in their environments.”

2. Display the collection of household and kitchen tools. Ask the students:
   “What do these objects have in common?”
   “All of these objects are representative of some of the ways that animals, especially birds, have adapted to their environments.”
   “What are some of the adaptations represented by these tools?”

   Write the student responses on the chart.
   “Can you think of other household or everyday objects that could be used to represent animal adaptations?”

   As the students share, add these ideas to the ones already listed. Ask:
   “Are there other adaptations by any animals that we can add to this list?”
   “What can we learn by looking at the adaptations of animals?”

3. Have the students move so they are sitting in clusters of 2-3 students. Distribute the pictures
of animals and a sheet of paper to each group. Ask the groups to look over each picture and to compile a list of things they can find out by studying animal adaptations on the sheet of paper. Allow the students 2-3 minutes to look over the pictures.

4. As the students study their pictures, bring out the skull, mounted bird, and pelt. At the end of the time for reviewing the pictures, gain the students’ attention. Ask: “What things can you learn by studying the adaptive features of animals?”

5. After the students have responded, show, one at a time, the skull, pelt, and mounted bird. Point out the adaptive features on each, what the adaptation means for that animal, and describe the animal’s habitat. Be careful to point out teeth, eye location, beaks, feet, pelt thickness, color, etc.

6. Tell the students that now they will study adaptations using objects similar to the ones you just used. Distribute the Beaks, Feet, and Adaptations sheet to each student for use as they study the available objects. The students will conduct the study in groups of 3-4. The students will need to record, by drawing or in writing, their observations on the sheets. Encourage the students to discuss their observations before making their entries on their individual sheets.

7. At the end of the observation period, call the students back together to share their discoveries. Have each group share at least one observation about each adaptive feature. As they share their observations, ask questions that elicit what they think the assorted adaptive features tell them about each of the observed animal’s feeding habits, niche, place in their community’s food web, or temperature tolerance.

8. When all groups have shared, say: “Now that you have had time to study some of the many ways that animals are adapted to their environments, you will need to take some time to select two of each adaptation to record in your field notebooks. For each feature you select, you may draw or describe with words that adaptation and write what it tells you about that animal. I will complete a sample chart using the information from the samples I showed you at the beginning.” Complete your sample chart; then tell the students to begin work on their own. Remind them to answer the two questions following the chart.

9. After the recording is completed, lead the students in the following discussion. Ask:

   “What might happen to an animal if its habitat were changed suddenly and drastically?”
   “Would the animal need different adaptations to survive?”
   “How might an animal’s habitat be changed?”
   “What can people do to help save animal habitats?”

10. Say: “Where an organism lives must be some place where all the needs of that organism can be met. We have looked at some of the adaptations of animals that equip them to survive in their habitats. Our last activity will be one that lets us examine how trees meet the needs of those plants and animals that make their home on/in it.”
### Beaks, Feet, and Adaptations

Complete the table for the animals you saw and their adaptations. You may describe with words or a drawing.

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Home, Home in a Tree
(adapted from “Trees as Habitats,” Project Learning Tree)
(25 minutes)

Activity Overview
From their leafy branches to their tangled roots, trees provide a habitat for a host of plants and animals. In this activity, students will discover how plants and animals depend on trees in many ways.

Learning Objectives
To successfully complete this activity the students will:
• take inventory of the plants and animals that live on, in, and around trees
• identify ways those animals and plants depend on trees for survival
• identify ways those animals and plants influence the trees
• communicate their understanding of the interdependency of organisms

Science Process Skills
The students will engage in scientific inquiry through: observing, identifying relationships, collecting data, organizing data, inferring, predicting

Background for Teachers
A habitat is the place where a plant or animal gets all the things it needs to survive, such as food, water, shelter, and space for living and raising offspring. Habitat may be the hundreds of square miles of grassland needed for a lion, while an insect may spend its entire life on a single plant.

Trees are important components of a forest habitat. They provide food, shelter, and structure. Trees may serve as part of an organism’s habitat, or may be the organism’s entire habitat. For example, an oak tree can provide food for squirrels, a nest site for crows, or provide home and food for the lichens, mosses, or ferns growing on its branches.
Home, Home in a Tree
(25 minutes)

Materials
field notebooks, pencils, hand lenses, binoculars, bug boxes, field guides, chart paper, chart pens, easel, Tree Story sheet (1 for each group)

Preparation
• Locate several trees and shrubs that provide homes for a variety of plant and animal life in the study area. Tag these trees as starting points for the study groups during this activity.
• Set up a chart, similar to the one on page 14 in the field notebook, for summarizing the findings from the entire group.

Activity Outline
Introduction (Steps 1-2, 3-4 minutes)
Habitat Study (Step 3, 8-10 minutes)
Presentation of Findings (Step 4, 4-5 minutes)
Closure (Steps 5-6, 5-6 minutes)

Procedural Steps
1. Point to a tree and ask the students to name some plants and animals that might depend on the tree. List their answers on the chart.
2. Tell the students that they are going to study a tree to find out which plants and animals depend on it or use it in some way. Explain that they should try to determine which animals only visit a tree, and which plants and animals actually live on it or in it. They should watch for clues and signs such as chewed leaves, holes in the bark, etc. They should be sure to record where on the tree they find either living things or signs of life on page 14 of their field notebooks.
3. Have students form groups of 2-3. Point out the tagged trees as the starting point for the study. Tell students that they may move to another tree if they finish the inventory of the first tree before the observation time has elapsed. Encourage the students to draw pictures of all the plants and animals they find on page 14, especially those they cannot identify. Distribute binoculars and bug boxes. (The binoculars may be used by the students to get a closer look at the branches and treetops. The bug boxes may be used to place the insects for a closer look.) Caution students to return each organism to the place from where it was taken as soon as they have finished their observation of it.
4. When the time has elapsed, have the teams present their data to the rest of the group. As the groups share, enter their data into the table you set up earlier. Discuss these questions with the students:
   “Were there similarities among the animals found on the tree’s trunk? Its leaves? Near its base?”
   “How might the tree be affected by the plants and animals that live in or on it?”
   “Did any of the plants or animals you found seem to harm the tree? Why do you think so?”
   “Do any of the plants and animals you observed seem to benefit the tree? In what ways?”
5. To close the activity ask each group to complete the Tree Story page to develop a short story from the perspective of a tree. In the story, the tree should tell how different plants and animals depend on it and how they affect it. Have the students share their stories.
6. To conclude the field study ask: “What are some of the vocabulary terms we used to study the connections between forest plants and animals? What do these words mean?” Have students write four or five of these terms on page 13 of the field notebook under "Vocabulary Retained."
**Tree Story**

I am a __________________ tree. My home in the forest is ______________________________________________. There is no other tree in the forest like me because__________________________ __________________________________________________________________________________________. I am important to the forest because plants like _______________________________ __________________________________________________________________________________________ and animals like ___________________________ __________________________________________________________________________________________ make their home on or in me.

The ________________________ plant likes me because __________________________ __________________________________________________________________________________________. It depends on me for __________________________ __________________________________________________________________________________________. Another plant that I provide a home for is the __________________________ __________________________________________________________________________________________. This plant depends on me for __________________________ __________________________________________________________________________________________. These plants affect me by__________________________ ____________________________________________________________________________________________.

I feel really special because two of the animals that live in me are __________________________ __________________________________________________________________________________________. They depend on me for __________________________ __________________________________________________________________________________________. These animals affect me by__________________________ ____________________________________________________________________________________________.

I like being a tree because __________________________ __________________________________________________________________________________________. Sometimes it’s not so good being a tree when __________________________ __________________________________________________________________________________________. But being a tree is all I can be. I want you to know this about me: __________________________ ____________________________________________________________________________________________.
Meadow Plant & Animal Survey
An Investigation of Relationships Within and Between Ecological Communities
A Field of Dreams
(adapted from “Define and Locate Plant Communities,” USDA Forest Service)
(15 minutes)

Activity Overview
This activity gives students the opportunity to explore a meadow environment and to define those features that distinguish this ecosystem.

Learning Objectives
To successfully complete this activity the students will:
• observe and describe those features characteristic of a meadow community
• develop an operational definition of a meadow
• infer the type of plant and animal life found in meadow using the observed characteristics
• communicate the uniqueness of a meadow community

Science Process Skills
The students will engage in scientific inquiry through: observing, defining, inferring, analyzing, operationally defining

Background for Teachers
In an ecosystem, living and nonliving elements constantly interact. For examples, most plants depend on soil for water and nutrients, and they need sunlight to manufacture food. Some plants also depend on animals for pollination and seed dispersal. Animals in turn, depend on plants for food and shelter. Some animals may also depend on other animals for food and protection.

An open meadow or field can provide an wonderful outdoor classroom for students to explore ecological relationships. The lack of shade in a meadow gives it characteristics very different from those in the pond or forest.

Many of the large meadows we see today were once farmland. Some meadow and field areas were never cultivated, but for various reasons, trees in these areas were removed, did not survive, or have been very slow to take over. Sometimes a meadow or field exists because the soil is sandy or because it has large, underlying areas of rock. It may lack adequate amounts of life-sustaining nutrients for trees.

Due to the lack of an overstory, meadows and fields have little protection from wind and rain and receive direct sunlight at ground level. Direct sunlight makes the habitat hot and causes rapid evaporation of moisture. These conditions have an effect on plant and animal life.

A special group of plants and animals live with the unique challenges present in meadows. Many plants have leaves and stems with tiny hairs. These hairs effectively reduce air flow over the surface of the plant, which minimizes water loss through evaporation. Plants growing in this environment also have smaller, thicker leaves which leave less surface area for water loss through transpiration. Meadow animals often live underground where it is cool and protected. Many of the animals get the moisture they need from the plants they eat.

The edge of meadows and fields, the transition zones between the meadow and other ecosystems, may provide clues for clues to the state of change in the meadow. Is the meadow a stable community? If left alone, would it continue as a meadow? Or is it just a step along the evolutionary path to an entirely different community? Plants and animals are often more diverse in a meadow than we first imagine because of the changing nature of the habitat.
The SMILE Program
Outdoor Science Adventures for Elementary Students

Materials
pencils, field notebooks, chart paper, chart pens, pictures of different fields (soccer, football, baseball, rice, minefield, etc.)

Preparation
• Determine a strategy for displaying all of the field pictures after you have introduced them. This will allow the students to view them all simultaneously as they look for similarities and/or differences.
• Scout the study area to locate three places that have well-defined transition zones, one of which is from a forest.
• Decide on the physical boundaries for the students as they conduct the study. Will all groups simultaneously survey a given site and then move together to the next area? Will the groups be assigned to different areas of the study site to begin the survey?

Activity Outline
Introduction (Steps 1-5, 2-3 minutes)
Observing in a Meadow (Steps 6-8, 6-7 minutes)
Defining a Meadow (Steps 9-11, 2-3 minutes)
Closure/Transition (Step 12, 1-2 minutes)

Procedural Steps
1. Hold up the field pictures, one at the time, and ask: “Do you recognize what’s in this picture? What is it used for?”
2. When you have gone through and displayed all the pictures, say: “These pictures represent different areas that are called fields. Can you look to see what things these different fields have in common.” As the students share their ideas, write them on the chart.
3. When the students have completed their list, ask: “Can you use this list to develop a definition of field?” Elicit responses from a few other students. Again, write the ideas on the chart.
4. When the list is complete, say: “This study area, a meadow, is often referred to as a field. Do the definitions you just shared fit this area?”
5. Say:
   “Before we try to develop a definition for this field or meadow, we will need to make some careful observations. While we are focusing this year on the living factors in ecological communities, your observations may address both living or biotic and nonliving or abiotic aspects of this community.”
   “In groups, you will observe three areas in this meadow, and we will use your observations to develop a definition for meadow.”
6. Divide the students into groups of 3-4 and point out the three areas. Explain why they will be collecting data in three areas to develop a definition of meadow.
7. Tell the students the logistics for the session you settled on previously. Ask:
   “What kinds of things should you look for in each area?” Say:
   “You will need to record your observations of the three areas on page 15 in your notebooks. Be sure to fill in the column header ‘Boundary with...’ with the what the meadow transitions into on the other side.”
Send the students off to conduct their study.
8. At the end of the observation period, gather the students and have them share their observations. Write these on the chart. Ask:
   “Are you surprised by any of the observations you made? Why?”
9. Say: “With these observations, do you feel ready to define meadow?” Display the list of student observations, as you prepare to write down their suggestions for the definition of a meadow.
10. Ask: “What is a meadow?” Encourage input from all students as you lead them to a definition that includes the openness, lack of shade, direct sunlight, and bordering ecosystems that would, if not prevented, spread out into the open area of the meadow.

11. Have students write the definition of meadow in their notebooks on page 15.

12. Ask:

“Are there any similarities between this meadow or field we have been observing and the ones we show in the pictures earlier?”

Say: “Just as each of those fields has a use, this field, the meadow, has a use?”

“Can you think of some ways that this meadow is useful?”

“Our next activity will help us find out how the meadow provides a home for special plants.”
Plant Neighbors
(adapted from “Plant Neighbors,” Massachusetts Audubon Society)
(25 minutes)

Activity Overview
This activity helps develop the concept of plant diversity. Through this activity, students will inventory a plot in a meadow community and map the distribution of selected plants in their environment.

Learning Objectives
To successfully complete this activity the students will:

• inventory a plant community
• describe the differences in plant distribution in a plot
• infer factors affecting this distribution
• communicate conclusions about plant distribution in a meadow community

Science Process Skills
The students will engage in scientific inquiry through: observing, using numbers, inferring, concluding, classifying, hypothesizing

Background for Teachers
An ecosystem is a community of different species interacting with each other and with the chemical and physical factors making up its nonliving or abiotic environment. It is a system of interrelationships among organisms, and between organisms and the physical environment.

Plants and animals in an environment interact with each other in various ways. Plants and animals also interact with the nonliving elements of their environment. Physical factors such as sunlight, moisture, temperature, and wind influence the suitability of an area for particular organisms. Those factors determine the kinds of plants and animals that live there. Physical factors may be determined by the area’s geography, such as its proximity to water, its elevation, or its geological features. In addition, the resident organisms (particularly plants) may affect the sunlight, moisture, temperature, and wind of the area.

Unlike what happens in a forest community, the openness of the meadow allows sunlight to reach the ground. For your discussion with the students, consider these questions: How are plant species distributed in the meadow? Is there a pattern throughout the meadow? Can we see the influences of the environment on the living, or abiotic community?
Plant Neighbors
(25 minutes)

Materials
pencils, notebooks, 4 hula hoops, chart paper, chart pens, three colors of colored pencils (4 of each color), markers to match the three colors of pencils (2 of each color), Plant Distribution Map (4 per group)

Preparation
• Locate 4 plots in the meadow that contain at least three of the same species of plants. If possible, the survey plots should be spread throughout the meadow. Place a hula hoop in each area. Be sure to position it to include the different plant species.
• Collect a sample of each of the three plants to be surveyed.
• Select a small area in the vicinity of the staging area and inventory and map two of the three species the students will be inventorying. Place the distribution map of this area on the large chart and save for later use. Use a different color of marker for each species of plant. Stake your small survey area so that students can view the area you used for collecting your data.

Activity Outline
Introduction (Steps 1-3, 1-2 minutes)
Plant Inventory (Steps 4-9, 5-7 minutes)
Compiling Data (Steps 10-12, 4-5 minutes)
Drawing and Writing Conclusions (Steps 13-14, 3-4 minutes)
Closure/Transition (Step 15, 1-2 minutes)

Procedural Steps
1. Ask: “What is a neighbor?”
2. Hold up the samples you collected earlier. Say: “In this activity we will find out where these plants live in the meadow and who their neighbors are.”
3. “Will each of these plants be found throughout the meadow?”
4. “Will their relative numbers in different plots be the same?”
3. Tell the students to take a look around the meadow. Ask: “What do you think you will find out about where and how many of these plants are found in this meadow?”
4. Divide the students into four groups of three each. Assign each person in a group to inventory one of the three sample plants you showed earlier.
5. Display the inventory map you completed earlier. Emphasize to the students that they will need to use a different color for each of the three species. Assign colors to make sure that each group uses the same color for a particular species of plant. Also, add that they will need to count and map from the same side of the plot, since they will need to combine their data to compile a distribution map for their plot.
6. Assign study plots for the four groups.
7. Distribute the Plant Distribution Map and colored pencils to each student.
8. Take care to ensure the students understand the instructions before they are sent off to their plots.
9. As students are working on the activity, circulate, monitor and adjust, and check for understanding.
10. When time is up for taking inventory, gather the students so that each group can compile a map for its plot. Give them a blank copy of the Plant Distribution Map to put their group map on. Tell the students to copy their group’s map to page 15 in the field notebook.
11. As they are working on their group maps, divide a sheet of chart paper into four squares, one for each group’s map.
12. Have each group draw an enlarged version of its map on the chart. Also, have groups share any other observations they made while doing the inventory.

13. When all maps are on the chart, ask:
   “Do the plots seem to have the same numbers for each kind of plant?” “Why do you think this is the case?”
   “What factors could have led to the plant distributions that we see here?”
   “What similarities and/or differences do you notice among the plots?”
   “Are there any patterns to the distribution of plants?”

14. Ask: “From our investigation, what factors have influenced the patterns of plant distribution in this meadow?” Have the students write their thoughts in their notebooks on page 15. Make sure they have copied their group map into their notebooks.

15. To transition to the next activity, say: “Now that we have looked at the distribution of plants in your study plot here in the meadow, we will focus on the characteristics of an individual plant.”
1. As a group, complete the legend at the bottom of this page.
2. Each of you choose one of the plants to count, map, and describe.
3. Working on your own paper, but from the same side of the plot as your group, map each location of your study plant.
4. When you complete your map, make a group map by combining the information from all three people’s maps onto a blank map.

First Study Plant ______________________________________________ Symbol

Second Study Plant ____________________________________________ Symbol

Third Study Plant _____________________________________________ Symbol
Activity Overview
When is a weed not a weed? This activity gives students a chance to study common “pest” plants in a setting in which they are valued members of the community.

Learning Objectives
To successfully complete this activity the students will:

• describe, measure, and record the characteristics of a plant often considered a weed
• infer the impact of location on the value given a plant
• infer the impact of location on the plant characteristics
• communicate inferences

Science Process Skills
The students will engage in scientific inquiry through: observing, recording, measuring, using numbers, inferring

Background for Teachers
Dandelions, bluebonnets, buttercups, and other flowering plants that grow in woods, meadows, deserts, and other natural areas are called wildflowers. These same flowering plants would be called weeds in a farmer’s cornfield.

A weed is generally thought to be any plant that grows where it is not wanted. A pecan tree growing among orange trees is a weed if only orange trees are wanted. Even a rose is considered a weed if it is growing in a field where a farmer has planted wheat. But roses in a rose garden, pecan trees in a pecan orchard, and dandelions in a meadow are not weeds.

While any unwanted plant is a weed, there are plants that are considered weeds no matter where they grow, such as cockleburs, nut grass, and ragweed. Plants that are not useful as food or admired for their beauty are also considered weeds. Most weeds seem to grow anywhere and need no special care. Their seeds spread easily, and weeds often grow even better than plants cared for in gardens and pastures. They are well adapted to a variety of conditions.

Not all wildflowers grow everywhere. Habitat conditions and hereditary traits determine where particular kinds of wildflowers will flourish. The physical characteristics of a habitat, variables such as temperature, moisture, light, wind, soil type, and the topography of the land, influence its suitability for a wildflower species. Even within a habitat some wildflowers tolerate wildly fluctuating physical conditions, while others are sensitive to the slightest variations. Many wildflowers have adapted to some of the earth’s most extreme environmental conditions.

Meadow-dwelling plants often have root systems designed for areas with limited water. The shallow, spreading root of chickweeds can absorb surface water quickly. Many wildflowers that grow in poor, sandy soils have long taproots that reach deep down into the earth to search for water.

Many meadow plants are protected from grazing animals by a coat of unpleasant-tasting fuzz. Still some other meadow plants sport stout thorns on their stems and sharp spines on their leaves. Thistles have certainly adopted this strategy.
Materials
pencils, field notebooks, ruler, six garden trowels, three pairs of garden gloves, chart paper, chart pens

Preparation
• Find an area of the meadow with an abundance of plants: dandelions, Canada thistle, yarrow, or burdock. The plants should be common enough in the meadow that removing a few will not disrupt the environment.
• Select two or three of the plants from the previous list. Collect one sample of each plant.
• These will be used to show the students what plants may be collected for their study.
• Decide if you want the students to collect their plants and return to a central location for the detailed study or to study their plants at their collection sites.
• Set up a table on the chart for groups to share their observations about leaves, root systems, branch patterns, and other major features after they have studied the different plants.

Activity Outline
Introduction (Steps 1-2, 2-3 minutes)
Plant Collecting and Study (Steps 3-6, 8-10 minutes)
Discussion (Steps 7-8, 4-5 minutes)
Closure/Transition (Steps 9-11, 1-2 minutes)

Procedural Steps
1. Hold up the plant samples you collected earlier. Ask:
   “What do you usually call these plants?”
   (Weeds)
   “Why are they called by that name?”
   “Does that name mean there is no value to these plants?”
   “What might be some useful things about these plants?”
2. Say: “In this activity you will study in detail one of these plants, note some general characteristics, and try to tie these characteristics to the habitat of the plant.”
3. Tell the students they will work in pairs. Each pair will collect one plant, and observe and measure some of its features. Also, remind students they should be careful to disturb the environment as little as possible when they are collecting their plant. Caution the students to be careful in removing the plant from the ground. As much as possible, the plant and its parts should be intact. Also, caution them to return as much soil as possible to the hole once they have removed the plant.
4. Have the students turn to page 16 in their notebooks. Use the following to explain the table to them: They should sketch their observations in the first three columns of the table under "Outcast." In addition to observing the features in these three columns, the students should take measurements of each feature and record that data in the proper column. The fourth column should be used for any other major features of the plant not covered in the first three columns.
5. Divide the students into pairs. Distribute a ruler, garden trowel, and one garden glove to each study pair.
6. Point out the areas you selected for the plant
collecting. Share with them the instructions for collecting and studying. Send the students on their way.

7. When the allotted time has elapsed, conduct a discussion about the students’ findings. One at a time hold up your plant samples, and ask which pair studied a plant similar to your sample. Have a volunteer come up and sketch in the appropriate spaces on the chart the leaves, branch pattern, and root system for that plant. Measurements should be included. You may choose to write in the observations about other major features. Continue with the remainder of the species studied.

8. While viewing the chart, ask:

   “Are their similarities that you notice among any of the features of the different plants?”

   “What explanations can you offer for these observations?”

   “Since all these plants were found in the meadow, what effect does location have on these features?”

9. Say: “To conclude our study of some plants we often think of as weeds, you should complete the sentence on page 16. "A weed is not a weed when..."

10. Ask some students to share their sentences.

11. To transition to the next activity say: “Now that we have looked at some of the plant life in the meadow community, let’s find out what animals live here.”
Activity Overview
A ground-level inspection of a meadow can reveal an amazing amount of animal presence and activity. Through this activity, the students use a different perspective to explore the meadow habitat, while looking for signs of animal life.

Learning Objectives
To successfully complete this activity the students will:
• observe the diversity of animal life in a meadow
• describe the animals that live in a meadow habitat
• make inferences about their observations
• communicate ways the meadow provides homes for these animals

Science Process Skills
The students will engage in scientific inquiry through: observing, interpreting, concluding, inferring

Background for Teachers
Habitat refers to the place where an organism lives. Its habitat provides an organism with everything it needs to survive, including its specific needs for food, water, shelter, space, and reproduction.

Habitats vary tremendously in terms of size and appearance. For example, a field is home to many types of grasses and to mice, rabbits, and other animals that live among the grasses. A tree is the entire habitat for many tiny animals that live in its bark and among its leaves. A crack in a sidewalk is the habitat for the dandelions and ants that live there.

Even in the most sterile-looking environment, you can usually find some signs of animal life. In the meadow, one might find things such as spider webs, casings, scat, chewed blades or leaves, tracks, burrows, nests, feathers, insect egg masses (galls), etc.
An Ant’s Eye View
(30 minutes)

Materials
pencils, field notebooks, jeweler’s loupes (1 per student), string (2 m long per student), chart paper, chart pens

Preparation
• Determine a strategy for the students to lay out their individual strings so they can conduct this “microhike” without encroaching on someone else’s space.
• As the students will be moving on their knees and stomach along the ground, conduct a careful survey of the area for any potential hazards. Remove the hazards or mark the area as one the students should avoid.
• Refine your microhiking technique so that you may demonstrate it for the students.

Activity Outline
Introduction (Steps 1-2, 2-3 minutes)
Hiking the String Trail (Steps 3-10, 12-14 minutes)
Sharing Observations (Step 11, 4-5 minutes)
Poem Writing (Step 12, 4-5 minutes)
Poem Sharing/Closure (Steps 13-15, 2-3 minutes)

Procedural Steps
1. Ask:
   “When you look around this meadow, what do you see?”
   “Are there things in this meadow that you don’t see right away?”
   “How could you get a view of these things?”
Record the students’ responses on the chart.
2. Say: “To help us get a better view of what’s in this meadow, you will be going on a hike unlike any you may have ever gone on. Your trail will be a string, and each of you will “hike” bit by bit along your trail on your stomach.”

3. Ask: “What might be some of the things you could see from this position that you can’t see from your present position?” Make a list of the students’ ideas. Add, if needed, ideas about signs of animal life.
4. Distribute the string and magnifier to each student.
5. Point out the areas the students may hike. Have the students stretch their strings out over an interesting area of ground that they would like to “hike.” With the students standing next to their strings say:
   “You will need to stop along your trail to record some of your observations. You should stop three times to record your observations on page 16: at the beginning of the trail, near the middle of the trail, and at the end of the trail. You may record using words or drawings.”
Ask:
“What things could you record?” If the students have little input, offer suggestions for things they might record: animals observed, signs of animals life, activities of the observed animals, etc.
6. Demonstrate for the students how they should position themselves at one end of the string to start their hikes.
7. Tell the students to position themselves as you demonstrated. Say: “As you hike along your trail, you must keep your eyes below ankle height. Also, you should go very slowly so that you have a chance to see everything there is to see.”
8. Start the students along their trails.
9. As you move among the students, be sure to also get down on the ground as you interact with the students. To help them focus on the hike and their observations, you could ask some of the following questions:
“Does the animal seem to have any neighbors?”

“Do these animals seem to be friendly toward each other?”

“What is the animal doing?”

“Describe the animal’s house.”

“What other things around the animal do you observe?”

10. As the students could become very engrossed in observing at this level, be careful to remind them to stop and record some of their observations along the way.

11. Call the students together after the hike. Let the students share some the more exciting things that they observed. Encourage each student to share; when all have contributed, say: “Now that you have gone on the microhike and gotten a different perspective on the animal life in the meadow, you will have a chance to summarize your observations by completing the four line poem on page 16 in your notebooks.”

12. Allow the students time to compose and write their poems.

13. Allow willing students to share their poems.

14. To end say: “Because of the observations you made along your string trails, you now know that there is much more in a meadow than what first meets the eye.”

15. To close this field study ask: "What are some of the important terms we’ve used during these activities? What do they mean?” As students respond have all students write four or five of these terms on page 16 in their field notebooks under "Vocabulary Accrued."
Meadow Ecological Connections
An Investigation of Relationships
Within and Between Ecological Communities
Influence, Influence All Around
(adapted from “Plant Influences, Functions and Value,” USDA Forest Service)
(20 minutes)

Activity Overview
Organisms both affect and are affected by their environment. In this activity the students will have an opportunity to explore ways plants affect their environment.

Learning Objectives
To successfully complete this activity the students will:
• look for and observe evidence of a plant’s influence in its community
• list ways plants influence other things
• look for and observe evidence of ways plants are influenced by their community
• list some ways plants are influenced by other factors, natural or human-caused
• communicate the ways in which plants influence and are influenced by their communities

Science Process Skills
The students will engage in scientific inquiry through: observing, inferring, interpreting data, questioning, hypothesizing

Background for Teachers
A meadow is a living community largely defined by the lack of shade. Each plant in the meadow has its own specific needs for sunlight, nutrients, and moisture. Because meadow environments vary tremendously, a specific location will be better for one plant species than another, and that species will grow more abundantly as a result.

The meadow ecosystem also depends on animals. Animals are vital to most plants because they pollinate flowers and disperse seeds. Additionally, plants depend on earthworms to aerate the soil. At the same time, animals such as deer, rabbits, and insects may eat certain plants, greatly reducing their numbers in the meadow. Some insects can substantially damage a meadow ecosystem if their numbers get too high. Insect-eating predators play an important role in keeping insect populations in check.

Plants and animals also interact with the abiotic or nonliving elements of their environment. Physical factors such as sunlight, moisture, temperature, and wind influence the suitability of an area for particular organisms. Those factors determine the kinds of plants and animals that live there. Physical factors may be determined by the community’s geography, such as its proximity to water, its elevation, or its geological features. In addition, the resident organisms (especially plants) may affect the sunlight, moisture, temperature, and wind of the area. For example, the tall trees of a redwood forest tend to block sunlight and thus create a dark, moist environment on the forest floor that is suitable for shade-loving plants but is too shady for many kinds of plants. In a meadow, plants with leaves several inches off the ground can provide “shade” for the smaller plants growing below it.

Another way that meadow plants and animals are connected is through a food web. One primary function of the meadow, like any other ecosystem is to “repackage” and distribute energy. All life depends on the ability of green plants to use sunlight to synthesize simple sugars from carbon dioxide and water. Plants take energy from sunlight and make it available to animals. Plant eaters, herbivores, eat the plants directly; flesh-eaters or carnivores, in turn eat both herbivores or other carnivores, thus forming a food chain. However, rarely does an animal eat only one type of food. A food web better describes the interconnections of organisms in eating relationships.
**Influence, Influence All Around**  
(20 minutes)

**Materials**  
Pencils, field notebooks, Plant Influence activity sheets (one for each group), chart paper, chart pens, magnifiers, clipboards (one for each group)

**Preparation**  
- Locate areas in the meadow with several distinct plant communities. Tag these so that students will be able to view plant life in at least two of these areas.

- Locate two plants near the staging area for this activity, one should have leaves very close to the ground; the other’s leaves should be higher off the ground. You will use these plants to show the students what features to look for when selecting their plants to observe. Demonstrate how to look for evidence on and around the plant that indicate influences either on the plant or by the plant.

**Activity Outline**  
Introduction (Steps 1-3, 3-4 minutes)
Influence Survey (Steps 4-7, 8-10 minutes)
Discussion of Findings (Step 8, 4-5 minutes)
Recording in Notebooks (Step 9, 3-4 minutes)
Closure/Transition (Steps 10-11, 1-2 minutes)

**Procedural Steps**

1. Ask:  
“What can you say about the plants and animals living in this meadow community?”  
“Do the plants and animals living here interact with each other?” “In what ways might they interact?”

As students share their responses to this last question, write their ideas on the chart.

2. Ask: “What’s more important in this meadow, plants or animals? Why do you think so?” Help students to realize that plants and animals in a community influence each other and that they both are influenced by physical and human factors.

3. Say:  
“In this activity you will study the ways plants influence animals, other plants, and their community overall and the ways plants are influenced by animals, physical factors, and people.”

“Do you understand the idea of influence?”

Take time to clarify here if needed.

4. Have the students form groups of 2-3. Distribute the Plant Influence activity sheet. Point out the tagged areas where the students will conduct their study. Say: “Each group should look at plants in two of the areas that are staked out. Look for two plants, one with leaves very low to the ground and one with leaves higher up.” Point out the two plants you selected that illustrated this.

5. Say: “You will need to look both on and around the plants for evidence of ways that the plant influences or is influenced.” Demonstrate how this can be done. Be sure to use a magnifier to give a closer look. Invite the students to view any evidence you find. Ask: “What other evidence could you look for?”

6. Remind the students that they are looking for evidence both of how plants influence and of how they are influenced. Ask for clarifying questions about the activity. Send students out to the designated areas.

7. Constantly monitor and adjust as the students are working.

8. Call the students together to discuss their findings. Ask:  
“What evidence did you find of how plants have influence in their community?”  
“Can you make a general statement about the value of plants?”
“What evidence did you find of how people influence plants?”

“What results did the influence of people have on the plant community?”

“With all these influences, will the plants you studied survive in this community if things continue on?” “Why or why not?”

9. Tell the students to choose two of the plants they surveyed and to record information about those two on page 17 in their notebooks.

10. Ask: “From your investigation, what can you say about the relationships between plants and people?”

11. To transition to the next activity, add: “One source of influence in the meadow is the deer. Our next activity allows you to role play a deer feeding in the meadow.”
Influence of Plants

Record the influence of your plants on the following:

<table>
<thead>
<tr>
<th>Neighboring Plants</th>
<th>Other Plants</th>
<th>Overall Meadow Community</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Type 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant Type 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant Type 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant Type 4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Influence on Plants

Record evidence of natural and people-caused influences that affect your plants and the whole meadow community.

<table>
<thead>
<tr>
<th>Influences on Plants</th>
<th>Evidence</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>People-Caused</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Activity Overview
How long does it take a deer, grazing in a meadow, to eat a specific amount of grass? This activity gives students the chance to be deer, charged with “grazing” for a period of ten minutes as a tool for exploring the competition among animals for available resources.

Learning Objectives
To successfully complete this activity the students will:

• infer how deer use their adaptive features to obtain and escape their enemies
• recognize some of the limiting factors in an environment’s ability to support a species of organisms
• describe how competition affects the survival of members of a species
• communicate the importance of adequate resources to sustain life

Science Process Skills
The students will engage in scientific inquiry through: inferring, analyzing, determining causes and effects, concluding

Background for Teachers
Scientists estimate that people share this planet with 40 to 80 million different species of plants and animals, most of which are insects. So far, scientists have only identified about 1.5 million different species of plants and animals!

The biological diversity (biodiversity), one of the Earth’s most valuable resources, consists of three components: genetic diversity, species diversity, and ecological diversity.

Genetic diversity is the variability in the genetic makeup among individuals within a single species. Species diversity is the variety of species on Earth. Ecological diversity is the variety of forests, deserts, grasslands, streams, lakes, oceans, and other communities that interact with one another.

When an organism’s environment changes, the organism must either move, adapt, or die out. The change of an organism over time that makes it suited to its environment is called adaptation.

Adaptation is the result of variation and the selecting power of the environment. For example, plants in a population have differing capacities for producing cutin (a waxy, outer coating) on their leaves. Some individuals are heavily covered with this protective coating, while others are only thinly covered. If the climate becomes drier, as it did in the Sahara Desert, plants with thicker cutin will not dry as fast as those with thin cutin and may live to set a crop of seed. These individuals have been “selected.” Succeeding generations will also show variability, and those with the best protection against drying will be the ones to live and reproduce. In this instance, only one feature, cuticular covering, was pointed out, but in reality a plant would have to possess a whole range of features that work together. It is the species, not the individual, that adapts.

Deer represent just one species of an amazing assortment of animals we refer to as wildlife. Deer, like all species of wildlife, have basic needs for food, water, shelter, and space. A deer’s social group is the herd. Even apart from the herd, no deer lives totally on its own. Each deer has relationships with other species, different plant communities, various climatic conditions, and with all the various elements that affect life on planet Earth. And the deer survives. What are some of the adaptations that allow deer to escape from their predators, travel over varied terrain, find protection for their young, and find sufficient food and water?
Grazin’
(25 minutes)

Materials
pencils, field notebooks, pictures of deer showing their adaptive features (long legs, ears, nose, eyes, hoofed feet, etc.) child-sized scissors (one for each student), three platform balances (postal scales will work or you can make your own, directions in the "preparation" section), gallon size resealable bags (one for each student), stakes and string, display board, chart paper, chart pens, watch or stopwatch

Preparation
• Use scissors to collect meadow grass for a period of ten minutes. Be sure to save this sample of meadow grass so you may show it to the students. This will give them an idea of how much they can expect to "eat."

• Note what area was needed to provide the amount of grass you collected. Use this as a basis for staking off 4 grazing areas of the same size, two will be overcrowded and two will have adequate grazing room. Determine the mass of your collected sample of grass. This will serve as the survival standard.

• Enlist the assistance of teachers and chaperones to help you in the role of predator. Share with them the rules of predator-prey interactions: 1) When a predator approaches a grazing area, the deer closest to the predator must stop feeding and leave the feeding area and is not allowed to return until the predator has moved on. 2) Predators should approach only one of the overcrowded areas, as well as only one of the spacious areas.

• Mount the pictures of deer features on a display board for introducing the activity.

• To make a simple scale for comparing the students’ “eaten” grass to the amount needed for survival, you will need: 1 meter stick, large binder clips or rubber bands, string, metric liquid measure (1 liter graduated cylinder), water. Put empty bags at each end of meter stick; secure. Tie a string near the middle of the meter stick and suspend it to find the balance point. Secure string with tape. To determine the mass of grass collected by each student, place the student’s sample into one of the bags. Add water to the other bag, keeping track of the milliliters of water used, until the system is again balanced. The number of milliliters is the same as the mass of the grass in grams.

Activity Outline
Introduction (Steps 1-4, 4-5 minutes)
Deer in the Meadow (Steps 5-11, 10-12 minutes)
Weighing In (Step 12, 1-2 minutes)
Factors Affecting Grazing (Steps 13-15, 3-4 minutes)
Closure/Transition (Steps 16-17, 1-2 minutes)

Procedural Steps
1. Show the display of deer pictures. Allow students time to study the pictures.

2. Ask:
   “What are some of the special features of deer that you see in these pictures?”

   Set up a table and list the students’ responses on the chart.
   “How do these features help the deer to survive?”

   Add these ideas to the chart.

3. Tell the students to copy the completed chart onto page 17 in their notebooks. Say: “Although deer have special features that allow them to survive, we know that not all deer survive. What could be some reasons that deer die?” List the suggestions on the chart.

4. Say:
   “Some deer, like all other organisms, die because their environment is not able to meet their basic life needs.”
“What are these needs?”

“What could be happening so that a deer’s needs were not being met?”

5. Tell the students that in this activity they will get to experience some of the factors affecting the survival of deer. Explain to them that they will be deer and will have to graze in the meadow for ten minutes. Warn them that there will be other deer and predators present as they feed.

6. Divide the students into four grazing groups so that two grazing areas are overcrowded and two have adequate space to support all the deer grazing in them. Assign each group to a grazing area.

7. Tell the students that they will use scissors and a plastic bag to eat their grass and that they can feed only within their grazing area. If approached by a predator, a deer leaves the scissors and bowl behind. Point out the predators among the teachers/chaperones and share with the students the rules for the predator-prey interactions.

8. Give each student a pair of scissors and plastic bowl. Say: “Once you reach your assigned grazing area and I give the signal, you will have ten minutes to eat as much grass as you can. Remember that if a predator is nearest to you, you must stop eating and leave the area. Leave your scissors and bowl. You may come back and continue feeding only after the predator has departed from your grazing area. When I give the signal to stop, you must immediately stop eating.” Tell the students what the start and signals will be.

9. When all the students are in place, give the signal to start.

10. While the students are getting started confer with the other predators to inform them which grazing groups should be disturbed and which should be left undisturbed. Also, discuss the frequency of disturbances for those groups to be “hunted.” When all are clear on what is to be done, go out among the groups and implement the predation.

11. Be mindful of the time so that the feeding period is stopped exactly after ten minutes.

12. Call the students together and have them weigh their food. They should record the amount on page 18 in their notebooks.

13. Have the students come forward, one grazing group at a time, to show the amount of food each deer was able to eat. Ask each person to tell about the factors affecting how much food they were able to get. As each new factor is listed, write it on the chart so that a comprehensive list is developed. Tell the students to record their factors in the box on page 18.

14. When all groups have shared, say: “If a deer needed to eat _X_ grams of grass in order to survive, how many of you deer are still alive?” (Use the mass of the amount of grass you collected area as survival value.)

15. Ask: “If you did not get enough to eat what was the cause(s) of your death?” Tell students to write their ideas on page 18.

16. Finally to close the activity, ask students to summarize what they learned about interrelationships and adaptations in a meadow community.

17. For a transition to the last activity, say: “The deer-grass connection is just one part of a complex cycle of feeding relationships that can be observed in the meadow community. Next we will investigate another one of them.”
Meadow Banquet
(20 minutes)

Activity Overview
In this activity students will take a close look at a meadow ecosystem to observe the feeding cycles that connect plants and animals.

Learning Objectives
To successfully complete this activity the students will:
- observe specific feeding relationships among meadow plants and animals
- infer additional relationships among these organisms
- describe the role of decomposition
- communicate numerous connections in a meadow web of life

Science Process Skills
The students will engage in scientific inquiry through: observing, inferring, describing, communicating, concluding

Background for Teachers
A meadow is a living community without an overstory. There are several different types of meadows, as determined by the most dominant plant species in the meadow. This variation between meadows is possible because each plant has different requirements for growth. As the availability of sunlight, water and nutrients varies from meadow to meadow, a specific location will be better for a plant species than for another, and that species will grow more abundantly as a result.

While grasses and wildflowers are usually the dominant elements of a meadow, the ecosystem also depends on animals. Animals are vital to most plants as they aid in pollination and seed dispersal. However, if their numbers get too high, deer, rabbits, insects, and other animals can damage a meadow ecosystem.

One primary function of a meadow is to produce and distribute energy. Animals depend on the ability of green plants to photosynthesize. By using sunlight to synthesize simple sugars from carbon dioxide and water, plants take energy from sunlight and make it available to animals. Plant eaters, or herbivores, eat the plants directly; flesh eaters, or carnivores, in turn eat herbivores or other carnivores, thus forming a food chain. A food chain is a simplified way of showing energy relationships between plants and animals in an ecosystem. For example, the food chain of sun—sunflower seed—mouse—owl shows the transfer of energy from the sun to the owl through eating relationships. However, rarely does an animal eat only one type of food. The term food web better describes the interconnection of the many food chains in an ecosystem.

The final level of the food web is the decomposer. Herbivores, and carnivores become food for decomposers such as fungi and bacteria if they are not eaten by other carnivores or scavengers. Plants weakened by injury and disease will eventually die and fall to the ground. After they die, plants and animals return some of their nutrients and other elements back into the soil through decomposition to be recycled through the meadow ecosystem.
Meadow Banquet
(20 minutes)

Materials
field notebooks, pencils, chart paper, chart pens, magnifiers, garden trowel, one of the following for each pair: Meadow Banquet chart, clipboard, plastic fork, laminated sheet of white poster board

Preparation
• Find an area where the students can view feeding relationships.
• Observe a complete feeding cycle.
• Brainstorm closure ideas that allow the students to maximize their completed cycles.

Activity Outline
Introduction (Steps 1-4, 1-2 minutes)
Observing the Feeding (Steps 5-11, 8-10 minutes)
Sharing / Recording (Steps 12-13, 5-6 minutes)
Closure / Transition (Steps 14-15, 1-2 minutes)

Procedural Steps
1. Ask: “What foods did you eat for your last meal before coming to camp?”  Make a list of the foods on the chart.

2. Select one of the foods that places the student as a third level consumer.  Ask the students to trace a possible path of this food back to soil nutrients.

3. Write their suggestions on the chart so that visually they show a cycle.

4. Ask: “Can you suggest reasons why feeding relationships are shown as a cycle?”

5. Tell the students that in this activity they will look for interactions that show four real-life feeding connections in a meadow food web.

6. Distribute a Meadow Banquet chart and clipboard to each pair.

7. Explain to the students that they will need to find, if possible, a plant and three animals to complete the chart.  (Evidence of an animal may be used if a feeding relationship is known.) Show the students where to enter the data.

8. Tell the students they may write the name of the plant or animal, describe it, or sketch it.  If evidence is used, a description or sketch of the evidence should be given.  Ask: “Since bacteria and fungi are the decomposers that return nutrients to the soil and we can’t see them, what can you look for that would show decomposition of a dead plant or animal?”

9. Explain to the students the following steps:
   a. First select a plant.  Name, sketch, or describe this plant on the chart.
   b. Using a magnifier, look on that plant to locate an animal feeding on it.  Name, describe, or sketch this animal on the chart.
   c. Next, look for a second animal feeding on the first animal.  Enter on chart.
   d. Finally, look for a dead or decaying sample of the second animal.  Enter.

10. Some dead animals may be found on top of the ground.  However, it may be necessary for students to look through the soil in search of a decaying one.  Demonstrate for the students a technique for examining the soil using a garden trowel, plastic fork, magnifier, and laminated white sheet.  Remind the students to return all soil contents back from where it was taken.

11. Send the students out.

12. When all pairs are have returned, ask pairs to share their charts and other observations.

13. Have students transfer the food web to "Meadow Banquet" on p. 18 of the field notebook.

14. For closure choose an idea you like.

15. Transition with: “Look around you.  What is happening in this meadow?  For the final activity in the meadow, you will look closer at ways this meadow is changing.”
Activity Overview
Change is a constant process and is the theme of this activity. The observations the students make are only for one time on one day. At different times of day and in different seasons, they might find conditions very different. To help the students get a more complete understanding of the meadow, they will look for evidence of changes and how these changes affect life in the meadow.

Learning Objectives
To successfully complete this activity the student will:
• identify evidence of change
• explore cause and effect relationships
• draw inferences about conditions in the meadow at other times
• communicate how change is affecting meadow life

Science Process Skills
The students will engage in scientific inquiry through: observing, inferring, categorizing, hypothesizing, communicating

Background for Teachers
Meadows are often communities created by destructive events. After being created by fire or clearing by humans, these communities are then maintained by forces such as grazing or other continued disturbances. Without these, the community will change over time as plants, such as trees and shrubs, move in to create a new ecological community, like a forest. We see these changes most clearly at the edges of the clearing or meadow as new plants and animals move in.

Another example of meadow succession is when a wet area, such as a pond or wetland, fills in and creates a meadow. Windblown materials and decaying matter fill in wet areas until there is no open water. At this point, plants more adapted to meadow communities can move in, increasing the creation of soil and speeding up the change from pond to meadow. We will look closely for evidence of these changes as they may not be obvious at first glance.

Frequently, the recognition of conditions after a change has occurred is the only evidence we have of the change. Making observations that lead us to discover previous conditions is the first step in exploring change. We combine experiential evidence, that which we perceive with our senses, with previous experience and research to make inferences about what conditions were present before the change. We can then conclude what change took place. With this conclusion, one may move even further to predict how that change is affecting or has affected the life in a particular community.

Inferences about the causes of change and predictions about what may happen in response to those changes are supported by the same sources of information. It is important to be able to distinguish the evidence of change from the change itself. Birth and death are two ever-present processes in a community that bring about changes. Any evidence of these processes is evidence of change in a community. It is also important to be able to distinguish the change from the cause of the change. To read the environment, it is necessary to consider that some changes are slow and occur over long periods of time.
As the Meadow Changes
(15 minutes)

Materials
field notebooks, pencils, cloth-covered tray of 5-6 assorted items from general field study materials, stopwatch, chart paper, chart pens

Preparation
• Survey areas in and around the meadow to find those areas that have evidence of change taking place. An example would be seedlings on the meadow side of the forest-meadow boundary. Another example could be residual cut grass from a previous mowing.
• Find as many examples of change as possible so that you will be able to supplement the students’ findings, if needed.
• Check out the edges of the meadow, looking for potential hazards (poison oak, etc.)

Activity Outline
Introduction (Steps 1-5, 1-2 minutes)
Looking for Change (Steps 6-7, 6-8 minutes)
Discussion (Steps 8-11, 2-3 minutes)
Closure (Steps 12-13, 1-2 minutes)

Procedural Steps
1. Bring out the covered tray. Before uncovering the tray, tell the students you want them to take careful note of the objects on the tray and their positions. Explain that they are not permitted to write down anything about the objects or their positions.
2. Uncover the tray, have students gather closely around it, and allow them 30 seconds to study the objects.
3. Remove the tray. Out of sight of the students, make one or two changes to the objects on the tray. Replace an object with one of a different color; replace a larger item with a smaller version, etc.
4. Again, bring out the covered tray. Tell the students the number of changes you made, uncover the tray, and ask them to figure out what changes were made. If the students are not able to detect your changes, provide hints to lead them to discovery.
5. Say:
   “Some changes are not as obvious as the ones I made, and lots of changes, especially those in nature, take much longer to occur.”
   “In this activity we want to look for evidence that this meadow is changing.”
   “What kinds of things might be happening to cause change in the meadow?”
   “What things can we look for to show these changes?”
As the students share their ideas, write them on the chart.
6. Say: “Using these ideas, you will have five minutes to look for evidence of the changes taking place in and around the meadow. You will work in pairs. Each pair should look in the open area as well as along the edges of the meadow. Record on page 18 any evidence that you find. Each pair should discuss and decide upon a cause, but leave the "result" column empty until after we're back together and have discussed your findings.” Caution the students about any areas to be avoided.
7. Have the students form pairs. Ask for clarifying questions before sending the students out.
8. When all the pairs return, ask the students what evidence they found. Tell pairs to share their perceived cause behind the evidence. On the chart compile a list of evidence and causes.
9. Ask:
   “Considering the evidence you found, how is this meadow changing?”
   “What do you think would happen to this meadow as it changes?”
meadow if it were left alone?” “Why do you think this?”

10. Say: “For each evidence and cause you have in your table, tell what you think is the result of the change. Answer the question: ‘How is the meadow being affected by each change for which you found evidence?’”

11. Have students write the results on page 18 of their notebooks, then share their ideas.

12. Conclude with: “Some changes have natural causes. Other changes are caused by people and their activities. Think about whether or not our activities in this field study have affected this meadow and the plants and animals living in it.”

13. To conclude, ask student to share the new vocabulary they learned as they participated in the activities of the field study. Have the students record four or five of these on page 17 of the field notebook under "Vocabulary Added."
Final Project: Habitat Study
An Investigation of Relationships Within and Between Ecological Communities
Final Project: Habitat Study
(adapted from “Field, Forest, and Stream,” Project Learning Tree and “Habitats,” Insights Educational Development)
(90-minute field study, 90-minute project creation, 30-minute project sharing)

Activity Overview
This culminating study allows students, working in SMILE Club groups, to apply the process and hands-on field study skills developed through the earlier six field studies. They will apply these skills to an unfamiliar site. Each SMILE Club will then share with the rest of the camp their findings from the investigations of their new site.

Learning Objectives
Through the investigations and presentations, the students will:
• demonstrate an understanding of the factors that create living communities
• apply field study investigation skills
• create an organism uniquely suited to a niche in the given communities
• share the results of their investigations

Science Process Skills
The students will engage in scientific inquiry through: operationally defining, observing, identifying, hypothesizing, drawing conclusions, inferring, using numbers, classifying, gathering data, analyzing data, interpreting data, constructing models, communicating

Background for Teachers
Basic Needs
All organisms require food but differ in the types and amounts. Plants make their own complex food using water, gases from the air, energy from sunlight, and minerals from the earth. Some animals eat plants for food; some eat other animals; and others, such as human beings, eat both plants and animals.

Water is a major component of cells and is necessary for life. Most animals obtain the water they need by drinking. Some, particularly desert-dwelling creatures, get all the water they need from the food they eat. Plants need water as one of the ingredients for making food through photosynthesis. They absorb water from the ground through their root system.

Organisms seek or make shelter to protect themselves against the elements and predation. Some animals make or use holes in the ground, trees, or rocks. To avoid insect pests, animals may seek a windy spot where the insects will be blown away, or they may wallow in mud or water. Some seek protection from predators in dense brushy cover where they are not easily seen. Plains animals may seek the shelter of distance by moving or running away from predators. Plant embryos are sheltered in hard seed coats that protect them from drying out. Many young plants can survive only in the shade of other plants that protect them from drying out and dying until they are large enough to survive using their own body mechanisms. Most young organisms have greater need for shelter than adult organisms.

Air and light are two other basic needs. Most organisms need air in order to get vital gases: oxygen for animals and carbon dioxide and oxygen for plants. Some microorganisms acquire gases from sources other than air. Light is necessary for most plants and animals, although the amount needed may vary considerably.

All organisms occupy space. Plants are usually located in one place and take up more space as they grow, eventually competing with their neighbors. Animals move around in their environment in search of their basic needs. The amount of space necessary is determined in part by the availability of food, water, air, light, and shelter.
Habitat

An organism’s environment includes everything around it: air, water, soil, heat, rocks, clouds, other plants and animals, others of its own kind, and so on. An organism’s habitat is that part of the total environment which it uses to meet all its basic needs for survival. Simply, it is the place where the organism makes its living.

Each type of organism has its own ways of getting the basic resources it requires to meet its needs. Ecologists call the distinctive ways the organism goes about doing this within its habitat its niche. Habitat, then, is where the organism finds the resources to meet its basic needs; niche is how the organism interacts with its environment and which specific parts of the habitat it uses to obtain those resources. There can be niches for many different organisms in a single habitat.

As with other animals, human beings’ habitat is the place where we make our homes and meet our needs and desires. Unlike most small animals whose habitat must give them immediate access to all the resources they need to survive, human beings have learned to transport and store materials from distant places. Whereas plants and other animals generally must have a complete habitat, human beings can live in incomplete habitats as long as they can bring in necessary resources from other places. Of course, some creatures migrate between incomplete habitats in order to meet all their needs.

Any large area or habitat is actually a collection of many microhabitats. Small organisms can meet their needs from much smaller areas than larger ones if the necessary resources are suitably arranged. Our tendency is to think of habitat in terms of larger organisms such as ourselves and to ignore the smaller organisms and the microhabitats within the larger ones. The key to a habitat, whether large or small, is that it provides all the resources a particular type of organism needs to survive.

Areas that provide sufficient resources to meet the basic needs of a variety of organisms are the richest habitats. Any given area can also provide either a rich or a poor habitat for a particular species, depending on the concentration and distribution of the resources that species needs. In any area, resources are often randomly distributed. The pattern of their distribution will create an unequal distribution of microhabitats. Some areas will be such that a variety of organisms can make their homes there; other areas will have the resources for only a few species but there may be many individuals of each. Still other sites lack key resources to meet the needs of any organisms and appear barren.

The quality of a habitat, that is, the amount of each resource available to fill an organism’s needs, determines the number, or population, of that organism that can survive there at any given time. As the number of individuals increases, some of the basic resources are used up, reducing the quality of the habitat and its ability to support so many individuals. Some of the organisms die off or move elsewhere and the habitat has a chance to recover. In time, it may again be able to support larger numbers of the organism. Thus, habitat quality rises and falls as do the populations of the organisms that depend on that habitat.

A good habitat for a particular organism or group of organisms is one in which all the necessary resources are abundant and fairly distributed. In a poor habitat, those resources are scarcer and scattered about.

What appears to be a good habitat for a living thing may nevertheless have few or none of them living it. Close examination of the habitat will show that the resources needed to meet a particular need are very scarce or perhaps missing even though the rest are present. Even if
resources are abundant, the presence of predators or competitors may severely affect the survival of an organism. Scarce or absent resources as well as the presence of other pressures are known as limiting factors. These factors set the limits on the population of a species that can survive in the area.

Physical conditions of temperature, humidity, precipitation, and soil texture all affect the nature of a habitat and its ability to provide the basic needs of its inhabitants. Such conditions vary over time and affect the seasonal quality and long-term ability of a habitat to sustain organisms. Although young children can only begin to understand the many ways physical conditions affect habitats, they can explore some of these conditions in an elementary fashion.

**Adaptation**

Different organisms have different preferences for light, moisture, and other physical factors. These preferences allow them to get their resources from the habitat in different ways and at different times of day, season, or year. Excesses or shortages of the various factors put different degrees of stress on an organism and may ultimately affect its survival. Each kind of organism has evolved different ways of dealing with the variability of physical factors in its environment. Some have insulating coverings of fur or feathers to deal with temperature changes; some relocate to more moderate conditions, such as going into burrows to get away from light, heat, or cold; some go further and migrate out of the area. Others hibernate, or in summer estivate, to avoid temperature extremes and to conserve energy.

Habitat is an integral part of the organism. For the organism to behave normally it has to be in its normal habitat. Outside of its normal habitat it shows signs of stress. Some organisms are able to adapt better to changes in habitat than others. If we want to see an organism going about its business of living in a fairly normal fashion, we have to either observe it in its native habitat or simulate the habitat as carefully as possible.

Every organism is a collection of adaptations that allow that organism to survive under a range of physical factors and to secure its basic needs from the habitat in which lives. The interaction of the organism with its habitat helps define the habitat and the organism. Each requires the other to be complete.

Some adaptations are extremely specific and do not provide much leeway to the organism in choosing a habitat. An example is the giant panda which can eat only bamboo leaves. Other adaptations are more generic and permit some flexibility in terms of the habitat, such as an elk which grazes on grasses.

When the adaptation is of the very specific kind, the organism is extremely vulnerable to changes in the habitat. When the adaptation is more generic, the organism can better sustain some changes in the habitat. Animals that do well in zoos are usually fairly adaptable and can satisfy their needs by using substitutes for items in their natural habitat. Animals with very specific needs and adaptations usually do poorly or may not be able to be kept in zoos at all. These are also species with a high likelihood of appearing on lists of endangered species as human activities radically alter or reduce their habitat. Conversely, more generalized species may overrun an environment because they can utilize such a wide variety of resources and are limited by fewer factors; pigeons, rats, and cockroaches are such species.
Final Project: Habitat Study
(adapted from “Field, Forest, and Stream,” Project Learning Tree)
(90-minute field study, 90-minute project creation, 30-minute project sharing)

Field Study Materials
field study notebook, pencil, 7 Habitat Study Sheets (1 set for each student group), jeweler’s loupes, hand magnifiers, dissecting microscope, quart-size plastic bag for collecting samples (4 for each student group), one each of the following to every group: garden trowel, small bug bucket, large bug bucket

Model Animal Materials
Design-a-Critter Sheet (1 for each student), modeling clay, paper tubes (from paper towels or bathroom tissue), chenille stems, toothpicks, assorted felt squares, assorted foam squares, feathers, burlap squares, sequins, cotton balls, batting, old socks, buttons, wiggle eyes, glue guns with glue sticks, tacky (craft) glue

Project Presentation Materials
3 sheets of white posterboard (26” x 28”), white construction paper (12” x 18”), masking tape, scissors, assorted colors of construction paper (9” x 12”), assorted markers, colored pencils, crayons, glue sticks, tape, white paper, set of animal stamps, ink pads, sheets of white paper (8.5” x 11”), white glue, scotch tape, 7 Habitat Study Sheets (1 set to be completed from the compiled team data for the study community)

Final Project Activity Outline
12:50-1:00 PM Travel from lunch/recreation site to final project site
1:00-2:30 PM Conduct field study as entire SMILE Club or in subgroups (Assigned camp staff will assist SMILE Club teachers as they lead their groups in the activities.)
2:30-2:45 PM Gather with students on site. Lead students in a discussion of model animals for different habitats in the final project site. Each student begins to develop ideas for the model animal, its features and needs, and its role in the community.
2:45-3:00 PM Return with students to Camp Central
3:00-4:30 PM SMILE Clubs work on their project presentation using a tri-fold display. Each SMILE student will construct a model animal for the surveyed community and complete an ecological story for the animals. (If a club’s students complete the project before the start of sharing time, the teachers and chaperones will need to supervise their students until project sharing begins.)
4:30-5:00 PM Project Sharing (A rotation schedule will be explained at the beginning of this activity.)

Procedural Guidelines
Each SMILE Club will go to a site some distance from camp and conduct a habitat study of the area using techniques learned during the field studies. They will investigate the features of the community, the type of life found in it, the ways in which the organisms are adapted for life there, and the impact of people on the community. Each club will be accompanied by three or more camp instructors.

SMILE teachers have the primary responsibilities for the final project study, preparation, and presentation. They will lead their students in conducting the habitat studies and collecting data about the community and the plants and animals found there. They will guide their students in using compiled data to develop animals that are ideally suited for living in this community. Additionally, they will direct the students’ efforts as they prepare their presentation and work on creating their model animals and writing the story for each animal.

Camp instructors have the responsibilities of providing support for the SMILE teachers during the time period from lunch until the end of the
presentation preparation. They are available as resource people during the final project field study and as assistants in guiding the students’ efforts and in maintaining their safety.

SMILE Club chaperones have the responsibilities of providing support for the SMILE teachers during the time period from lunch until the end of the project sharing time. They will assist in student supervision and help with group management and safety. They are available to help students focus their efforts.

Data Collection

It is suggested that each club divide into four teams. Each team will investigate and record observations of a different small site in the study community. (The small sites should be chosen so that, when combined, they represent a complete overview of the study community.) Each group will record their findings on the seven Habitat Study Sheets provided. After the students have had sufficient time to carry out their small-team investigations, they will come together to present, discuss, and compile their findings and share what they have learned in order to develop one big picture of the community. After club discussion, students should transfer information about their community to pages 19-24 of the field notebooks.

Responsibilities for each Study Team:

Plant Life

- observe the various kinds of plants (trees, shrubs, flowers, grasses, lichen, mosses, etc.) found in the site
- record the most common types and relative abundance of plants found in the site
- observe and record the distribution (relative location) of the plants in the site
- make a survey of leaf or needle types for the plants found in the site
- look for and record any signs of competition among the plants for sunlight, moisture, space, and nutrients
- look for and record any adaptations the plants have to help them survive in their sites
- make a survey of a rotting log or stump, if this feature is present in the site

Animal Life

- observe and record the various kinds of animals (insects, birds, reptiles, fish, frogs, or tadpoles, etc.) at each site
- look for and record evidence of animal presence (scat, tracks, burrows, chewed leaves, feathers, webs, etc.)
- look for and record possible food and water sources
- observe animals, if possible, and take note of body parts and any other adaptations that make the different animals best fitted for their environments

Interdependence of Organisms

- investigate the top 10 cm of soil in two different locations in the site to find any plants or animals residing there
- look for and record signs of predator/prey relationships
- develop a food or energy pyramid (with at least four levels) using plants and animals found in the study site
- infer connections between the types of vegetation and the animals that inhabit the study site

Change and Human Impact

- look for and record signs of human impact and other signs of change
- infer when these signs appeared at the site
- discuss and draw a picture of what the study site might look like fifty years from now
- make a list of the factors that would determine how the site could look
• develop a group response to the question: If this area were logged (if a forest), plowed (if a meadow), filled in (if a pond), what impact would this have on your model animals?

### Project Creation and Display

**Adaptations for Life**

To demonstrate an understanding of the habitat-organism connection, each student will consider specific adaptations for survival and:

- design and make a model animal perfectly suited for a particular niche in the study area
- use the following considerations in designing the model animal:
  1. Adaptations for food gathering
  2. Adaptations for defense and protection
  3. Adaptations for seasonal change
  4. Major food requirements
  5. Amount of habitat required for meeting needs
  6. Value of the animal to the environment
- name the model animal and place it in the community food web
- complete a story for the animal

**Poster**

The results of the final project will be displayed used a tri-fold poster display and other tabletop displays. The tri-fold display, to be made using the three sheets of poster board and masking tape, is illustrated below.

<table>
<thead>
<tr>
<th>Summary of Plant Life in Community</th>
<th>Community Food Web or Energy Pyramid</th>
<th>Summary of Animal Life in Community</th>
</tr>
</thead>
<tbody>
<tr>
<td>Special Adaptations of Organisms</td>
<td>Human Impact on Community</td>
<td>Predator / Prey Relationships</td>
</tr>
<tr>
<td>Habitat Study Sheets</td>
<td>Key for Grouping Leaves &amp; Needles</td>
<td>Habitat Study Sheets</td>
</tr>
</tbody>
</table>

Tabletop displays should include: soil sample and any life found in it, model animals (each with an accompanying life story sheet), collected plant and animal samples, samples of leaves and needles from the study community (grouped according to the key on the tri-fold display), etc.
Habitat Study: Plant Life

<table>
<thead>
<tr>
<th>Plant Life</th>
<th>Location</th>
<th>Relative Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Cover</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shrubs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grasses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broadleaved Trees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coniferous Trees</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Give several two-word descriptions that accurately describe your area. Use your imagination.

Is there any connection between the ground cover and the canopy (tree cover)?

What are water sources in this area, real or potential?
**Habitat Study: Animal Life**

<table>
<thead>
<tr>
<th>Animal</th>
<th>Where It Lives</th>
<th>Observed Activity</th>
<th>Evidence of Predator</th>
<th>Role in Community</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Evidence of Animals</th>
<th>Quantity Found</th>
<th>Location</th>
<th>Animal that Left Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Possible food sources for these animals:

Possible connections between the types of vegetation and the animals that inhabit the area.
Habitat Study: Energy Flow

Energy flow in this community

Construct a food or energy pyramid for this community. Try to have four levels in the pyramid. Use plants and animals you have seen or know live in your community.
Habitat Study: Leaf Study

Collect only one leaf or needle from each type of plant and vegetation (trees, shrubs, and flowers) found in your survey area. Take time to study the leaves and to answer the following questions.

1. Do any of the leaves (needles) look alike?

2. What features do all the leaves (needles) have in common?

3. What are some of the differences among the leaves (needles)?

4. In what different ways can you group the leaves (needles) that were collected?

5. If there are leaves from the same tree on the ground, collect several and examine them. Are any two of the leaves exactly alike? Explain.
Habitat Study: Community Description

List the characteristics of this community.

List some of the important things about this community that make it special for the plants that live here.

List some of the important things about this community that make it special for the animals that live here.

List any evidence you find of how the plants and animals in this community interact.
Habitat Study: Special Features of Plants & Animals

<table>
<thead>
<tr>
<th>Plant Feature</th>
<th>Helps Plant to...</th>
<th>Plant's Effect on Its Community</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What might one plant with all four features above look like? How would it fit into the community?

<table>
<thead>
<tr>
<th>Animal Feature</th>
<th>Helps Animal to...</th>
<th>Animal's Effect on Its Community</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What might one animal with all four features above look like? How would it fit into the community?
Habitat Study: Change and Human Impact

1. List ways this community is changing.

2. What do you believe is causing these changes?

3. List signs that people have impacted this community. (Be sure to bring back any litter that you find.)

4. What might this area look like fifty years into the future? What factor might determine how this area could look?
### Habitat Study: Design-a-Critter

<table>
<thead>
<tr>
<th>M</th>
<th>is a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>lives in/on</td>
</tr>
<tr>
<td>C</td>
<td>moves by</td>
</tr>
<tr>
<td>R</td>
<td>gets its food by</td>
</tr>
<tr>
<td>I</td>
<td>eats</td>
</tr>
<tr>
<td>T</td>
<td>is food for</td>
</tr>
<tr>
<td>R</td>
<td>protects itself by</td>
</tr>
<tr>
<td>E</td>
<td>can change its</td>
</tr>
<tr>
<td>T</td>
<td>needs</td>
</tr>
<tr>
<td>E</td>
<td>is important because</td>
</tr>
</tbody>
</table>

My special name for my critter is ____________________ because ____________________
Part One: Field Notebook
An Investigation of Relationships Within and Between Ecological Communities
**Pond Plant and Animal Survey**

**Vocabulary Acquired:**

What is a pond?
A pond is ____________________________

____________________________________

Record your observations of the ponds:

<table>
<thead>
<tr>
<th>Pagoda Pond</th>
<th>Lower Pond</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What lives here?

Plants:

<table>
<thead>
<tr>
<th>Type (Name)</th>
<th>Description (or sketch)</th>
<th>Where Found</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Animals:

<table>
<thead>
<tr>
<th>Type (Name)</th>
<th>Description (or sketch)</th>
<th>Where Found</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Were the same plants found in each pond? ______
Were the same animals found in each pond? ______
Give one reason for your results:

**A Bowl of Mud**

Number of different living things you think will be found in your bowl. ______________

<table>
<thead>
<tr>
<th>Sketch</th>
<th>Descriptive Name</th>
<th>Special Features</th>
<th>Number Found</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Number of different living things:
in your bowl_____    in all bowls_______
Number of all things:
in your bowl_____    in all bowls_______
**Pond Ecological Connections**

Vocabulary Amassed:

**Fitting In: Critter Information**

<table>
<thead>
<tr>
<th>Body</th>
<th>Breathing</th>
<th>Eating</th>
<th>Movement</th>
<th>Other behaviors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Draw your critter, give it a name, and label its features and what they're used for.

---

Draw your critter in its pond habitat.

---

**Weaving the Web**

**Change Detective**

<table>
<thead>
<tr>
<th>Evidence Found</th>
<th>What's the change in the Community?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Forest Plant and Animal Survey**

**Vocabulary Gained:**

What is a Forest?
Forest Sounds: ________________________________

<table>
<thead>
<tr>
<th>Item</th>
<th>Importance to Forest Community</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A forest is________________________

**Tree Growth**

<table>
<thead>
<tr>
<th>Tree Source</th>
<th>Wood Cookie 1</th>
<th>Wood Cookie 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Rings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ring Pattern</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conditions Affecting Growth</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Tree Study**

<table>
<thead>
<tr>
<th>M</th>
<th>looks like</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>feels like</td>
</tr>
<tr>
<td></td>
<td>smells like</td>
</tr>
<tr>
<td>T</td>
<td>has leaves/needles that</td>
</tr>
<tr>
<td></td>
<td>has bark that</td>
</tr>
<tr>
<td>E</td>
<td>is home to</td>
</tr>
<tr>
<td></td>
<td>is</td>
</tr>
</tbody>
</table>

Is your tree alive? ____________

How can you tell? ____________

**Animal Detective**

<table>
<thead>
<tr>
<th>Animal Sign</th>
<th>Where Found</th>
<th>Animal That Made It</th>
<th>About this Animal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Forest Ecological Connections

Vocabulary Retained:

Stumpin' Around

<table>
<thead>
<tr>
<th>Living Thing</th>
<th>Where Found</th>
<th>Observed Activity</th>
<th>Effect on Stump</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Forest Cycles

Beaks, Feet, and Adaptations

<table>
<thead>
<tr>
<th>Beaks</th>
<th>Feet</th>
<th>Teeth</th>
<th>Eye Locations</th>
<th>Pelts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

What was the most interesting adaptation you saw?

Why?

Home, Home in a Tree

<table>
<thead>
<tr>
<th>Tree Trunk</th>
<th>Tree Branches</th>
<th>Tree Base</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How might the tree be affected by the organisms living in or on it?
Meadow Plant and Animal Survey

Vocabulary Accrued:

A Field of Dreams

<table>
<thead>
<tr>
<th>Boundary with Forest</th>
<th>Open Area</th>
<th>Boundary with__________</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

A meadow is ____________________________
______________________________
______________________________

Plant Neighbors

Conclusions: ________
______________________________
______________________________
______________________________

Outcast

<table>
<thead>
<tr>
<th>Leaf Shape</th>
<th>Branch Pattern</th>
<th>Root System</th>
<th>Major Features</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A weed is not a weed when ___________________
_______________________________________
_______________________________________

An Ant's Eye View

<table>
<thead>
<tr>
<th>Trail Start</th>
<th>Trail Middle</th>
<th>Trail End</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In a meadow you see ___________________
Animals there ___________________
Homes are ___________________
A meadow’s swell 'cause ___________________
**Meadow Ecological Connections**

Vocabulary Added:

**Influence, Influence All Around**

<table>
<thead>
<tr>
<th>Plant Sketch</th>
<th>Plant’s Influence on:</th>
<th>Influences on Plant:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Other Plants</td>
<td>Natural Factors</td>
</tr>
<tr>
<td></td>
<td>Animals</td>
<td>People Factors</td>
</tr>
<tr>
<td></td>
<td>Community</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other plants</td>
<td>Natural Factors</td>
</tr>
<tr>
<td></td>
<td>Animals</td>
<td>People Factors</td>
</tr>
<tr>
<td></td>
<td>Community</td>
<td></td>
</tr>
</tbody>
</table>

**Grazin’**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Helps Deer to...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Factors Affecting Your Grazing**

Amount of grass you ate: ____________
Did you get enough food to survive?

If not, what caused your death? ________

**Meadow Banquet**

**As the Meadow Changes**

<table>
<thead>
<tr>
<th>Evidence</th>
<th>Cause</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>
**Final Project: Habitat Study**

**Type of Community (Habitat)**

________________________________________

**Description of Community**

________________________________________

________________________________________

________________________________________

**Most Abundant Plant Life**

<table>
<thead>
<tr>
<th>Sketch</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Leaf (Needle) Study**

<table>
<thead>
<tr>
<th>Similarities</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaves</td>
<td></td>
</tr>
<tr>
<td>Needles</td>
<td></td>
</tr>
</tbody>
</table>

Number of collected leaf types _________________

Number of collected needle types _______________

**Plant Adaptations**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Helps Plant to...</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Animal Life

### Observed Animals

<table>
<thead>
<tr>
<th>Name (Sketch)</th>
<th>Where Found</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

### Signs of Animal Life

<table>
<thead>
<tr>
<th>Sign</th>
<th>Where Found</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

### Animal Adaptations

<table>
<thead>
<tr>
<th>Animal</th>
<th>Feature</th>
<th>Helps Animal to...</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

### A Community Food Web (or Pyramid)

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td></td>
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</tbody>
</table>

### Signs of Change

<table>
<thead>
<tr>
<th>Food Sources</th>
<th>Water Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Design-a-Critter

My critter looks like...

<table>
<thead>
<tr>
<th>M</th>
<th>Y</th>
<th>C</th>
<th>R</th>
<th>I</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>is a</td>
<td>lives in/on</td>
<td>moves by</td>
<td>gets its food by</td>
<td>eats</td>
<td>is food for</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

A day in the life of my critter...

<table>
<thead>
<tr>
<th>T</th>
<th>T</th>
<th>E</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>protects itself by</td>
<td>can change its</td>
<td>needs</td>
<td>is important because</td>
</tr>
</tbody>
</table>

My special name for my critter is__________________________ because...

________________________________________________________________________________________

________________________________________________________________________________________

If this community were ________________________ my critter would...


Part Two
Integration of Biotic and Abiotic Factors to Create Ecological Communities
Part Two/Introduction:
Overview

**Focus**
Part Two focuses on the relationship between the biotic (living) and abiotic (nonliving) aspects of an ecological community. Investigations cover soil types and characteristics, nutrient cycling, sunlight levels, and the water cycle and address how these factors affect the communities under study. Students will also become competent in the use of tools and techniques characteristically used by scientists who study ecological communities. These include sampling and mapping techniques, chemical analysis, use of compasses, and the use of light and other meters. Questions to be answered include: How are these communities maintained? How are they supported? How fragile is this support?

**Goals**
By the end of camp, students will have an overview of three living communities, pond, forest, and meadow, understand sampling and mapping techniques, and have a feel for the relationships among various abiotic elements and their effects on the biotic elements. Students will understand the importance of taking measurements to study these elements and to reduce observer error.

**Final Project**
Students will use these understandings to perform a final field study at a new site where they will collect data using their newly acquired knowledge and skills. They will bring their data, their materials, and other collections back and create a display to share with the staff and other students. Each SMILE Club will take these materials with them to their home communities so that the students may share what they learned.
Part Two/Introduction:
Community Mapping

The goal of the Community Mapping studies is to allow students opportunities to explore the location, boundaries, physical dimensions and characteristics, and the role of the pond (forest) [meadow] in its community and to construct a two-dimensional map of the pond (forest) [meadow] area. The questions the students will answer are:

- What are the physical characteristics and dimensions of a pond (forest) [meadow]?
- What is the role of the pond (forest) [meadow] in its community?
- How is water or air temperature related to one’s location in a pond (forest) [meadow]?
- How does weather affect a pond (forest) [meadow]?
- To what level or depth does sunlight penetrate a pond (forest) [meadow] community?
- How does sunlight penetration affect the type of life found at different levels or depths in the pond (forest) [meadow] community?
- How does the pond (forest) [meadow] community enter into the water cycle?

**Science Process Skills**
- observe
- measure
- infer
- predict
- hypothesize
- use numbers
- communicate
- collect and handle data
- interpret data
- draw conclusions

**Vocabulary**
- albedo
- affect
- aquatic tolerance
- canopy
- compass
- erosion
- food web
- forest
- greenhouse effect
- humidity
- hygrometer
- hypothesis
- infer
- mapping
- meadow
- orientation
- photosynthesis
- pond
- psychrometer
- quadrant
- qualitative
- quantitative
- sampling
- Secchi disk
- succession
- sunlight penetration
- surface map
- swale
- temperature profile
- transect
- transition zone
- turbidity
- undergrowth
- understory
- water cycle
Part Two/Introduction: Maintaining Life in the Community

The goal of the Maintaining Life in the Community studies is for students to investigate the factors that impact the presence and the quality of life in a pond (forest) [meadow] community and to summarize the connectedness of these factors. The questions the students will answer include:

- What are the origin and composition of soil and pond detritus?
- What is the relationship between soil or water chemistry and the type of plant or animal life that is found in the soil or water?
- What are the factors affecting soil and water chemistry and quality? What are ways to improve the quality?
- How do nutrients move from the soil or water to the plants and animals?
- What constitutes healthy soil or pond water?
- What are the effects of impurities in the water and air?
- How are the biotic and abiotic factors related in a pond (forest) [meadow] community?
- What does it take to maintain life in a pond (forest) [meadow] community?

### Vocabulary
- abiotic
- absorption
- acidity
- aerate
- air quality
- alkalinity
- aquatic tolerance
- biotic
- carbon
- carbon-oxygen cycle
- clarity
- competition
- composition
- condensation
- deciduous trees
- decomposition
- detritus
- dissolved oxygen
- duff
- ecosystem
- evaporation
- humus
- natural litter
- nitrates
- nitrogen cycle
- nutrients
- nutrient recycling
- oxygen
- particulates
- percolation rate
- pH
- phosphorus
- photosynthesis
- plasticity
- potting soil
- precipitation
- productivity
- purity
- resources
- respiration
- soil chemistry
- soil compaction
- soil profile
- soil texture
- topsoil
- transpiration
- water chemistry
- water cycle
- water quality
- watershed

### Science Process Skills
- observe
- measure
- recognize error
- classify
- infer
- predict
- hypothesize
- use numbers
- communicate
- collect and handle data
- interpret data
- draw conclusions
Part Two/Introduction: Activity Overviews

Pond Mapping

Pond Surface Map
Through this activity students survey the margins and boundaries, and record the physical dimensions and characteristics of a pond. The students use their collected data to construct a two-dimensional map of a pond’s surface.

Temperature Profile
Students investigate the relationship between pond water depth and water temperature. Additionally, students use collected data to construct a temperature profile for the pond.

Water Turbidity
In this activity, the students use constructed Secchi disks to investigate sunlight penetration and water turbidity in a pond.

Pond-ering the Weather
As long-term weather conditions are important factors in the topography and environmental conditions of an ecosystem, the students look for signs and/or effects of weather around and in the pond. They use their senses to make weather observations and instruments to collect quantitative weather data. They summarize their findings in a free-verse poem.

Maintaining Pond Life

What’s in the Water?
The students predict and analyze water characteristics based on life requirements of aquatic life collected from two ponds. Additionally, the students infer how the measured characteristics of the ponds account for the animal life found in them.

Who Says the Water’s Dirty?
Students observe water color and clarity, infer the “purity” of the water, and relate these to the productivity of a pond.

Sticks in the Mud
This activity gives students an opportunity to explore the origin and composition of pond detritus.

Forest Mapping

Stake Out
Students survey a forest and explore the relationship between tree sizes, canopy heights and forest undergrowth.

Along the Line
This activity allows students to use a transect sampling technique to measure and/or estimate sunlight levels, soil & air temperatures, humidity, undergrowth, and openness of the canopy.

Washed Out
In this activity, students search for signs of water flow and erosion in the forest.

Maintaining Forest Life

Getting the Dirt on Dirt
Students conduct a soil study by looking at profiles of soil samples from a forest area and conducting a variety of tests on the characteristics of the soil.

What Goes Around
This activity allows students to examine the forest floor and discover materials that are breaking down and returning nutrients to the forest soil.

Where’s the Water?
This activity introduces students to the various steps in the water cycle and to the paths water can take through a forest.
Meadow Mapping

Checking Out the Meadow
Students construct a two-dimensional map of a meadow community, noting features distinctive in a meadow.

Sampling in the Meadow
In this activity, students conduct a random sampling study in the meadow using instruments to measure sunlight level, temperature, humidity, and wind conditions.

Succeeding Beyond Measure
This activity helps students make the connection between biotic and abiotic factors and the successional changes in a meadow community.

Maintaining Meadow Life

What’s the Scoop on Soil?
Through this activity students have the opportunity to investigate the characteristics of soil found in a meadow community.

Rich Soil, Poor Soil
Students investigate the relationship between soil chemistry and plant life in the meadow community.

Going in Cycles
This lesson enables students to investigate, in part through simulation, some of the natural cycles occurring in the meadow (e.g., the water cycle, the nitrogen cycle, and the oxygen-carbon dioxide cycle.) The students summarize their experiences by diagramming one of the cycles.

Final Project: Community Survey

In this culminating study, students work together as a SMILE Club group. At an unfamiliar site, students apply the process and hands-on field study skills developed through the earlier six field studies. The students in each SMILE Club make a presentation and share with the rest of the camp their findings from the investigation of the new site.
Pond Mapping
Integration of Biotic and Abiotic Factors to Create Ecological Communities
**Activity Overview**
Students survey the margins and boundaries of a pond and record the physical dimensions and characteristics. The students use their collected data to construct a two-dimensional map of a pond’s surface.

**Learning Objectives**
To successfully complete this lesson the students will:
- observe the physical characteristics of a pond
- estimate the dimensions of a pond
- determine the directional markers of pond boundaries
- construct a two-dimensional surface map of a pond
- develop orienteering skills

**Science Process Skills**
The students will engage in scientific inquiry through: observing, estimating, describing, collecting data, modeling, constructing, scaling, measuring, inferring, communicating

**Background for Teachers**
Understanding a complex community, or studying a large area, requires students to develop their skills of making models. One of the most important models for ecologists is the map. A map can contain large amounts of information in a small space.

Mapping integrates many skills for students as they learn to develop a two-dimensional model of an area. They must collect data, compass directions, paces, etc., and translate it into information that can be used to make the map.

Students have a variety of skill levels and prior knowledge. Many will know about pieces of the map-making puzzle, however, many may not know how to use graph paper, develop a scale, or use a compass. This activity provides opportunities to teach these skills. Students also increase their ability to estimate. When we ask students to map the pond area, they are really estimating the boundaries of the pond using paces and the compass. This is a valuable tool, however, as they learn to relate the physical world to their map and the graph paper.

Students may have difficulty understanding how models reflect or represent the real world. For many students the concept of scale is difficult. They don't see the connection between the scale of the map and distances or size of things on the ground. If students use a pace to equal a square on the graph paper, they begin to see a connection between the scale (1 square = 1 pace) and the drawing of the map.

While modeling is a powerful tool for understanding, it is quite abstract. We use this mapping task to enable students to develop a concrete idea of the relationship of their map to the surrounding world. Through this hands-on experience, they begin to understand the idea of modelling the environment.
**Pond Surface Map**
(30 minutes)

**Materials**
laminated graph paper, water-soluble and permanent overhead projector pens, field notebook, calculators, compass, metric measuring tape, clipboard, pencil, Pond Mapping sheet

**Preparation**
- Scout Pagoda Pond to ensure the safety of the students as they move about determining features and landmarks.
- Select a spot near Pagoda Pond to gather with the students to initiate and conclude this activity. This will be the staging area for the activity.
- Have a selection of both permanent and water-soluble pens for use in fair or rainy weather.
- Be familiar with the use of the compass so that you can instruct the students in its use.
- Have enough compasses so that the students may work in pairs as they learn to use the compass.
- Map the pond and determine an appropriate scale for the students to use to draw their maps in their field notebooks.

**Activity Outline**
Introduction (Step 1, 2 minutes)
Instruction in Use of Compass (Steps 2-3, 3 minutes)
Surveying the Pond and Constructing the Map (Step 4, 13 minutes)
Transferring the Map (Steps 5-7, 10 minutes)
Closure (Step 8, 2 minutes)

**Procedural Steps**
1. Gather with the students at the staging area to introduce this activity. Ask: “How would you describe this pond? How big do you think this pond is? What would you need to know to be able to draw a map of the surface of this pond?” Allow the students to respond. If none of them mentions that a compass would be useful for determining the actual orientation of the boundaries and markers of the pond, bring up the uses for a compass.

2. Place students in their working groups of 3-4.

3. Introduce the compasses to the students and allow time for them to practice using them. The students should be able to sight an object and measure its orientation.

4. In their working groups the students will:
   a) determine the length of the step of the student who will be stepping off the distance. Record this information on the Pond Mapping sheet.
   b) locate a feature or landmark on the edge of the pond and face it.
   c) hold the compass waist high and level.
   d) record this reading as your beginning reading on the Pond Mapping sheet.
   e) pace off the distance to the feature or landmark. Record the number of steps and the feature on the sheet.
   f) repeat steps (b) through (e) until you have moved around all possible sides of the pond.

5. Once the students have collected the data for drawing their maps, have them reassemble so that you may discuss with them what they discovered as they surveyed the pond. Have students convert their paced distances to meters using the measured pace of the student marking off the distance. Ask the students why there is a need to have a scale in order to draw the map. Guide the students as they think about an appropriate scale. After they have given input, propose an appropriate scale to use. Have students select a scale for drawing the map. Convert survey steps to map distances. (e.g. 1 step = 1 square = 2.5 feet)
6. To draw the map on graph paper, students will:

   a) determine the direction of north on their map and how they want to draw the map on their paper.

   b) make a dot on the graph paper to show their starting point.

   c) use the compass to draw a straight line on the paper in the direction of their travel. Make the length of the line correspond to the distance using the scale found in step 5. Make a dot at the end of this line.

   d) draw in the landmarks from their notes at the correct distances along the line.

   e) hold the pen on the dot at the end of the first line and again use the compass to draw a second line in the direction of travel. Add landmarks from their notes for this line of travel.

   f) continue drawing the survey notes on the map in this manner until their survey map is complete.

7. When the groups have completed their maps on the graph paper, each group member should transfer the map to his/her field notebook on page 7.

8. Provide closure for this activity by asking the students to share what surprised them most in their survey of the pond. Ask them what they think someone reading their maps would find out about this pond. Close by saying: “Our first look at the pond has been that of a survey of its boundaries and surface features. Our next activity will allow us to take a closer look at how the depth of the water affects it temperature.”
### Pond Mapping Sheet

<table>
<thead>
<tr>
<th>Feature or Landmark</th>
<th>Compass Reading (Bearing) to Next Landmark</th>
<th>Distance in Paces to Next Landmark</th>
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Length of Pace (Step) ______
Activity Overview
Students investigate the relationship between pond water depth and water temperature. Additionally, students use collected data to construct a temperature profile for the pond.

Learning Objectives
To successfully complete this activity the students will:
- relate water temperature to depth of water
- relate water temperature to dissolved oxygen
- explore the concept of aquatic tolerance for organisms
- compare water and air temperature in and around a pond

Science Process Skills
The students will engage in scientific inquiry through: observing, measuring, comparing, inferring, communicating, modeling, recording

Background for Teachers
Collecting data and making predictions is central to understanding a pond’s relationship to the surrounding community. For example, air temperatures near a pond are strongly affected by the water’s temperature and by the water vapor formed at the pond’s surface. Water is slow to heat and slow to cool. This property of water keeps the temperature moderate compared to the temperature extremes which can occur on the land or in the air away from a pond.

The upper surface layers of the pond trap and absorb most of the sun’s energy. Therefore the upper layers experience a much greater temperature swing than layers only a few feet deeper. If you have ever swum in a pond, you may have noted that on a sunny day, the top layer of water is considerably warmer than the bottom. The sun’s energy not only heats the water but also provides the energy that supports all life in the pond and surrounding community as plants trap the energy through photosynthesis.

Temperature Profile
(adapted from “Measure Water Characteristics to Test Predictions,” USDA Forest Service)
(20 minutes)

What predictions can we make about the types of plants and animals that live in each of these layers? An animal or plant’s tolerances will determine where they live. For example, some animals feed on the algae that forms on the surface of a pond, others can’t live in the warmer waters found near the surface. The oxygen level will affect where plants and animals live. The level of oxygen in the water may be quite low near the bottom of a pond, particularly at night. Thus, an animal that is intolerant of low oxygen will spend less time near the bottom. Many animals make the best of both worlds, by commuting from the bottom layers up to the top layer to feed, as this is often the layer with the most energy for photosynthesis.

After students have collected samples, they will infer the pond’s temperature profile, filling in the spaces between their data. Few students will understand the meaning of ‘infer,’ but the concept of making predictions is not beyond them. They will need prompting to make a guess about what they think happens between two data points. In much the same way as the mapping, learning to infer from data is a skill of modeling. Make sure they understand these two key concepts: we can’t collect data for every possible location, so we use the data collected to make predictions for the rest of the pond.
Temperature Profile
(20 minutes)

Materials
air thermometers, water thermometers, plankton nets, rope (with distance marked every 3 m), poles for depth measuring, thin ropes with floaters, sinkers to weigh down thermometers, pencil, field notebook, demonstration thermometers, meter sticks, metric measuring tape, easel, chart pad, markers, three (or more) medium-sized jars with lids

Preparation
• Use a measuring pole to determine the depth of the Pagoda Pond around the pier. Use this information to determine the number of thermometers you should have positioned around the pier. You should have at least three, two at different pond depths and one at the bottom of the pond. You should allow the students to place the thermometer for the surface water temperature reading.
• Plan an arrangement of the water thermometers that will allow the students (in groups) to move from station to station, taking the temperature readings.
• Each water thermometer should be placed in a water-filled jar with its lid on. The jar should then be attached to a thin rope for lowering and raising the jar from the pond. Where the ropes are attached, place cards that indicate the depth of each thermometer.
• Have two thermometers, placed in different locations, available for demonstration.
• Draw a sample temperature profile on the chart to share with the students.

Procedural Steps
1. Gather with the students away from the pier so that they will not be distracted by the equipment that is set up. Ask: “How do you think the temperature of the water changes as you go deeper in a pond? Why? If you measure the temperature of the air just above the water and the temperature on the surface of the water, how do you think the two would compare? Why? Why is the temperature of pond water important?”
2. After allowing time for the students to respond, say: “In this activity you will measure the water temperature at different levels, measure the air temperature, construct a temperature profile for the pond, and think about the importance of the data you collected.”
3. Ask: “How many of you know how to read a thermometer? Just to make sure we are all working together, let’s practice reading these demonstration thermometers.” Have students volunteer to read each thermometer.
4. Once you are confident that the students can read the thermometers, have the students form groups of three. In their groups, have students:
   a) measure and record the temperature of the air 5-10 cm above the surface of the pond by placing a thermometer in a plankton net and holding it above the water. Record on page 8 of your field notebooks.
   b) use a similar procedure to find the temperature of the air 1 m above the surface of the water. Record in notebooks.
   c) read and record the temperature of air 5-10 cm and 1 m above the bank of the pond.
   d) place a thermometer in a plankton net and hold it just at the surface of the water so that the thermometer bulb is just below the surface. Allow 1-2 minutes for the thermometer to stabilize and then read and record the surface water temperature.
e) pull up the jar containing the thermometer at each of the pond temperature stations, read and record the water temperature and the depth of the thermometer in your field notebook. Quickly replace thermometer in the jar and the jar in the pond.

5. When all the groups have measured and recorded the temperatures at each of the seven locations, gather them around so that you may discuss their findings. Ask: “Are the temperature readings what you expected? Did the temperatures change in the pond as you thought they would? How do the water and air temperatures compare? Why do you think they are different? Why is this important? How do the air temperatures above the water compare to those above the land? Would you expect them to be the same? Why?”

6. Tell the students they will show in a graphical way how the temperature changed at different heights above and different depths into the water. Show and explain the temperature profile you developed. Allow the students to ask questions to ensure they understand what they will need to do.

7. Using their group’s data, each student will infer and construct a temperature profile for the pond on page 8 of the field notebooks. Move among the students as they are working on this to assist or redirect as needed.

8. To close this activity and to transition to the next, ask: “What conclusions can you make about temperatures around and in a pond? When might this information be important? What effect does water temperature have on a pond? What things might affect the temperature of the water at different depths in a pond?” “In our next activity we will investigate one of the factors that affects water temperature: water turbidity. Let’s turn our attention to it now.”
Water Turbidity
(20 minutes)

Activity Overview
In this activity, the students use constructed Secchi disks to investigate sunlight penetration and water turbidity in a pond.

Learning Objectives
To successfully complete this lesson the student will:
• construct and use a Secchi disk
• observe and record the depth at which a Secchi disk can be seen at various locations in the pond
• relate penetration of sunlight to the turbidity of the water
• infer a relationship between water turbidity, sunlight penetration, and water temperature

Science Process Skills
The students will engage in scientific inquiry through: observing, measuring, constructing, inferring, relating, drawing conclusions

Background for Teachers
Turbidity is a measure of the amount of visible materials suspended in the water. High turbidity means there are a lot of suspended materials and the water appears murky. Conversely, water with low turbidity is relatively clear. Turbidity influences the sunlight penetration into the water. The higher the turbidity, the less the sun can penetrate into the depths of the water.

When water is rapidly flowing into a pond, such as in the winter, there may be high turbidity due to large amounts of suspended soil from surface erosion. Some of these materials settle fairly quickly, but clay particles may stay suspended for long periods of time, even weeks or months.

For a calm pond the majority of suspended particles will be living microscopic plants and animals (plankton). If the pond’s water does not contain suspended soil particles, the turbidity measurement of other materials is a measure of a pond’s condition. If the water is clear this may mean there is a lack of nutrients. Clear water, in terms of plankton and other living microscopic organisms, is comparatively dead. Murky water contains a rich soup of living and dead materials and is high in nutrients. However, water turbidity that is too high, from overabundance of plankton or algae, can cause a loss of life as dissolved oxygen is used up and sunlight is unable to penetrate into the water. Given the right combination of nutrients and sunlight, the water is a rich concoction that provides for a productive foundation of a pond’s food web.

This richness, while supporting life, also factors into the succession of a pond. In a pond with high turbidity, more living things are cycling through the food web and more material is deposited on the bottom of a pond. Slowly the pond’s margins will shrink and finally the pond will be replaced by a marsh, then a meadow. Ponds, like all living communities, are constantly changing through succession.

Materials
commercial Secchi disk for demonstration, pencil, field notebook, phonograph records (1 for each group), white contact paper, Secchi disk pattern, scissors, thin ropes with distance markings, fishing weights (assorted sizes), metric measuring tape

Preparation
• Scout locations around Pagoda Pond where the students may safely lower their Secchi disks and see when the disk is no longer visible. Try to match locations in this activity with those used for the Temperature Profile. The pier and the dock are two recommended locations for this activity.
• On the contact paper, make several circles the same size as the record (including the center hole). Use the Secchi disk pattern to divide
the circles into sections. (All these sections will be white as the record provides the needed black.)

• Cut out one of the circles. Use the pattern to place the sections on one side of a record to make a sample “Secchi record.”

• Thread a thin rope through the center hole of your “Secchi record” and knot the end. Leave enough at the end to attach fishing weights.

Activity Outline

Introduction (Step 1, 2 minutes)
Constructing Secchi Disk (Steps 2-3, 4 minutes)
Measuring Sunlight Penetration (Step 4, 8 minutes)
Discussion (Step 5, 5 minutes)
Closure (Step 6, 1 minute)

Procedural Steps

1. Gather the students on the pier at Pagoda Pond. Allow students to carefully peer over the edge into the water. Ask them to describe what they see. Ask: “Can you see to the bottom of the pond? How do you know you are not seeing the bottom? What prevents you from seeing all the way to the bottom? If we moved to another location would you be able to see to the same depth? Why do you think so?”

2. Show the commercial Secchi disk to the students and introduce the terms water turbidity and sunlight penetration. Demonstrate how the disk is used. (Slowly lower the Secchi disk into the pond until you can no longer distinguish the black and white areas on the disk. Remove the disk from the water; measure and record the distance to which the disk was lowered.) Show the students your constructed disk. Ask how they think the disk was constructed. Tell them that in groups they will make and use their own Secchi disks in measuring sunlight penetration.

3. Have students form pairs or trios. Give the required materials to each group. Make sure the students understand how to construct the disks.

4. As groups complete their disks allow them to move to the selected area to use the disks. Each group should collect data from each of the sites you selected in your scouting.

5. When all the groups have measured each site, gather them to discuss their findings. Ask: “Were the depths the same? What might account for the differences? How can this be related to the temperature profile you constructed in the last activity? Would you expect the results to be the same if you conducted this activity next week? What might have changed? How might this affect the life found in this pond?”

6. To close, say: “One factor that may affect the turbidity is soil particles suspended in the water. The weather around the pond influences how much soil and what size particles are in the pond. In our next activity we survey the signs and/or effects of weather.”
Pond-ering the Weather
(adapted from “Weather Scavenger Hunt,” Ranger Rick’s Naturescope)
(20 minutes)

**Activity Overview**
As long-term weather conditions are important factors in the topography and environmental conditions of an ecosystem, the students look for signs and/or effects of weather around and in the pond. They use their senses to make weather observations and instruments to collect quantitative weather data. They summarize their findings through a free-verse poem.

**Learning Objectives**
To successfully complete this activity the students will:
- identify the signs or affects of weather in and around a pond community
- discuss several ways the Sun, Earth, air, and water interact to create weather
- observe weather conditions around the pond community
- explore the relationships between weather features and quantitative data
- communicate the impact of weather on the pond community and/or the role of the pond in the weather

**Science Process Skills**
The students will engage in scientific inquiry through: observing, recording, discussing, inferring, relating, communicating

**Background for Teachers**
Weather is the state of the air at a given time in a given place. Weather changes daily and seasonally, and results from the complex interactions among the Sun, the Earth, the Earth’s atmosphere (air), and water.

The Sun affects all other components of the system. Much of its energy, in the form of light, is reflected into space by the Earth’s surface, the atmosphere, and the clouds. (This reflective action is known as the “albedo effect.”) The rest of the Sun’s energy is absorbed by the Earth’s atmosphere, land and water surfaces, and human-made surfaces, such as asphalt. This absorbed light energy is changed into heat energy. The Earth’s atmosphere, water, and occupants are all heated by the Sun’s heat energy.

The atmosphere allows the shorter light wavelengths to pass through it, but it traps the longer waves of heat energy that reradiate from the Earth. This is part of what is called the “greenhouse effect” and the heat that stays in the atmosphere is essential to life on Earth. Global warming is an unnatural increase in temperature due to extra carbon dioxide in the atmosphere.

Air influences the Earth in two ways. It moves across the Earth’s surface as wind, and it presses down on the Earth’s surface, resulting in air pressure. Air pressure is the force of a column of air exerted over a unit area of the Earth’s surface. Warm air is less dense than cold air, so warm air exerts less force downward per area of the Earth’s surface. Warm air expands and rises. Cold air, more dense than warm air, flows in to take the place of the rising warm air. In other words, air from cooler high pressure areas moves into warmer low pressure areas.

Wind is caused by the uneven heating of the Earth’s atmosphere by the Sun. Warm air expands and rises. Cold air, more dense than warm air, flows in to take the place of the rising warm air. In other words, air from cooler high pressure areas moves into warmer low pressure areas.

Winds are named for the direction from which they come: a north wind blows across the Earth from north to south. Wind direction is caused by the rotation of high and low pressure systems. In the Northern Hemisphere, high pressure systems generally rotate in a clockwise direction and low pressure systems in a counterclockwise direction. These are attributed to general circulation patterns and forces related to the rotating earth.
Wind interacts with water (oceans, lakes, clouds, etc.) and moves, warms or cools it.

Moisture on the Earth’s surface and in the air affects weather. Surface water affects the amount of the Sun’s energy reflected back into space. Large bodies of water heat or cool the air masses above them. Atmospheric water interacts as part of the complex water cycle. Atmospheric water may stay in the air (which accounts for humidity), condense to form clouds or fog, or precipitate out in the form of rain or snow and fall to the Earth.

Earth’s weather patterns are also affected by the tilt, rotation, and revolution of the Earth and the color and texture of the Earth’s surface. All these interactions form one of the most complex and interesting topics of study, the weather.
Pond-er-ing the Weather
(20 minutes)

Materials
field notebook, pencil, cloud chart, weather pictures, Weather Scavenger Hunt sheet, rain gauge, wind speed meter, wind vane, barometer, thermometer, relative humidity gauge, cobalt chloride paper, easel, chart pad, chart markers, support boards, tape, push pins

Preparation
• Select places around the pond where you can place the weather instruments so groups of students may move among them to make quantitative readings.
• Place the cloud charts and weather pictures on the support boards so students can see them during the introduction. Students will also need access to them as they make their weather observations.
• Have an easel and attached chart pad for use during the introduction. Label two columns on the top sheet of the pad: (1) "Weather Is, Weather Events," and (2) "Effects of Weather Events." On a second sheet of the pad, make a column for each weather condition listed on page 8 in field notebook.
• Locate signs of weather near the pond area that you can use as examples for the students before they begin their own searches.
• Select a staging area for this activity.

Activity Outline
Introduction (Step 1, 2 minutes)
Looking for Signs (Steps 2-3, 5 minutes)
Discussion (Step 4, 2 minutes)
Weather Observations (Steps 5-8, 5 minutes)
Poem Writing (Steps 9-10, 4 minutes)
Sharing/Closure (Step 11-12, 2 minutes)

Procedural Steps
1. Gather the students in the staging area and ask:

   "What is weather? What are some of the weather events you remember from your communities? What effects did these events have on the communities you were in? What major weather features were most noticeable during the events?"

   Record student responses under "Weather Is, Weather Events" on chart pad. After discussing students' responses, say:

   "During the first part of this investigation you will scavenge for various signs that indicate past or present effects of weather conditions and events. What might be some of the things you could look for?"

   Make a list of student responses on the chart pad and save it to supplement the Scavenger Hunt list, if the responses are different from what’s on the list.

2. Have students form groups of 2-3. Give each group a Weather Scavenger Hunt sheet. Say: “The items on this list are just some of the things that indicate something about the effects of weather. Each of your groups will use this sheet as a guide as you look over this pond community for signs of weather. Be sure to record in your field notebooks the specific signs that you find. You will have 5 minutes to conduct your search. Be sure to listen for my signal for all groups to reassemble here.”

3. Send the groups out on their searches. Be sure to connect with each group as they are looking for signs. Be prepared to provide further examples if the students in a group are having a hard time finding their own examples or locating items from the scavenger list.

4. After the allotted time has passed, regain the attention of all students and have them gather for a discussion of their findings. Allow students to share some of the signs and encourage them to tell what each sign indicates about the weather.
5. After the students have shared, ask:

"Is it enough to look for signs of weather and try to interpret them? When might it be important to know some of the numbers associated with weather conditions?" Add:

"Now you will continue to work in your groups to make weather observations for the conditions listed on page 8 in your field notebooks."

6. Ask the students if they know what is meant by each of the terms. Be ready to offer an explanation or clarification for any of the terms, if needed. "What words could you use to describe each of the conditions listed?" List these choices on the chart pad under the different conditions. Be sure to fill in any missing terms and discuss with the students how quantitative observations can be made for each of the weather conditions.

7. Say: "It is important to have numerical information about the weather as well, so we can better understand patterns and conditions in the long-term. For this part you will first make qualitative observations of the weather using some of the terms we listed just now. When your group has completed their descriptive observations, you will make quantitative readings on weather instruments. Specific readings should include temperature, barometric pressure, relative humidity, wind speed and direction, and rainfall for the last 24 hours. After your group has finished making both qualitative and quantitative weather observations, each of you will need to compose a short poem about weather conditions around this pond. This poem may be free verse and should be placed on page 6 in your field notebooks."

(A free verse poem is one that is written in any style. For example:

**Weather Is**
Weather is the rain that fell yesterday.
Weather is the leaves blowing in the air.

Weather is here.
Weather is now.
Weather is everywhere.)

8. Allow the students to conduct their weather observations. Be mindful of any groups that seem to be taking a long time to complete the observations. Encourage the groups to move right into the poem writing.

9. After the observation/poem writing time has passed, call the students together. Ask: "How did your descriptive observations compare with the measurements for the present weather conditions? How would you summarize the weather conditions around this pond?"

10. Allow several students to share their weather poems.

11. Close this session by saying: "We have looked at the physical boundaries and attributes of the pond and the weather conditions around it. As you move to your next field study, you will have opportunities to investigate some of the conditions necessary for maintaining life in a pond community."

12. To conclude this field study, ask students to review some of the vocabulary used during the field study. Have students record four or five of these terms on page 7 in field notebooks under "Vocabulary Pondered."
Weather Scavenger Hunt

Use the clues below to find weather-related things in the community you are studying.

1. Something bending toward the sun
2. Something hiding from sunshine
3. Something that may become part of a cloud
4. Something that tells you the wind is blowing
5. Something left by the rain
6. A place where icicles might form
7. A place to go where it’s cool
8. A place where rain has moved the soil
9. A place that gets little sunshine
10. Something that bends in the wind
11. Something that won’t bend in the wind
12. Something that reflects lots of sunlight
13. Something that absorbs lots of sunlight
14. Something that will soak up rain
15. Something that makes rain splatter
16. Something that protects people from rain
17. Something that uses sunlight or wind or water to work
18. Something that smells better after a rain shower
19. A good windbreak
20. Something shaped by wind or water
21. A sign of wind or rain damage
22. Something the color of the sky (that’s not the sky)
23. Something the color of snow
24. Something that would make snow melt

What other weather-related things or signs of weather can you find?
Maintaining Pond Life
Integration of Biotic and Abiotic Factors to Create Ecological Communities
What’s in the Water?
(adapted from “Aquatic Tolerance,” Minnesota Valley National Wildlife Refuge and “Predict Water Characteristics,” USDA Forest Service)
(45 minutes)

Activity Overview
The students predict and analyze water characteristics based on life requirements of aquatic life collected from two ponds. Additionally, the students will infer how the measured characteristics of the ponds account for the animal life found in them.

Learning Objectives
To successfully complete this activity the students will:
• predict water characteristics of ponds based on the needs of aquatic life found in them
• measure the physical characteristics of ponds
• analyze these characteristics in terms of health requirements of aquatic life
• compare the results of scientific measuring with their predictions

Science Process Skills
The students will engage in scientific inquiry through: measuring, observing, classifying, inferring, interpreting data, predicting, drawing conclusions

Background for Teachers
Many characteristics of the pond’s water can’t be seen. While we might see evidence of some materials by visual inspection, chemical testing gives us a more accurate picture of the materials dissolved in the water. Students will measure a number of important chemical features of the water that, in turn, predict the types of plants and animals the pond can support.

One of the most important and easiest to measure is pH. In chemical terms, pH is the measure of the potential hydrogen ions found in the water (p = potential, H = hydrogen). If the pond water has more free hydrogen than normally found in pure water it is considered more acidic; basic or alkaline water has less hydrogen. pH is controlled by the water entering the pond, by the materials found in the pond, and by evaporation.

If the water flows across limestone, the pH changes. If the rain entering the pond is mixed with air pollution, acid rain, it will make the pond more acidic. Ponds with high evaporation rates can become alkaline as the dissolved materials become more concentrated. For living things sensitive to pH levels, these differences may make the pond inhospitable, or change the types of plants and animals that survive there.

Other chemicals measured are nitrates and phosphorus. These nutrients are both extremely important for life but are usually found in limited supply in pond water. Very high levels suggest an outside source, such as runoff from farm fields. Ponds with very low levels of these nutrients often have very clear water but are relatively dead in terms of floating life, plankton. Waters high in these nutrients are well fertilized and therefore rich and murky. Too much of this richness becomes a burden and plants and algae will use up too much of the oxygen in the water causing fish and other animals to die. This is why we need to lower the levels of these nutrients flowing into our water by decreasing their use in fertilizers and other products, such as laundry detergents.

The last chemical test is for dissolved oxygen. The amount of dissolved oxygen is directly related to the temperature of the water. Two measures of dissolved oxygen are used: % saturation and parts per million (ppm). Each value reflects different issues. Percent saturation gives an idea of how much oxygen is used by various processes, such as living organisms and decay. Very low values for percent saturation would indicate greater oxygen demand. Parts per million measures the absolute concentration of the oxygen in the water. Ppm are important as some animals need certain levels of oxygen in order to survive. These animals are intolerant of low oxygen levels.
What’s in the Water?  
(45 minutes)

Materials
field notebook, pencil, goggles, trash bag, 6 buckets (for water collection), small jars, thermometers, Aquatic Tolerance chart, Aquatic Life Requirements chart, 8 buckets (large bug buckets work well, for holding collected aquatic specimens), aquatic plant and animal field guides, water chemistry kit (for pH, dissolved oxygen, nitrogen, and ammonia), water chemistry chart for comparison

Preparation
• Select prominent places at each pond to display the water chemistry chart so that the students have easy access for comparing the colors of their water samples to the chart.
• Select a good staging area for this activity, the island at Pagoda Pond is suggested.
• Scout Lower Pond for safe locations for the students to collect water samples for testing. As this is the first activity in this field study, have the students collect the water sample from the Lower Pond as they leave the Dining Hall on the way to Pagoda Pond.
• Select good observation points at each pond.
• Collect and set aside four buckets of aquatic specimens from each pond for the students to use in predicting water characteristics. Include both plant and animal life. Become familiar with the names of the specimens you collect. You may use field guides. Return the specimens to their respective ponds when you are finished.

Activity Outline
Introduction (Steps 1-2, 4 minutes)  
Predicting Water Characteristics (Steps 3-8, 10 minutes)  
Analyzing the Water (Steps 9-12, 20 minutes)  
Interpreting Results (Step 13, 8 minutes)  
Closure (Step 14, 3 minutes)

Procedural Steps
1. Gather with the students at Lower Pond. Ask the students to describe what they see. Ask them what type of animals they think live in this pond. Remind them that this activity is about water characteristics. Ask them what they think is the connection between water characteristics and the plant and animal life found in a pond. Introduce the notions of nutrients and the health of a pond.

2. Say: “Many aquatic organisms have specific needs to support their life functions. The presence or absence of various plants and animals can be used to make educated guesses about water characteristics of a pond. To begin this activity you will have the chance to predict some water characteristics based on what lives in this pond as well as Pagoda Pond. I have collected some samples of the plant and animals from each of the ponds; they are up at Pagoda Pond and you will use the samples and some charts to predict water characteristics.”

3. Have students form groups of 3-4.

4. Explain the procedure for collecting the water sample from the pond. The sample should not be too cloudy or filled with too many sediments. The water should be collected from the surface of the pond. Once each group has collected its sample, have a student in each group take the temperature of the water. Each group member should record the temperature on page 9 of their field notebooks. (Collect your bucket of aquatic specimens on your way by.)

5. As you walk with the students to Pagoda Pond, lead them in a discussion of what the results of this investigation may be. Once at Pagoda Pond have each group collect a sample of the surface water from this pond. The temperature of this sample should be taken and recorded. Each group should place its two pond water samples in a safe place for later use.
6. Distribute to each group two buckets of aquatic specimens, one from each of the ponds. Tell the students they will need to use the Aquatic Life sheets to identify some of the organisms present and use this information to predict the characteristics of the water in each of the ponds.

7. Allow the students ten minutes to observe the specimens, look over the Aquatic Life Requirements chart, and make their predictions for the water characteristics.

8. When the students have completed their observations and predictions, regain their attention and say:

“What are some of the predictions you made? Why did you make the choices that you did?”

After allowing sufficient time for the students to respond, add:

“Your predictions form the foundational data from which you will continue this activity. Now we will test what you hypothesized. One way to test your predictions about water characteristics is to use a chemical kit to actually measure the characteristics you predicted.”

9. Have each group decide which two students in each group will handle the chemicals and bags. Distribute goggles to these students. Students should follow the chemical procedures for each chemical for which they are testing. The students should conduct each test for both ponds before moving on to the next test. Each group should label six bags, three with "PP" for Pagoda Pond, and three with "LP" for Lower Pond.

Remember: Always have the students using the chemicals and handling the bags wear goggles! Also, remind students to keep track of the results from the two ponds.

The students wearing goggles should:

**pH**
- Carefully add Pagoda Pond water to line “C” on the "PP" bag.
- Add wide Range pH tablet and slowly shake for 30 seconds. **Do not pinch!**
- Compare color of water to pH colors on the chart. Make estimates for intermediate colors.
- Record the pH in field notebook on page 9.
- Repeat with water from the Lower Pond.

**Dissolved Oxygen (D.O.)**
- Label two glass tubes, "PP" and "LP."
- Fill glass tube completely to the top.
- Add two dissolved oxygen tablets. Expect a little water to spill.
- Carefully close the cap.
- Slowly mix the contents in the tube by repeatedly turning over the tube. It should take about 4 minutes.
- Wait approximately 5 more minutes for the color to appear in the tube.
- Compare the color in the tube to that D.O. colors on the chart. Estimate values for intermediate color levels.
- Record DO in field notebook.
- Repeat with water from the Lower Pond.

**Ammonia**
- Carefully fill plastic bag labeled "PP" to line “C” with Pagoda Pond water.
- Add Ammonia Tablets #1 and #2. Roll down and seal close.
- Shake gently for about 3 minutes. **Do not pinch or squeeze.**
- Wait five minutes for some the color to appear in the bag.
- Compare the color in the bag to chart colors. Estimate values for intermediate color levels.
- Record ammonia value in field notebook.
- Repeat with water from the Lower Pond.
Nitrogen
• Fill plastic bag labeled "PP" to line “C” with Pagoda Pond water.
• Add one Nitrate #1 tablet.
• Roll down bag and shake gently for 30 seconds to mix.
• Carefully open plastic bag and to it add Nitrate #2 tablet. Re-roll and seal bag.
• Mix for 2 minutes and wait 3 minutes more for color to appear.
• Compare the color in the bag to chart colors.
  Estimate values for intermediate color levels.
• Record nitrogen value in your field notebook.
• Repeat with water from the Lower Pond.

10. Compare the data collected from the two samples. Are the results what were expected? What might be an explanation for these results? Review the Aquatic Tolerance chart so students can see how chemical characteristics of pond water affect the animal life found in it.

11. Once the chemical tests have been completed, have students compare the measured results with their predictions and compare the measured results between the two ponds. Ask: “Are the results what you expected? What factors might account for the differences in the values for the two ponds? How do you think these nutrients get into pond water? What have we found out about these two ponds? What might happen to the organisms living in a pond if the temperature, pH, or dissolved oxygen were drastically changed? What other water characteristics might we investigate for these ponds?”

12. To close this activity, say to the students: “Looking specifically at water chemistry allows us to check the health of the aquatic environment in a pond. The levels of nutrients can be too high or too low for the organisms living in a pond in order for these organisms to receive what they need to survive. The chemical characteristics of a pond affect the overall water quality of it. We will consider other aspects of general water quality in our next activity.”
Aquatic Life Requirements

Temperature Ranges Required for Certain Organisms

<table>
<thead>
<tr>
<th>Temperature Range in degrees Fahrenheit</th>
<th>Examples of Aquatic Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater than 68 (warm water)</td>
<td>Much plant life, many fish diseases</td>
</tr>
<tr>
<td></td>
<td>Most bass, crappie, bluegill, carp, catfish, caddis fly</td>
</tr>
<tr>
<td>Middle Range (55 - 68)</td>
<td>Some plant life, some fish diseases</td>
</tr>
<tr>
<td></td>
<td>Salmon, trout, stone fly, mayfly, caddis fly, water beetles</td>
</tr>
<tr>
<td>Low Range (cold water, less than 55)</td>
<td>Trout, caddis, stone fly, mayfly</td>
</tr>
</tbody>
</table>

pH Ranges that Support Aquatic Life

<table>
<thead>
<tr>
<th>Most Acid</th>
<th>Neutral</th>
<th>Most Alkaline</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>13</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

Bacteria

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Most Acid</th>
<th>Neutral</th>
<th>Most Alkaline</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td></td>
<td>13.0</td>
</tr>
</tbody>
</table>

Plants (algae, rooted, etc.)

<table>
<thead>
<tr>
<th>Plants (algae, rooted, etc.)</th>
<th>Most Acid</th>
<th>Neutral</th>
<th>Most Alkaline</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>13.0</td>
<td></td>
</tr>
</tbody>
</table>

Carp, suckers, catfish, some insects

<table>
<thead>
<tr>
<th>Carp, suckers, catfish, some insects</th>
<th>Most Acid</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6.0</td>
<td>9.0</td>
</tr>
</tbody>
</table>

Bass, crappie

<table>
<thead>
<tr>
<th>Bass, crappie</th>
<th>Most Acid</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6.5</td>
<td>8.5</td>
</tr>
</tbody>
</table>

Snails, clams, mussels

<table>
<thead>
<tr>
<th>Snails, clams, mussels</th>
<th>Most Acid</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7.0</td>
<td>9.0</td>
</tr>
</tbody>
</table>

Largest variety of animals

<table>
<thead>
<tr>
<th>Largest variety of animals (trout, mayfly, stone fly, caddis fly)</th>
<th>Most Acid</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6.5</td>
<td>7.5</td>
</tr>
</tbody>
</table>

Dissolved Oxygen (DO) Requirements for Native Fish and Other Aquatic Life

<table>
<thead>
<tr>
<th>Examples of Life</th>
<th>DO in ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold-water organisms including salmon and trout (below 68 degrees). Spawning, growth and well being (caddis fly, stone fly, mayfly)</td>
<td>6 ppm and above</td>
</tr>
<tr>
<td>Warm-water organisms including game fish such as bass, crappie, catfish and carp (above 68 degrees). Growth and well-being (some caddis fly)</td>
<td>5 ppm and above</td>
</tr>
</tbody>
</table>

NOTE: Pure, cold water can hold a maximum of 16 ppm under field conditions.
Aquatic Tolerance

This chart contains tolerance levels for different types of aquatic organisms. The factors given are preferred range of pH, minimum dissolved oxygen (DO) in parts per million (ppm) and temperature range in degrees Fahrenheit.

<table>
<thead>
<tr>
<th>Organism</th>
<th>pH Range</th>
<th>Dissolved Oxygen (DO) in ppm</th>
<th>Temperature in degrees Fahrenheit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bass</td>
<td>6.5 - 8.5</td>
<td>3</td>
<td>34 - 80</td>
</tr>
<tr>
<td>Sucker</td>
<td>6 - 9</td>
<td>2</td>
<td>32 - 80</td>
</tr>
<tr>
<td>Mayfly Nymph</td>
<td>7 - 9</td>
<td>6</td>
<td>55 - 68</td>
</tr>
<tr>
<td>Bluegill</td>
<td>6.5 - 8.5</td>
<td>3</td>
<td>32 - 80</td>
</tr>
<tr>
<td>Diving Beetle</td>
<td>6 - 9</td>
<td>4</td>
<td>45 - 80</td>
</tr>
<tr>
<td>Caddis Fly</td>
<td>7 - 9</td>
<td>5</td>
<td>32 - 80</td>
</tr>
<tr>
<td>Bacteria</td>
<td>1 - 13</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Mosquito Larva</td>
<td>5 - 12</td>
<td>2</td>
<td>45 - 80</td>
</tr>
<tr>
<td>Plants</td>
<td>6.5 - 12</td>
<td>NA</td>
<td>55 - 80</td>
</tr>
<tr>
<td>Sludge Worm</td>
<td>6 - 9</td>
<td>2</td>
<td>32 - 80</td>
</tr>
<tr>
<td>Hellgrammite</td>
<td>7 - 9</td>
<td>7</td>
<td>55 - 68</td>
</tr>
</tbody>
</table>
Who Says the Water’s Dirty?
(adapted from “Investigating Your Environment,” USDA Forest Service)
(25 minutes)

Activity Overview
Students observe water color and clarity, inferring the “purity” of the water and relating it to the productivity of a pond.

Learning Objectives
To successfully complete this activity the students will:
• draw conclusions about water quality from sample results
• relate productivity to water clarity and color
• investigate various means of filtering water
• infer how natural filtration works
• determine how human activities have affected water quality

Science Process Skills
The students will engage in scientific inquiry through: observing, interpreting data, inferring, drawing conclusions, relating, classifying

Background for Teachers
Students will make a number of qualitative observations to determine the water quality of the pond. Good water quality for rich array of life provides needed food sources, but is not overburdened by excess turbidity and nutrients. One of the measures used to make an evaluation about water quality will be clarity. We often think of water that is clear as “good” and water that is murky as “bad.” This may be true for recreation or drinking water, but may not be true in terms of a pond’s health. Additionally, this assessment scheme does not address any “hidden,” yet potentially damaging, pollutants.

Productivity is a measure that reflects many aspects of a pond community. Each of these aspects form a link in the productive chains of the pond, with the weakest link controlling the final net productivity. A very productive community may be the result of too much of some material. For example, too much phosphate may allow algae populations to rise and bloom. As the algae die and decay, the oxygen levels in the pond decrease. This may lead to a die-off of a fish species sensitive to low oxygen levels. If the fish normally eat algae, the process may accelerate. Similar to the biases about water purity, there may be biases about pond productivity as well.
Who Says the Water’s Dirty?
(25 minutes)

Materials
pencil, field notebook, magnifying lens, jars with lids, coffee filters, sand, gravel, charcoal, funnels (make from 2-liter bottles), buckets for collecting water, Productivity chart, petri dishes, permanent markers, potting soil, plastic spoons

Preparation
• Label four lidded jars 1 through 4. Nearly fill each jar with pond water. Set these aside for a later demonstration.
• Place the Productivity chart in an accessible location.
• The students should work in pairs for this activity. Give some thought to group management. Investigate the dock or island at Pagoda Pond as a staging area for this activity.
• Decide if you will use any Lower Pond water left over from “What’s in the Water?” or have students collect new samples from Lower Pond. Consider the time limitations as you make the choice.
• Set up demonstration water filtration system from coffee filters, gravels, and 2-liter bottles.

Activity Outline
Introduction (Step 1, 3 minutes)
Water Color and Clarity (Steps 2-11, 7 minutes)
Water Filtration (Steps 12-14, 10 minutes)
Discussion (Step 15, 3 minutes)
Closure (Step 16, 2 minutes)

Procedural Steps
1. Gather the students and say: “What is meant by clean pond water? What would you want the water to be like in a pond in which you wanted to swim? Describe a pond in which you would not want to swim.” Allow students ample time to respond. Then say: “The things that affect the quantity of life in a pond at any given time may not be the same as those things that make the water desirable for recreational use. For instance water with a foul odor and lots of weeds might be considered a nuisance by people. But this type of water may support a large number of bass or catfish. The productivity of a pond is related to the quantity of life present in it at any given time.”
2. Continue with: “Two additional water characteristics that are related to water quality are color and clarity. These are not characteristics that we can measure with chemicals, so we will need to use our powers of observation to determine color and clarity for our two study ponds.”
3. Have students form their study pairs. Each pair should fill and cap two lidded jars, one sample from each pond. (If the students are to collect the samples from the ponds, rather than from buckets you filled previously, you need to allow for travel time to and from Lower Pond. Adjust the outline times accordingly.) In order to keep the samples from the two ponds distinguished, let students labels the jars using a permanent marker.
4. Have the students describe the appearance of the water in each jar. They should record these observations in their field notebooks on page 9.
5. Have the students hold each jar up to the sunlight to study both the color and clarity of the water. Each pair should discuss their choices of colors and arrive at some agreement for the color of each sample. Record colors on page 9. To determine the clarity, students look through the jars of water at a selected object. Using a relative scale of 1-5, pairs should determine the clarity of the water (5 is foggy, difficult to see selected object, 1 is clear, easy to see selected object.) Record clarity ranking.
6. When all the pairs have determined color and clarity, regain the students’ attention and
say: “We have a chart that we can use to help us determine the productivity of each of these ponds. But before we use the charts, I would like you to think about what we’ve found out already about water quality and the types of life in each of the ponds. How would you classify each pond: very productive, somewhat productive, or barely productive? Why would you make that choice?”

7. Allow the students to respond and then say: “Let’s use the chart to see how the productivity in each pond would be classified.”

8. Have students examine the Productivity chart and draw some conclusion about the productivity of each pond using their observations. Then say:

“How did you classify each pond? Why?”

“What might be some things that could change either the color or the clarity of pond water? What might cause these changes to occur?”

“Observe this demonstration.”

9. Into the jars of pond water you set aside earlier add one, one and a half, and two teaspoons of potting soil respectively (leaving one jar as a comparison). Shake a jar. Ask students: “How have the color and clarity of the water changed? Could a pond filled with water such as this still be productive? Why?”

10. Repeat the observations and questions of Step 9 with jars the other two jars.

11. Say: “Consider the two jars of water you have and the jars I have. What kinds of activities would you use each of these jars of water for? Why? Can we make any of our samples cleaner for other things we might want to do? How might cleaning or filtering pond water affect the productivity of that pond? If we try to make the water good for us to use, will it necessarily be good for the aquatic life found in it?”

12. After students have responded, add: “Let’s see how filtering might change the color and clarity of our water samples.

13. Show students the demonstration filtering system and explain how the system was set up. Ask: “How do you think the water samples from the two ponds will look after passing through this system? How will the muddy water be affected? Why would you filter water?”

14. Have pairs set up filtering systems and use them to filter the water from each pond. The students should record their observations of the filtered water samples in their notebooks. You may filter the jars with potting soil as a comparison.

15. To conclude this activity, ask the students what makes water “dirty” and when is “dirty” water what you want. Have them answer the questions on page 10 of the field notebooks. Emphasize that “clean” water is a relative value that varies depending on what the water will be used for. Ask them what might happen if the water in the two ponds were “cleaned” up.

16. To transition to the last activity in this field study, say to the students that it is not only water that is important to life in a pond. The banks around the pond are also important. In the next activity they will take a close look at the bank, looking at the mud and the things found there.
Productivity

The quantity of life that may be present in any given body of water at any given time is often referred to as the “productivity.” A water of low productivity is a poor water, biologically speaking, but is often clean water and desirable as a water supply or for recreational use. Productive water may be either a nuisance to people or it may be highly desirable. Foul odors and weed choked waterways are usually branded a nuisance; however, bumper crops of bass, catfish, or sunfish may be the result and are highly desirable.

Relationships of Water Color to Productivity

<table>
<thead>
<tr>
<th>Color of Water</th>
<th>Probable Cause</th>
<th>Fish Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>Absence of algae and microorganisms</td>
<td>Low</td>
</tr>
<tr>
<td>Greenish hue</td>
<td>Blue-green algae</td>
<td>Moderate</td>
</tr>
<tr>
<td>Yellow to Yellow-Brown</td>
<td>Diatoms (microscopic, one-celled algae)</td>
<td>Moderately High</td>
</tr>
<tr>
<td>Red</td>
<td>Micro-crustaceans</td>
<td>High</td>
</tr>
<tr>
<td>Dark Brown</td>
<td>Peat, Humus</td>
<td>Low</td>
</tr>
</tbody>
</table>

Relationships of Water Clarity to Productivity

<table>
<thead>
<tr>
<th>Relative Water Clarity Rank</th>
<th>Depth into water (Secchi disk reading)</th>
<th>Fish Productivity (if reasons for degree of clarity are biological-algae, etc.)</th>
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<td>5 (foggy-hard to see selected object)</td>
<td>0” - 6”</td>
<td>Most productive water for fish Maximum oxygen from photosynthesis (greatest diurnal variation) Maximum algae growth</td>
</tr>
<tr>
<td>1 (clear-easy to see selected object)</td>
<td>24”+</td>
<td>Least productive water for fish Minimum oxygen from photosynthesis (least diurnal variation) Minimal algae growth</td>
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Activity Overview
This activity gives students an opportunity to explore the origin and composition of pond detritus.

Learning Objectives
To successfully complete this lesson the students will:
• investigate the nature of pond detritus
• describe the components of pond detritus
• infer a relationship between pond detritus and pond life

Science Process Skills
The students will engage in scientific inquiry through: observing, data collecting, data recording, inferring, relating

Background for Teachers
Ponds are shallow bodies of water. Large areas support plants that root on the bottom and may extend through the water’s surface. This lush growth supports a large variety of organisms that feed on this plant material.

For all living communities, the ability to trap the sun’s energy is essential for productivity. Plants convert the sun’s energy to sugars through a process called photosynthesis. Ponds provide a rich, hospitable environment for plants to grow. Once the plants die the decaying plant material, detritus, provides a rich source of nutrients. The nutrients and energy from the plants returns to the pond as the plants decay.

Much of the detritus is found at the bottom and edges of the pond in the mud. As students explore this material they will find large numbers of animals present that feed on this debris and provide the first link in many pond food chains.

Materials
field notebook, pencil, petri dishes, dissecting microscopes, compound microscopes, squirt bottles (with water), large plastic spoons, magnifying lenses

Preparation
• Check the compound microscopes to ensure that you are familiar with their operation and can direct the students in their use.
• Scout the two ponds to find suitable locations for detritus study and collection. Be prepared to share a definition of detritus with students.
• Select your staging areas at each pond.

Activity Outline:
Introduction (Step 1, 2 minutes)
Detritus Observation and Collection at Pagoda Pond (Steps 2-4, 4 minutes)
Discussion while moving between ponds (Step 5, 3 minutes)
Detritus Observation and Collection at Lower Pond (Step 6, 4 minutes)
Microscopic Viewing and Comparisons (Step 7, 5 minutes)
Closure (Steps 8-9, 2 minutes)

Procedural Steps
1. Gather the students around Pagoda Pond, near a site of abundant detritus. Ask the students: “What would you expect to find in the mud along the pond bank? How did the things get there? How are these things important to what happens in the pond?”
2. Have the students form groups of 3-4. Direct them to walk along the pond bank and observe what is found there. They should record their observations on page 10 in their notebooks.
3. Have the students collect a sample of mud from the pond bank. What can they see in the mud? How big are these things? They should rub some mud between a thumb and forefinger.
Sticks in the Mud
(20 minutes)

What is the texture of the mud? What gives the mud this texture? Record observations.

4. Have the students use magnifying lens to look at the mud. What can they see now? What effect do these things have on the mud? The students will carry their sample of mud to the microscopes on the Dining Hall porch. Have them place a small amount in a labelled petri dish.

5. Gather the students together to walk to Lower Pond. As you walk, ask: “Did you find what you expected in the mud around Pagoda Pond? What surprising things did you find? Is what you found important to the life in the pond? How? Would you expect to find the same things in the mud around Lower Pond? Why?”

6. Once at Lower Pond, have the students repeat steps 2-4. Caution the students to keep the samples from the two ponds separate.

7. At the microscopes, they can squirt some water on the samples to thin them out for ease in further investigation. “How do the two samples compare? Are these observations consistent with what’s happening in and around the ponds? What conclusions can you draw about the importance of pond detritus?” Allow students to complete and record their observations.

8. To close, have the students share what they think is important about pond detritus and sum up the differences observed for Lower and Pagoda Ponds. Ask: “What does the detritus along the pond bank tell you about the nature, life, and changes of the pond it surrounds?” Have students complete the sentence about detritus in their field notebooks on page 10.

9. To conclude this field study, ask the students to review the vocabulary used during the last few activities. Write their responses on the chart paper. Have the students record four or five of these terms under “Vocabulary Filtered” on page 10 of their field notebooks.
Forest Mapping
Integration of Biotic and Abiotic Factors
to Create Ecological Communities
Stake Out
(adapted from “Use the Compass and Pacing Skills,” USDA Forest Service)
(40 minutes)

Activity Overview
Students survey a forest and explore the relationship between tree sizes, canopy heights and forest undergrowth.

Learning Objectives
To successfully complete this activity the students will:
• draw a field map of a forest quadrant
• compile a comprehensive survey map of a forest using their own data and that of other students
• survey the spacing and size of trees in the forest
• infer the relationship between tree diameter, height and forest undergrowth

Science Process Skills
The students will engage in scientific inquiry through: observing, collecting data, recording data, analyzing data, predicting, drawing conclusions

Background for Teachers
Mapping skills are applicable to many areas of science. The idea of noting one’s observations and keeping accurate records is central to scientific fieldwork. Students will use a number of tools with which they may not be familiar. This is an excellent opportunity to teach them about graph paper, using a scale, and using a compass. Foresters use many methods to keep records and to get a feel for the forest as they attempt to answer questions such as: “How many trees are found in a section of forest? How close together are these trees? What types of trees and other plants are key to understanding the community?”

Mapping and other forms of modeling provide powerful tools to understanding large complex systems. The aphorism, “Can’t see the forest for the trees,” reflects the problem inherent in studying a forest. We often lose sight of the bigger pictures as we study an individual location or single tree. These studies are, however, the foundation upon which we build our understanding. Mapping allows us to generalize a larger picture from more specific data.

For example, if we find that certain soil supports a species of tree, then a soils map is a powerful tool for predicting where those trees could be found. Another relationship you can map is the distance between trees (density) and the number of plants in the understory. It takes a number of observations over many locations for some of these patterns to emerge. The scientist then develops a hypothesis to explain these patterns, furthering their research questions. If we have an understanding of the hypothesize-test-hypothesize cycle, we can make predictions and test them by specific observations. We use the model to guide our studies.
Stake Out
(40 minutes)

Materials
measuring tape, laminated graph paper, Forest Mapping sheet, overhead projector pens, clipboards, compass, stick, ruler, surveyor’s flags (red, pink, orange, and green), twine, unsharpened pencils, chart, chart pens

Preparation
• Select the section of the forest to be surveyed and mapped. Divide this section into quadrants, using four colors of surveyor’s flags. (Use a different color for each quadrant. Each quadrant should be 10 m x 10 m.) Make sure these quadrants are adjacent. Try to find a section of forest and then quarter it so that there is a variety of undergrowth and canopy features.
• Prepare a large map that has four quadrants, color-coded to match the surveyor’s flags used to section off the forest. This will be used by students to compile a comprehensive map of the entire forest section.
• Locate some sizable trees in the survey area that can be used by the students to size trees. If necessary, tag these trees in some way so that they can be readily identified.
• Become familiar with the use of the compass so that you may instruct your students in its use.
• Orient yourself in the forest so that you can easily point out the four directions.
• Practice the technique for measuring the height of a tree using an unsharpened pencil.
• Become familiar with the map symbols so that you may explain them to the students.
• Select a staging area for this activity.

Activity Outline:
Introduction (Steps 1-2, 2 minutes)
Orienteering Instruction (Steps 3-5, 4 minutes)
Surveying and Mapping (Steps 6-10, 15 minutes)
Transferring Map to Field Notebook (Steps 11-18, 3 minutes)
Sizing up Trees (Steps 19-22, 8 minutes)
Discussion (Step 23, 6 minutes)
Closure (Step 24, 2 minutes)

Procedural Steps
1. Gather with the students in the staging area to introduce this activity. Ask the students how they would describe this forest. How big is this forest? What features are important in this forest?
2. Tell the students they will have a chance to survey the forest and draw a map of the surveyed area.
3. Divide the students into four groups of 3-4. Assign each group to a quadrant of the forest.
4. Have the students in each group select job assignments. One student is needed as pacer, one as navigator (managing the compass), one or two as recorders.
5. Students should conduct a brief survey of their quadrant and describe what they see.
6. Introduce the compasses to the students and allow time for them to practice using them. The students should be able to sight an object and measure its orientation.
7. In their working groups the students will:
   a) determine the length of the step of the student who will be stepping off the distance. Record this information on the Forest Mapping sheet.
   b) locate a feature or landmark on the edge of the forest quadrant and face it.
   c) hold the compass waist high and level.
d) record this reading as the beginning reading on the *Forest Mapping* sheet.

e) pace off the distance to the feature or landmark. Record the number of steps and a description of the feature on the sheet.

f) repeat steps (b) through (e) until they have moved around all sides of the quadrant.

8. When all groups have collected the mapping data for their quadrants, regain the attention of all students to discuss general data and the need to select a scale for drawing the map. Discuss with students how they should convert survey steps to map distances.

9. Students should determine a north direction on their map and how they want to draw the map on their graph paper.

10. They will need to make a dot on the graph paper to show their starting point.

11. They should use the compass to draw a straight line on the paper in the direction of their travel. Make the length of the line to correspond to the distance found in step 7e. Make a dot at the end of this line.

12. At this time, students should draw in the landmarks from their notes at the correct distances along the line.

13. Students should continue to hold their pencil on the dot at the end of the first line and again use the compass to draw a second line in the direction of travel. Add landmarks from their notes for this line of travel as well.

14. Have students continue drawing the survey notes on their maps in this manner until their survey maps are complete. The map should show the types and spacing of trees, the undergrowth, and other significant features. The students in each group should make a sketch of their group’s survey map in their field notebooks.

15. Ask students to look at and record their estimations of the spacing of the trees in the forest. How is this spacing related to the undergrowth near the trees? Is the spacing regular or irregular? Is this spacing a factor of the size of the trees? Tell students that they will now have a chance to size up some trees in the forest to see how tree size changes or does not change in a section of forest. Challenge students to think of ways to determine which of the trees they see is the biggest. (The students should realize that there are three aspects to consider when determining the size of a tree: height, trunk circumference (girth), and the spread of branches (crown).)

16. For the students to determine the size of a tree in the forest, the students will work in pairs and do the following:

a) Ask each pair of students to wrap a piece of string around the tree at approximately their chest level. After measuring, they should place the length of string that encircled the tree along a meter stick to determine the tree’s circumference. Record in the field notebooks on page 11.

b) To measure a tree’s crown, have one student in each pair as observer and the other as measurer. The observer should stand far enough away to see the tree in its entirety. Then the measurer should move to the farthest tip of the outermost branch on one side of the tree and mark that spot on the ground. The measurer should then follow the observer’s directions to the outermost branch on the opposite side of the tree and mark that spot on the ground. Students should determine the size of the crown by measuring in meters the distance between the two marked locations.

c) To measure a tree’s height, have one student stand next to the trunk while the other student back away from the tree, with arm outstretched and holding an
unsharpened pencil perpendicular to the ground in his or her fist. Sighting down the arm, the student should adjust the pencil’s position so that the top of the tree appears to be at the top of the pencil, and the base of the trunk appears to rest on top of the fist. See the figures on the following page.

d) The student may need to move forward or backward and to adjust the length of the pencil to see this image. Then the student should turn the pencil 90 degrees to the left or right, making sure that the base of the tree is still aligned with the top of the fist, and direct his or her partner to walk away from the trunk in the direction the pencil points. The student says “Stop!” when his or her partner appears to be at the end of the pencil. Then they can determine the tree’s estimated height by measuring, in meters, the distance from the base of the tree to where the partner stands.

17. Once the students have measured these aspects of a tree’s size, have them estimate if their tree size is more than, less than, or the same as the average size for trees in this forest.

18. To see which pair measured the tree of greatest size, have the students combine the circumference, crown, and height measurements for each tree measured. The resulting number represents the tree’s size points.

19. Have students identify the largest tree by comparing size points. Graph the students’ data on chart paper, showing the size points and number of trees. (The y-axis is the range of the size points and the x-axis is the number of trees.)

20. To close this activity, ask students to summarize what they discovered about the forest, tree size, tree spacing, and undergrowth. Was the undergrowth the same around all the trees surveyed? Which trees seemed to have the least or most undergrowth? Why is this the case? Say: “Now that we have had a chance to survey a section of forest, we will spend some time looking at changes as one moves from the forest into an open area.”

21. Before they go, remind the students of the importance of maps. If time allows, they may reflect on more familiar maps and the types of information these maps contain.
Figure 1
Holding a pencil perpendicular to the ground in his or her fist, the student sights down the arm, backing up until the tree top and the pencil top align and the base of the trunk appears to rest atop the fist.

Figure 2
Next, the student turns the pencil 90 degrees to the left or right, keeping the base of the tree aligned with the top of the fist. Then the student directs a partner to walk from the trunk of the tree in the directions the pencil points until she or he appears to be at the end of the pencil. The distance from the trunk to where the partner stands is the tree’s height.
## Forest Mapping Sheet

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<th>Distance in Paces to Next Landmark</th>
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Length of Pace (Step) _______
Along the Line
(adapted from “A Transect Study,” Mesa Public Schools, Mesa AZ)
(25 minutes)

Activity Overview
This activity allows students to use a transect sampling technique to measure and/or estimate sunlight levels, soil and air temperatures, humidity, undergrowth, and openness of the canopy.

Learning Objectives
To successfully complete this activity the students will:
- conduct a transect sampling survey
- describe the sunlight, temperature, humidity and canopy conditions of a forested and an open area
- infer the relationship between sunlight, canopy, and forest undergrowth

Science Process Skills
The students will engage in scientific inquiry through: observing, measuring, collecting data, recording data, interpreting data, inferring

Background for Teachers
Transect literally means “to cut across.” This survey technique is useful for sampling within a community and across the boundaries between communities. Sampling is an important means of collecting data in a community. When we study something as large as a forest, we cannot collect data from the entire forest, so we must study samples. Types of sampling methods must be carefully considered to find a method that accurately reflects the forest as a whole. A transect uses the idea of collecting data along a line, taking samples along the way, then inferring data between points to get a picture of the entire forest.

It is important to use tools to make measurements to reduce human error. It is difficult for us to estimate measurements with our body’s tools. For example, our eyes adapt to light levels, whereas a light meter does not.

Students will develop their understanding of a community by collecting data in a small area and inferring the community in between. For example, if they sample two adjoining sites and find largely the same plants they can infer that the space in the middle contains similar plants. In this way they build a picture of the whole community.

In this transect activity, students will collect soil and air temperatures, percent humidity, and light levels. They will try to find relationships between these values. For example, we would expect to see a rise in soil and air temperature, and a decrease in humidity, as light levels rise. Students will then relate these observations to the living community. For example, what light levels do different types of forest communities have? Do light levels affect the components of the living community? In forested areas with very low light levels, the forest floor will have plants that are adapted to low light, or the forest floor may be almost bare. Forests where the canopy is open will have many understory plants and a greater diversity of species, similar to the margins of a forest.

Another interesting topic for students is the connection between light and energy in living systems. In a mature forest with a largely closed canopy, a great deal of its growth and productivity happens up high. However, leaves, branches, and trees fall to the forest floor. This creates a rich environment for decomposers such as fungi as they recycle these nutrients.
Along the Line
(25 minutes)

Materials
pencil, field notebook, surveyor’s flags, twine,
soil thermometer, air thermometer, hygrometer,
sling psychrometer, light meter, Relative Humidity chart

Preparation
• Select an open area near the forest that has grasses and some bushes if possible.
• Stake out four transects that start in a forested area and end in an open area. Each transect should be at least 7 m (21 feet), with half of it in the forest and the other half in the open area.
• Practice using the sling psychrometer so that you may demonstrate it for the students.
• Select a staging area for this activity.

Activity Outline
Introduction (Steps 1-2, 2 minutes)
Transect Sampling (Steps 3-9, 11 minutes)
Discussion (Step 10, 5 minutes)
Poem Writing (Step 11, 6 minutes)
Closure (Step 12, 1 minute)

Procedural Steps
1. Gather with the students in the staging area of the forest. Ask them to describe what they see besides trees. When students have completed sharing, walk with them into the open area near the forest. Ask students to describe what they see in this area. How do the descriptions compare? What things might be responsible for the differences in the two areas? How might sunlight be a factor in the two areas?
2. Tell the students in this activity they will measure sunlight and other factors along a transect (line) that starts in the forest and transitions to an open area.
3. Have students form four groups and select the measurements each student in the group will take: soil temperature, air temperature, light intensity, and humidity.
4. Have students start at one location along the transect line to initiate the sampling process for determining forest characteristics. They will need to collect data at three different locations along this line: in the forest, at the forest/open area boundary, and in the open area.
5. The students measuring soil temperature should place the soil thermometer in the ground by pushing firmly. Allow time for the thermometer to reach its final reading (30 seconds). Note the temperature on the soil thermometer and record it in field notebooks on page 12.
6. Students taking air temperature readings should hold the thermometer just above the ground (2.5 cm or 1 inch) for 1-2 minutes. Record this reading on page 12. Next the students should hold the thermometer 1 m above the ground. Record this reading. How does the temperature at this level compare to that just above the surface? What explanations can the students offer for their observations?
7. Students using the light meter should hold the sensor end straight up and allow the meter to reach its peak reading. Record this value in the notebook.
8. Students using the psychrometers should first read and record the dry-bulb temperature then twirl the apparatus for 15-20 seconds and read and record the wet-bulb thermometer reading. Groups should use these readings to determine the humidity at this location using the Relative Humidity chart.
9. Encourage students to change job responsibilities within each group and have them repeat steps 5-8 at two other locations along the transect. All readings should be recorded in the field notebooks.
10. When the data collection is complete, bring the students together to discuss their findings. How do the readings for each characteristic compare at the different locations along the transect? Where was the sunlight level greater? Smaller? How is the sunlight level connected to the ground cover at the different locations? Why is this so? What things might account for the differences in the air and soil temperatures in the three locations? How might the data appear if the transect were placed in a forest with a different canopy?

11. After students have responded to the questions, direct them to write a poem about forests and trees using some of the concepts covered during this activity. Allow time for some of the students to share their poems.

12. Finally, close by saying: “Some of the important features of the forest are directly attributable to the amount of sunlight that gets below the canopy layer. The type of ground cover and other undergrowth are important factors in how rain impacts the forest. The last activity in this field study will allow you to look for and record signs of erosion in the forest caused by water and other agents.”
Relative Humidity (%)

Go down the first column and find the record of your dry-bulb temperature. Move across the columns to the right until you find the column that has the difference between the wet and dry bulb temperatures. The number in the box is the relative humidity in percent (%).

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Washed Out
(adapted from “Evidence of Change,” USDA Forest Service)
(15 minutes)

Activity Overview
In this activity, students search for signs of water flow and erosion in the forest.

Learning Objectives
To successfully complete this lesson students will:
• describe changes in the forest due to erosion
• look for and describe signs of water flow through the forest
• predict other changes that might be taking place in the forest
• infer a relationship between canopy and erosion

Science Process Skills
The students will engage in scientific inquiry through: observing, describing, comparing, predicting, inferring

Background for Teachers
Communities change over time and some evidence of this change exists, if you know where to look. Changes often reflect events that happen at other times of the year. With this in mind, one can search for clues of evidence for water’s effect on the community.

Water often moves material. We can see signs of flow by looking for either erosion or the debris left by the water. Other signs are more subtle, such as a gentle swale on a hillside or an area where few plants grow. Both may be signs of water flow. In the case of the swale, it may represent an area where water flows underground and is slowly moving the hillside downhill. The other example is an area that may be subject to flash floods where debris moves quickly downhill, often removing the vegetation as is goes. Other signs of water flow might include wet areas in the ground or plants that require constantly moist soils.

Using evidence, particularly of past events, allows one to infer an action. Often scientists see evidence rather than events. This is an important aspect of research.
Washed Out
(15 minutes)

Materials
field notebook, pencil, erosion posters, push pins

Preparation
• Acquire laminated pictures or posters of the effects of erosion.
• Locate as many places as possible in the forest that have obvious signs of erosion and water flow. Consider marking these so that you will be able to readily find them again. If possible, use areas different from those used for the other two activities in this field study.
• Select sites for posting the forest erosion pictures for ready reference for the students.
• Select a staging area that has one or two obvious signs of erosion that can be used to introduce the activity.

Activity Outline
Introduction (Steps 1-2, 2 minutes)
Hunting for Signs of Erosion (Steps 3-4, 8 minutes)
Discussion (Step 5, 4 minutes)
Closure (Steps 6-7, 1 minute)

Procedural Steps
1. Gather with the students in the staging area and ask them to describe what they see. Help the students realize that the canopy and undergrowth are important factors in the forest. Ask the students what the forest might look like if the ground cover and undergrowth were not present. What things might they look for to investigate the changes taking place in the forest? How does water flow through this area of the forest?

2. Direct them to a couple of the closest erosion and water flow areas you located in the area. Talk about what the path of water can reveal and the impact of erosion and water flow on the forest.

3. Have students pair up as they prepare to conduct the hunt for erosion and water flow in the forest. Direct the students to the areas of the forest where they can find erosion and water flow signs. Remind them to pay attention to ground cover and undergrowth and to record their observations on page 12 of their notebooks.

4. Allow the students time to conduct their hunt and then call them back together.

5. Ask: “What signs of water flow/erosion did you find in the forest? Where were these found? What do you think were the effects of these changes? How much erosion did you notice? What was the ground cover like in these areas with many signs of water flow/erosion? What was the canopy like in those areas with many signs of water flow/erosion? How do you think water flow/erosion in this forest would be affected if the tree spacing were changed? Why? What impact would this change in spacing have on the features measured in the last activity?”

6. Ask: “In this activity we looked at the impact of flowing water on the forest and the relationship between canopy, ground cover, and forest erosion. As we close, I want each of you to think about the signs of changes you observed and what forces or causes might be behind these changes.” Be sure students understand these relationships and causes of change.

7. To conclude this activity, ask students to review the significant vocabulary of the forest mapping field study. As students respond, record the terms on chart paper and restate the students’ definitions. Have all the students record four or five terms on page 11 of their field notebooks under “Vocabulary Captured.”
Maintaining Forest Life
Integration of Biotic and Abiotic Factors to Create Ecological Communities
Getting the Dirt on Dirt
(adapted from "'Dirt' Data," USDA Forest Service)
(45 minutes)

Activity Overview
Students conduct a soil study by looking at profiles of soil samples from a forest area and conducting tests on several soil characteristics.

Learning Objectives
To successfully complete this activity the students will:
• explain the origin and composition of soil
• discuss the importance of the different layers of the soil
• classify and name soils using percentages of soil particle sizes
• define soil in their own words.
• predict the influence of soils classification on the rate of water absorption and retention

Science Process Skills
The students will engage in scientific inquiry through: observing, sampling, collecting data, predicting, analyzing data, classifying, measuring

Background for Teachers
Soils develop over long periods of time through weathering of parent materials. The climate, type of parent material, topography, and presence of living organisms factor into the speed of soil development. Soil is a basic part of the environment and necessary to life on Earth. It is, however, often taken for granted and misused. People think of soil as "just dirt" and do not recognize that many of their needs rely on soil, and many of their actions impact soil.

Although soil may appear to be static, constant changes are taking place. For example, glacial deposits change the amount of sand or rock in the surface soils; a fallen log will add organic matter as it decomposes; a stream can wash away fine silt, clay, and organic matter; or construction projects may move subsoil with less organic materials to the surface. Wind plays an important role in moving particles. Loess is soil created from the windblown rock floor created by glaciers during the Ice Age. We all have seen pictures of the dust bowl of the 1930’s when the protective layer of the soil was plowed under.

By understanding the characteristics of soils, we can classify them and predict how soils will function for different uses. Soil is a mixture of mineral ingredients (rock, clay, silt, and sand); organic ingredients (living organisms, decomposing organic matter); moisture; and air spaces. Soils are classified by texture, which is determined by the amounts of clay, silt and sand they contain. Loam is the term for a fairly equal mix of all three. Other soil textures have more of one element than another, i.e. silt loam or sandy loam. Several soil types can exist in a small area, in fact several different soil types exist right on the grounds of the 4-H Center.

You can test for the component parts of the soil by feel, by rolling the moist soil in your hand while noting textures. The parts can also be separated in settling jars. The three mineral components settle from water at different rates. If we place a soil sample into a small jar with water and shake to mix well, we can note the layers that form as the soil settles. Sand settles first as it is relatively large and dense, followed by humus and silt. Clays are extremely small particles and can remain in suspension for long periods of time. We can estimate the percentages of each part and use a chart to name the soil type.

The space between soil particles is also an important component of soils. These spaces are critical to plant growth. These spaces trap needed air and moisture and provide room for roots to grow. Moisture facilitates the transfer of nutrients to the roots. Air provides the oxygen necessary for roots to burn the carbohydrates created in the plant’s leaves.
The percolation rate is the rate at which water enters the soil. The proportions of the materials that make up the soil affect the percolation rate. For example, soil with a high clay content has a low percolation rate. Another factor affecting percolation is compaction. A compacted layer at the soil surface reduces the percolation rate.

The soil in any given location will have layers or horizons, with each horizon composed of different materials. The thin, uppermost layer is humus, a layer very rich in decaying plants and organic matter. Horizon A is the topsoil, Horizon B is the subsoil, and Horizon C is the parent material or bedrock. The number of layers found in a particular location is determined by the age of the soil. Immature soil has two layers while mature soil has all three horizons. The presence of organic material in the soil is a general measure of the soil health. Generally, soil with higher organic content is better for growing plants (agriculture, gardening, etc.)

Color, presence of nutrients, water-holding and water-absorbing capacity, thickness of the layers, and the consistency of the material are other important components of soils. These and other soil properties determine the soil’s ability to sustain and support plant life, withstand erosion, and support human structures.

The components of soil also affect what vegetation will grow in them. Some trees need soils that hold a lot of water, while other trees need drier soils. Cedars, red and silver maples, alders, and Oregon ash prefer poorly drained soils. Hemlocks, red spruces, balsam firs, and aspens prefer moderately drained soils. White pines, Douglas firs, and white birches prefer well-drained soils. Often, one can predict the type of soil under one’s feet by recognizing the kinds of trees growing there.

Common Soil Textures

<table>
<thead>
<tr>
<th>Particle</th>
<th>Size, mm</th>
<th>Feel</th>
<th>Fertility</th>
<th>Air Space</th>
<th>Availability of Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>2.0-0.05</td>
<td>gritty</td>
<td>low</td>
<td>many in number; large in size</td>
<td>low</td>
</tr>
<tr>
<td>Silt</td>
<td>0.05-0.002</td>
<td>smooth</td>
<td>medium</td>
<td>many in number; fair to small in size</td>
<td>good</td>
</tr>
<tr>
<td>Clay</td>
<td>&lt;0.002</td>
<td>sticky</td>
<td>high</td>
<td>few in number; tiny in size</td>
<td>slow movement of water</td>
</tr>
</tbody>
</table>
Getting the Dirt on Dirt
(45 minutes)

Materials
pencil, field notebook, soil thermometers, large tin cans with both ends removed, aluminum pie pans, soil pH meter, jars with lids, water, soil sampling auger, magnifying lens, bucket, gardening trowels, samples of clay, silt, and sand particles, dissecting microscope, mesh screen, metric rulers, hand spade, spray bottle, clock or stopwatch, permanent marker

Preparation
• Locate a suitable site for a soil “pit” for demonstrating the layers of soil. Excavate the pit so that one side is straight up and down and the opposite side is sloped. Cut the pit to a depth that exposes the various soils layers, usually 30 to 60 cm. Be sure to keep the soil removed from the pit close at hand so that it may be placed back in the pit when the field studies are done. You may locate a roadcut or other disturbance that shows layers.

• Collect a variety of soil samples from the forest edge, near a tree in the forest, from the center of the forest, from under a forest shrub, etc.

• Make sure you have sample bags of clay, silt, and sand soils for the students to have as reference as they conduct their soils investigations.

• Have groups bring samples from home to compare with those on site. Place the soil sample from each community into a labeled container. Be prepared to allow students to use these samples as they make their observations of on-site soil.

• Draw a line around circumference of hollow tin can 5 cm from one end. (The end of the can closest to this line will be pressed into the soil.)

Activity Outline
Introduction (Steps 1-3, 2 minutes)
Sensory Investigation of Soils (Steps 4-7, 6 minutes)
Collecting Soil Samples (Steps 8-9, 4 minutes)
Drawing a Soil Profile (Step 10, 5 minutes)
Investigating Physical and Chemical Characteristics of Soils (Steps 11-15, 11 minutes)
Soil Percolation (Steps 16-19, 7 minutes)
Discussion (Step 20, 8 minutes)
Closure (Step 21, 2 minutes)

Procedural Steps
1. As you approach the pit with the students, ask them to scan the site from several directions. Have them to describe what they see. Ask: “Is there anything that you see that could help us understand what is beneath our feet?” Allow for their responses and then gather with the students around the pit.

2. Ask: “What things do you notice as you look at this soil profile? What might be some important things to know about the soil we’re seeing?” Continue to ask questions to bring forth as much information as possible.

3. End the introduction by saying: “Various characteristics such as color, texture, structure, temperature, and pH affect the productivity of the soil. Knowing these characteristics is important in determining the health and suitability of soil for particular plant life or planned usage. In this activity we are going to collect, record and analyze some information about these soil characteristics.”

4. Have each student take a handful of soil from some depth in the soil pit. Tell her/him to squeeze and ball the soil and attempt to form a ribbon between the fingers and thumb as a test of the plasticity and moisture content. (The finer the particles, the easier it is to ribbon. Clay-like soils ribbon very easily.) Have each student
describe the sensations. Is it wet, sticky, cold, etc.? Students should also smell the soil.

5. Have students take a second sample of soil from a different depth in the soil pit. They should conduct the same tests as in Step 4 and make comparisons of the soils from the two different levels. Which sample was wetter, stickier, colder? Did the samples smell the same?

6. Regain the attention of the students and ask them about their discoveries. What conclusions can they draw about the type of soils in the pit?

7. Use the bags of sand, silt, and clay to demonstrate soil texture and particle size. (This gives students a comparison for texture and size.) Explain that many soil types are combinations of two or more of these soil particles. Allow students to feel a sample of each of these types. Ask which particles seemed present in their soil samples from the pit. Have students’ look at the soil from their communities. What types of particles are in these soils? How do they compare to the soil found in the forest?

8. Say: “You will work in groups to conduct a more thorough investigation of a soil sample taken from the forest. Have students form groups of 2-3.

9. Have one student in each group use the soil sampling auger to remove a sample of forest soil and place it in a pie pan. Place a soil thermometer in the sample and read the temperature of the soil. Record this reading on page 13 of the field notebook.

10. In their groups students should measure the thickness of the different soil layers, draw a profile of the soil, and record these measurements on the soil profile sketch in their notebooks.

11. Each group should use a pH meter to measure the acidity or alkalinity of the forest soil. They should record this reading on their sketch on page 13.

12. Next have the students make observations about and record the color, thickness of layers, size of particles, consistency of materials, and the presence of various materials such as roots and rocks in the soil. Remind students that soil must be moistened to get true colors and textures. They may need to spray the soil sample often as they examine it.

13. Encourage students to examine their samples with a magnifying lens. They should look specifically for evidences of organic matter. Are there undecayed and decayed materials present? Where are they found? Is there evidence of insects present? Is there any non-soil material present? Describe it and explain how it got there.

14. When the above observations are complete, each group should fill a small jar about two-thirds full with water. Add crushed soil from their sample to the jar until it is full. Then they should cap, shake vigorously, and allow the jar to settle. How thick are the layers that form as the particles settle out of the water? Describe the appearance of the water above the layered soil. Are there materials floating around in the water? What might these things be? Where could they come from?

15. At this point, regain the attention of the students and say: “Now that you have gathered more in-depth information about soils, what things have you learned about soils and their characteristics?”

16. After allowing for responses, add: “There is one additional characteristics we need to consider. Does any one have an idea of what it might be? The air space in soil is what we want to investigate now. How could you check for air in the soil? Which soil type do you think would have the most air space? Least? Why is air space important?” Assign students to the areas where soil samples were collected.
17. As they continue to work in groups, have one student in each group push a tin can into the ground up to the 5 cm mark around the outside of the can. A second student in the group should quickly pour enough water in to fill the can to the rim.

18. Each group should observe the bubbling that takes place as the water is being absorbed into the soil. The amount of bubbling is related to the amount of air in the soil. Students should record this bubbling as a little, some, or a lot.

19. While the others are observing the bubbling, one student should be measuring the time it takes for all the water to be absorbed by the soil.

20. Ask: “What did you find out? How is percolation rate related to soil type? How is the rate at which water drains through some soils related to the ability of roots to push through these same soils? What factors other than soil texture might affect the rate of soil percolation?”

21. To close this activity and transition to the next ask: “Based on the data you collected in this activity, what type of soil seems to be the best for the trees and other plants in this forest? What supports your conclusions? While soil type is very important in determining a soil’s ability to sustain and support plant life, plants will either grow slower or die if they do not get needed nutrients from the soil. Our next activity gives us a chance to look at the movement of nutrients through a forest ecosystem.”
What Goes Around
(adapted from "What’s This ‘Duff’ on the Forest Floor?” USDA Forest Service)
(20 minutes)

Activity Overview
This activity allows students to examine the forest floor and discover the materials that are breaking down and adding nutrients to the soil.

Learning Objectives
To successfully complete this activity the students will:
• identify some of the materials on the forest floor which form soil
• explain how nutrients are recycled in a forest community
• understand the role of decomposers in recycling

Science Process Skills
The students will engage in scientific inquiry through: observing, inferring, questioning, defining, classifying

Background for Teachers
Soil is considered a renewable resource in the long-term. Healthy soil supports plant growth, which in turn decomposes back into organic matter in the soil. Under the best conditions, one millimeter of new soil per year can accumulate. Under adverse conditions, it may take thousands of years for the same accumulation.

Plant life depends on soil to provide water and nutrients. How well soil sustains a plant depends on its texture (compact or porous), its water-holding capacity, its acidity, and its population of beneficial soil organisms.

What are the nutrients that are vital to the growth and development of plants? How do they move into the plants? How do they return to the soil? Nitrogen, phosphorus, and potassium are macronutrients that are essential for the survival of plant life and move from soil to plants and back to the soil. These three nutrients comprise the three common ingredients in commercial fertilizers. Both soil texture and pH influence the nutrients found and held in the soil.

Once absorbed by a plant’s roots, these nutrients play vital roles in a plant structure. The nutrients account for nearly 1.5% of a plant’s weight. When the plant dies or drops leaves and twigs on the soil, these nutrients must be returned to the soil by important living organisms—decomposers. Without these organisms, debris would build up and lock up vital nutrients.

Materials
pencil, field notebook, magnifying lens, easel, chart pad, chart markers, commercial fertilizers, hula hoops

Preparation
• Locate an area in the forest that is large enough for your field study group to use hula hoops to mark 4-5 individual study sites.
• Investigate the area to be sure that the students will be able to find all the components you’ll be studying.
• Select a staging area that will fit a chart.

Activity Outline
Introduction (Steps 1-3, 4 minutes)
Looking at Duff (Steps 4-6, 10 minutes)
Discussion (Step 7, 5 minutes)
Closure (Steps 8-9, 1 minute)

Procedural Steps
1. Gather the students and ask them to describe the characteristics of a bank (money, employees, saving accounts, checking accounts, loans, bank patrons, etc.) On a large sheet of paper, draw a model of a bank which includes the characteristics the students mentioned. Then develop an analogy to the soil bank.
• Money: The soil nutrients
• Bank employees: Soil decomposers. They process the nutrients and make them available to fungi, bacteria, and earthworms.
• Savings accounts: Some plants and animals deposit matter into the soil bank which will decompose very slowly. The nutrients are saved in these accounts for future use (e.g., a fallen tree).

• Checking accounts: Other plants and animals deposit organic matter into accounts which can be quickly decomposed. Nutrients are available for quick withdrawal (e.g., leaves from deciduous trees and annual plants).

• Loans: Sometimes the plants and animals in an ecosystem do not have enough in their accounts to meet their needs. They depend on a loan to supply the nutrients they need (e.g., fertilizers).

2. Before moving with the students to the study area, ask them to write down some of the things they would expect to find on a forest floor on page 14 of their field notebooks.

3. Tell the students they will look at checking accounts in the soil bank by examining the duff on the forest floor. Define duff for the students.

4. Have the students form groups of 2-3 and move to an area in the forest that is sufficiently spaced from the others around them and drop the hula hoop. Their study site will be the area with the hoop.

5. Students should sift through the top 8 cm (3 inches) of the materials on the ground.

6. Students should answer the questions in their field notebooks about the things they find.

7. After the time has passed, regain the attention of all students and lead them in a discussion about what they found. Ask: “What did you find? In what materials did you find the most evidence of animals? Of plants? What might account for the difference? What are some of the ways the soil is affected by what you found?”

8. To close, say: “Based on your observations what are some ways nutrients are being recycled?”

9. To move to the next activity, add: “Just as we have looked at the cycle of nutrients in the forest, we want to move now to look at another cycle and investigate how the forest affects it. Our last activity in this field study is that of looking at how water moves through the forest.”
Where’s the Water?
(adapted from “Water Wonders,” Project Learning Tree)
(25 minutes)

Activity Overview
This activity will introduce students to the various steps in the water cycle and to the paths water can take through a forest.

Learning Objectives
To successfully complete this activity the students will:
- simulate the paths that water takes in the water cycle
- describe the importance of the water cycle to living things
- conduct an experiment to discover how trees affect the movement of water in a watershed
- describe how trees are important in maintaining water quality

Science Process Skills
The students will engage in scientific inquiry through: organizing information, predicting, comparing and contrasting, inferring

Background for Teachers
Liquid water covers 71 percent of Earth. It constitutes 50-70 percent of the weight of all plants, animals, and humans. Water consists of two parts hydrogen and one part oxygen. It can exist as a liquid, vapor, or solid (ice). Its unique physical properties enable life to exist on Earth. Those properties include water’s ability to remain liquid in a wide range of temperatures, its ability to dissolve and transport other substances, such as mineral nutrients, and the fact that its solid form is less dense than the liquid form (ice floats.)

Water moves through the system in what is known as the hydrologic, or water cycle. In a simplified model, it evaporates from oceans into the atmosphere (air), condenses into clouds, falls as rain or snow, and eventually returns to oceans through a drainage system of streams and rivers. Energy from the Sun, which causes evaporation, and gravity are the forces that drive the cycle.

The movement of water on land is controlled by contour and geologic features such as mountains, valleys, and hills. Water’s movement, in turn, changes the contours of the land through erosion and sedimentation. A watershed is the area of land drained by a stream or river. Large rivers have huge watersheds encompassing many smaller rivers and streams, and may be bordered by large mountain ranges.

In addition to clouds, oceans, rivers, and valleys, living organisms are part of the water cycle. All living organisms need water to survive, it is essential to their bodily functions. Plants and animals take in water and return it to the atmosphere as vapor (breathing, transpiring) or to the soil as liquid (excreting.) Water also becomes an essential part of the cells of the organisms. Sugars are formed from carbon dioxide and water in plants leaves.

Forests greatly affect watersheds. Trees, small plants, and forest litter absorb rainwater, preventing erosion and runoff. If rain falls on bare ground, the full force of the raindrops can wash soil into streams, making them muddy. But when rain falls on the forest, it drips down through leaves and branches to the forest floor. The forest’s canopy, as well as layers of plant litter under trees, protect the soil from the full force of rain. Tree roots hold the soil in place so that it doesn’t wash away.

Forests also help to improve water quality by filtering out impurities that could be potentially harmful in streams or ground water. As water is absorbed by tree roots and then transpired as vapor through leaves, impurities (many of which are nutrients for a tree) remain in the tree.
Where’s the Water?  
(25 minutes)

Materials
6 buckets labeled as follows: “Ocean” (2); “Plants” (2); “Ponds and Streams” (2); 6 cups, laminated poster of the water cycle, easel, chart pad, chart markers, sign labeled “Mountains”; laminated names tags with strings attached, labeled: “Evaporation” (4); “Transpiration” (2); “Condensation” (2); “Precipitation” (2); “Percolation/Runoff” (2); 2 watering cans, 2 shallow pans.

Preparation
- Locate two sloped sites with about the same angle of slope: one should have little or no vegetation on the soil and one should be covered with plants (grass, shrubs or trees). These two sites should be as close together as possible. You will need to place a shallow pan, perhaps partly buried, at the base of each slope to collect the runoff. Try the procedure to make certain you have positioned the pans properly.
- Prepare a full bucket of water labeled “Ocean” at the bottom of the hill. Further up the hill have a full bucket labeled “Plants” and a full bucket labeled “Ponds and Streams.” At the top of the hill place a “Mountains” sign.
- Find an additional hilled area in or near a forest for staging the water cycle game.
- Place a plastic bag over a leaf/needle of a tree in the forest. Look for a low branch so that students will be able to see the condensed water in the bag from the transpiring tree.

Activity Outline
- Introduction (Steps 1-2, 3 minutes)
- The Water Cycle Game (Steps 3-9, 8 minutes)
- Discussion (Steps 10-12, 3 minutes)
- Water Flow Experiment (Steps 13-18, 8 minutes)
- Closure (Steps 19-21, 3 minutes)

Procedural Steps
1. Begin the lesson with a discussion of the water cycle. Let the students tell you as much as they can about the process. Ask questions to bring forth as much information as possible: “Why do we need water? Name some ways we use water. Why does it rain more here in the valley than it does in Eastern Oregon? Can you find examples of the water cycle around us?” Be prepared to write student responses on the chart pad.
2. When the students have finished their responses, say: “Now that we have talked some about the water cycle, we now are going to simulate it.”
3. At the bottom of the hill have a student take a partial cup of water from the “Ocean” bucket. “What is this process called?” (Evaporation: water going from the liquid to the gaseous state.) Put the “Evaporation” name tag around this student’s neck.
4. Walk the group up the hill to the bucket labeled “Plants.” Have another student take a cup of water from the “Plant” bucket. “What is this process called?” (Transpiration: water evaporating through the pores in plant leaves or needles.) Put the “Transpiration” name tag around this student’s neck.
5. Continue to the “Pond” bucket. Have another student fill the “Evaporation” person’s cup. (This step is a good place to review and reinforce the idea that water enters the atmosphere and is moved throughout the biosphere through air movement.)
6. As the group continues uphill, explain that the gaseous water converts back to a liquid through the process of condensation, and that clouds are actually made up of tiny drops of liquid water.
7. Continue, by adding: “As the air rises over mountains, our hill in this simulation, it picks up more water. As the clouds get bigger, they become heavier. In the cooler air in the
mountain, the air can hold less of this water and larger drops are formed. At some point the droplets are too massive to remain in the air and fall back to the Earth’s surface. This process is called precipitation.

8. Have a student pour out the two cups of water on the ground. This student gets the name tag labeled “Precipitation”.

9. Ask: “What happens to the water when it lands on the ground?” (Water moves downhill either on the surface or percolates into the ground and moves slowly downhill through tiny air holes in the soil called pore space.)

10. Add: “The cycle is complete when this water eventually reaches the ocean or a pond/lake.”

11. At this point have students pair up and find a spot to sit on the ground. Each pair should work together to draw in their field notebooks a diagram of the water cycle, labeling each step.

12. Allow pairs to share their diagrams.

13. To move to the last part of this activity, say: “The importance of trees in the water cycle can be demonstrated through the following experiment.”

14. If necessary move with the students to the two hilly areas. Be sure you have the needed equipment in place.

15. Explain to the students the procedure that equal amounts of water will be poured on the two sloped areas. Ask them what they expect the results to be. How will the runoff water samples compare?

16. After the students have responded select two students to pour the water. It is important both students pour at a slow, steady rate.

17. Start the experiment, with the students not actively involved stationed at the base of the slope.

18. After the runoff is finished, have students observe the water in each pan. Ask them to describe and compare what they see. Ask: “What might explain the difference between the appearance of these two samples? Using your observations, what general statement can you make about the role of forests and trees in the water cycle?”

19. Finally, move with the students to the tree where the leaf/needle is enclosed in a plastic bag. Explain to the students that the bag was empty when you placed it on the leaf/needle. Ask: “How did this water get into the bag? What part of the water cycle does this illustrate? If the bag were not here, what would have happened to this water?”

20. Say: “Life in the forests require that the plants and animals living there get the water and nutrients they need. Are there things that you do that affect either the nutrient or water cycle?”

21. To conclude this field study, have students review the significant vocabulary used during the field study. As they give the words and definitions, record the terms on chart paper. Instruct all students to write four or five of these terms on page 13 of their field notebooks under “Vocabulary Retained.”
Meadow Mapping
Integration of Biotic and Abiotic Factors to Create Ecological Communities
Checking Out the Meadow
(adapted from “Using Compass and Pacing Skills,” USDA Forest Service)
(35 minutes)

Activity Overview
This activity gives students the chance to construct a two-dimensional map of a meadow community, noting features distinctive to a meadow.

Learning Objectives
To successfully complete this activity the students will:
• describe features of a meadow community
• draw a scaled map of a section of a meadow community, with features and boundaries noted
• compile a comprehensive survey map of a meadow community using their own data and that of other student groups

Science Process Skills
The students will engage in scientific inquiry through: observing, collecting data, recording data, analyzing data, predicting, drawing conclusions

Background for Teachers
Maps, as with many models, help display a great deal of information. In addition, a complete map can help answer questions. Map making, map reading, and using maps to answer questions are all skills that form an important piece of scientific research. We often model systems that are very complex, or use models to show the very small and the very large.

Mapping is key to understanding communities. In the meadow it is important to learn to see beyond the first impression that the community is simple. Mapping the community will help the students focus on the complex details of the meadow.

Students will need help learning to use graph paper, understanding mapping skills, and using a compass. We will use the idea of a pace as an estimation tool for their maps. One of the keys to understanding mapping is seeing the connection to the physical world. Students may not realize that maps are a representation of the physical world. We use these mapping activities to help students understand the connection between the map and the community.

To help students understand the mapping process we will introduce the concepts of landmarks, estimation, and direction. Maps require the use of a scale. Scales may be confusing for students, they may not see the connection between the scale and the size of objects or distances on the map. In the activity students will have to establish a scale for their map. Try to help them find one that makes sense. For example, if they set one pace equal to one square on the graph paper, they begin to see a connection between the scale, 1 square equals 1 pace, and the drawing of the map.
Checking Out the Meadow  
(35 minutes)

Materials  
laminated graph paper, overhead projector pens (permanent and water soluble), compass, clipboard, pencil, field notebook, Meadow Mapping sheet, easel, chart pad, chart pens

Preparation  
• Select the section of the meadow to be surveyed and mapped. Divide this section into quadrants, using four colors of surveyor’s flags. Each quadrant should be at least 9 m (30 ft.) x 9 m (30 ft.). (Use a different color for each quadrant.) The boundaries of these quadrants need not be one straight line. Make sure these quadrants are adjacent and large enough that the students can conduct their study without tripping over neighboring groups. Two of these quadrants should be near a transition zone of the meadow. Try to find an area of the meadow that has a variety of plant life and landforms.
• Prepare a large map that has four quadrants with boundaries that match those you staked out, color-coded to match the surveyor’s flags used to section off the meadow. This will be used by students to compile a comprehensive map of the entire meadow section.
• Locate some sizable features in the survey area that can be used by the students as markers as they map out their study sites.
• Become familiar with the use of the compass so that you may instruct your students in its use.
• Orient yourself in the meadow so that you can easily point out the four directions.
• Become familiar with the map symbols so that you may explain them to the students.
• Select a staging area for this activity.

Activity Outline  
Introduction (Steps 1-2, 2 minutes)
Orientation Instruction/Review (Step 3, 4 minutes)
Surveying and Mapping (Steps 4-10, 15 minutes)
Transferring Map to Field Notebook (Steps 11-17, 3 minutes)
Drawing the Community Map (Steps 18-22, 10 minutes)
Closure (Step 23, 1 minute)

Procedural Steps  
1. Gather the students in the staging area to introduce this activity. Ask the students how they would describe this meadow. How big is this meadow? What features are important in this meadow?
2. Tell the students they will survey the meadow and draw a map of the surveyed area.
3. Divide the students into four groups of 3-4. Assign each group to a quadrant of the meadow.
4. Have the students in each group select job assignments. One student is needed as pacer, one as navigator (managing the compass), one or two as recorders.
5. Students should conduct a brief survey of their quadrant and describe what they see.
6. Introduce the compasses to the students and allow time for them to practice using them. The students should be able to sight an object and measure its orientation.
7. In their working groups the students will:
a) determine the length of the step of the student who will be stepping off the distance. Record this information on the Meadow Mapping sheet.
b) locate a feature or landmark on the edge of the meadow quadrant and face it.
c) hold the compass waist high and level.
d) record this reading as the beginning reading on the Meadow Mapping sheet.
e) pace off the distance to the feature or landmark. Record the number of steps and a description of the feature on the sheet.
f) repeat steps (b) through (e) until they have moved around all sides of the quadrant.

8. When all groups have collected the mapping data for their quadrants, regain the attention of all students to discuss general data and the need to select a scale for drawing the map. Discuss with students how they should convert survey steps to map distances.

9. Students should determine a north direction on their map and how they want to draw the map on their graph paper.

10. They will need to make a dot on the graph paper to show their starting point.

11. They should use the compass to draw a straight line on the paper in the direction of their travel. Make the length of the line to correspond to the distance found in step 7e. Make a dot at the end of this line.

12. At this time, students should draw in the landmarks from their notes at the correct distances along the line.

13. Students should hold their pencil on the dot at the end of the first line and again use the compass to draw a second line in the direction of travel. Add landmarks from their notes for this line of travel as well.

14. Have students continue drawing the survey notes on their maps in this manner until their survey maps are complete. The map should show the types and spacing of trees, the undergrowth, and other significant features. The students in each group should transfer their survey map to page 15 of their field notebooks.

15. After all students have transferred their group’s map to their notebooks, tell them they now will work together to compile one large map for the meadow community.

16. Allow the groups time to discuss their division of labor in transferring their data to the large map. Suggest to the groups that they use a scale of 1" = 4 paces and use a ruler to help transfer their data to the community map.

17. When the job assignments have been determined, tell the groups that they will need to give a brief summary of what they discovered as they mapped their section before transferring data.

18. Have groups come up and share their data.

22. When the community map is complete, lead the students in a discussion of the size and features of the meadow. Ask directed questions to elicit responses about the areas noting any transition zone(s).

19. Ask:
   “What other factors not shown on this map are important in the meadow?”

Next add:
   “Now that we have a general picture of what’s in the meadow, we will turn our attention to abiotic factors in this community.”
<table>
<thead>
<tr>
<th>Feature or Landmark</th>
<th>Compass Reading (Bearing) to Next Landmark</th>
<th>Distance in Paces to Next Landmark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starting Point</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Activity Overview
In this activity, students conduct a random sampling study in the meadow using instruments to measure sunlight level, temperature, humidity, and wind conditions.

Learning Objectives
To successfully complete this activity the students will:

- conduct a random sampling survey
- describe the sunlight, temperature, humidity and wind conditions of an open area
- measure and analyze data for abiotic factors in the meadow
- infer the relationship between sunlight, moisture, and wind on the condition of a meadow

Science Process Skills
The students will engage in scientific inquiry through: observing, measuring, collecting data, recording data, interpreting data, inferring, recognizing patterns

Background for Teachers
Each community we study uses a different strategy for sampling. In the meadow we study a random sample, selected using hula hoops, to help us pick an area that is representative of the larger community. We use this random technique to avoid possible bias as we might otherwise pick areas that are not representative of the whole meadow. For example, we might pick an area of pretty flowers to study that are not found anywhere else in the meadow. We could hardly say this site was representative. In this way, we can build the big picture from our random sample.

At this sampling site we will record a number of abiotic factors that we assume will affect the living community such as temperature of the air and soil, and light levels. Air is heated very little directly by the sun. The majority of heat in the air comes from its contact with objects, such as soil. Once heated at the surface, the warm air rises and creates currents that move the heated air around. Unlike in the forest, the meadow is often breezy. Air moves past the warmer soils and is heated. Bare soils and unshaded areas heat more and thick grasses heat less. This creates small microclimates for plants and animals that are adapted to these conditions.

We will also make a sun print to look at patterns we find in the meadow. The connection between art and science is often given as one of patterns. Artists use patterns to create their art and scientists try to explain why patterns exist. Many interesting forms are found in the meadow and sun prints are a fun way to select and note these.
Sampling in the Meadow
(25 minutes)

Materials
pencil, field notebook, surveyor’s flags, twine, soil thermometer, air thermometer, hygrometer, sling psychrometer, light meter, humidity/temperature chart, sun print kit, 2” masking tape, support board, construction paper

Preparation
• Select areas in the meadow that has grasses and some bushes if possible. Try to locate enough general sites so that each group can make two random samplings.
• Practice using the sling psychrometer so that you may demonstrate it for the students.
• Familiarize yourself with the use of the sun print materials. Scout the meadow for objects that might be suitable for use in making these prints. You may need to suggest some possibilities to the students.
• Select a staging area for this activity near a transition zone of the meadow.

Activity Outline
Introduction (Steps 1-2, 2 minutes)
Random Sampling (Steps 3-9, 11 minutes)
Discussion (Step 10, 5 minutes)
Sun Printing (Step 11, 6 minutes)
Closure (Step 12, 1 minute)

Procedural Steps
1. Gather with the students in the staging area near a transition zone of the meadow. Ask them to focus their attention along the boundary of the transition zone and describe what they see other than trees. When students have completed sharing, walk with them into the open area of the meadow. Ask students to describe what they see in this area. How do the descriptions compare? What things might be responsible for the differences in the two areas? How might sunlight be a factor in the two areas?
2. Tell the students this activity will enable them to measure sunlight and other factors at two random locations in the meadow.
3. Have students form four groups and select the roles for each student in the group. In their roles, students will use instruments to measure one of the following: soil temperature, air temperature, light intensity, and humidity. Demonstrate tossing the hoop. Have hoop throwers gather around you, facing outward. Each thrower should take five steps away from you and make a medium toss of the hoop.
4. Have students to write a general description of the area inside the hoop.
5. The students measuring soil temperature should place the soil thermometer in the ground by pushing firmly. Allow time for the thermometer to reach its final reading (30 seconds). Read the reading on the soil thermometer and record it in field notebooks on page 16.
6. Students taking air temperature readings should hold the thermometer bulb just above the ground for about 1 minute. Record this reading. Next the student should hold the thermometer 1 m above the ground. Record this reading. How does the temperature at this level compare to that just above the surface? What explanations can the students offer for their observations?
7. Students using the light meter should hold the sensor end straight up and allow meter to reach its reading. Record this value.
8. Students using the psychrometers should take and record first the dry-bulb temperature and then twirl the apparatus for 15-20 seconds before taking and recording the wet-bulb thermometer reading. Groups should use these readings and the temperature-humidity chart to determine the humidity at this location.
9. Encourage students to change roles within each group and have them repeat steps 5-8 at another random site in the meadow. One site should be near a boundary of the meadow. All readings should be recorded in the notebooks.

10. When the data collection is complete, bring the students together to discuss their findings. How do the readings for each factor compare at the different locations in the meadow? Where was the sunlight level greater? Smaller? What things might account for the differences in the air and soil temperatures in the three locations? How might the data appear if the sample were taken in the meadow near a shrub?

11. After students have responded to the questions, have them write a summary of the meadow’s uniqueness. Next, direct them to collect their meadow objects for sun printing. Ask some students to share why they made their particular selections. Direct the students in the making of these prints.

12. Finally, close by saying: “Some of the important features of the meadow are directly attributable to the amount of sunlight, moisture, and wind conditions. What you see now in this meadow won’t always be the case. With time and changes in both biotic and abiotic factors, this meadow will develop into a different type of community. The last activity in this field study will allow you to look for and record signs of changes in the meadow.”
Succeeding Beyond Measure
(adapted from “Nothing Succeeds like Succession,” Project Learning Tree)
(25 minutes)

**Activity Overview**
This activity helps students make the connection between biotic and abiotic factors and the successional changes in a meadow community.

**Learning Objectives**
To successfully complete this activity the students will:
- identify successional stages in a meadow community
- draw conclusions about the process of succession based on study test plots in different stages of succession
- explain how a meadow might form

**Science Process Skills**
The students will engage in scientific inquiry through: observing, classifying, identifying relationships, analyzing, interpreting, evaluating

**Background for Teachers**
Meadows are transitional communities. An area that is a meadow now may not stay a meadow for long. Through the process of succession it may be replaced by a forest or other community, or may be altered by human development.

Meadows are usually formed by disturbances. A meadow may open up in an area of a forest destroyed by fire, insects, or wind. Once the meadow is formed, it immediately begins to change back into the original community. Meadows only stay meadows if there are continued disturbances, such as fire or grazing. We can see these changes, or evidence of them, at the margins of the meadow where the forest is encroaching. At this transition zone we can see steps in the process of succession leading slowly from meadow to forest.

Wet areas or marshes also form meadows. As marshes fill in, more plant life is able to grow. As these plants grow and die, they help the marsh fill in even more. As succession takes place, the types of plants found in the area change. Eventually plants that like living in wet conditions are replaced by those we associate with the meadow community.

Many trees or larger plants don’t grow well in wet conditions. Historically, beavers helped “create” many wet meadow areas. Through the disturbance of damming the streams, beavers flooded large areas that, in turn, began the successional process into a meadow. As there are fewer beavers today, we see fewer wet meadows.

Meadows areas are often “developed” by draining wet areas, creating levees along rivers, and filling low spots. Eliminating wet habitats and ponds has profoundly reduced the population of many species. Further, these wet areas served as sponges and filters, slowing water down enough to permit percolation into groundwater, and filtering out sediments and nutrients before they reached mainstream rivers.

**Materials**
chart pad, easel, chart pens, pencil, field notebook, scissors, various colors of construction paper, tape or glue, surveyor’s tape and flags

**Preparation**
- Identify areas in the meadow community that exhibit several stages of succession: pond, marsh, meadow; grassy meadow, shrub zone, saplings, forest; etc.
- Check the accessibility of the areas that show the stages of succession, as the students will need to move around in these areas.
- If possible, select an area that has several types of vegetative communities so that the students might try to find plant communities in different stages of succession.
- Select a staging area.
Activity Outline

Introduction (Steps 1-2, 2 minutes)
Succession and Plant Communities (Steps 3-4, 6 minutes)
Discussion (Step 5, 4 minutes)
Visualizing Succession (Steps 6-7, 6 minutes)
Sharing (Step 8, 6 minutes)
Closure (Steps 9-10, 1 minute)

Procedural Steps

1. Gather the students in the staging area. Ask: “What are some of the changes taking place in this area? What might cause of these changes?”

2. After receiving the students’ responses, explain to them that looking at the plant life in the community provides important information about some changes that are taking place.

3. Ask the students to make a cursory look over the community and describe the different plant communities that they see. “What story does the presence of these communities tell?”

4. Direct the students, in groups of 3-4, to the areas you have staked out. Have them find plant communities in different stages of succession. They can look for these stages of succession:
   - Grasses and non-woody plants
   - Grasses and woody and non-woody plants
   - Grasses and shrubs with young tree saplings
   - Ground vegetation and young trees

   Students should also look for evidence of disturbance (erosion, tire tracks, construction, fire, etc.) that might have altered succession.

5. Call the group together and define the stages of succession evident at your site. Lead a discussion of what factors might alter succession at this site, including disease, insects, fire, wind, lightning, pollution, drought.

6. Assign a group for each of the stages of succession that were observed.

7. Have each group use different colors of construction paper to cut out the shapes of plants that are characteristic of their assigned stage of succession. Each group should develop a brief story describing their stage of succession.

8. Have groups come up, in order, and place their plants in appropriate places on the poster board and tell their stories.

9. To close this activity, ask students: “Have you ever stopped succession? What did you do? If you remember that succession is a natural pattern of change that takes place over time in an ecosystem, you should be able to think of number of things that you do that slow down or stop succession. For example, we stop succession every time we mow our lawns.”

10. To conclude, ask students to review the vocabulary used during the Meadow Mapping field study. Ask students to define the terms. List the terms on the chart paper. Have students record four of five terms on page 15 in the field notebook under "Vocabulary Preserved."
Maintaining Meadow Life
Integration of Biotic and Abiotic Factors to Create Ecological Communities
What’s the Scoop on Soil?
(adapted from “Soil Stories,” Project Learning Tree)
(45 minutes)

Activity Overview
Through this activity students have the opportunity to investigate the characteristics of soil found in a meadow community.

Learning Objectives
To successfully complete this activity the students will:
• identify and explore important characteristics of soil
• draw conclusions about the characteristics of soil that dictate its suitability for planned uses
• make comparisons of meadow soil with potting soil and with sand
• simulate a wetlands filtration system

Science Process Skills
The students will engage in scientific inquiry through: observing, sampling, collecting data, predicting, analyzing data, classifying, measuring

Background for Teachers
Soils develop as a result of climate, living organisms, parent material, topography, and time. The layers of weathered materials that develop result in profiles we call soils. By understanding the characteristics of soils, we can classify them and predict how soils will function for different uses. Soil is basic to the environment and human life upon the Earth. It is, however, often taken for granted and misused. People think of soil as dirt and do not recognize that many of their needs rely on soil’s special relationship to life on Earth.

Soil, the foundation of life on Earth, is a mixture of mineral ingredients (rock, clay, silt, and sand); organic ingredients (living organisms, decomposing organic matter); moisture; and air spaces. Soils are often classified by texture, which is determined by the relative amounts of clay, silt and sand they contain. Loam is the term for a fairly equal mix of all three. Other soil textures are heavier in one element than another, i.e. silt loam, sandy loam, and so forth.

The ratio of these components in relationship to the other environmental factors helps determine: 1) how well soil can sustain plants and withstand erosion; 2) which plants will grow well; and 3) whether the soil can support human development.

Another important component of soil is the spaces between soil particles. These spaces are critical to plant growth, since they are where roots grow and where moisture and air are trapped. Moisture facilitates the transfer of nutrients to the roots.

Although soil may appear to be static, constant changes are actually taking place. For example, glacial deposits may change the amount of sand or rock in the surface soils; a fallen log will add organic matter as it decomposes; a stream can wash away fine silt, clay, and organic matter; or construction projects may move subsoil with less organic materials to the surface. Various types of soils exist in close proximity.

The soil in any given location will have layers or horizons, with each horizon made up of different things. The thin, uppermost layer is humus, a layer very rich in organic matter. Horizon A is the topsoil, Horizon B is the subsoil, and Horizon C is the parent material. The number of layers found in a particular location depends on the age of the soil. Immature soil has two layers while mature soil has all three horizons. The presence of organic materials in the soil is a general measure of the health of the soil. Generally, the higher the organic content the better the soil is agriculturally. This mature layer with its decomposing organic material is often called “topsoil,” reflecting both its position and its quality.
Other important characteristics of soils are the color, the presence of soil nutrients, the water-holding and water-absorbing capacity, the thickness of the layers, and the consistency of the material. Soil properties have a lot to do with the soil’s ability to sustain and support plant life, as well as its suitability for other uses.

As with other communities, understanding soils are key to the meadow community. In the meadow soils play a key role as they provide moisture, store nutrients and support many of the animals that live in the meadow.

Testing the percolation rate, the rate at which water enters the soil, reflects the types of materials that make up the soil. Soils contain clay, sand and humus in various proportions and these percentages affect the percolation rate. In the case of meadow, another factor is compaction. As grazing animals and the weather form a hard layer at the surface that reduces the percolation rate. Soils are tested for their component parts by feel, rolling the moist soil in the hands while noting textures, and in settling jars. The three mineral components settle from water at different rates. If we place the soil sample into a small jar with water and shake to mix well we can note the layers that form as the soil settles. Sand settles first as it is relatively large and dense followed by humus and silt. Clays are extremely small particles and can remain in suspension for long periods of time. We can estimate the percentages of each part and use a chart to name the soil type.

Other attributes of the soil include its pH, the measure of acidity, which reflects the soils chemistry and affects the types of plants that will live in the meadow. Wet meadows often have fairly acidic soils due to the rotting materials and high water content. This acidic water, in turn, inhibits the decomposition of woody debris and creates a bog with a great deal of the nutrients locked up and unavailable for the plant community. Bogs are such good preservers that animals and even humans have been found that are well preserved after many thousands of years buried in the bog. Peat bogs contain thousands of years of mosses and serve as soil amendments and are burned as fuel.

The other chemical components of soils include nitrogen, potassium and phosphorus. These are the same three major nutrients found in fertilizers we add to our soil. The NPK numbers on a sack of fertilizer are the percentages of each element by weight. They are all key to healthy plant communities. There presence, or absence, will strongly affect the plants community and in turn the animals found in the meadow.

### Common Soil Textures

<table>
<thead>
<tr>
<th>Particle</th>
<th>Size, mm</th>
<th>Feel</th>
<th>Fertility</th>
<th>Air Space</th>
<th>Availability of Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>2.0-0.05</td>
<td>gritty, visible particles</td>
<td>low</td>
<td>many in number; large in size</td>
<td>low</td>
</tr>
<tr>
<td>Silt</td>
<td>0.05-0.002</td>
<td>smooth, floury</td>
<td>medium</td>
<td>many in number; fair to small in size</td>
<td>good</td>
</tr>
<tr>
<td>Clay</td>
<td>&lt;0.002</td>
<td>sticky, slimy, greasy</td>
<td>high</td>
<td>few in number; tiny in size</td>
<td>slow movement of water</td>
</tr>
</tbody>
</table>
What’s the Scoop on Soil?  
(45 minutes)

Materials
pencil, field notebook, hula hoops, soil thermometers, tin cans with both ends removed, aluminum pie pans, pH meter, jars with lids, water, soil sampling tube, magnifying lens, bucket, gardening trowels, sandy soil, potting soil, cotton balls, coffee filters, spray bottle, 2” masking tape, mortar and pestle, set of mesh screens

Preparation
• Collect a sample of meadow soil. Dry it and break it into fine particles using a mortar and pestle. You will need enough of the soil for each group to have 1-2 tablespoons.
• Collect samples of meadow soils from different areas in the community. Place each of these samples in a separate plastic bag and be sure to keep these bags closed tightly.

Activity Outline
Introduction (Step 1, 2 minutes)
Sensory Investigation of Soils (Steps 2-3, 6 minutes)
Collecting Soil Samples (Steps 4-5, 4 minutes)
Drawing a Soil Profile (Step 6, 5 minutes)
Investigating Physical and Chemical Characteristics of Soils (Steps 7-11, 11 minutes)
Soil Percolation (Steps 12-15, 7 minutes)
Discussion (Step 16, 8 minutes)
Closure (Step 17, 2 minutes)

Procedural Steps
1. As you gather with the students to introduce this activity, pass the plastic bags containing meadow soil samples around for the students to observe. Ask them to describe what they see. How could we go about finding out these things? Ask: “What might be important things to know about the soils contained in these bags?”

2. After the bags have been circulated, bring out the sample of powdered meadow soil. Ask: How is this sample of meadow soil different from those in the bags? Are there other differences that may not be so obvious?” Ask students to think about the types of information about soils they could obtain using moist soil samples and dry soil samples.

3. End the introduction by saying: “Various soil characteristics such as color, texture, structure, temperature, and pH affect the productivity of the land. Knowing these conditions is important in determining the health and suitability of soil for particular plant life and planned usage. In this activity we are going to collect, record, and analyze some information about these soil characteristics.”

4. Have students form groups of 2-3. Say: “You will work in groups to conduct an investigation of a soil sample taken from within the hoop. You will use the hula hoop to define the meadow area within which you will be working.”

5. Place a soil thermometer in the sample area and read the temperature of the soil. Record this reading on page 17 of the field notebooks.

6. Next have one student in each group use the soil sampling tube to remove a sample of meadow soil and place it in a pie pan. Each student in the group should sketch a profile of this sample in the field notebooks.

7. Then have them take a small amount of soil from the tube and place the soil between their fingers, roll it, and describe its texture. “What is its color? What size are the particles of the soil? Record your observations on your sketch.”
8. Next direct the students to take a sample each of sand and potting soil. They should use their magnifying lenses to compare the soil they extracted from the meadow with the sand and potting soil. How are these three different?

9. Now they should use a pH meter to measure the acidity or alkalinity of the meadow soil. Record this reading on their profile sketch.

10. Continuing with their investigation, students will need to place some of the soil sample into a jar of water, cap the jar, and shake it. Allow the soil to settle out of the water. (Layers will form in the jar, with the largest soil particles settling out first and the smallest settling out last. Are there any particles left in the water on top of the settled soil?)

11. Have students simulate a filtration system by doing the following: Pour the water from the jar through a coffee filter. Observe what collects in the filter. Next pour this once-filtered water through a layer of cotton balls. Again, observe what collects on the cotton balls. Record these findings in their notebooks.

12. Push a tin can into the ground. Quickly pour about two pints of water into it.

13. Observe the bubbling that takes place as the water is being absorbed into the soil. The amount of bubbling is related to the amount of air in the soil. Record this bubbling as a little, some, or a lot.

14. Remove the can from its first location and push it into the ground at a site close to the first one. Quickly pour about two pints of water into it.

15. Measure the time it takes for the water to be absorbed by the soil. Record this time.

16. Ask: “What did you find out? How is percolation rate related to soil type? How is the rate at which rate drains through some soils related to the ability of roots to push through these same soils? What factors other than soil texture might affect the rate of soil percolation?”

17. To close this activity and transition to the next ask: “Based on the data you collected in this activity what type of soil seems to be the best for the plants in a meadow community? Should we attempt to answer this question now, or should we collect more data before answering? Collecting more data will enable you to make a much more informed choice in your response. Our next activity will allow us to look in detail at the big things we can see in the soil and the nutrients that we cannot see.”
Rich Soil, Poor Soil
(adapted from “Soil Shakedown,” Minnesota Valley National Wildlife Refuge)
(25 minutes)

Activity Overview
Students investigate the relationship between soil chemistry and plant life in the meadow community.

Learning Objectives
To complete this activity the students will:
• identify the organic content of meadow soil
• draw conclusions about the relationship between soil chemistry and plant life in the meadow community
• infer the cycling of nutrients through the meadow community

Science Process Skills
The students will engage in scientific inquiry through: observing, inferring, questioning, defining, classifying

Background for Teachers
Soil is considered a renewable resource in the long term. Healthy soil supports plant growth, which in turn decomposes back into organic matter in the soil. Under the best conditions, soil can accumulate one millimeter of new soil per year. Under adverse conditions, it may take thousands of years for the same accumulation.

Plant life depends on soil to provide water and nutrients. How well soil sustains a plant depends on its texture (compact or porous), its water-holding capacity, its acidity, and its population of beneficial soil organisms.

What are the nutrients that are vital to the growth and development of plants? How do they move into the plants? How do they return to the soil? Nitrogen, phosphorus, and potassium are macronutrients that are essential for the survival of plant life and move from soil to plants and back to the soil. These three nutrients comprise the three common ingredients in commercial fertilizers. Both soil texture and pH influence nutrient composition and the community supported by the soil.

While we can’t often see the animals that frequent the meadow from other communities, there are a large number of animals found in the meadow soil. As most of the meadow vegetation is low to the ground, many animals seek shelter underground. Field mice (voles) are common and are avid tunnel builders. Moles create deeper, larger tunnels, breaking up the soil and providing areas where water can percolate into the ground. Snakes hunt small animals and live in borrowed homes.

While these larger animals are important, insects, worms, and other small creatures form the majority of meadow life. A few square feet of soil may contain thousands of worms, hundreds of insects and other arthropods, and innumerable bacteria, fungi and protozoa. These animals move materials, recycle the debris and build healthy soils. Careful study of the soil will reveal a wealth of animals underfoot. They all play key roles in maintaining a healthy meadow community.

The majority of living things in soils are microscopic. It is difficult, even with a good microscope, to see these organisms. They include fungi, bacteria and protists. All play central roles in nutrient recycling in the meadow soil. In fact, many meadow plants form special relationships with these organisms and work together to provide for each other’s needs. An example is clover, which hosts a soil bacteria that fixes nitrogen directly form the air. Nitrogen is the most common component of air but nitrogen compounds in soil are much more limited. This is why we add nitrogen containing fertilizers to soil to encourage plant growth. Clover, and other legumes, use the bacteria to provide their own nitrogen and the bacteria are given homes in nodules in the plant’s roots. This process is an example of symbiosis.
Rich Soil, Poor Soil  
(25 minutes)

Materials  
pencil, field notebook, soil sampling auger, magnifying lens, soil chemistry kit, goggles, gardening trowel, Topsoil Tour chart, aluminum pie pan, 8 large petri dishes, dissecting microscope, 1 settling tube (clear, plastic, cylindrical container), poster board rectangles (30 cm X 45 cm)

Preparation  
• Trim away the above-ground vegetation where the meadow sample is to be taken. Take a sample about 15 cm x 15 cm x 15 cm in size. Spread this soil out on newspapers for later use by the students.

• Have in place a system for collecting the soils after each field study so that all the soil can be returned to the dig after the last field study. You will need a new sample of excavated soil for each field study.

• Prepare a container of water (2/3 the volume of the container) and meadow soil (1/3 the volume of the container) to be used as a settling tube. The container should be clear, cylindrical, and slender. Shake the tube very vigorously. Place the tube in a location where it will be undisturbed until you are ready to share it with the students. Be sure the soil sample has a significant amount or organic matter.

Activity Outline  
Introduction (Steps 1-2, 2 minutes)  
Looking for Organic Matter (Steps 3-4, 5 minutes)  
Discussion (Step 5, 3 minutes)  
Conducting Soil Chemistry Tests (Steps 6-8, 10 minutes)  
Discussion (Steps 9-10, 3 minutes)  
Closure (Step 11, 2 minutes)

Procedural Steps  
1. Gather the students around the area from which you took the soil sample. Show them the settling tube with layers defined. Some organic matter should be floating in the water above the layers. Ask the students to describe what they see. Have them offer explanations for why things happened as they did. Ask about the importance of the materials floating in the water.

2. Tell students that although color is a fairly accurate indicator of the amount of organic material present in soils, they will have a chance to actually take a soil sample apart. (Soils dark in color are generally rich in organic matter.)

3. Distribute poster board rectangles and soil samples to each student. Direct the students to carefully separate the soil into (a) plant matter such as sticks, leaves, and roots; (b) animal life such as worms, grubs, etc.; and (c) mineral matter such as gravel, sand, and silt.

4. Caution the students to be careful to keep the three piles separate. Once the soils are separated, have the students compare the amount of matter in each pile and estimate the percentage each part makes up. These data should be recorded as a circle graph in their field notebooks on page 18.

5. Once the recording is finished, invite students to share their findings. How much of each type of material did they find? The samples came from the same area, so what might explain the differences?

6. Say: “Now that we have looked closely at the materials in this layer of soil, we will now perform chemical tests on the litter-free soil to check for the levels of nitrogen, phosphorus, and potassium. For this activity you will need to work in groups of three to four.”

7. Explain to the students that in their groups they will take turns handling the chemicals but that the persons handling the bags and the chemicals must wear goggles!
8. Have students follow the chemical procedures given below. After the interpretation of each test result, the students should record the data in their field notebooks.

**Chemical procedures**
Always have the students with chemicals and bags wear goggles. Soil samples should be fairly free from debris and stones.

**Note:** Test bags are included in soil chemistry kit

**pH**
- Add 1/2 cup of water and 5 teaspoons of soil to a test bag.
- Mix briskly for 1 minute.
- Let bag sit for 1 minute.
- Filter the soil particles from the water using a Dixie cup with the bottom removed and a coffee filter inside the cup.
- Collect into another cup.
- Fill the test bag to line “C” and add 1 pH tablet.
- Wait until dissolved, about 30 seconds.
- Compare water color to chart color and estimate the intermediate values.

**Soil Extraction procedure for NPK (nitrogen, phosphorus, potassium) Tests**
- Pour 1/2 cup of water into a test bag.
- Add 1 Soil Extraction Tablet to the bag and seal. Slosh back and forth until dissolved.
- Add 5-6 teaspoons of soil and seal.
- Shake briskly for one minute, holding onto the sealed edge.
- Let bag sit for 1-2 minutes to settle the particles.
- Filter the solution into a Dixie cup, using a Dixie cup with the bottom removed and a coffee filter.
- Use the filtered solution for the NPK tests.

**Nitrogen**
- Fill test bag to line “C.”
- Add Nitrate tablet #1, roll down bag and seal.

**Potassium**
- Fill test bag with solution to line “C.”
- Add 1 potassium tablet and seal the bag.
- Gently shake bag. **Do not pinch or squeeze!**
- Wait 2-3 minutes.
- Compare color to chart and estimate intermediate values.

**Phosphorus**
- Dilute the filtered solution 7 to 1. (For every ml of solution, and 7 ml of water.)
- Fill test bag with diluted solution to line “C.”
- Add 1 phosphorus tablet and seal.
- Shake gently for 3 minutes.
- Wait five more minutes.
- Compare water color to chart color and estimate intermediate values.

9. When the chemical tests are complete, refocus the students’ attention and lead them in a discussion of their results.

10. Have students use their data to classify the soil as rich or poor. Would this classification change depending on the plant life to be supported by the soil? Why? What things might cause soil chemistry to change? What could be the sources of the changes?

11. To close, say: “Life in the meadow is very much dependent on the quality of soil in the meadow. We have considered just some of the factors that affect soil quality. Think about the things that you do which impact this resource.”
Activity Overview
Students investigate, partly through simulation, some of the natural cycles occurring in the meadow (the water cycle, the nitrogen cycle, and the oxygen-carbon dioxide cycle). The students summarize their experiences by diagramming one of the cycles.

Learning Objectives
To successfully complete this lesson, the students will:
- investigate natural cycles occurring in the meadow community
- describe the role of plants in each of the cycles
- identify ways the abiotic factors of water, nitrogen, carbon, and oxygen affect the biotic components in the community

Science Process Skills
The students will engage in scientific inquiry through: observing, identifying relationships, inferring, drawing conclusions

Background for Teachers
Plants and animals in an environment interact with the nonliving (abiotic) elements. In a local environment, factors such as sunlight, moisture, temperature, and wind influence the suitability of an area for particular organisms. Physical factors may be determined by the environment’s geography, such as its proximity to water, its elevation, or its geological features. In addition, resident organisms (particularly plants) may affect the sunlight, moisture, temperature and wind of the area. For example, the tall trees of a redwood forest tend to block sunlight and thus create a dark, moist environment, or microclimate, on the forest floor that is suitable for shade-loving plants but is too shady for other kinds of plants. Microclimate refers to special conditions of light, moisture, and temperature that occur in a narrowly restricted area within an ecosystem, for example under a small area of a bush or larger area in a small woodland opening.

The movement of matter through an ecosystem is another example of biotic/abiotic interactions. Matter, in the form of chemicals, flows in cycles from the nonliving part of the environment to the living and back again. If materials are not recycled, they become limiting factors to the ability of living systems to survive. Three such cycles of particular interest in ecological studies are the water cycle, the nitrogen cycle, and the carbon-oxygen cycle.

In addition to clouds, oceans, rivers, and valleys, living organisms are part of the water cycle. All living things need water to live because it is essential to their bodily functions. Plants and animals take in water and return it to the atmosphere as vapor (breathing, transpiring) or to the soil as liquid (excreting). Plants play a major role in the water cycle. Plants take in liquid water through their roots and release some water vapor through their leaves. The processes of the water cycle are given in the chart on the following page.

Nitrogen is a part of the proteins of all living things. However, before nitrogen can be used by most organisms, it must be chemically changed into a form that can be absorbed by the organism. The process of converting nitrogen from the air into nitrogen-containing molecules that plants can use is called fixation. Nitrogen fixation usually takes place in one of two ways.

A bolt of lightning on a warm, summer evening does more than just brighten up the sky. The energy from the lightning separates the nitrogen in the air so that it can combine with oxygen. As rainfall washes these nitrogen-containing molecules to the soil, they can be taken in by plants and become part of a cycle.

A host of microorganisms including bacteria and blue-green algae can also fix nitrogen. These organisms fix about 90% of the nitrogen in the biosphere. Many of these organisms live in the bulb like nodules on the roots of certain plants.
These plants include soybean, pea, clover, and some water plants. After the bacteria fix the nitrogen, the plants take the nitrogen-containing molecules up into their roots. Plants then use these molecules to make proteins. Organisms that eat plants use the plant proteins to make their own proteins, and so on up the food chain.

Humans add nitrogen to the soil to grow their crops. This nutrient is often the most limiting factor for plant growth. We’ve used a variety of techniques to add nitrogen, including adding seaweed and fish, compost, animal waste, and ammonium sulfate made from natural gas.

Nitrogen returns to the air when certain kinds of bacteria, the decomposers, break down wastes and the proteins of dead organisms. The decomposers change the proteins into ammonia. The ammonia can return to the plants, or other bacteria can convert it back to nitrogen gas.

The movement of oxygen and carbon dioxide through an ecosystem is a third example of matter being cycled through the biosphere from the air to organisms and back to the air again. Oxygen makes up 21% of the earth’s atmosphere and may occur as molecular oxygen (O$_2$), ozone (O$_3$), or in chemical combination such as carbon dioxide (CO$_2$) and water vapor (H$_2$O$\lambda$).

Two processes in living systems are important for this cycle: photosynthesis and respiration. In respiration, living organisms remove oxygen from the air as they breathe. When an organism respires, it uses the oxygen and returns carbon dioxide to the air as a waste product. Carbon dioxide is also added to the air by the decomposition of organic matter, and the burning of coal, gas, and oil. Plants balance this action by carrying on photosynthesis as well as respiration. Just like animals, plants remove oxygen from the air and produce carbon dioxide that may stay in the plant or be released to the air. During photosynthesis, plants take in carbon dioxide, which they combine with water, from the air and release oxygen to the atmosphere. They use this carbon for growth and store it for an energy source.

Plants play an important role in each of the cycles mentioned above. Thus, plants will be the focus of the study of natural cycles in the meadow.

### Water Cycle

<table>
<thead>
<tr>
<th>Process</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaporation</td>
<td>Process by which liquid water changes to water vapor.</td>
</tr>
<tr>
<td>Transpiration</td>
<td>Process by which water evaporates from the leaves of plants.</td>
</tr>
<tr>
<td>Condensation</td>
<td>Process by which water vapor changes to liquid water.</td>
</tr>
<tr>
<td>Runoff</td>
<td>Process by which water flows over the surface of the ground.</td>
</tr>
<tr>
<td>Precipitation</td>
<td>Process by which water, in any form, falls from the atmosphere to the Earth’s surface.</td>
</tr>
</tbody>
</table>
Going in Cycles
(20 minutes)

Materials
field notebook, pencil, easel, chart pad, chart markers, Water Cycle chart, Nitrogen Cycle chart, Oxygen-Carbon Dioxide Cycle chart, 2 different-types of excavated meadow plants with leaves and roots intact, 2 gallon-size plastic bags, 8 Water Cycle Dice, 8 water cycle station cards, 5 Nitrogen Cycle Dice, 5 nitrogen cycle station cards, 3 Oxygen-Carbon Dioxide Cycle Dice, 3 oxygen-carbon dioxide cycle station cards, Travel Record sheets

Preparation
• Make three columns on the chart pad and label them: Water, Nitrogen, and Oxygen-Carbon Dioxide.
• Select a staging area where the three cycles at the end of this activity can be displayed.
• Stake out three areas in the meadow. These areas should be far enough apart that the students may move about and around them without bumping into other student groups. Each area should be at least 4 m (12 ft) x 4 m (12 ft). Place the station cards and dice in each of these areas so that there is easy flow of movement. (Make dice out of cardboard and self-stick labels using the “moves” provided.)
• Draw on chart paper diagrams that illustrate the following processes: photosynthesis, plant respiration, transpiration, and water absorption. Add a definition to each diagram.

Activity Outline
Introduction (Steps 1-4, 5 minutes)
Cycling Through (Steps 5-10, 9 minutes)
Discussion (Steps 11-13, 4 minutes)
Closure (Steps 14-15, 2 minutes)

Procedural Steps
1. Gather the students in the staging area. Ask: “What is a cycle? What cycles are taking place right now in this meadow? What evidence is there that these things are happening?” Record and discuss student responses.
2. Next display the two excavated plants. Ask: “How are these plants important to the meadow’s natural cycles?” After students have responded, share the definitions and diagrams of the cyclical processes. Encourage students to think about what happens in the following processes: photosynthesis, plant respiration, transpiration, water absorption. If necessary, guide the students to the recognition that plants are critical to the natural cycles in the meadow. Highlight any student responses that reflect water, nitrogen, and oxygen-carbon dioxide cycles.
3. Say: “Although plants are important in the movement of matter through the meadow, they are one of several ‘stops’ matter can make. Where are some of the different locations water and other nutrients can go as they move through the meadow?” Write the students’ responses in the appropriate column on the chart pad.
4. Recruit three students to demonstrate the oxygen-carbon dioxide cycle. Send one student to each station of the cycle. Ask the students to share the name of each station. Then ask each student to roll the die at their stations and share what the top of the die says. After each of these students has shared, ask the rest of the students what move should be made by the helping students. Allow the helping students to make their moves. Have them throw the die one more time and make the next move. Ask all the students if they understand how the game works. Respond to students’ questions.
5. Tell the students they will become molecules of water and nitrogen as they move through two of the other natural cycles taking place in the meadow.
6. Move with the students to the water cycle area. Assign at least one student to each station.
in this area. Explain the setup for the activity. Have the students identify their own stations and the different places water can go from their station in the water cycle through the meadow. Discuss with the students the conditions that cause the water to move. Also have students think about the form in which water moves from one location to another. (Most of the movement will take place when water is in its liquid form.) Have students record their starting point in the meadow's water cycle. Tell them they will need to keep track of all their movements, including "stays" on their Travel Record sheets.

7. Have one student at each station roll the die. Explain that the face-up side indicates where the water molecule moves to from that station. At each station, the students should line up behind the die.

8. Tell the students they will begin and end their cycle with the sound of a whistle. Begin the game. Allow 5 minutes for the students to cycle through various stations.

9. At the end of the allotted time, regain the attention of the students and have them move to the nitrogen cycle area. Students should be distributed evenly among the different stations in the nitrogen cycle. Because there are fewer stations, students should make their movements in pairs when possible. Have the students identify their stations and remind them to keep track of their journey as molecules of nitrogen compounds.

10. Begin the game. Allow 3 minutes for the students to cycle through this area.

11. Have at least one student share a journey for each of the cycles. Be sure to ask them to describe the necessary conditions for their movements to take place and to discuss any cycling that occurred (that is, if they returned to the same station(s) during the course of the game).

12. Ask the students what conclusions they can draw about natural cycles in the meadow and the role of plants in these cycles.

13. Finally, have the students select one of their Travel Records and draw a diagram of that cycle in their field notebooks. If time permits, ask one or two students to share their diagrams with the group.

14. To close this activity, display the charts for these three cycles. Tell students that while these charts show the general cycles they have focused their attention to these cycles in and through the meadow. Ask them to think about how the meadow fits into the big scheme of each cycle and how these cycles would be affected without life in the meadow.

15. To conclude the field study, ask the students to review the significant vocabulary used during this field study. Write their responses on chart paper and ask each student to record four or five of these terms in their field notebooks on page 17 under "Vocabulary Monitored."
**Travel Record: A Molecule's Journey**

As you move through the meadow, record each location to which you travel and the reason for each move you make. Be sure to include any “stays.”

<table>
<thead>
<tr>
<th>Molecule's Location</th>
<th>Reason for Molecule's Movement</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
Water Cycle
Oxygen-Carbon Dioxide Cycle
Nitrogen Cycle
Cycle Stations

Within each cycle there will be several stations, one for each die. You will need to make up cards for each station and place the matching die with it.

Nitrogen Cycle Station Cards

Atmosphere (die with 4 sides “surface,” 2 sides “stay”)
Surface (die with 4 sides “soil,” 2 sides “stay”)
Plant (die with 2 sides “surface,” 2 sides “animal,” 2 sides “stay”)
Animal (die with 1 side “surface,” 1 side “soil,” 4 sides “stay”)
Soil (die with 1 side “atmosphere,” 2 sides “plants,” 3 sides “stay”)

Oxygen-Carbon Dioxide Cycle Station Cards

Atmosphere (die with 2 sides “plant,” 3 sides “animal,” 1 side “stay”)
Plant (die with 3 sides “atmosphere,” 3 sides “stay”)
Animal (die with 3 sides “atmosphere,” 3 sides “stay”)

Water Cycle Station Cards

Soil (die with 2 sides “plant,” 1 side “groundwater,” 2 sides “clouds,” 1 side “stay”)
Plant (die with 4 sides “clouds,” 2 sides “stay”)
River (die with 1 side each “lake,” “groundwater,” “ocean,” “animal,” “clouds,” and “stay”)
Clouds (die with 2 sides “soil,” 1 side “lake,” 2 sides “ocean,” 1 side “stay”)
Ocean (die with 2 sides “clouds,” 4 sides “stay”)
Lake (die with 1 side “animal,” 1 side “groundwater,” 1 side “river,” 1 side “clouds,” 2 sides “stay”)
Animal (die with 2 sides “soil,” 3 sides “clouds,” 1 side “stay”)
Groundwater (die with 1 side “river,” 2 sides “lake,” 3 sides “stay”)

250  The SMILE Progr.m / Outdoor Science Adventures for Elementary Students
Nitrogen Cycle Dice

Surface
Decaying matter on the ground interacts with nitrogen compounds in the air

Surface
Decaying matter on the ground interacts with nitrogen compounds in the air

Surface
Decaying matter on the ground interacts with nitrogen compounds in the air

Surface
Decaying matter on the ground interacts with nitrogen compounds in the air

Stay
Nitrogen remains in the air

Stay
Nitrogen remains in the air
Nitrogen Cycle Dice

Soil
Decaying leaves and animals release nitrogen into the soil

Soil
Decaying leaves and animals release nitrogen into the soil

Soil
Decaying leaves and animals release nitrogen into the soil

Soil
Decaying leaves and animals release nitrogen into the soil

Stay
Nitrogen is used by the plant and stays in the cells

Stay
Nitrogen is used by the plant and stays in the cells
Nitrogen Cycle Dice

**Surface**
Leaves fall from plants to the ground

**Surface**
Leaves fall from plants to the ground

**Animal**
Animal eats parts of the plant

**Animal**
Animal eats parts of the plant

**Stay**
Nitrogen remains in leaves of the plant for use by it

**Stay**
Nitrogen remains in leaves of the plant for use by it
Nitrogen Cycle Dice

**Stay**
Nitrogen is used by animal to build proteins

**Stay**
Nitrogen is used by animal to build proteins

**Stay**
Nitrogen is used by animal to build proteins

**Stay**
Nitrogen is used by animal to build proteins

**Surface**
Animal dies or excretes solid waste

**Soil**
Animal excretes liquid waste
Nitrogen Cycle Dice

Stay

Nitrogen compounds remain in the soil

Stay

Nitrogen compounds remain in the soil

Stay

Nitrogen compounds remain in the soil

Plants

Nitrogen-fixing bacteria in plant roots enable plants to absorb nitrogen

Plants

Nitrogen-fixing bacteria in plant roots enable plants to absorb nitrogen

Atmosphere

Some nitrogen containing compounds are broken down by bacteria and other materials, releasing nitrogen into the air
**Oxygen-Carbon Dioxide Cycle Dice**

**Plant**
- Carbon dioxide is removed from the air by a plant for use in photosynthesis

**Animal**
- An animal breathes in oxygen from the air

**Stay**
- Oxygen remains in the air

**Animal**
- An animal breathes in oxygen from the air

**Plant**
- Plant removes carbon dioxide from the air for use in photosynthesis

**Stay**
- Carbon dioxide remains in the air
### Oxygen-Carbon Dioxide Cycle Dice

<table>
<thead>
<tr>
<th>Stay</th>
<th>Atmosphere</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some oxygen remains in the plant for its respiration</td>
<td>Oxygen from photosynthesis is released by plant</td>
</tr>
<tr>
<td>Both oxygen and carbon dioxide are used by the plant</td>
<td>Oxygen from photosynthesis is released by plant</td>
</tr>
<tr>
<td>Some carbon dioxide is used in making carbohydrates for the plant</td>
<td>Oxygen from photosynthesis is released by plant</td>
</tr>
</tbody>
</table>
**Oxygen-Carbon Dioxide Cycle Dice**

**Atmosphere**
- Animal releases carbon dioxide from respiration into the air

**Atmosphere**
- Animal releases carbon dioxide from respiration into the air

**Atmosphere**
- Some oxygen remains in animal for use by its body

**Stay**
- Some carbon dioxide remains

**Stay**
- Oxygen is used by the animal
### Water Cycle Dice

<table>
<thead>
<tr>
<th>Ground Water</th>
<th>Stay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water is pulled by gravity; it filters into the soil</td>
<td>Water remains on the surface (perhaps in a puddle, or adhering to a soil particle)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plant</th>
<th>Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water is absorbed by plant roots</td>
<td>Water is absorbed by plant roots</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clouds</th>
<th>Clouds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat energy is added to the water, so the water evaporates and goes to the clouds</td>
<td>Heat energy is added to the water, so the water evaporates and goes to the clouds</td>
</tr>
</tbody>
</table>
Water Cycle Dice

**Clouds**

Water leaves the plant through the process of transpiration

**Stay**

Water is used by the plant and stays in the cells
### Water Cycle Dice

<table>
<thead>
<tr>
<th>Stay</th>
<th>Ocean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water remains in the current of the river</td>
<td>Water flows into the ocean</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clouds</th>
<th>Animal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat energy is added to the water, so the water evaporates and goes to the clouds</td>
<td>An animal drinks water</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ground Water</th>
<th>Lake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water is pulled by gravity; it filters into the soil</td>
<td>Water flows into a lake</td>
</tr>
</tbody>
</table>
Water Cycle Dice

Lake
Water condenses and falls into a lake

Stay
Water remains as a water droplet clinging to a dust particle

Ocean
Water condenses and falls into the ocean

Soil
Water condenses and falls on soil

Soil
Water condenses and falls on soil

Ocean
Water condenses and falls into the ocean
**Water Cycle Dice**

**Stay**
- Water remains in the ocean

**Stay**
- Water remains in the ocean

**Stay**
- Water remains in the ocean

**Stay**
- Water remains in the ocean

**Clouds**
- Heat energy is added to the water, so the water evaporates and goes to the clouds

**Clouds**
- Heat energy is added to the water, so the water evaporates and goes to the clouds
<table>
<thead>
<tr>
<th>Ground Water</th>
<th>Animal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water is pulled by gravity; it filters into the soil</td>
<td>An animal drinks water</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stay</th>
<th>Clouds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water remains within the lake or estuary</td>
<td>Heat energy is added to the water, so the water evaporates and goes to the clouds</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>River</th>
<th>Stay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water flows into a river</td>
<td>Water remains within the lake or estuary</td>
</tr>
</tbody>
</table>
### Water Cycle Dice

<table>
<thead>
<tr>
<th>Soil</th>
<th>Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water is excreted through feces and urine</td>
<td>Water is excreted through feces and urine</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clouds</th>
<th>Clouds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water is respired or evaporated from the body</td>
<td>Water is respired or evaporated from the body</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stay</th>
<th>Clouds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water is incorporated into the body</td>
<td>Water is respired or evaporated from the body</td>
</tr>
</tbody>
</table>
**Water Cycle Dice**

**River**
Water filters into a river

**Lake**
Water filters into a lake

**Lake**
Water filters into a lake

**Stay**
Water stays underground

**Stay**
Water stays underground
Final Project: Community Survey
Integration of Biotic and Abiotic Factors to Create Ecological Communities
Final Project: Community Survey
(adapted from “Field, Forest, and Stream,” Project Learning Tree)
(90-minute field study, 90-minute project creation, 30-minute project sharing)

Activity Overview
In this culminating study, students work together as a SMILE Club group. At an unfamiliar site, students apply the process and hands-on field study skills developed through the earlier six field studies. The students in each SMILE Club make a presentation and share with the rest of the camp their findings from the investigation of the new site.

Learning Objectives
Through the investigations and presentations, the students will:
• demonstrate an understanding of the factors that define ecological communities and the conditions necessary for maintaining life in these communities
• apply field study mapping and investigation skills
• create a bracelet and story that illustrate the water cycle specific to the study community
• prepare a presentation and share the results of their investigations

Science Process Skills
The students will engage in scientific inquiry through: observing, defining, identifying, hypothesizing, drawing conclusions, interpreting data, inferring, using numbers, classifying, gathering data, analyzing data, constructing maps, communicating

Background for Teachers
An ecosystem is a community of different species interacting with each other and with the chemical and physical factors making up the abiotic or nonliving environment. It is a system of interrelationships among organisms, and between organisms and the physical environment.

In an ecosystem, living and abiotic or nonliving elements constantly interact. For example, most plants depend on soil for water and nutrients, and they need sunlight to manufacture food. Some plants also depend on animals to pollinate their flowers, disperse their seeds, and fertilize the soil in which they live. Animals, in turn, depend on plants for food and shelter. Some animals may depend also on other animals for food and protection.

Plants and animals also interact with the abiotic elements of their environment. In a local environment, physical factors such as sunlight, moisture, temperature, and wind influence the suitability of an area for particular organisms. Those factors determine the kinds of plants and animals that live there. Physical factors may be determined by the environment’s geography, such as its proximity to water, its elevation, or its geological features. In addition, the resident organisms (particularly plants) may affect sunlight, moisture, temperature, and wind of the area. For example, the tall trees of a redwood forest tend to block sunlight and thus create a dark, moist environment, or microclimate, on the forest floor that is suitable for shade-loving plants. Microclimate refers to special conditions of light, moisture, and temperature that occur in a narrowly restricted area within an ecosystem, for example, under a bush or in a small woodland opening.

Green plants get their energy from the sun. In a process called photosynthesis, sunlight activates the chlorophyll in leaves to convert raw materials from soil and air into carbohydrates (starches and sugars), which are the plant’s food. Plant leaves draw carbon dioxide from air and combine it with water to make these carbohydrates, which is the beginning of the carbon cycle.

Water is essential to plants for several reasons. Besides being a main ingredient in photosynthesis, water is a primary component of protoplasm, the basic material that constitutes the plant’s structure. Water also helps transport nutrients from the soil to the plant’s roots. Many
of life’s processes depend on water’s ability to hold dissolved materials, chemicals.

Plants depend on soil to sustain and support them as it provides water and nutrients. How well soil sustains a plant depends on its texture (compact or porous), its water-holding capacity, its acidity, and its population of beneficial soil organisms. Different plants depend on different soil types for their particular needs.

Plants also need space to grow. If they do not have enough space and if they must compete with neighboring plants for nutrients, light, and water, plants may find it difficult to grow or survive.

Liquid water covers 71 percent of Earth. It constitutes 50-70 percent of the weight of all plants and animals, including humans. The unique physical properties of water enable life to exist on Earth. These properties include water’s ability to remain liquid in a wide range of normal Earth temperatures, the ability of the solid form (ice) to float in the liquid form, and its ability to dissolve and transport other substances. The movement of water on the earth is known as the water cycle. The sun and gravity are the energy forces behind the water cycle.

Water is constantly moving. The movement of water is influenced by the contours of land, such as mountains, valleys, and hills. A watershed is an area of land that guides water through small streams toward a major stream or river. Water’s movement in the watershed, in turn, creates contours of the land through erosion and sedimentation.

Living organisms, as well as clouds, oceans, and rivers and valleys are part of the water cycle. All living things need water to live because it is essential to their bodily functions. Plants and animals take in water and return it to the atmosphere as vapor (breathing, transpiring) or to the soil as liquid (excreting.)

Forests greatly affect watersheds. Trees, small plants, and forest litter absorb rainwater, reducing erosion and runoff. When rain falls on bare ground, the full force of raindrops can wash soil into streams, making them muddy. But when rain falls on the forest, it drips down through leaves and branches to the forest floor. The forest’s canopy, as well as layers of plant litter under trees, protect the soil from the full force of rain. Tree roots hold the soil in place so that it doesn’t wash away.

Forest also help improve water quality by filtering out impurities that could be potentially harmful in streams or ground water. As water is absorbed by tree roots and then transpired as vapor through leaves, impurities (many of which are good for the tree) remain in the tree.

Field Study Materials
5 air thermometers, 2 soil thermometers, 1 light meter, 1 soil auger, 1 pH meter, 4 clipboards, 1 thin nylon rope, 3 stakes, 20 flags, 6 jars with lids, 4 compasses, colored pencils, laminated graph sheets, regular graph sheets, 2 garden trowels, transparency markers, field notebooks, pencils, 2 30-gallon garbage bags, 2 gallon-size garbage bags, 4 quart-size garbage bags, Soil Composition Triangle, Weather Scavenger Hunt sheets, water chemistry kit (if in pond community)

Project Presentation Materials
2 sheets of white posterboard (22” x 28”), 1 sheet of gridded posterboard (22” x 28”), 1 teacher-packet of prescribed beads for water cycle bracelet, 1 teacher-packet of optional beads for water cycle bracelet, 1 teacher-packet of beading string, 14 trays for holding beads, 20 beading racks, masking tape, scissors, assorted colors of construction paper, assorted markers, colored pencils, and crayons, glue sticks, tape, white paper, A Water Cycle Story sheets
Final Project: Community Survey
(adapted from “Field, Forest, and Stream,” Project Learning Tree)
(90 minute field study, 90 minute project creation, 30 minute project sharing)

Final Project Activity Outline
12:50-1:00 PM  Travel from lunch/recreation site to final project site

1:00-2:30 PM  Conduct field study as entire SMILE Club or in subgroups (Assigned camp staff will assist SMILE Club teachers as they lead their groups in the activities.)

2:30-2:45 PM  Gather with students in an area of project site. SMILE teachers are to lead students in working on water cycle story in their field notebooks. (Teachers and camp staff may use their own water cycle bracelets and stories as examples.)

2:45-3:00 PM  Return with students to Camp Central

3:00-4:30 PM  SMILE Club members work on their project presentation using a tri-fold display. Group will discuss and decide upon the siting plan using their compiled data from the final project study. Each SMILE student will complete the water cycle story and assemble the water cycle bracelet. (If a group completes the preparations before the start of sharing time, the teachers and chaperones will need to supervise their students until project sharing begins.)

4:30-5:00 PM  Project Sharing (A rotation schedule will be explained at the beginning of this activity.)

Procedural Guidelines
Each SMILE Club will go to a site some distance from camp and survey this “new” community using techniques learned during the field studies: mapping, defining collection sites, random sampling (hula hoops), transecting, nutrient recycling, observational surveys, etc. Each club will be accompanied by three or more camp instructors.

SMILE teachers have the primary responsibilities for the final project study, preparation and presentation. They will lead their students in conducting the community surveys and collecting data about the community. They will guide their students in developing a siting plan for the community, using the compiled field study data. Additionally, they will direct the students’ efforts as they prepare their presentation and work on their water cycle stories and bracelets.

Camp instructors have the responsibilities of providing support for the SMILE teachers during the time period from lunch until the end of the presentation preparation. They are available as resource people during the final project field study and as assistants in guiding the students’ efforts and in maintaining their safety.

SMILE Club chaperones have the responsibilities of providing support for the SMILE teachers during the time period from lunch until the end of the project sharing time. They will assist in student supervision and help with group management and safety. They are available to help students focus their efforts.
Data Collection
It is suggested that each club divide into four teams. Each team will investigate and record observations on pages 19-22 of field notebook of a different component of the study site. After the students have had sufficient time to carry out their investigations, they will come together to present, discuss, and compile their findings and share what they have learned.

Study Teams and Responsibilities:

Large Community Mapping
• develop a description for the community
• create an overview of the community, including boundaries, physical features, study sites, transect locations, water and erosion features, key, scale, and north arrow

Transect Study (2 teams)
• each team will collect data from a transect line through the transition zones of the community. Data should include temperature, sunlight levels, pH, humidity, and components of the living community. The teams should choose two areas have different physical features.
• develop a cross-sectional view of the community

Detailed Site Survey
• use appropriate techniques to survey a “typical” area of the community. Data should include soil type and characteristics, soil samples, natural litter and debris, living animals found
• observe the air spacing in and percolation through soil from two different areas in the community
• collect some typical plants (or parts of these plants) and evidence of animals
• make weather observations and look for and record the effects of weather in and on the community

• collect community samples needed for a resource analysis, if this is to be done

Back at Camp Central, each club may choose to do a:

Resource Analysis
• conduct non-pH chemical and other tests on soil and/or water samples from two areas in the community. Tests may include nitrates, phosphorus, dissolved oxygen (in the water), potassium

Products

Project Creation and Display
The results of the final project will be displayed used a tri-fold poster display and other tabletop displays. The tri-fold display is illustrated below:

<table>
<thead>
<tr>
<th>Transect Data</th>
<th>Detailed Survey Data</th>
<th>Weather Observations and Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gridded Community Map</td>
<td>Cross-Sectional View of Community</td>
<td>Siting and Design Plan</td>
</tr>
</tbody>
</table>

Tabletop displays should include: soil samples, water cycle stories and bracelets, living community samples, etc.

A Water Cycle Story
Each student will develop a story for the journey of a water molecule through their final project community, see directions on the Community Water Cycle sheet and on pages 23-24 of field notebook. They may use the chart in the field
notebooks, then transfer it onto the full-size Water Cycle Story sheet. They need to complete it during the preparation time, as the full page version of the story and the water cycle bracelet illustrating it will be a part of the SMILE Club’s display.

Siting and Design
As a means of evaluation and synthesis, students will be asked to consider a proposal to develop a homestead on their final project site in light of their compiled data about the community. The club will need to display their design, a map with building and resources shown, along with reasons for the choices and potential impact on the community.

The scenario is as follows:
We have a proposal to develop a homestead on this site. Development resources will be created as they are needed. There could be a number of structures and buildings.

A primary consideration will be including appropriate uses of locations in this site. You will need to detail the reasons for this choice. Your role is to decide where to place these buildings and to make suggestions for other needed development. You may wish to limit the development. You may wish to allow some pieces of the development but not others. Again, share your reasons and thoughts. The final product will be a map, with the building and resources shown, along with notes and comments.

Buildings may include:
- a house: two stories, about 24 feet by 36 feet
- workshop/shed: one story, 16 feet by 24 feet
- garage: one story, two car, 16 feet by 24 feet
- barn: two floors, hay loft above, 36 feet by 50 feet with two large paddocks approximately 25 feet by 25 feet off one side of barn
- well house: small building to cover well, 10 feet by 10 feet

Development resources needed:
- roads to the house and all buildings
- well
- overhead power lines
- 40 ft x 60 ft area for a garden

Considerations:
- house should be upwind of barn in summer
- barn should be away from the water source, downstream
- road and driveways should not be in wet areas
- garden should be near house and barn, with good soil and sunlight levels
Soil Composition Triangle

To use this diagram:
1. Locate the percentage of sand (0 to 100%) and project inward as shown by the arrow.
2. Locate the percentage of silt (0 to 100%) and project inward as shown by the arrow.
3. Locate the percentage of clay (0 to 100%) and project inward as shown by the arrow.
4. Determine the point at which the three percentages intersect. The label of the region in which the point falls is the name of the textural class of the soil.

For example:
A. A soil composed of 30% sand, 40% silt, and 30% clay is: __________________________
B. A soil composed of 70% sand, 20% silt, and 10% clay is: __________________________
C. A soil composed of 20% sand, 60% silt, and 20% clay is: __________________________
D. A soil composed of 50% sand, 10% silt, and 40% clay is: __________________________
You will make a water cycle bracelet with 12-24 beads. Each bead represents a step in a water molecule's journey through your final project community. You should use the organisms and processes below, plus two or three additional steps. Decide on the order of beads, then write your water cycle story.

**Community Water Cycle**

**Order**

**A Water Cycle Story**

begins its journey

<table>
<thead>
<tr>
<th>Step</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun</td>
<td>yellow</td>
</tr>
<tr>
<td>Evaporation</td>
<td>red</td>
</tr>
<tr>
<td>Condensation</td>
<td>purple</td>
</tr>
<tr>
<td>Precipitation</td>
<td>orange</td>
</tr>
<tr>
<td>Ice/snow</td>
<td>white</td>
</tr>
<tr>
<td>Liquid Water</td>
<td>blue</td>
</tr>
<tr>
<td>Water vapor</td>
<td>clear</td>
</tr>
<tr>
<td>Plant</td>
<td>green</td>
</tr>
<tr>
<td>Animal</td>
<td>brown</td>
</tr>
</tbody>
</table>

<p>| | |</p>
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</tr>
</tbody>
</table>

**Bead Key**

**M O L E C U L E**

**W A T E R**

**M Y**

**R E T**

**M O L E C U L E**

**begins its journey**
## A Water Cycle Story

<table>
<thead>
<tr>
<th>begins its journey</th>
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<tbody>
<tr>
<td></td>
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</tbody>
</table>
Weather Scavenger Hunt

Use the clues below to find weather-related things in the community you are studying.

1. Something bending toward the sun
2. Something hiding from sunshine
3. Something that may become part of a cloud
4. Something that tells you the wind is blowing
5. Something left by the rain
6. A place where icicles might form
7. A place to go where it’s cool
8. A place where rain has moved the soil
9. A place that gets little sunshine
10. Something that bends in the wind
11. Something that won’t bend in the wind
12. Something that reflects lots of sunlight
13. Something that absorbs lots of sunlight
14. Something that will soak up rain
15. Something that makes rain splatter
16. Something that protects people from rain
17. Something that uses sunlight or wind or water to work
18. Something that smells better after a rain shower
19. A good windbreak
20. Something shaped by wind or water
21. A sign of wind or rain damage
22. Something the color of the sky (that’s not the sky)
23. Something the color of snow
24. Something that would make snow melt

What other weather-related things or signs of weather can you find?
Part Two: Field Notebook
Integration of Biotic and Abiotic Factors to Create Ecological Communities
Pond Mapping
Vocabulary Pondered

Pond Surface Map

<table>
<thead>
<tr>
<th>Height or Depth, cm</th>
<th>Temp. in Celsius</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 m above</td>
<td></td>
</tr>
<tr>
<td>5-10 cm above</td>
<td></td>
</tr>
<tr>
<td>pond surface</td>
<td></td>
</tr>
<tr>
<td>___ cm below surface</td>
<td></td>
</tr>
<tr>
<td>___ cm below surface</td>
<td></td>
</tr>
<tr>
<td>___ cm below surface</td>
<td></td>
</tr>
<tr>
<td>___ cm below surface</td>
<td></td>
</tr>
</tbody>
</table>

Temperature above pond bank: 5-10 cm ___ 1 m ___

Water Turbidity

<table>
<thead>
<tr>
<th>Site</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Factors affecting turbidity are: ___

________________________

Pondering the Weather

<table>
<thead>
<tr>
<th>Signs / Effects of Weather</th>
<th>Present Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sky / Clouds</td>
</tr>
<tr>
<td></td>
<td>Wind: Speed ___ Direction ___</td>
</tr>
<tr>
<td></td>
<td>Pressure</td>
</tr>
<tr>
<td></td>
<td>Humidity</td>
</tr>
<tr>
<td></td>
<td>Temperature</td>
</tr>
<tr>
<td></td>
<td>Other Observations</td>
</tr>
</tbody>
</table>

MapKey Scale Compass

7
## Maintaining Pond Life

### What's In the Water?

Some reasons the ponds have different water chemistry might be:

<table>
<thead>
<tr>
<th></th>
<th>Pagoda</th>
<th>Lower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ammonia</td>
<td></td>
<td></td>
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<tr>
<td>Dissolved Oxygen</td>
<td></td>
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</tr>
</tbody>
</table>

### Who Says the Water's Dirty?

<table>
<thead>
<tr>
<th></th>
<th>Appearance</th>
<th>Color</th>
<th>Clarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfiltered</td>
<td>Pagoda</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lower</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filtered</td>
<td>Pagoda</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lower</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dirty water means

The collected water samples are clean enough for

### Sticks in the Mud

<table>
<thead>
<tr>
<th></th>
<th>Microscopic View</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pagoda</td>
<td></td>
</tr>
<tr>
<td>Lower</td>
<td></td>
</tr>
</tbody>
</table>

Detritus is important because

Vocabulary Filtered
**Forest Mapping**

Vocabulary Captured

**Stake Out**

Record your map of the forest

**MapKey**

<table>
<thead>
<tr>
<th>Scale</th>
<th>Compass</th>
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</thead>
<tbody>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Tree Measurements:</th>
</tr>
</thead>
<tbody>
<tr>
<td>circumference</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

---

**Along the Line**

Record your data.

<table>
<thead>
<tr>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Temp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Temp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Temp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light Level</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dry Bulb</th>
<th>Wet Bulb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humidity</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Bulb</td>
</tr>
<tr>
<td></td>
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</tbody>
</table>

---

**Washed Out**

Observe the changes water makes in the forest.

<table>
<thead>
<tr>
<th>Erosion / Water Flow Sign</th>
<th>Undergrowth / Ground Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

---
The importance of soil in the forest community is

**What Goes Around**
Things I expect to find on the forest floor: 

Things I found: 

Nutrients are recycled through the forest by: 

**Where's the Water?**
Draw a water cycle for the forest.

### Getting the Dirt on Dirt

Draw your soil profiles

<table>
<thead>
<tr>
<th>Soil Sample</th>
<th>Color</th>
<th>Smell</th>
<th>Feel</th>
<th>Other Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Sample 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil Sample 2</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

pH
Meadow Mapping
Vocabulary Preserved

Checking Out the Meadow
Your meadow map

Sampling in the Meadow

<table>
<thead>
<tr>
<th>Factor</th>
<th>Site 1</th>
<th>Site 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light Level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative Humidity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A meadow is a special place because ____________

Succeeding Beyond Measure

<table>
<thead>
<tr>
<th>Plant Community</th>
<th>Changes Taking Place</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

Over time this meadow could become a __________ because ________________
Maintaining Meadow Life
Vocabulary Monitored

What's the Scoop on Soil

Sketch your soil sample

Describe the Soil Layers
Feel/Texture

Color

Particle Sizes

pH

Other Observations
Filtering
Settling
Percolating

Rich Soil, Poor Soil

Divide the circle into three parts to represent the percent of plant materials, animal materials, and mineral materials found in your sample. Label each section.

Rich Soil, Poor Soil

Chemical Data

Nitrogen ___________ Phosphorus ___________
Potassium ___________

My sample is rich/poor because _______________________

Going in Cycles

Draw a natural cycle for the meadow
Final Project: Community Survey

On your map, record all locations at which you collected samples and made measurements.

Community Mapping
Record data and draw the map for your study area

<table>
<thead>
<tr>
<th>MapKey</th>
<th>Scale</th>
<th>Compass</th>
</tr>
</thead>
</table>

Site Survey
Record data from two different locations along a transect or around a pond

<table>
<thead>
<tr>
<th>Description of Area</th>
<th>Site 1</th>
<th>Site 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil/Water Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light Level/Turbidity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Weather Conditions and Effects
Clouds/Sky cover
Wind
Precipitation

Use the scavenger sheet to list other weather effects you observe.

__________________________
__________________________
__________________________
**Soil Study**
Collect soil samples from two distinct sites in your area and draw their profiles.

<table>
<thead>
<tr>
<th>Sample 1</th>
<th>Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Examine the texture of the samples, estimate their compositions, and name the soils.

<table>
<thead>
<tr>
<th>Sample</th>
<th>% Sand</th>
<th>% Clay</th>
<th>% Silt</th>
<th>Soil Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
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</tbody>
</table>

Use the test kit to do a chemical analysis of the soil or water.

- pH ____________
- Phosphorus ______
- Nitrogen ______
- Potassium ______

What is the quality of the soil or water? ______
Why? ________________________________________

How is community life affected by this resource?
________________________________________________

**Community Nutrient Recycling**

Look for and record evidences of the nitrogen and carbon-oxygen cycles taking place.

<table>
<thead>
<tr>
<th>Nitrogen Cycle</th>
<th>Carbon-Oxygen cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Community Water Cycle

You will make a water cycle bracelet with 12-24 beads. Each bead represents a step in a water molecule’s journey through your final project community. You should use the organisms and processes below, plus two or three additional steps. Decide on the order of beads, then write your water cycle story.

Bead Key

<table>
<thead>
<tr>
<th>Step</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun</td>
<td>yellow</td>
</tr>
<tr>
<td>Evaporation</td>
<td>red</td>
</tr>
<tr>
<td>Condensation</td>
<td>purple</td>
</tr>
<tr>
<td>Precipitation</td>
<td>orange</td>
</tr>
<tr>
<td>Ice/snow</td>
<td>white</td>
</tr>
<tr>
<td>Liquid Water</td>
<td>blue</td>
</tr>
<tr>
<td>Water vapor</td>
<td>clear</td>
</tr>
<tr>
<td>Plant</td>
<td>green</td>
</tr>
<tr>
<td>Animal</td>
<td>brown</td>
</tr>
</tbody>
</table>

A Water Cycle Story

begins its journey

| M | Y | W | A | T | E | R | M | O | L | E | C | U | L | E |
Appendices

Appendix A
References and Resources

Appendix B
Pre-Camp Teaching Activities

Appendix C
Equipment/Materials List

Appendix D
Equipment Suppliers
Appendix A: References and Resources

Cornell Cooperative Extension
Department of Natural Resources
Cornell University
  _Pond and Stream Safari: A Guide to the Ecology of Aquatic Invertebrates_

Insights Education Development
  _Habitats_

Massachusetts Audubon Society
South Great Road
Lincoln MA 01773
  _Various Field Guides_

Mesa Public Schools
Mesa AZ
  _Field Guide to the Outdoor School_

Minnesota Valley National Wildlife Refuge
3815 E 80th St.
Bloomington MN 55425
  _Environmental Education on the Refuge_

National Wildlife Federation
8925 Leesburg Pike
Vienna VA 22184
  _Ranger Rick's Naturescope Wild About Weather_

Oregon 4-H Conference & Education Center
5390 4-H Road NW
Salem OR 97304
  _Welcome to Our Woods: A Guide to Outdoor Experiences_

Project Learning Tree
American Forest Foundation
1111 19th Street, NW
Washington DC 20036
  _Environmental Education Pre K-8 Activity Guide_

Project Wet
201 Culbertson Hall
Montana State University
Bozeman MT 59717-0570
  _Project WET K-12 Curriculum and Activity Guide_

USDA Forest Service
Pacific Northwest Region
PO Box 3623
Portland OR 97208
  _Investigating Your Environment: An Interdisciplinary Curriculum for Grades 7-12_
Appendix B: Precamp Teaching Activities

Pre-Camp Teaching Activities are recommended and selected to provide the students an introduction to some of the important concepts that will be addressed during the elementary camp. Some activities are essential: those that must be presented to the students before their arrival at camp, as they provide necessary foundational skills and concepts for the studies at elementary camp. Other activities are optional: those that extend the necessary learning by providing further opportunities for investigation. While the actual activities are not being included here, the objectives of those activities chosen to prepare students for the experience of Outdoor Science Adventures are given below.

**Part One: An Investigation of Relationships within and between Communities**

**Charting Diversity**
Students explore the diversity of life on Earth and discover how organisms are adapted for survival.

**Birds and Worms**
Students discover the value of protective coloration (camouflage).

**Can It Be Real?**
Students discover extraordinary plants and animals and gain insight into how these organisms are uniquely adapted to environmental conditions.

**Into the Forest: Nature’s Food Chain Game**
Students become familiar with the plants and animals in the forests and their interrelationships.

**Presto, Change-O**
Students become familiar with the differences between immature and mature insects. Students will see that living things change in shape and appearance as they get older and mature.

**Wetland Food Web**
Students gain understanding of the interrelationships of plants and animals in the wetland habitat.

**Natural Selection and Adaptation**
Students use various process skills to explore the connections between natural selection and adaptation.

**Part Two: Integration of Biotic and Abiotic Factors to Create Ecological Communities**

**Cabbage Patch Detective**
Students use the juice of a red cabbage as a universal acid-base indicator to test a variety of household substances.

**The Litmus Test**
Students further explore pH and acid-base indicators by using litmus paper.

**What Do You Already Know about Soil?**
Students recall and share previous experiences, values and knowledge about soil and its parts.

**Spit on Oregon Soil**
Students learn an easy method for measuring soil texture and discover a range of soil textures found in their communities.

**The Weather Game**
Students describe several ways the Earth, Sun, air, and water affect our weather.

**Weather Mapping**
Students observe weather conditions and phenomena, draw conclusions, using their data, and form and test hypotheses concerning physical influences on weather in a small area.

**Compass Travel**
Students gain concrete experience in translating abstract, directional terms and be able to read and follow a compass over a prescribed course.

**Mapping**
Students identify the important aspects of a map, utilize their knowledge of a compass in mapmaking, understand the idea of a grid in mapmaking, and draw a map using a compass.
Appendix C: Equipment & Materials

In large part, the materials are common to many hardware and variety stores. We have tried to use common materials both to decrease costs and to help students see science as accessible. The first section is materials you will need to have for many activities. If you are putting together a series of experiences or a camp you will need to begin collecting these. Following are additional items needed for each specific activity.

Note: Each item in italics is included in this packet following the activity that refers to it.

<table>
<thead>
<tr>
<th>General Materials</th>
<th>Part 1: An Investigation of Relationships within and between Ecological Communities</th>
</tr>
</thead>
<tbody>
<tr>
<td>field notebooks</td>
<td>Pond Plant and Animal Survey</td>
</tr>
<tr>
<td>pencils</td>
<td>plankton nets</td>
</tr>
<tr>
<td>crayons</td>
<td>dish pans, one per small group</td>
</tr>
<tr>
<td>colored pens or pencils</td>
<td>dissecting microscopes or good hand lens</td>
</tr>
<tr>
<td>permanent and water soluble overhead markers</td>
<td>pond life books</td>
</tr>
<tr>
<td>chart pens</td>
<td>mini ice cube trays</td>
</tr>
<tr>
<td>chart paper</td>
<td>Aquatic Life cards</td>
</tr>
<tr>
<td>laminated graph paper, quad. paper</td>
<td>fish or crawdad trap</td>
</tr>
<tr>
<td>clipboards</td>
<td>bucket with rope attached</td>
</tr>
<tr>
<td>tape: masking, duct, clear</td>
<td></td>
</tr>
<tr>
<td>scissors</td>
<td></td>
</tr>
<tr>
<td>tweezers</td>
<td></td>
</tr>
<tr>
<td>meter sticks</td>
<td></td>
</tr>
<tr>
<td>resealable bags: quart and gallon sizes</td>
<td></td>
</tr>
<tr>
<td>garbage bags: various sizes</td>
<td></td>
</tr>
<tr>
<td>hand lens</td>
<td></td>
</tr>
<tr>
<td>binoculars</td>
<td></td>
</tr>
<tr>
<td>calculators</td>
<td></td>
</tr>
<tr>
<td>stopwatch</td>
<td></td>
</tr>
<tr>
<td>field books such as Golden guides:</td>
<td></td>
</tr>
<tr>
<td>Insects, Pond Life, etc.</td>
<td></td>
</tr>
<tr>
<td>baby food jars</td>
<td></td>
</tr>
<tr>
<td>Petri dishes</td>
<td></td>
</tr>
<tr>
<td>bug boxes or similar containers</td>
<td></td>
</tr>
<tr>
<td>buckets of various sizes: 1 gal, 5 gal</td>
<td></td>
</tr>
<tr>
<td>probes</td>
<td></td>
</tr>
<tr>
<td>compasses</td>
<td></td>
</tr>
<tr>
<td>metric tapes: 25 to 100 m</td>
<td></td>
</tr>
<tr>
<td>stakes or survey pins (flags)</td>
<td></td>
</tr>
<tr>
<td>rope</td>
<td></td>
</tr>
<tr>
<td>string</td>
<td></td>
</tr>
<tr>
<td>garden trowels</td>
<td></td>
</tr>
<tr>
<td>shovel</td>
<td></td>
</tr>
<tr>
<td>plastic spoons</td>
<td></td>
</tr>
</tbody>
</table>

In large part, the materials are common to many hardware and variety stores. We have tried to use common materials both to decrease costs and to help students see science as accessible. The first section is materials you will need to have for many activities. If you are putting together a series of experiences or a camp you will need to begin collecting these. Following are additional items needed for each specific activity.

Note: Each item in italics is included in this packet following the activity that refers to it.
Forest Ecological Connections
jeweler’s loupes
field guide to insects, spiders and nonflowering plants
a variety of examples of animals in stuffed or picture form
a variety of skulls, or bones
a wide variety of tongs, pliers, nutcrackers to demonstrate bird’s beaks
*Birds, Beaks and Feet* sheet
*Tree Story* sheet
binoculars
pictures of animals

Meadow Plant and Animal Survey
picture of different “fields”
garden gloves
jeweler’s loupes
bug buckets
*Plant Distribution Map*
garden forks
plastics sheeting, 3’ x 24’
stakes
surveyor’s tape
string, 2 m in length

Meadow Ecological Connections
picture of a deer
platform balance
1/4” wood dowels
binder clips
rubber bands
tray and cloth to cover
white foam board
*Plant Influence* sheets
*Meadow Banquet* sheets
surveyor’s tape
laminated sheet of white posterboard

Final Project
Items for Field Study
*Habitat Study Sheets* (1 set for each group)
jeweler’s loupes
hand magnifiers
dissecting microscope
Project Presentation Materials
3 sheets of white posterboard (26” x 28”)
white construction paper (12” x 18”)
assorted colors of construction paper (9” x 12”)
set of animal stamps, ink pads
sheets of white paper (8.5” x 11”)
white glue
*Habitat Study Sheets* (1 set to be completed from the compiled team data)
Craft Parts for *Camp Critters*
*Design-a-Critter* sheet
modeling clay
paper tubes (from paper towels, etc.)
chenille stems ("pipe cleaners")
toothpicks
assorted felt squares
assorted foam squares
feathers
burlap squares
sequins
cotton balls
batting
old socks
buttons
wiggle eyes
tacky (craft) glue
glue guns with extra glue
Year 2: Integration of Biotic and Abiotic Factors in Communities

**Pond Mapping**
demonstration thermometers
water thermometers
plankton nets
rope marked each 3 meters
poles with thin lines
large fishing floats
three medium sized jars with lids
Secchi disks
white contact paper
phonograph records
fishing weights, a variety
poster or chart of cloud types
pictures of different types of weather
*Weather Scavenger Hunt* sheet
rain gauge
wind speed meter
wind vane, store bought or homemade
barometer
humidity gauge
cobalt chloride paper

**Pond Maintaining Life**
"Pond Water Tour" or water chemistry test kit
for pH, dissolved oxygen, nitrate, ammonia
goggles for eye protection
refuse bag
thermometers
*Aquatic Tolerance* chart
*Aquatic Life Requirements* chart
field guides: Aquatic plants and animals
coffee filters
sand, gravel, charcoal, mud
*Water Color/Clarity and Productivity* charts
potting soil
dissecting microscopes or hand lens
compound microscopes
squirt bottle filled with water

**Forest Mapping**
unsharpened pencils
twine
soil thermometers
hygrometer
sling psychrometer
light meter
*Relative Humidity* chart
erosion pictures or posters
push pins

**Forest Maintaining Life**
soil thermometers
large tin cans with both ends removed
aluminum pie pans
soil pH meter
soil sampling augers or tubes
sample of sand, clay and silt
dissecting scopes or magnifying lens
mesh screen
spray bottles
commercial fertilizer sample
hula hoops
six labeled buckets, 2 each: Ocean, Plants, and Ponds and streams
water cycle poster
sign labeled "Mountains"
laminated name tags: Evaporation (4), Transpiration (2), Condensation (2), Precipitation (2), Percolation/Runoff (2)
watering can
shallow pans

**Meadow Mapping**
soil and air thermometers
hygrometer
sling psychrometer
light meter
*Relative Humidity* chart
Sun Print kits
construction paper, various colors
Meadow Maintaining Life
hula hoops
soil thermometers
large tin cans with both ends removed
soil auger or soil sampling tube
potting soil
sandy soil
aluminum pie pans
soil pH meter
cotton balls
coffee filters
spray bottles
paper cups
set of measuring spoons
strainers
mortar and pestle
set of mesh screens
goggles
soil chemistry kit
soil chemistry chart
topsoil tour chart
settling tube
dissecting scopes
Water Cycle
Nitrogen Cycle
Oxygen-Carbon Dioxide Cycle
two types of meadow plants, roots excavated intact
Water Cycle dice and cards
Nitrogen Cycle dice and cards
Oxygen-Carbon Dioxide Cycle dice and cards

Final Project
Field Study Materials
air thermometers
soil thermometers
light meter
soil auger
pH meter,
jars with lids,
Soil Composition Triangle,
Weather Scavenger Hunt sheets,
water chemistry kit (if in pond community)

Project Presentation Materials
2 sheets of white posterboard (22” x 28”)
1 sheet of gridded posterboard (22” x 28”)
beads: colors required by water cycle story and other optional colors
beading string
trays for holding beads
beading racks
A Water Cycle Story sheets
colored construction paper
Appendix D: Equipment Suppliers

Whenever possible, we use materials that are available at local hardware, office supply or variety stores. In part this is to make the science more accessible to students. The other materials, equipment and supplies we have purchased from the following suppliers. Not enough can be said about asking people at other schools, companies or local resources about materials. They often have items stored away that you may find useful.

Acorn Naturalists
17300 E. 17th Street #J-236
Tustin CA 92780
1(800)422-8886
1(800)452-2802 fax
www.acornnaturalists.com

Ampersand Press
750 Lake Street
Port Townsend WA 98368
1(800)624-4263
1(360)379-0324
www.ampersandpress.com

Carolina Biological
2700 York Road
Burlington, NC 27215
1(800)334-5551
1(800)222-7112 fax

Frey/Beckley-Cardy
1 E. First St.
Duluth, MN 55802
1(800)446-1477
1(800)237-4098 fax

LaMottes
PO Box 329
Chesterfield MD 21620
1(800)344-3100

Tree cookies
1(541)745-5604
Debbie Pierce