Ellie's Log

Exploring the Forest Where the Great Tree Fell

Teacher's Guide

by Judith L. Li
Illustrated by M. L. Herring

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+ Requires pre-class teacher preparation for classroom or outdoor setup

* Uses text of *Ellie's Log* in the activity

- Students can share their results at ElliesLog.org

Introduction

"Inquiry into authentic questions generated from student experiences is the central strategy for teaching science."
National Science Education Standards, 1996

The book that this guide accompanies, *Ellie's Log*, follows ten-year-old Ellie and her new friend, Ricky, as they explore the Douglas fir forest where Ellie lives. From the winter day when the Great Tree falls until the bloom of spring and early summer they learn about how trees decay in a conifer forest, discover where a great diversity of critters live, and experience the wonder of seasonal changes. The setting is modeled after the H. J. Andrews Experimental Forest in the western Cascades of Oregon. Colored pen and ink drawings of forest habitats tell the "forest's story," while narrative sketches bring to life the animal's stories. Readers observe how science is conducted as they read about the children's explorations, and learn from the examples set by Ellie's parents who are resident scientists in the forest. At the end of each chapter Ellie's own field notebook provides examples of the data, notes, and drawings for children as they create journals of their own. This Teacher's Guide presents ways to explore, in a classroom setting, the scientific content woven into the seven-chapter book.

Enthusiasm, curiosity, and inquiry are woven into each chapter of *Ellie's Log*. Each walk through the forest, every peek under a log or scan of the forest canopy is designed to help readers relate personally to the forest where Ellie lives. Though the narrative is fictional, descriptions of ecological processes and biota are based on scientific studies at the H. J. Andrews Experimental Forest; the story's information about plants and animals can be used as observational data in classroom activities. The ways in which Ellie and Ricky ask questions about what they see, record information, and pursue answers to their own questions are examples for budding scientists.

How to Use This Guide

Content: In this teacher's guide, I suggest how content in *Ellie's Log* can be used to explore concepts of diversity, habitat structure, decomposition, and food webs—all themes that run through several chapters. Several activities require that students be familiar with book content, either having read it independently or, alternatively, having listened to the teacher read it aloud. Then students will be ready to work together in uncovering scientific techniques and forest diversity presented in the book. Suggested discussions and examples of answers are meant to be only starting points as guides for teachers and their pupils. The time intervals for preparation and classwork are approximated to guide teachers in planning, but are only estimates. Modifications of these estimates can be suggested on the *Ellie's Log* website (ellieslog.org).

The varied experiences enjoyed by characters in *Ellie's Log* naturally lend themselves to a multi-disciplinary experience for students using this book in a classroom. The book's scientific content, combined with the joy of adventures, provide an authentic literary experience for readers. The book's illustrator, Peg Herring, and I anticipate this book will provide a genuinely cross-curriculum resource for upper elementary students.

Activities: Several of the book-related activities serve as a foundation for investigating places more familiar to readers. Approaches and methods for expanding fieldwork are described in several activities. Integral to these activities are classroom and small team discussions in which students practice skills in logic and testing ideas. Assessment opportunities are often summary exercises that use critical thinking, writing, and other creative skills. Some assessment assignments suggest efforts in which pairs or teams work together to encourage learning among peers. I hope teachers will find many creative opportunities for student expression in writing and visual arts.

Website: ellieslog.org
The *Ellie's Log* companion website encourages readers to share information with each other. A section of the "Sharing Results" page is devoted to classrooms or teams sharing information about specific activities. These opportunities for sharing on the website are indicated with each activity. The website also provides an opportunity for adults (particularly teachers and homeschooling parents) to share ideas and experiences in using these materials. There are also several suggestions for related websites that encourage citizen science participation or help with identifying plants or animals.

For Teachers: Several data matrices about *Ellie's Log* are included to summarize information for teachers. At the end of each activity, related, grade-appropriate exercises from the Project Learning Tree (www.plt.org) Pre K-8 Environmental Education Activity Guide, American Forest Foundation, Sixth printing 2012, and from the Project WILD (www.projectwild.org) K-12 Curriculum and Activity Guide, Council for Environmental Education 2006, are provided. These comprehensive guides may have other activities of interest. Both of these guides are available by taking a workshop taught in each program as explained on their websites. In addition, a few potential student readings for 4th–6th grades have been listed.

For Students: Handouts with an "s" are provided at the end of activities in formats handy for copying.

Teaching standards: College and Career Readiness (CCR) Anchor Standards for fourth, fifth and sixth grades for the Common Core State Standards (CCSS) (2010), and the Science Teaching Standards adopted by the Oregon State Board of Education (2009) are used in this guide.

With the hope that your students, like Ellie Homesly, will soon be skipping along, enjoying their explorations in the natural world,

Judith Li
Author of *Ellie's Log*

Theme One: Nature Detectives at Work

Concept:
Scientific inquiry is an investigation of the natural world that upper elementary students can pursue.

Scientific evidence is information systematically collected and recorded that includes quantitative measurements, detailed observations, and specific details of time and place.

In *Ellie's Log*, Ellie Homesly and Ricky Zamora make observations, collect information, and pose questions in ways that show they are learning to be scientists. In these activities, after identifying how the fictional children are succeeding, students are encouraged to follow their model.

Background:
Learning activities in this theme help students recognize and evaluate how the story's characters use scientific approaches in answering questions. Students will also uncover how Ellie and Ricky often repeat approaches to collecting and recording information. Table 1 (Inquiry methods found in *Ellie's Log*) provides an overview of what students are likely to find as they re-examine the book. In their highly focused search through the chapters, students may present additional details about particular animals or plants. As noted in the introduction to this guide, answers to questions posed for discussion are offered as guidance for teachers, and open-ended conversations are encouraged.

Teaching Standards for Theme One
OR Science Standards: Scientific Inquiry
CCSS: Reading (Literature; Informational Text); Writing; Speaking and Listening

Activity 1: Scientific Curiosity

Estimated class time to read story aloud (if students don't have their own books): about 20 minutes per chapter
If students have read the book independently: 30 minutes for chapter exploration.
Discussion time: 20 minutes
Assessment: 30 minutes

Objective:
Students will identify questions posed by Ellie and Ricky as models for scientific inquiry.

Introduction:
Scientific investigations are structured around good questions. Ellie and Ricky are not only energetic explorers in the forest, they are also very curious. They are nature detectives, and students in the class can be detectives too. In *Ellie's Log* the children's curiosity and observation skills often lead to good science inquiry questions. Sometimes their conversations include approaches for answering their questions.

1A.
Discussion: Curious Questions

What kinds of questions did Ellie and Ricky ask, and how did they get their answers?

The first chapter asks a very big question: Why did the Great Tree fall? This was not a question that could be answered quickly or by simple experiments.

What answers did Ellie and Ricky propose?

- Roots decaying before the storm—perhaps from fire
- Weight of snow on branches
- Slope of the hill was steep
- Wind

Ellie's mother suggested it may have been a combination of these factors—and the answer may have been too complex to quantify easily.

(Perhaps with physical scientists, engineers who could calculate the power of forces, and botanists to recognize the level of root decay, an approximation could be made eventually.)

Approaches to discovering other questions posed in the book depend on how students will read or hear the story. If there are enough books for all children to read the book individually, then they can uncover questions and answers in pairs as suggested in 1B. If the teacher reads the book aloud to them, then she can ask students to "listen" for the questions and answers as she reads.

(Note: inquiry exploration in Activity 2: Tracking the Nature Detectives should be as teacher is reading aloud.)

Activity 1: Scientific Curiosity

1B.
For classrooms where all students have read the book student pairs are assigned to chapters (there will be multiple pairs/chapter). Their mission will be to:

> Review and report the questions asked that required scientific evidence to answer.
>
> Describe evidence Ellie & Ricky found to answer their questions, or what ways they suggested to answer more complex questions.
>
> Suggest other ways for finding answers.

Discussion:
Students list questions and evidence they have uncovered.

Ch. 2: *How long do different mushrooms live?*
Answer: Mapping locations to watch over time when they appear and disappear.

Ch. 3: *How does the coloring of mites affect their survival?*
Answer: Feeding experiment to discover whether likely predators would eat them.

Why were there patches of mosses?
Answer: Observing the chipmunks' scratches in Chapter 5.

Ch. 3: *What happens to animals living in moss when the moss dries out?*
Answer: Drying experiments followed by re-examining mosses.

Ch. 4: *How do logs become part of the forest floor?*
Answer: Observations of stages with information from Alice Homesly in this chapter.
Also: ways in which trees fall (Chapter 2)

Ch. 5: *How does a log serve as habitat?*
Answer: Accumulated evidence during several trips to discover amphibians, fish, birds, insects using logs in water, on land, and above the stream.
Also: In other seasons, track or mark animals to discover what habitats animals use.

Ch. 6: *Who made the trail leading to the stream?*
Answer: Observations in Chapter 6 build evidence for potential users going towards the stream.

Ch. 6: *Who lives in the snag?*
Answer: Observations made during the evening in the meadow in this chapter and animals seen in the daylight when children return to the snag in chapter seven.

Ch. 7: *How will the forest change in the future?*
Answer: Measurements and photographs made to document plants as they grow. Dated records of birds at different life stages as they grow

How could these questions be used for other subjects?
Each question could take a variety of subjects.
For example, "How long do mushrooms live?" can be changed to "How long do dandelions live?"
What other things might be substituted for "mushrooms"?
How can "Who lives in the snag?" be changed?

1C.
Assessment Opportunity:
Posing and Answering Questions

Students write down three of the original questions from the activity, then substitute the subject to create a question that they believe could be answered using scientific evidence. Each question is followed by a description of what they would do (measure, collect, etc.) to answer it.

Activity 2: Tracking the Nature Detectives

Class time: If teacher is reading aloud, this activity can occur simultaneously with Activity 1.
If students read the book independently, 20 minutes for student review
Discussion time: 30 minutes.
Assessment: 30 minutes.

Objective:
Students will identify methods needed for scientific inquiry. They will discover the characters' methods as nature detectives and young scientists as they review *Ellie's Log.*

For Teachers:
Table 1: Inquiry Methods found in *Ellie's Log*

2A.
Introduction

How would you describe Ellie and Ricky?
Based on their reading, students suggest what kind of personalities Ellie and Ricky have (curious, funny, active, silly, etc.). Encourage students to justify why they have these impressions of the characters.

In Chapter 2,
Ricky discovers the mission of their forest adventures.

What does he tell Ellie?
Answer: "We're going to draw, map, and record the changes [that fallen trees make]. It's a mission of discovery."

In Chapter 7,
Ellie's father suggests that Ellie and Ricky can help in collecting scientific information for the experimental forest.
How does he plan to use their data?

2B.
Methods of young nature detectives

What skills did Ellie and Ricky use in becoming nature detectives?
These questions could be recorded as the teacher reads chapters aloud, or student pairs can track them in a review of the book. Particular chapters can be assigned to student pairs to speed the process:

1) what methods were used to learn about the forest
2) the kinds of information that were collected

Results are tallied on the chalk/white board table organized much like Table 1: Inquiry methods found in *Ellie's Log.*

What activities has the class participated in or have individual members done that are similar?

Evaluating the methods Ellie and Ricky used:

How did Ellie and Ricky make permanent records?
Answers: Notes made in field notebooks; dried and pressed plants; photographs

Activity 2: Tracking the Nature Detectives

Sometimes Ellie and Ricky were only able to make estimates of what they saw.

How were estimates used?
What was the value of the estimates/predictions that Ellie and Ricky made?
Answers: Estimates provided background for follow-up with other information. Relative measurements provided sufficient information at the time records were made.

When are more accurate measurements important?
Answers: Accuracy was needed to make comparisons over time—e.g., growth of plants or progress of rotting. Also records of rare or uncommon animals often require accurate confirmation (e.g., red tree voles)

How were collections made?
What did Ellie and Ricky do with them?
Examples: Nest materials—sufficient materials collected to identify their source.
Moss invertebrates or stream insects—were generally kept alive to observe, then returned to habitats (forest soil, the stream).

What was the value of drying and pressing the moss?
Answers: The dried sample provides a permanent record. They were very abundant in the wild and would not harm the resource. Samples would be useful for future identifications.

How were Ellie and Ricky able to make identifications themselves?
Answers: They made careful observations and careful records. They compared their observations with illustrations and information in guidebooks.

2C.
Assessment Opportunity:
An Imaginary Field Trip
(Students can share their stories at ElliesLog.org)

Explains that each student has a chance to take an imaginary field trip to a real place in which the purpose is to bring home a piece of scientifically acquired information. Their imaginary trip will only take two hours. It can be:

1) about finding a kind of animal or plant
2) a map of a particular spot
3) measurements of a physical factor such as temperature or light

Students discuss suggestions for places (e.g., a park where they went for vacation; a lake; a beach) and what they might collect. Each student writes a description of where they choose to go, what they are studying, and how they will collect information. Just as Ellie and Ricky employed several methods in collecting information, so students should expect to use several techniques, even on their imaginary trips.

Related Activity: “How Big is Your Tree?” in Project Learning Tree p. 284-287.

This activity emphasizes the importance of measurements, and students measure objects using various techniques, including the span of their hands. A tree’s circumference is measured by students joining arms and also by stretching a string around the tree. A tree’s height is measured on a sunny day using ratios of the tree and its shadow compared to the student and her shadow.

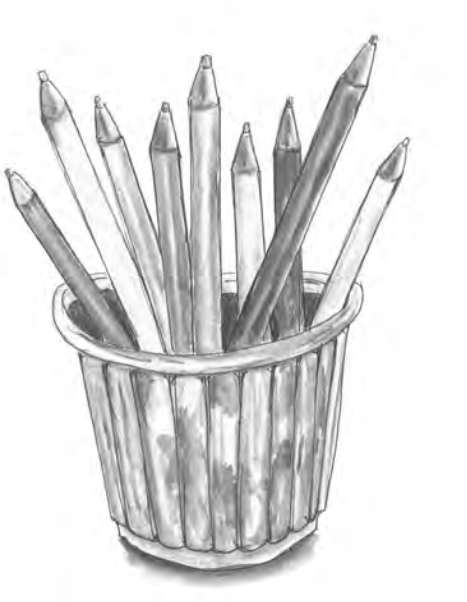
Table 1. Inquiry Methods Found in *Ellie's Log*

Methods:	Chp 1	Chp 2	Chp 3
Direct Measurement		Length of log Log diameter	
Estimates		Nest height Count:snags & log pieces	Number of invertebrates
Mapping		Log, fallen logs Snags Mushrooms	Moss samples
Labeling			Moss samples Plant pressing
Drawing	Great Tree Winter stonefly	Salal, Deer fern	Mosses, Trillium
Collecting	Winter stoneflies	Nest materials Ambrosia beetle	Mosses
Identification	Winter wren	Ambrosia beetle	Invertebrates in moss
Observations:			
Touch			
Sound		Douglas squirrel	
Sight	Fir cones Tree roots Fallen trees Winter wren Animal tracks	Douglas squirrel Bark beetles Fallen trees Mushrooms	Invertebrates (under microscope)
Smell	Fir trees Dirt		

Table 1. Inquiry Methods Found in *Ellie's Log*

METHODS	Chp 4	Chp 5	Chp 6	Chp 7
Direct Measurement	Nurse log hemlocks			Mushroom width Hemlock height
Estimates				
Mapping	Birds	Stream habitats		
Labeling				
Drawing		Stream insects		Iris
Collecting		Stream invertebrates		
Identification		Swainson's thrush		
Observations:				
Touch	Lichens	Caddisfly		
Sound	Chipmunk	Songbirds	Songbirds Owl; Screech owl	Winter wren
Sight	Inside the Great Tree and logs; Fungal mat Salamander	Songbirds Animals in the stream Emerging mayflies	Animals at night	Snake Woodpecker
Smell	Forest air			
Photography				Great Tree Conk mushroom

Theme Two: Logging On



Concept:
Part of the scientific inquiry process is systematically taking records of measured differences and detailed observations over time and from place to place.

Background:
For centuries, seafarers and other explorers kept logbooks to help them measure the course and distance they traveled each day. Today, astronauts, airline pilots, and engineers use logbooks to record events significant for navigation and maintain high performance in equipment.

Similarly, forest scientists use logbooks to record details that are important to understanding the health of the forest ecosystem. Often referred to as a field notebook, this type of logbook records physical measurements such as the flow of the river, temporal events such as the first hatch of stoneflies, or qualitative observations such as the color of flowers or behavior of animals. Measurements and observations over time establish seasonal and developmental changes in the forest.

The title of this book, *Ellie's Log*, plays with the word log. The central story focuses on the children's exploration of the huge fallen log and its place in the forest community, but the title also refers to Ellie's logbook, where she records her observations of what she learns about the forest. This theme encourages students to explore ways in which they can make accurate, detailed observations in a logbook.

Teaching Standards for Theme Two
OR Science Standards: Structure and Function; Scientific Inquiry
CCSS: Reading; Speaking and Listening

Activity 3: Creating Personal Logbooks

Preparation time: 25 minutes to gather logbook materials, copy handout
Estimated class time: Exploring logbooks: 20 minutes; Creating logbooks: 30 minutes
Field exploration: 50 minutes

Objective:
Students will create individual field notebooks that can be used for recording data and/or illustrating their observations.

Background:
When scientists work in the field, they often keep journals to record observations and data that help them measure differences they observe from time to time or from place to place. Natural history artists also keep journals, recording details they discover from patient observation in nature.

For some students, a spiral notebook might seem sufficient, but this activity helps all students consider wider opportunities for observation. The experience of creating their own beautiful books can be as much a journey of discovery as the nature observations that will fill its pages.

Materials:

For each log book:
One sheet of 8.5" x 11" cardstock
Eight to ten sheets of unlined 8.5" x 11" paper
(Optional: lined paper or graph paper)
Large (3-inch diameter) rubber band
Stout 8-inch twig or popsicle stick
Drawing pencils or other media for decorating cover
Hole punch

Optional materials for the covers:
Relevant maps, photographs

For Students:
S3. Creating Your Logbook

Activity 3: Creating Personal Logbooks

3A.
Introduction: Exploring old logbooks

Journals are permanent records of fleeting experience. When Lewis and Clark traveled across North America from 1804–1806, they recorded detailed observations of the land, people, plants, and animals they encountered. The journals of Lewis and Clark were extremely valuable to President Thomas Jefferson because he could see through the explorer's notes and drawings what opportunities lay beyond the known boundaries of the young United States. Those journals are still used by scientists more than two hundred years later to measure how the land and its inhabitants have changed over time.

The class breaks into small groups to review some of the great explorers' journals online, including:

Lewis and Clark Corps of Discovery (1804–1806)
Lewis and Clark's journals map the lands and describe the natural wonders of western North America at the beginning of European settlement. Celebrating the journey two hundred years later, Walter Kim wrote in Time magazine, "If not for the . . . epic the captains scratched out while crouching on hillsides and squatting on riverbanks, we might not remember Lewis and Clark at all." - http://lewisandclarkjournals.unl.edu/

James Cook and the voyage of HMB Endeavour (1768 -1771)
The official purpose of the voyage was to observe the alignment of Venus. Unofficially, Cook was to search for the great southern islands and claim them for Britain. As a result, Cook and his crew charted the coastlines of New Zealand and eastern Australia and increased the number of known plant species in the world by 10 percent. Cook recorded his experiences and the details of events such as running aground on the Great Barrier Reef. - http://nationaltreasures.nla.gov.au/%3E/Treasures/item/nla.ms-ms1-s256r

Optional: To inspire creativity in journal illustrations, the class can review children's books that are beautifully illustrated journals, such as these two:

The Robin Makes a Laughing Sound: A Birder's Journal by Sallie Wolfe. Charlesbridge, Watertown, MA. 2010. 43p. Organized informally with delightful watercolors, short poems, and observations that inspire readers of any age to try sketching and writing.

Looking for Seabirds: Journal from an Alaskan Voyage by Sophie Webb. Houghton Mifflin Co., Boston. 2004. 48p. A true story of the author's trip in search of seabirds she illustrates with irresistible charm. In a casual diary format she describes the daily life of scientists working in the arctic as well as the biology of the birds she finds.

When Ellie went out to explore the forest, she took her field notebook. Hers was a "Rite-in-the-Rain" notebook, in which she recorded her observations over time.
What are examples of scientific data that Ellie and Ricky collected?
In contrast, when did they record their observations with drawings?

Students review what they uncovered in Activity 2 (Tracking the Nature Detectives).

What might be the design requirements for data collecting and drawings?
Answers: Lines needed to make tables of data. A handy way of making measurements (small ruler or graph paper). Sufficient space for making maps or drawings. A cover hard enough for a drawing surface.

Activity 3: Creating Personal Logbooks

3B.
Creating individual logbooks

Students follow handout to make their logbooks.
This activity is adapted from
www.readingrockets.org/article/41463/.

3C.
Finding purpose for the logbooks
(Students can share their drawings at ElliesLog.org)

To encourage immediate use of the logbooks, an outdoor activity that allows time for observation and sketching might be designed to explore planted areas on or near the school grounds.

Sample exploration exercise in which each observation and drawing activity is ten minutes long:
Each student chooses a spot within the area designated by the teacher.

For each observation he or she draws what is seen and records any activity (for example, insect or spider behavior).

Observation 1: focus on an area about 2“ x 2”, about the size of his or her hand
Observation 2: expand the observation that in cludes the original one, but now encom passes 1’ x 1’
Observation 3: expand view to a much bigger area, e.g., the size of a picture window

What did students learn about their special spot by changing the perspective?
Each student can contribute animals and plants observed to a table drawn on the chalkboard. Organize the table according to interesting physical differences among the sites (e.g., different parts of the schoolyard, sunny vs. shady spots).
What questions or dilemmas were raised by the observations?

What stories could be told using all their observations?
By combining entries from all students, the class record would be a log of the schoolyard at the time they made simultaneous observations.

The logbooks could also be used for several activities in this guide:

This theme, Activity 4 (Changes in a Flipbook Journal)
Theme Four Activity 9 (Critter Hunt)
Theme Four Activity 10 (Trees as Treasures)
Theme Five Activity 12 (A Rotten Experiment)

Related Activities:
“Drawing on Nature” in Project WILD K-12 pp. 285–286. In an activity where students are taken to an area where they can observe wildlife, students use techniques of visualization and observation to draw animals they observe. Recognizes the important connection between good observation and good science.

S3: Creating Your Logbook

Materials you will need:

One sheet of 8.5 x 11 cardstock
Several (8-10) sheets of 8.5 x 11 unlined paper
Large (3-inch diameter) rubber band
Stout 8-inch twig or popsicle stick
Drawing pencils or other media for decorating cover
Other materials you wish to use for the cover

Optional: lined paper and/or an envelope to stash small treasures and tape to attach it

Instructions

1. Fold cardstock sheet in half to form the journal cover.

2. Fold the inside pages and place them inside the cover to form the book.

3. Punch two holes along the folded edge of the book, about 2 inches from the top and 2 inches from the bottom.

4. Thread one end of the rubber band through the bottom hole and slide twig into the loop. Pull the other end of the rubber band through the top hole and slide the other end of twig through the top loop.

5. Decorate the cover, and include your name.

Activity 4: Changes in a Flipbook Journal

Preparation time: Laboratory materials: 1 hour; Flipbook materials & copy handout: 15 minutes
Estimated class time: Watching video: 20 minutes; Making flipbooks: 20 minutes
Laboratory observations: A few minutes each week per student; Evaluating observations: 30 minutes
Assessment: 40 minutes

Objective:
Students will create a series of images in a flipbook journal to record multiple observations of decay and growth.

Background:
In this activity students will be introduced to decomposition, or decay, in familiar foods and compare it to growth of organic material. Decomposition is the process whereby bacteria and fungi breakdown organic materials into dissolved and small particulate components. This process is a theme that weaves through *Ellie's Log*, and is the focus of Chapter 4, Lots of Rot. Growth in plants occurs by the conversion of carbon dioxide and water, in the presence of light, into organic tissue via photosynthesis; organic material is built up during the process of growth. Both decay and growth provide clear examples of biological change. (See also Theme Four in this guide, in which students study this process more specifically related to logs).

By recording many observations of these changes students will learn more about how biological processes can change materials. A single journal entry is like a snapshot, one measure at one time in one place. Multiple journal entries are like a movie, showing how living things grow, or rot, or change in other ways. Students will create a flipbook to incorporate single entries into a moving image of a biological process.

The introduction to this activity includes reference to YouTube sites. The teacher should preview sites ahead of time to be certain the sites are still available, and to scan comments that follow the videos for appropriateness.

Additional Teaching Standard for Theme 2, Activity 4:
CCSS Writing

Materials:
A sample flipbook for demonstration.
Paper (4 sheets 8 ½ x 11 white paper per student)
Scissors
Stapler
Observation stations for watching decay and growth for two weeks.

1. Decay stations: a piece of fruit or vegetable that has been cut or bitten to enhance rotting (e.g., apple, banana, tomato, avocado)
   Placing a mesh net or other cover over these stations will reduce fruit flies or other insects.
2. Growth stations: seeds (e.g., peas or beans) or very young seedlings (e.g., young ferns, marigolds) in soil planted into small clear plastic containers to increase visibility of growing roots.
   Place in natural light and in temperatures that are not too cool to inhibit germination.

Students could be assigned the task of keeping young plants moist by checking on seedlings every day and watering as necessary.

For Students:
S4. Making a Flipbook Journal

Activity 4: Changes in a Flipbook Journal

4A.
Introduction

Ellie recorded the changes she observed from winter to summer. If she observed the same plant growing, or a particular kind of bird developing from chick to adult, she was measuring a rate of change. By continuing to track the date of the first trillium bloom or the arrival of migratory birds for many years, Ellie's records would estimate how much variation occurs from year to year. In this activity students will observe the rates of change in decaying and growing things.

4B.
Students watch the processes of growth and decay on websites that demonstrate biological changes.
(These website were last viewed April 9, 2012. As noted previously, the teacher should preview sites ahead of time to be certain the sites are still available, and to scan comments that follow the videos for appropriateness.)

1. High-speed photography of mushrooms growing
   http://www.youtube.com/watch?v=DthWjUo4HTQ

2. A banana rotting
   http://www.youtube.com/watch?v=O2B1Fcs5sC4

3. An apple rotting
   http://www.youtube.com/watch?feature=endscreen&v=lRiwXMeKoGk&NR=1

Several examples of seeds growing are also available on the web including:

4. Acorn to oak filmed over an 8 month period.
   http://www.youtube.com/watch?v=ZK4LjURtaDw

5. Time lapse of fern sprouting.
   http://www.youtube.com/watch?v=xN8c_X0LNcg

6. Time lapse of plants growing - bush beans over 24 hours.
   http://www.youtube.com/watch?v=W-FO8tZQGfk

4C.
Introducing the observation stations

Direct students towards the observation stations so that all students can see what the foods and plants look like at the beginning of the study:

1. Decay: each station contains one piece of fruit, vegetable, or cheese that will mold during the weeks devoted to observation.

2. Growth: each station contains a small container with a fast-growing seed (peas, beans) or young plant (sprouting fern, marigolds) that will develop in the same time interval.

Discussion: Collecting data.
The flipbook will record physical changes; in addition students will need complementary scientific records. Designate how these records will be recorded—for example, on the back side of flipbook pages, a separate journal, or data sheets the class designs.

What kinds of changes might we expect to see at our stations?
Answers: Changes in texture, color, shape, size. Development of new structures, molds. Inadvertent introduction of insects.

4D.
Making a flipbook

Demonstrate how a series of pictures in sequence creates a "moving" image by flipping the pages one at a time.

Following instructions in the handout, students each make a flipbook journal.

Students are assigned as teams to observe an item from either the decay or growth group. All members of each team will record changes over the next two–three weeks. You can modify the length of the study and number of observations per day or week depending on progress of decay and growth. Note that 24 pages will be available in the flipbook.
Optional: A photographic record could be made with daily photographs at each station.

Activity 4: Changes in a Flipbook Journal

4E.
Comparing observations

Students share their flipbooks within their teams, between those observing decay, and with those observing growth.
What conclusions can be drawn from only the first page and the last page of observations?
How does that compare to conclusions drawn from examining all pages of observations?
How would the time interval of observation be different for other foods or plants?

Comparing decay and growth:

Given observations of decay, what is happening to rotting food?
Answers: Loss of material in the original food. Gain of material in molds. Possible loss as gases detected in smells.

What is happening during growth?
Answers: Added organic material seen in roots, stems, and leaves.

How do you think these processes are affected by the environment around them?
Warmer temperature can increase rates of growth and decay. Water is necessary for plants; moisture enhances decay. Light is important for plant growth. Decay in logs occurs in the dark.

4F.
Assessment Opportunity:
Evaluating details in the flipbook and data notes:

Students use their data notes and ideas from the discussion to write a description of decay or growth processes observed during their observations. They could take a "journalist's" point of view as a way of encouraging factual descriptions.

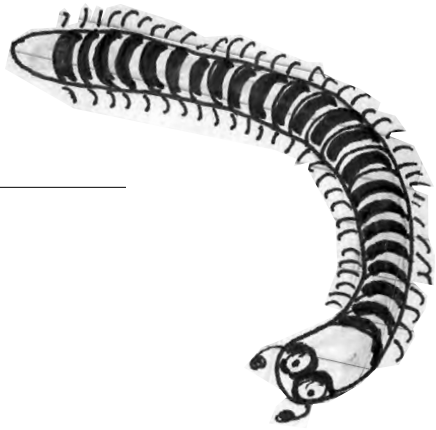
Related Activities in this Guide:
Theme Five: The Biology of Rotting

Other Related Activities:
"How Plants Grow" in Project Learning Tree pp. 179–181. Students devise experiments to test for effects of light, water and soil on growth of beans, peas, or alfalfa seeds. Provides experiential activities in understanding elements of photosynthesis, Also includes making a "flip-it" book made of 3"x 5" cards to show growth of a seed into a plant.

"Sunlight and Shades of Green" in Project Learning Tree pp. 182–184. Students demonstrate the effect of light on photosynthesis by blocking light from leaves for 4 days. Discussion includes importance of water, gas exchange, in photosynthesis.

Related Film:
"The Rotten World About Us" (1980): Uses advanced time-lapse photographs and electron microscopy for an intriguing view into the complex world of mycology, an unseen world of mold, mildew, and mushrooms. An older film that is sometimes available in school libraries, more information and clips are available on the website for Wild Film History and the BBC (www.bbcmotiongallery.com).

S4: Making a Flipbook Journal



To make your own flip book, you can use paper of any size, although you will use only about a 2-inch square area for your drawing on each page.

You will need a stack of paper that has 24 pages; each page needs to have about a 2-inch square area for your drawing.

Basic Instructions using 8 ½ x 11 paper
For each piece of paper:

- Fold length into 3 equal parts
  (each folded section will be 3 5/8 inch by 8 ½ inches)
- Fold sheet in half (now there are 6 rectangles, 3 5/8 inches by 4 ¼ inches)
- Cut along fold lines to make 6 pages for your flipbook
- Fold and cut 3 more pieces of 8 ½ inch by 11 inch paper in the same way

Result: 24 pages for your flipbook.
Pile the pages into a very neat stack and staple together.

Notes from M. L. Herring, illustrator of *Ellie's Log*:
I like to sketch my series of drawings on the right-side edge of a flipbook so they can be "flipped" easily.

Your drawings should be *no more than 2 inches high and wide.*

Design your drawings in a series to show incremental action in very small steps.

Make sure each drawing is on the *same place on each page*, so they all align when you flip them.

There should be at least 24 pages to flip, more is better (depending on how many you can staple together).

Theme Three: Biodiversity in the Forest

Concept:
A forest supports a wide variety of organisms. Forest structures provide homes for many organisms.

Background:
In biology, biota are classified into levels of taxonomic hierarchy—for example, many species may be included within a genus, many genera in a family, families within orders. Even higher levels of classification are phyla and kingdoms. In *Ellie's Log*, organisms are referred to across various levels of these hierarchies. Douglas fir is a common name for a tree species, whereas moss is a broad name for many kinds of plants in a community at small scale. Likewise Douglas squirrel is a particular species, but bats can refer to many species within a family of mammals.

The name used to identify an organism, irrespective of taxonomic level, is a taxon; the plural, taxa, will refer to the many kinds of things identified. In ecological studies, diversity expresses not only how many kinds of things (taxa) there are, but also describes the relative abundance of those things. Some taxa will be rare, others may be very common. A highly diverse system (much like the coniferous forest where Ellie lives) would have a wide range of taxa. A system in which there are only a few, very common taxa (for example, brine shrimp in a very salty lake), would have low diversity. Though we will not be calculating the abundances of organisms in these activities, the lists of biota include the range in abundances from rare (e.g., red tree voles) to very common (e.g., Douglas firs).

Biological diversity in the forest is dependent on diverse habitats. The forest structure provides shelter, refuge, and places for nesting. The plants are the base of food chains connecting many levels into a food web. Microclimates of temperature and moisture add to the diversity in living and decomposing trees. After identifying biota in the forest, students will consider the kinds of habitats where forest organisms are found.

Teaching Standards for Theme Three
OR Science Standards: Structure and Function
CCSS: Reading

Activity 5: Searching Ellie's Log for Richness

Preparation time: 10 minutes to copy handouts
Estimated class time: 50 minutes
Assessment time: 30-45 minutes

Objective:
Students will classify organisms found in *Ellie's Log* into major animal and plant groups.

They will estimate the diversity of organisms and habitats encountered by Ellie and Ricky and recognize that animal diversity is related to habitats where they live.

Students explore biological diversity using a list of organisms found in *Ellie's Log* by classifying and counting biota from the list. They consider the effects of different climates and terrain by comparing the conifer forest to a ponderosa forest in the drier climate of Eastern Oregon.

For Students:
S5A. Animals and Plants Found in *Ellie's Log*
S5B. Eastern Oregon Forest Plants and Animals

5A.
Estimating diversity

Students work in pairs to classify the animals and plants listed in Handout S5A. Half the class classifies the animals into major taxonomic groups (birds, mammals, insects, trees, shrubs, mushrooms and mosses). The other half uses the same handout to classify animals by habitat.

Gather the class for students to summarize their work. To estimate biological diversity, ask students to total the kinds of organisms (plant and animal). To estimate habitat diversity, ask them to count habitats represented.

Discussion:
How else might the diversity of plants and animals be described?
Taxa could be classified in other ways such as roles animals play in the food web (predators, herbivores, etc.) or plants could be grouped by the kind of structure they represent (canopy trees, shrubs, herbs).

What might change the diversity in a forest?
1. If the forest is changed or disturbed, animals and plants would be affected. The kinds and numbers of living things may change.

What might disturb a forest?
Forestry activities can reduce the number of trees, and shift the kinds of trees and shrubs in the forest for several years. Increasing urban activities (cutting trees, building structures, trails, and roads) can affect what animals and plants would survive. Change in climate will also affect who survives in the forest.

Activity 5: Searching Ellie's Log for Richness

2. Different kinds of forests grow in different climates and geologies; we expect these differences will result in different kinds of plants and animals.

Students compare the list from the Douglas fir forest (Handout S5A) with the list from Eastern Oregon (Handout S5B).
What is the biological diversity of the Eastern Oregon forest?
Though estimates of diversity of the Douglas fir forest and Ponderosa forest are the same, biologically, structurally and climatically they are quite different.
What animals do students think best represent the Douglas fir forest?
How do their candidates for most representative animals represent typical habitat?

5B.
Discussion: Expanding Methods of Nature Detectives

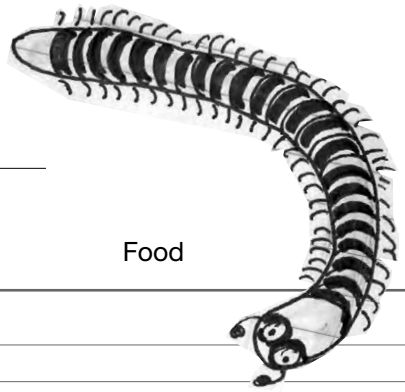
Though Ellie and Ricky may have tried hard to see quite a variety of things, how could they discover more kinds of animals and plants?
Change of season—only from March–early June is described in the book.
Change the time of day for observing animals.
Increase the number of observers (more people will likely cover more area and see and hear more).

5C.
Assessment Opportunity

Each student reviews the list of organisms developed for the coniferous forest where Ellie lives (Handout S5A). Their written assignment is to choose five organisms they believe are representative of that forest, and to explain why they have chosen each one.

Related Resources:
Identifying Priority Plants and Animals and Their Habitats. Oregon Forestry Research Institute, 2006. www.oregonforests.org. Animals and plants in this small handbook are protected by either state or federal listing, or are designated as "strategy" or "imperiled" species. Several species mentioned in *Ellie's Log* appear in the species accounts with excellent photographs and information about the biology of each. These animals and plants are also listed for the eight eco-regions of Oregon.

S5A: Plants and Animals Found in *Ellie's Log*

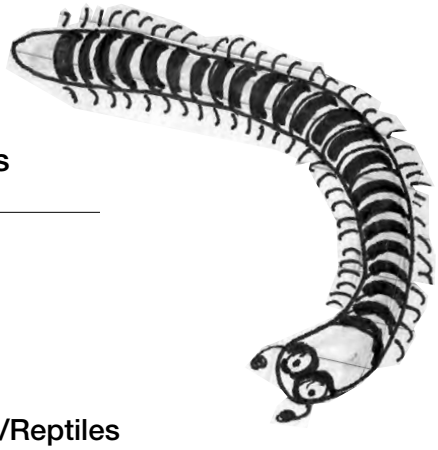


Plants and Animals	Habitat	Activity	Food
Chapter One			
bobcat	forest		
mountain chickadee	cabin deck		
nuthatch	cabin deck		seeds
winter stonefly	snow	emergence; flight	
winter wren	branch of fallen tree		
Chapter Two			
alder			
ambrosia beetle	bark of fallen tree	wood boring	ambrosia fungus
big leaf maple			
conk mushroom	on side of log		
deer fern	base of log		
douglas squirrel	doug fir canopy	feeding; defense	fir cone seeds
Lobaria	in maple canopy		
red tree vole	high in doug fir	nest building; night active	fir needles
Chapter Three			
mites	moss	swimming	
moss	wet ground; logs, limbs		
pseudoscorpion	moss	nest building with silk	smaller invertebrates
springtails	moss	springing with tail	
trillium	near trail		
water bears	moss		
Chapter Four			
ambrosia beetle	inner bark		
blue butterflies	sunny patch on road	flying	
boring beetles	cut log	boring holes	wood
carpenter ants	in log		
centipedes	log		
chipmunk	on log; in salal		fir cone
golden bark beetle	under log	crawling on ground	wood
mushrooms	fruiting body on log; fungal mat inside log		
slender salamander	under bark of a log	squeezing into insect tunnels	invertebrates
termites	in log	tunneling	wood
moss	hanging from tree		
lichen	hanging from tree		

S5A: Plants and Animals Found in Ellie's Log

Plants and Animals	Habitat	Activity	Food
Chapter Five			
blackflies	stream gravels		
belted kingfisher	along stream	perching; flight	
craneflies	stream gravels		
dipper	log in stream	bobbing in water;	aquatic insects
mayflies	stream pool	eating caddisfly	
midges	stream gravels	in flight; mating	
net-building caddisfly	pool at log in stream	net building	small invertebrates
pacific giant salamander	under log in stream	swim; hide	beetles
rock-cased caddisfly	pool at log in stream	case building; crawling	
Swainson's thrush	in salal; tree canopy	singing	seeds; caterpillars
trout	pool made by log		aquatic insects
Chapter Six			
American robin	top of big leaf maple	singing	
bats	tree snag for roost	night flight; searching for insects	moths; flying insects
deer	meadow	browsing	grass
flying squirrels	tree snag for nest	night gliding	mushrooms; lichen
porcupine	meadow	tears at bark	bark; leaves, fruit
raccoons	meadow	walking through meadow	
screech owl	tree perch at meadow edge	perched night call	rodents
spotted skunk	under brush		
swallow		night flying	insects
Chapter Seven			
Miner's lettuce	forest understory		
Oregon grape	along trail		
pileated woodpecker	snag	young birds feeding	rodents; insects
rhododendron	along trail		
rubber boa	basking in the sun		
tortoise-shelled butterflies	outside Ellie's window	fluttering	
wild iris	forest floor		
Appearing in Several Chapters:			
salal	forest understory		
hemlocks	on nursery log		
huckleberry	on nurse log		
douglas fir	all chapters		

S5B. Eastern Oregon Forest Plants and Animals



Plants
Ponderosa Pine
Douglas Fir
Cottonwood
Alder
Larch
Lichen
Orchid
Basalm Root
Sage
Indian Paintbrush
Willow
Cheatgrass
Rabbit Brush

Insects
Salmonfly (a stonefly)
Bark Beetle
Midges

Riffle Beetle
Mayfly
Blackfly
Horsefly
Grasshopper
Mosquito
Free-living Caddisfly
Rock-cased
Caddisfly
Dragonfly
Damselfly

Birds
Meadowlark
Kestrel
Merganser
Dipper
Robin
Swallow
Red-Tailed Hawk
Osprey
Great Blue Heron
Nighthawk

Mammals
Coyote
Beaver
Deer
Mink
Chipmunk
Porcupine
Bats
Elk
Bear

Amphibians/Reptiles
Garter Snake
Pacific Giant Salamander
Rattlesnake

Fish
Rainbow Trout
Sculpin
Dace
Chinook Salmon

Activity 6: What do I spy?

Preparation time: 2 hours for the first time this is played to collect photo images
Estimated class time: 45-50 minutes allows several turns for each student

Objective:
Students will improve observation skills and develop a list of relevant attributes to use in describing biota they encounter in the natural world.

Background:
Careful observations and clear descriptions are important skills for students as they begin to compare field data. In addition, learning to distinguish subtle differences between things is an important aspect of classification. This activity will help them hone their observation skills and recognize key attributes for identifying the animals and plants they encounter.

In this game students take turns looking at photos of animals and plants, with each student adding a morphological characteristic to describe the organism more fully. This activity gives students practice in skills needed for field exploration in Theme 4: Finding Diversity in Your World.

Additional Teaching Standards for Theme 3, Activity 6
OR Science Standards: 4. Structure and Function.
CCSS: Language

Materials:

- Projector for animal and plant images for students to describe during the activity.
- Photographs or drawings of contrasting organisms to be used in the game.
- For spelling bee format 6 examples per major group (such as birds, plants, or insects) will be needed. (See *Ellie's Log* website for images online that can be used for this game.)

For Teachers:
Table 2: Descriptors for Birds, Invertebrates, and Plants
Photo images on EllieLog.org (In "About" section - for HJ Andrews; also "Teachers" page)

6A.
"I Spy" Game

This description is for an intra-class competition in "Spelling bee" format. Alternatively the teacher can present one picture at a time, asking students to volunteer the descriptors.

Spelling bee format: Students are divided into teams of four to six students. Half the teams are League A, the other half belong to League B. The teacher or students can choose a name for the League and/or teams. Teams will be paired up in an "I Spy" contest. The goal for each team will be to provide the most descriptors for the animal or plant they are assigned.

Round One: Photographs of two very different birds are presented on a screen at the front of the classroom. (The example uses a red-tailed hawk and a robin.)

The first two teams, representing each League, come "up to bat." Players step up one at a time, with teams alternating speakers. On each player's turn, he or she starts with the expression "I Spy" followed by all descriptions of the bird previously listed, then adding a new one. Team One describes the bird on the left, team two describes the bird on the right, alternating between teams until someone runs out of reasonable descriptors. The name of the bird cannot be used. Students can write down the list so that they don't forget or get mixed up, and can help team members find new descriptors.

Sample Round looking at red-tailed hawk and a robin might begin:

Team 1: I spy a big bird.
Team 2: I spy a bird with a red breast.

Team 1: I spy a big bird with a sharp beak.
Team 2: I spy a bird with a red breast and a dark eye.

Team 1: I spy a big bird with a sharp beak and a brown and white breast.
Team 2: I spy a bird with a red breast, dark eye, and yellow feet.

Activity 6: What do I spy?

And this round continues until one of the teams runs out of descriptors. The team with the most descriptors, that is, the last at bat, scores one point for their League.

The difficulty of the next round may depend on the teacher's assessment of how well these skills are already developed in the class. To increase skills for birds in particular, two birds that are much more alike are shown in the next round (e.g., a black-capped and a chestnut-backed chickadee, a fox sparrow and a song sparrow).

Other rounds include other kinds of animals that students may encounter in their Critter Hunt (Activity 9) such as butterflies (e.g., monarch vs. swallowtail), insects from two orders (e.g., beetle vs. bumblebee), amphibians, local shrubs with different fruits or leaf shapes, trees with different barks, etc.

Team lists for rounds played are posted to help the discussion.

Follow-up Activity:
Trees or plants in the schoolyard could be "spied" on a walking tour.

6B.
Discussion

Students review what they have observed during the game. Some descriptors may be very general and not particularly good at making differences.
What attributes help distinguish between animals or plants of different groups?
What attributes distinguish between animals or plants in the same group?

6C.
Assessment Opportunity

Students individually create a list of important features for each major group (birds, insects, plants, and other groups the teacher has presented). Using these lists, the class creates a combined list that is posted to use in writing and drawing descriptions of what they find in their field studies.

Related Activities in this Guide:
Activity 7A Getting to Know You
Activity 7B Finding the Other Animals

Other Related Activities:
"How Big is Your Tree" in Project Learning Tree pp. 284. This activity emphasizes the importance of measurements, and students measure objects using various techniques, including the span of their hands. A tree's circumference is measured by students joining arms and also by stretching a string around the tree. A tree's height is measured on a sunny day using ratios of the tree and its shadow compared to the student and her shadow.

"Name That Tree" in Project Learning Tree pp. 288–290. Provides good illustrations of morphological differences associated with trees such as types and margins of leaves; differences in textures of bark, leaves, and twigs. Students hunt for particular trees by matching branches provided by the teacher, and race to find particular leaves associated with different tree species.

"Adaptation Artistry" in Project WILD K-12 Curriculum and Activity Guide pp. 128–129. Though this activity has students creating designs of imaginary birds, it emphasizes adaptive characteristics of birds that may be useful in the "I Spy" game, especially as students gain skills in describing birds they don't recognize.

Table 2: Descriptors for Birds, Invertebrates, and Plants

	General Features	More Specific Features
Birds	Size Color(s)	Body: markings on breast, wings, tail Head: shape of bill, eye color, eye ring Legs: color, presence of talons
Invertebrates	Shape Number of legs Number of eyes Color Markings	Insects Wings: number, hardened or transparent, size Eyes: location, color Antennae: shape, length relative to head Spiders Legs: length, shape Body: presence of hairs
Plants	Height Leaves: shape, color, location Flowers: shape, color, position on plant Seeds or cones: if present, shape, position General profile	Trees and shrubs Bark: texture, color

Activity 7: Getting to Know You

Preparation time Choosing descriptors to use in the game:10 minutes
Estimated class time: 50 minutes

Objective:
Students will use taxa from Ellie's forest as a basis for practicing skills in description and classification.

After each student writes a description of an organism including several characteristics of morphology, habitat, and behavior, the class responds with raised hands to the teacher's description of a particular organism, beginning with most general and ending with very specific descriptors, when very few students have their hands in the air.

Materials:

- For Student S5A: Animals and Plants Found by Ellie and Ricky found in *Ellie's Log*
- At least two index cards per student (Descriptor and Taxa cards)
- Sticky notes for each student

Additional Teaching Standards for Theme 3, Activity 7
CCSS: Writing; Speaking and Listening

7A.
Playing the Game "Getting to Know You"

Assign various chapters from *Ellie's Log* (as listed in the S5A handout) to different parts of the classroom. Students choose one organism from the assigned chapters, checking with each other to make sure most of the organisms on their part of the list are covered.
Instruction to each student for the "Descriptor" card:
On the card, describe your organism by how it looks, where it lives, how it behaves (if that is appropriate), but don't name the organism.
Try to leave some space for changes.

After the class is gathered together, explain that you are thinking of one of the organisms in the book, and will describe that organism one characteristic at a time. Students whose organism has that characteristic (as shown on the card or because the student recognizes it) raise their hands. Various kinds of information are used: taxonomic (e.g., vertebrates or invertebrates), morphological (e.g., color, anatomy), behavior (e.g., nest builder), habitat (e.g., tree canopy), life cycle (e.g., has a pupal stage). Students use sticky notes to add information they didn't include initially.

The idea is to start with enough generality that as many students as possible have hands raised at the beginning. For example, if you say the animal lives in water, all those with animals who live in water raise their hands. Then if the animal is a vertebrate, some of the students will put their hands down. Eventually the possibilities are narrowed until only a few students have their hands raised (e.g., has four legs—a giant salamander).

Disagreement is fine—it will generate ways in which to make the distinctions more useful. Playing several rounds gives opportunities for uncovering several ways of classifying the forest biota.

Discussion: Revising
Students identify the attributes they hadn't included at the beginning. Then, they modify their Descriptor cards, aided by the notes from their sticky tabs, in preparation for the next stage of the game.

Activity 7: Getting to Know You

7B.
Finding the *other* animals

On a new Taxa card, each student writes down only the name of the animal he or she described (there will be some overlap in animals chosen). The **Taxa** card is placed at the table or desk where the student is seated. The **Descriptor** card is put into a class mix that the teacher shuffles. Each student receives a Descriptor card from the shuffled deck, and moves to the place that matches the Descriptor to its Taxa card. Sort out animals that were not located by asking the original author what his or her critter was. Consider what they might have added to the description to make it more complete.

This activity was adapted from "The Classification Game" from the Academy of Natural Sciences.

Related Activity:
"Charting Diversity" in Project Learning Tree pp. 51–53. Students devise a chart of habitats, animal mobility, and adaptive characteristics, then identify animals that fit the features defined in the chart. Whereas Activity 7 associated with *Ellie's Log* begins by identifying organisms, the PLT activity approaches the objective for associating animals with habitats in the reverse order; that is, beginning with habitats.

Activity 8: Looking for Habitats

Preparation time: 10 minutes to copy handouts.
Class time: 30 minutes for discussion.
Assessment: Drawing forest communities: 30 minutes; "Day in a Life" begun in class: 30 minutes.
Student presentations: 5 minutes per student (about 2 + hours for a class of 24)

Objective:
Students will identify habitats where animals in *Ellie's Log* live, recognize the differing amounts of space those animals require to make a living, and associate particular resources, such as microclimate or refuge qualities, with those habitats.

Concept:
Forest habitat structures provide homes for many organisms.

Background:
Habitats are the homes where animals live. They include structure for shelter, for foraging, for movement between those areas, and for nesting. Habitats must include sufficient food resources (e.g., seeds, insects) and water for survival. The habitat space that individuals need varies greatly between taxa; for example, a spider stays within a very small area during its lifetime compared to adult dragonflies that range many meters defending territory or looking for food, or to deer that browse over a wide space while traveling to streams for water and meadows for rest at night. As a result, different animals can occupy similar habitats (e.g., a decomposing log) or overlapping habitats (e.g., fish and insects in a pool). In Chapter 5 (p.76), Ricky describes how a log in the stream is habitat for many animals.

Ecosystems are characterized by vegetation types, typography, and climate, and they contain multiple habitats. For example, a forest ecosystem might contain a stream, a riparian habitat adjacent to the stream, an upland forest, a meadow, etc.

A community of organisms is made up of many different plants and animals that share the same space. Within the community, organisms can influence each other in many ways—as food or prey for others, as competitors for the same resources, as benefactors for others, as predators or consumers. Members of other communities might immigrate into the shared environment or emigrate out during a year.

Using the Habitat Matrix handout (S8A) students will identify the structure of habitats observed in the Douglas fir forest and consider how members of the same community use those habitats. These activities integrate physical structure with biological activities. The relationships between members of the community are the focus of Theme 6: Forest Connections.

Additional Teaching Standards for Theme 3, Activity 8
OR Science Standards: Interaction and Change
CCSS: Speaking and Listening; Writing

For Students:
S8: Habitat Matrix
S5A: Animals and Plants Found in *Ellie's Log*

Activity 8: Looking for Habitats

8A.
How do trees create habitat in the forest?

Students organize organisms found in the handout from Activity 5 (S5A) into broader habitat categories shown in the Habitat Matrix (S8A). The matrix will help them generalize from particular habitats to a broader location. For example ambrosia beetles, who live in the "bark of fallen tree," would be listed in the column "ground level," along with the slender salamander who lives "under a bark of a log." Some more active animals will appear in more than one habitat (such as the chipmunk who was found on a log and in salal).

Discussion: The many dimensions of forest habitats. Each column in the habitat matrix represents a particular vertical dimension of the forest. The class illustrates these levels on the chalk or white board by sketching soil with downed logs and stream on the bottom, a shrub above ground, taller tree with limbs in the canopy. Then students suggest where animals and plant labels should be placed in the structure. In the process the drawing will likely expand to include animal activities.

For example, on the ground level:
- logs make runways
- spaces to hide or nest (amphibians, mammals, insects)
- soil at the base of trees for salal, deer fern

In the shrub understory:
- branches for perching, where seeds are available
- places for insects to feed
- birds find insects to eat

In the canopy:
- perches for birds
- nesting places for mammals and birds
- feeding opportunities for insects and birds

In the stream:
- perches for birds
- making pools for refuge used by salamanders, fish, insects

8B.
Assessment Opportunity:
Drawing a forest community in its environment
(Students can share their drawings at ElliesLog.org)

What communities live in forest habitats?
Each student chooses a particular habitat and draws a diagram or illustration of the community of animals within that habitat. The drawing activities prepare the class to discuss the importance of habitats.

For example:
On a log: moss, insects, salamander, chipmunks
In deciduous canopy: songbirds, insects, chipmunks

To complete their illustrations, students write a complete label for their diagram that identifies what kind of habitat they have drawn, the time of year and the time of day that it represents.

8C.
How do habitats affect the diversity of organisms in an environment?
Students use their drawings and the matrix they've developed to participate in a "What if?" discussion.
What if there were fewer logs?
What if the trees were different? (use local examples)

How might these conditions occur?
- Natural differences in climate, geography
- Land use changes—forestry, urban growth
- Natural events—storms, fire, landslide

Optional food for thought:
What might be the consequences of habitat change?

Students are asked to figure out the logical basis of their predictions. Each student writes out the logical argument beginning with "what we know," or assumptions, followed by an "if" and "then" statement.

For example:
What we know: Red tree voles depend entirely on Douglas fir trees for food and shelter.

If: Douglas fir trees disappeared in a place where red tree voles live. Then: Red tree voles would also disappear from that place.

What animals could survive habitat change more easily?
Compare red tree voles to an animal with more general habitat requirements (e.g., slender salamander).

8D.
Assessment Opportunity:
"A Day in the Life"
(Students can share their stories at ElliesLog.org)

Each student chooses one organism and reports its activities for twenty-four hours based on what was learned from *Ellie's Log* and what they learn from reference sources (field guides, online searches). Though this will be a creative description, students are instructed to approach it in the third person voice of a journalist who is "keeping track" of their animal. Students might be instructed to include typical activities for their animal; time of day or night when it is active; other organisms it might encounter; what it eats; where it sleeps.

This writing exercise contrasts with more fictional stories that anthropomorphize animals (e.g. *Stuart Little, Charlotte's Web, Peter Rabbit, In the Forest of S. T. Shrew*). If possible, students could be required to provide sources of information at the end of the "report."

Presentations: Student narratives are shared orally or in print, with discussions about how each student learned about the information they present and what difficulties they encountered gathering information, or while writing, or illustrating their report. The presentations might be organized by taxa groups (e.g., insects, mammals), with each group participating in a "panel" discussion of their set of stories following their presentation.

Related Activities:
"Rainfall and the Forest" in Project WILD K-12 Curriculum and Activity Guide, Council for Environmental Education 2006. pp. 73–76. Students use state highway and vegetative maps for determining relationships between rainfall and vegetation with animal habitats.

"Habitat Rummy" in Project WILD K-12 Curriculum and Activity Guide. pp. 14–18. Students identify sources of food, water, shelter, and space for four designated animals. Cards are created for each habitat element and used in the game, in which players aim to collect all four habitat cards for an animal. The approach could be revised for animals found in *Ellie's Log* (using matrix developed in this Activity 6), during the students' critter hunt (Activity 7), or as part of the Trees as Treasures project (Activity 8).

"The Forest of S. T. Shrew" in Project Learning Tree, pp. 40–44. Fictional visit through forest soils and a log guided by a short-tailed shrew. Introduces microhabitats in the forest. Because it is told in the voices of animals and insects, this story has a very different voice than the one suggested in the writing exercise (Activity 8D).

Related Resources
Brenner, Barbara. *One Small Place in a Tree*. HarperCollins 2004. Beginning with a bear using a tree as a scratching post, a hole is created and becomes home to a variety of animals Grades 2-4.

S8: Habitat Matrix

Team Members:

Chapter _____ _____

_____

_____

_____

For each organism, list how the animal uses its habitat use as described in *Ellie's Log*. When you can, list particular structures in the habitats (a log on the ground for example). Examples of Habitat Uses: shelter, feeding, perching, travel.

_____ HABITAT USE _____

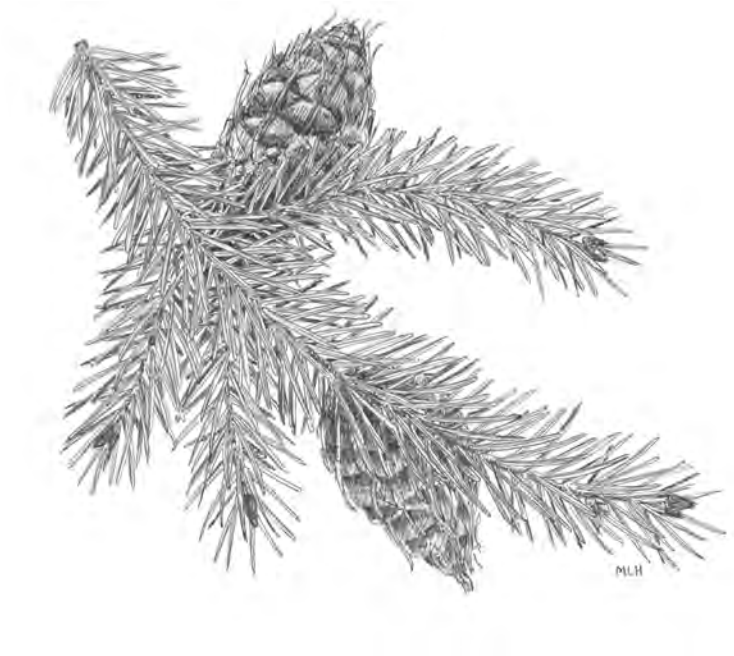
Organism	Ground Level	Shrub	Tree	Stream	Understory	Canopy

Theme Four: Finding Diversity in Your World

Concepts:
Habitats are all around us.
Scientific inquiry begins with asking an appropriate question, and proceeds through study designed to answer the question.

Background:
Identifying biota and habitats in the places where students live will depend in large measure on the accessibility of natural or semi-natural areas. Most ideal would be parks or natural areas within walking distance, or possibly accessible by bus transportation or field trips. However, trees, plantings, or grassy areas on school grounds could work, and student exploration of trees or yards in their neighborhoods may also be feasible. Contrasts between more natural areas (e.g., wildlife refuges or parks) with school grounds or backyards provide many opportunities for comparison, discussion, and asking scientific questions.

Teaching Standards for Theme 4
OR Science Standards: Structure and Function; Scientific Inquiry
CCSS: Reading; Speaking and Listening



Activity 9: Critter Hunt

Preparation time school yard survey and setting potential sites: 1 hr; Copy handout: 10 minutes;
Gathering materials for field work: 1 hr; Assembling "Full of Beans" game: 20 minutes,
Special note: An additional adult will be very helpful during the field work.
Estimated class time: "Full of Beans" game 30 minutes;
Introducing the Critter Hunt, Designing the Critter Hunt: 45 minutes
Field sampling for the Critter Hunt: 50 minutes + travel time from classroom
Data analysis: 30 minutes
Data Evaluation Assessment: 40 minutes
Mapping Assessment: 50 minutes

Objective:
To prepare for designing a field study, students will become familiar with the importance of replication. They will discuss the context of the field study at or on their school grounds, then design a class study to answer a specific question. Their study will also record the diversity of organisms in the study area.

Background:
In this activity students will conduct field observations that compare different conditions. Many instances of the same thing give a better representation of that condition than a singular instance. For example, in a study of insects on lavender shrubs, several shrubs will likely display a variety of insects, whereas only one shrub might reveal only a portion of that diversity. If the intent is to compare lavenders with another shrub species, like azaleas, then three or more examples of each shrub species could provide a good comparison. In this example, each of the shrubs of one species would be considered a replicate (each of the replicates would be represented by the number of insects counted). If there were only one lavender and one azalea plant examined, then we would not be able to tell whether differences were due to plant species. When only singular kinds of habitats or plants are available, then the study could assess the diversity in the entire area searched (for example, one big oak, or the whole schoolyard) rather than characterizing differences between species or habitat types. Replication as a critical element in study design will be explored in the game "Full of Beans."

Using a map sketched by the teacher students, will review potential habitats they can search, decide upon a question to answer, then conduct a "Critter Hunt" to search for biota in designated locations. They will analyze and map their data by comparing among and between habitats, focusing on ideas built into their study design.

The amount of time students search areas or examine plants of different dimensions is likely to vary (due to natural differences in location or in individual propensities of students). Adjustments can be made to make measurements equivalent in effort:

1. To adjust for differences in area searched at different sites, students can measure length, height, or areas they are observing. Then insect counts are expressed in terms of the area that was measured. For example, if bushes are different sizes, bush volume might be estimated with height and width measurements, then insects counted could be put in terms of critters per cubic foot.
2. Designating a set amount of time for searches will also help make observations comparable.

Materials:
For "Full of Beans" Activity 9B:
- At least five different kinds of beans to be scrambled and distributed in handfuls to students (e.g., split peas, navy beans, lima beans, black beans, red lentils)

For Critter Hunt:
- Flags for labeling habitats in the field
- Sharpie pen to label flags
- Clipboards or writing surface for taking notes on critter hunt checklist (p.39)
- Enlarged sketch of study area to project tallies of critters/site during data evaluation
- Sketch of area where all habitats are located, with assigned numbers marking each habitat (for field study) (1 per student)

For Mapping Assessment activity:
- Revised study area maps

Activity 9: Critter Hunt

For Teachers:
Classroom Chart: Comparing Critter Hunt Observations

For Students:
S9. Critter Hunt Checklist

Optional tools that will increase quality of information: hand lens, binoculars, small digging tools. A camera or phone device with camera that might be shared between student teams would help visualize differences between sites.

Preparation:
Prior to this activity, survey school grounds or nearby locations to find appropriate study sites. The challenge is to identify likely contrasting sites, and replicates of sites that represent the same condition. (e.g., shade vs sunny sites.)

To avoid confusion when students are sent out to conduct searches, place numbered flags at general locations (with colored plastic tape or flags on wire stems). Useful locations: individual trees, shrubs, grassy areas (e.g., playing fields) that might be "squared off" to provide separate units, areas of herbaceous plants or bulbs (e.g., flowers planted as edgings, daffodils in bloom). For this activity, at least three replicates of the same type will be needed to compare across vegetation types (e.g., three maple trees vs. three fir trees vs. three willows vs. three rose bushes). Sketch the total search area (e.g., the schoolyard or part of the park) for a study map and mark locations of suggested search areas with numbers matching flagging positions. This sketch will be used to introduce the habitats to be studied.

This activity can be the initial search for animals to be followed by subsequent surveys. Students may find signs of animals they want to explore, nests of birds yet to be determined, trails of insects unidentified. Those extended studies can also create a longer, seasonal view of change. Accumulated information may lead to understanding connections between animals (Theme 5) or lead to questions that result in testing ideas.

9A.
"Full of Beans": Seeing and Believing

Objective: to recognize the importance of replication in designing a scientific study.
This activity will help students answer the question:
How will we know if sites are different from each other?

Playing "Full of Beans"
The class is divided into two teams (e.g., Eastside and Westside). Each student receives a small handful of beans in a small sandwich bag. (see Materials for Activity Nine)

Only the Eastside receives the black beans—two per student.
Only the Westside receives split peas—from one to five each.
Other beans will be spread among all students randomly.
Label one bag from each side with a star—one has black, lima, and lentils, the other split, navy, and lentils.

The teacher asks the students who have a bag with a star to describe the beans in their bag. *Can the class tell what the difference between Eastside and Westside beans are with these two samples?* Another pair of students is asked to volunteer, one from each side.
Again, is the difference between sides certain?
Next, all students are asked to post what they have in their bags on the blackboard. There is a table for each team, with columns showing numbers of each kind of bean.

When all the beans are "in," what does the class conclude about differences between Eastside and Westside?
There is greater certainty about differences when there are many samples.

In this example, each bag of beans from one side, i.e. each student's bag, was a replicate for that side of the classroom. Each side was a "condition" or "treatment." Students will use this principle in their Critter Hunt study design.

Activity 9: Critter Hunt

9B.
Introducing the Critter Hunt

The objective of the critter hunt is to describe the biodiversity in the given area (school yard, park, etc.) In this activity students work in teams to:

- Count critters and describe habitats at particular locations
- Bring together separate observations to learn about the whole space, and
- Compare habitats within the entire study space.

Discussion: Designing studies to answer questions.
Discuss with the class how different parts of the schoolyard sketch differ in physical and biological ways.

Possibilities: shade or exposure to light, heat, soil types, moisture, foot traffic; vegetation types, habitats created by downed wood or rock surfaces.

Which of these differences might affect organisms living there?
Students can work in small groups to suggest a strong difference in habitats that they think will affect where animals live. Comparisons are listed for the entire class to consider.

Examples:
1. Difference: between shaded and open habitats
   Possible effects: differences in temperature, moisture, protection from predators

2. Difference: between grassy plots and understory shrubs
   Possible effects: differences in available food, structure for refuge and movement

3. Difference: between protected planting beds and plantings with high foot traffic
   Possible effects: differences in soil moisture and texture, disturbance from crushing, lack of favorable plants

Guide a discussion about what organisms would be associated with these habitats. The study question will be based on one of the differences students have identified.

Choosing the study question.
Possible criteria for choosing the most promising difference to study:

- A clearly recognized physical difference
- Potential for replication for each condition
- Ease of sampling similar sites
- Likely difference in the kinds of organisms encountered

Students discuss in small groups which differences meet the criteria, and consider what biota might be associated with the physical differences. They convert their chosen comparison into a study question (e.g., “How do the number of insects on plants in the shade differ from those in full sunlight?”; “How do the numbers of birds in trees next to foot paths differ from those in the play yard”?). Each group nominates a question, and the class decides on what question they would like to tackle together.

Determining the study approach:
Based on discussion with students, and your assessment from preliminary survey, appropriate search areas are assigned to student pairs. Assign study sites so that the areas and sampling effort for each pair of students will be equivalent. Search areas that could be identified in replicates might be:
- One square foot of grassy field, (that could be measured by placing a square foot frame made of PVC pipe or a wire hanger stretched into a square).
- Height of tree trunk to four feet.
- Observable tree canopy with measured canopy width.
- Two-foot length of log, to be examined around the log and at its end.

If practical, equal times for searching an area, once it is measured off, should be designated for all student pairs.

Before they start their fieldwork, students review what kinds of information Ellie used in her field notebook. What similar information will be useful in their work? (e.g., Date, time, location, observers)

In addition students may remember from Ellie’s notebook informal notes about animal behavior, unusual or puzzling things she sees, drawings/sketches that would be useful records.

Activity 9: Critter Hunt

The Critter Hunt Checklist is given to each student for field data collection. Prior to the critter hunt, the class is shown the Classroom Chart (Comparing Critter Hunt Observations) so that students can anticipate what will be done with the data. In reviewing the critter hunt checklist, the following points are important:

1. Notes about the habitat station:
   Dimensions of site
   Characteristics such as moisture, light levels, disturbance by humans

2. For each animal observed:
Identification: identify animal by name if possible. If the animal isn't recognized, draw a sketch and describe in detail:
Morphology: color, size, markings. Features to look for can be agreed upon as important for invertebrates and for vertebrates ahead of time (See "I Spy" Activity 4C)
Behavior: activity, interactions with any other organisms, movement
Habitat: what part of the study area was being used: size of the area
Optional: photograph

If data is to be recorded in a notebook rather than on separate field sheets, students should set up the first page in their field notebook based on the Critter Hunt data sheet.

9C.
Field Data collection and analysis
When students reach their assigned location, they check the map and mark the exact location on the map.

After field data is collected, students record their information into the Classroom Chart (Comparing Critter Hunt Observations), which groups together each habitat.

9D.
Assessment Opportunity:
Evaluating the data
(Students can share their study designs, results, interpretations, and maps at EllisLog.org)

After the Classroom Chart (Comparing Critter Hunt Observations) has been completed, working pairs of students write their answers to these questions prior to a full class discussion:
What animals were seen at most or all the sites?
How do collections between habitats compare?
How do collections within similar habitats compare (e.g. all trees, or all shady sites)?
What is the diversity for the entire site?

Discussion: Evaluating study results
The class joins in a larger discussion answering the assessment questions (listed above).
What affected the collection of class data?
Time of day, weather, accessibility to sites.

Questions about particular sites—
identifying unknown biota.
Students in other pairs may be able to help with identifications.
Students use their field notes as they consult guidebooks, other references to identify unknowns.

9E.
Assessment Opportunity:
Mapping the distribution of critters

1. The class maps numbers of each kind of organism and total numbers of critters per site tallied on an enlarged study map at the front of the class.
2. Each pair of students chooses one well-distributed organism to map on individual maps. For these more detailed maps, organisms that were observed at several sites can also be represented with numbers, or by larger symbols representing higher numbers, smaller ones for low numbers of the same organism.
3. On a second individual map, each pair of students shows biological diversities for each search area based on the class map.

Each map is given a title and legend to clearly identify what symbols or numbers mean.

Discussion:
How do their maps help answer the question set by the class?
The class reviews questions decided upon before fieldwork and considers how well their work answered their questions.

Activity 9: Critter Hunt

Related Activities:
"Trees as Habitats" in Project Learning Tree pp. 103–104. Students collect data similar to Activity 7, recording how plants and animals use a single tree. Observations of animal signs such as partially eaten leaves or scratches on bark are described. After a list of animals is compiled, discussion of how the tree was used as habitat is explored.

"Planet Diversity" in Project Learning Tree pp. 45–49. Students assess diversity on small plots of land as if they were visitors from another planet. Background for the teacher provides good information about biodiversity (i.e. genetic, species, and ecological diversity). Valuation for diversity is presented with a strong emphasis on utilitarian values.

"Microtrek Treasure Hunt" in Project WILD K-12 Curriculum and Activity Guide pp. 82–84. Students explore microhabitats on or near the school grounds with a list of things to find, particularly evidence of wildlife (broadly defined) sharing the same environment with humans.

"Tracks! In Project WILD K-12 Curriculum and Activity Guide pp. 30–33. Directions for making plaster casts of animal tracks may be useful if students find tracks at their study sites.

Related Resources:
Arnosky, Jim. *Crinkleroot's Guide to Knowing the Trees.* Simon and Schuster 1992. Illustrated introduction to trees with tips on identifying bark and leaves. Grades 2-7.

Pratt-Seafini, Kristin Joy. Saguaro Moon: A Desert Journal. Dawn Publications 2002. Megan records in her journal changes in the Sonoran Desert through the seasons. Grades 4-8.

Silver, Donald. *One Small Square: Woods*. Freeman 1995. Explains how to investigate plant and animal life found in a small section of the woods. Grades K-4.

Classroom Chart: Comparing Critter Hunt Observations

Teachers: A suggested format for classroom use on whiteboard or blackboard

Habitats to be Compared: (at least two) 1. _____ 2. _____

3. _____ 4. _____

Habitat	Station	Conditions	Animals Observed	Behaviors/Notes
1.				
2.				
3.				
4.				

S9. Critter Hunt Checklist

Hunt Team:_____

Date:_____ Time Begin:_____

Weather:_____ Time End:_____

Station:_____

Notes about conditions at the station:

Organism Location Behavior/Notes

(Number each one)

Unidentified Organisms Description/Drawings

(Number each one)

Activity 10: Trees as Treasures

Preparation time: Survey and draw map first time this lesson is taught: 3 hours; or purchase: 30 minutes; Letter to parents: 30 minutes
Estimated class time: Mapping trees: 30 minutes; Optional neighborhood walkabout: 50 minutes;
Revising the map: 30 minutes; Evaluating adopted tree data: 30 minutes;
Assessment, Trees as habitat: 30 minutes

Estimated class time for Branching Out: Planning longer tree study: 30 minutes
Graphing and analyzing expanded tree study: 50 minutes
Assessment: Writing about our trees: begun in class, about 30 minutes, completed out of class

Objective:
Each student will "adopt" a tree to learn about its use as habitat. The class will develop a map of trees near the school. In the extended activity they will make observations over a period of time. Students will record invertebrates and vertebrates they observe at the tree while documenting changes in the tree's growth and weather patterns.

Background:
This activity encourages students to better appreciate natural phenomena in the real world where they live. Trees in their backyards, nearby parks, strips along the sidewalk, or on the school grounds would work equally well. Comparisons can be made among trees of the same species at different locations. The activity may be most interesting during seasonal transitions such as leaf out in early spring when biological activities are changing.

For safety, a few rules about how to make observations will be necessary. For example: all observations must be made while standing on the ground (i.e.. no tree climbing, especially on trees that are not on their family's property). Trees in dangerous locations (e.g., on strips between busy roadways) are off limits. A note should be sent to families describing the project and expectations for this activity. For trees on private property, parents should help students obtain permission for monitoring, and adults should accompany students when observations are being made on those trees.

Additional Teaching Standard for Theme 4, Activity 10
CCSS: Writing

Materials:
- Neighborhood maps for marking tree locations, before and during neighborhood search for trees
- Information sheet explaining activities to parents

For Teachers:
Classroom Chart:
- Class Matrix for Trees as Habitats

Trees as Treasures Graph Examples

10A.
Introduction

What do students remember about the trees in Ellie's forest?
Answers: Conifers, maples, logs, snags, forest structure of canopies, etc. (Also see forest webcams at ElliesLog.org or AndrewsForest.oregonstate.edu

How do trees in this neighborhood compare to those in Ellie's Log?
Answers: Differences in species, in age, in groupings of trees (as forests, parks, individuals)

10B.
Mapping trees we know

What do we know about trees in the neighborhood around this school?
Students are given a map of the neighborhood around the school. They work in small groups to map locations of trees they know.

Confirming estimates with empirical evidence:
Students take maps with them and confirm what has been drawn. Depending on the area covered on their map or in their estimates, they might volunteer to check on particular streets or blocks and report the next day about how the map has changed with actual observations.

Revising the map
(Students can share their maps and data at ElliesLog.org)

Students present their evidence about what kinds of trees they found and locate them on the class map. The value of original estimates and post-study results are discussed, recognizing the importance of information gained in everyday environmental awareness.

Activity 10: Trees as Treasures

10C.
Our trees as habitats: Study design for adopting trees.

Each student will "adopt" a tree and record all the organisms he or she observes on it during the next three days. Minimum amount of time is fifteen minutes on at least one day.

Study design questions to discuss:
What kind of search areas will be used on each tree?
The number and kinds of things each student observes can be related to the time spent searching. How will students adjust for differences in their individual efforts?
Possible adjustments for making areas comparable:
A standard height could be chosen, though trunks will vary in surface area.
Measurements of trunk height and circumference could be made so that counts can be expressed as numbers per area.
In tree canopies, equal times for searching will make counts comparable (expressed as number per time).

Collecting and analyzing adopted tree data.
Students use format of S9. Critter Hunt Checklist to record "adopted" trees for three days in the next week.

After observations are complete, students record information on Class Matrix for Trees as Habitats

Discussion: How have we expanded our tree map?
Prior map is recovered and students confirm and/or add new trees to map.

What do we know about the diversity of trees in the area?
Students calculate tree species diversity using all the field information.

How are our trees used as habitat?
Students consider the kinds of organisms, activities, and habitat use recorded during individual field observations.

10D.

Assessment Opportunity:
Describing a tree as habitat
In a written exercise, each student describes how his or her tree was used as habitat by at least three organisms.

10E.
Branching Out: Tracking adopted trees during a season.
Students will return to adopted trees for repeated observations once a week for a month (or more, depending on teacher's decision) to observe changes in habitats and habitat use.

Discussion: What seasonal changes might be observed in this longer-term study, in addition to previous habitat categories? (These ideas can be used to create an expanded habitat data matrix.)
Possible observable answers:
- Weather
- Plant growth (e.g., changes in leaves, budding of flowers, seed or cone production)
- Animal development (e.g., birds build nests, fledge; insects emerge as adults)
- Habitat use changes (e.g., birds foraging for insects on this tree become focused on nest site)
- Changes in animal numbers (due to mortality, migration, emergence)

Given these differences, what questions could be asked in the longer-term study?
Study questions can combine seasonal changes with biological response. Examples:
How will the kinds of insects change as deciduous trees lose their leaves in the fall?
What is the difference between songbirds using tree canopies in conifers compared to deciduous trees in the spring?
What will be changes in the forms of insects and where they occur as the weather changes? (larvae or caterpillars, pupae, adults)

The class decides upon categories or measurements to add based on questions they expect to ask.

Expanded Mapping:
Students collect data and record information each week in an expanded Trees as Treasures data matrix.

10F.
Assessment Opportunity
(Students can share results and graphs of their observations at ElliesLog.org)

To understand patterns in the expanding database, students sort the matrix to examine trends in particular tree species, neighborhoods, and animals. They choose comparisons to graph each week or other interval convenient for the class schedule.

Discussion: Experimenting with how to display information
Using the Trees as Habitats matrix and graph examples, students evaluate what kinds of graphs work best to show their data.
Present the graph examples about birds in trees, asking students about what patterns they see in each graph.
What is happening in the line graph of "Birds in Study Oaks"?
This shows a change during the study's three weeks.

"Birds in Our Study Trees" also show results for three weeks.
What additional information is put into this graph?
This graph compares three kinds of trees.
How would you make a line graph of this information?
Do you prefer one kind of a graph over the other?
There is no clear choice, but a discussion helps students recognize that there is more than one way to present information.

Suggest the most straightforward comparisons students can make with their data, and help them explore others. (See possibilities below). Students work in groups to help each other as they draw their graphs. If class time permits, graphing results on a weekly basis will build student confidence in analyzing and displaying graphs of their data. Examples of comparisons to graph:

Week One:
- comparing numbers of insects on different tree species
- comparing numbers of birds on trees of the same species
- comparing number of organisms on trees north of school vs. south of school

Week Two:
- contrasting differences between weeks in different trees or particular locations

By Week Four:
- a series of samples from the same place, same species, etc.

See also: Activity 12: A Rotten Experiment—Assessment, which also discusses the value of graphs

Final study evaluation
Class reconsiders original questions and makes conclusions about what their evidence suggests.

10G.
Assessment Opportunity:
Writing about our trees.
(Students can share reports, essays, or poems at ElliesLog.org)

Reporting the evidence: Students individually write a one-page report that introduces the question being asked, provides evidence for the answer, and concisely reports the conclusion. There may be more than one question, and students could choose the one they understand or relate to most clearly. A graph of data that supports the conclusion should be included.

Describing the experience: Drawing on how they felt about the tree they adopted, each student writes a poem or descriptive narrative about the special characteristics of their tree, its inhabitants, or its possible future.

Activity 10: Trees as Treasures

Related Activities:
"Urban Nature Search" in Project WILD K-12 Curriculum and Activity Guide pp. 70–72. Students use an extensive questionnaire that structures a pre-determined nature search path near the school. It includes many more kinds of observations in the urban nature search than Activity 8 of *Ellie's Log* and suggests good ideas for expanding student awareness of how wildlife shares the environment with humans.

"Adopt a Tree" in Project Learning Tree pp. 97–101. A similar exercise that includes a "Student Page" suggesting information to collect, illustrations by drawing, photography, and bark rubbing.

"Poet-Tree" in Project Learning Tree pp. 31–33. Provides poetry forms to structure description of students' outdoor experience with trees.

Related Resources:
Kirkland, Jane. *Take a Tree Walk*. Stillwater Publishing 2002. Self-guided interactive book for children to use for identifying trees in their own locales. Grades 3-7.

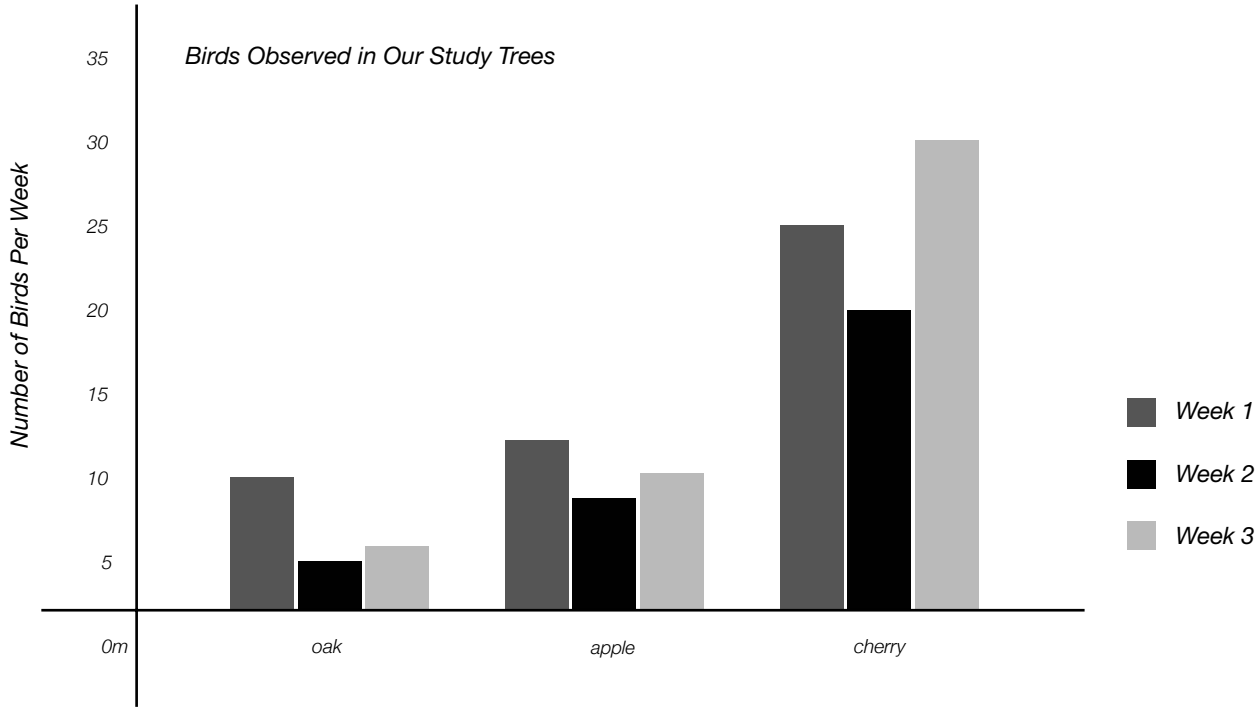
Morrison, Gordon. *Nature in the Neighborhood.* Houghton Mifflin Co. 2004. Naturalist Gordon Morrison reveals many plants and animals to be found in one's neighborhood through the seasons. Grades 2-5.

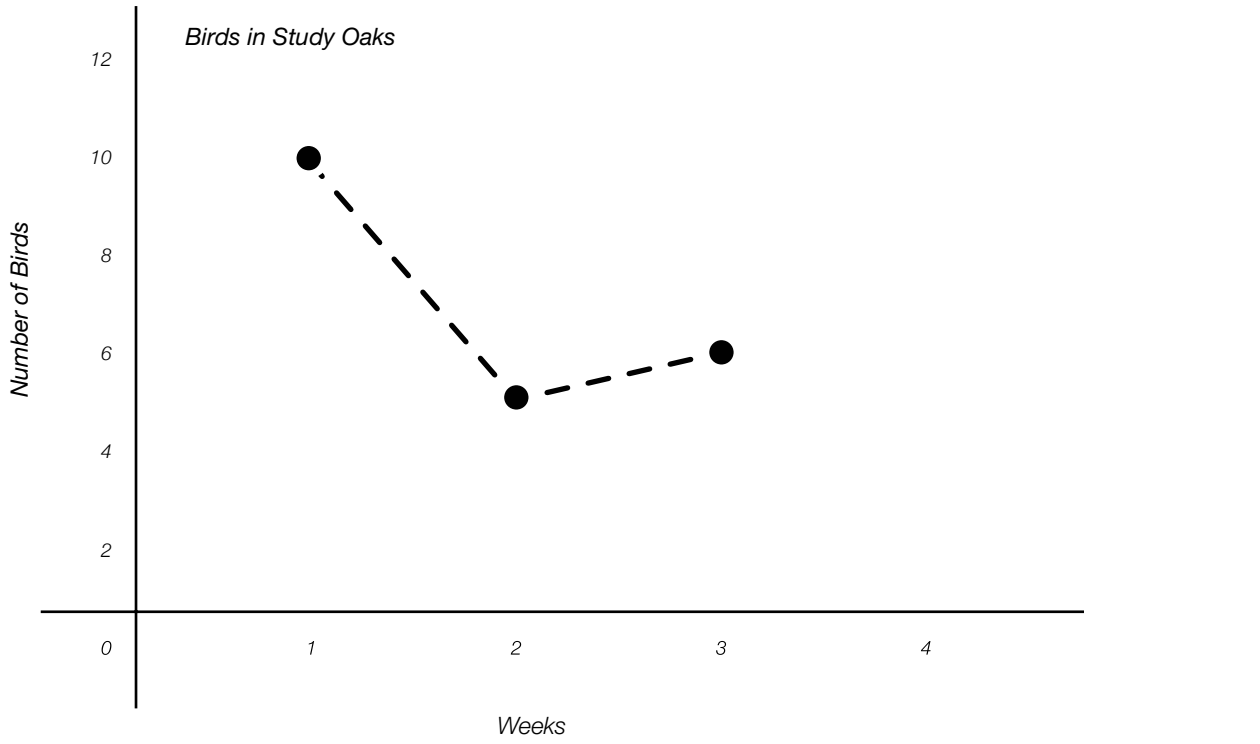
Classroom Chart: Class Matrix for Trees as Habitats

Teachers: A suggested format for classroom use on whiteboard or blackboard

Tree Species	Animals Observed	# Per Station	Location on the tree	Local Conditions	Behavior

Trees as Treasures Graph Examples





Theme Five: The Biology of Rotting

Concept:
Decomposition is a biological and chemical process.

Background:
The log falling in the forest at the beginning of *Ellie's Log* initiates a slow process of decomposition that Ellie observes on several trips to the forest, primarily in Chapter 4, Lots of Rot. This theme helps students better understand the process first by reviewing what is described in the book, then by observing decay in a leaf decomposition experiment.

Decomposition is the process whereby bacteria and fungi break down organic materials into dissolved and small particulate components. This process is enhanced by mechanical breakdown by physical forces (e.g., flowing water) and biological activities (e.g., invertebrate consumption). Fungi, like mushrooms, penetrate into wood with a network of fine mycelia. Ellie and Ricky see how insects also help break up the layers of a log by boring and tunneling. Lichens break down wood by releasing weak acids as they grow on trees and decaying wood. Roots of young plants growing in nurse logs, absorbing nutrients from the decaying wood, further break up the inner layers of the log. Mosses help keep the woody environment moist and suitable for other plants and animals.

Teaching Standards for Theme 5
OR Science Standards: Interaction and Change
CCSS: Speaking and Listening

Activity 11: Detecting Decomposition

Class time: 45 minutes
Assessment: 30 minutes

Objective:
Students will identify the steps in how a log decomposes by reviewing Chapter 4 in *Ellie's Log*.

Additional Teaching Standards for Theme 5, Activity 11
CCSS: English Language Arts & Literacy

11A.
Introduction

Students review how they define decay and rot, recalling their experiences from Activity 4: Changes in a Flipbook Journal.
Examples: fruit rotting, cheese molds, wood rotting

Decomposition in *Ellie's Log*
Ellie and Ricky find evidence of decay during many of their forest adventures; the chronological order of log decay is most specific in Chapter 4 (Lots of Rot).

After a careful reread of Chapter 4, students list the order of log decomposition that Ellie and her mom uncover, beginning with the Great Tree. (Also refer to the illustration in Ellie's notebook at the end of chapter 4). The class works together to post the order of this process on the chalk or whiteboard.

At the Great Tree:
1. Tree falls, comes in contact with the ground.
2. Boring beetle chews through tough outer bark.
3. Beetles (like Ambrosia beetle) feed on softer inner bark.

At an older log with mushrooms, covered with moss:
4. Inner bark gone.
5. Following tunnels made by boring beetles, mushroom mycelia make a fungal mat that helps dissolve inner tissues. Bacteria assist in dissolving inner bark.
6. Carpenter ants and termites chew harder tissues.
7. Other beetles continue chewing on remaining heartwood.

Another older log provides nutrients for young plants:
8. As a nurse log it feeds hemlocks and huckleberry.
9. Specialized fungi dissolve heartwood into crumbling chunks.
10. Spaces make homes for centipedes, beetles, plant roots, lichens, and mosses.

At a log buried in the ground:
11. As the old log finally decomposes, it becomes part of the forest floor.

11B.
Assessment Opportunity:
Illustrating log decomposition

The class has described a process in which one biological activity leads to another. To help conceptualize the idea of process, each student illustrates decomposition as a color drawing or diagram. Students are encouraged to think creatively about how to show the flow of resources. How are the different phases related to each other? What animals might weave into several parts of the process?

Related Activities:
This Guide, Theme Two, Activity 4: Changes in a Flipbook Journal

"The Fallen Log" in Project Learning Tree pp. 105–107. This exercise is highly dependent on locally accessible decomposing logs. The background information reviews the process of decomposition and how organisms facilitate decay, as encountered in *Ellie's Log*.

Related Resource:
Lavies, Bianca. *Compost Critters*. Duttons Children's Books. 1993. Description of the creatures that live in a compost pile, from microbes to millipedes and earthworms, and what they do to aid decomposition. Grades 3-7.

Activity 12: A Rotten Experiment

Preparation time: Schoolyard survey: 30 minutes; Gathering materials: 1 hour; Copy handouts 15 minutes
Estimated class time: Study design: 50 minutes; Collecting leaves: 30 minutes; Making and placing packets: 50 minutes; Retrieving and weighing packets: 40 minutes each time
Assessment: 50 minutes

Objective:
Students will design and execute an experiment to compare rates of leaf decomposition.

Background:
Decomposition of logs in the forest where Ellie lived required many years, even centuries. The experiment described in this activity takes advantage of decay that happens in a short time interval with observable and measurable leaves. The conditions favorable for leaf decay include adequate moisture, the presence of colonizing bacteria, and sufficient warmth. The methods for the student experiments are designed to explore these conditions.

Additional Teaching Standards for Theme 5, Activity 12
OR Science Standards: Scientific Inquiry

Preparation:
Survey a likely study site or sites where leaves can be placed and left for the duration of the experiment. During this survey determine how the rings will be protected and undisturbed during the experiment.

The class will observe rates of decomposing leaves that have been placed in packets bound by bird netting. This is an opportunity to design an experiment in which students expect different rates of decomposition. Begin by introducing elements of the experiment, then ask for ways to set up the experiment that would likely create different rates. Deciding upon the class study question will help students understand what each study treatment will be (e.g., How do rates of decomposition differ between leaves from different tree species?, How do rates of decomposition differ in different moisture levels?)

Materials:

- Deciduous leaves collected by students into small paper bags or buckets
- Buckets to soak leaves for twenty-four hours (One bucket per leaf type)

To make leaf packets
(described in For Student S12A):

- Bird netting to hold leaf packets
- Large safety pins to pin leaves together
- Pipe cleaners or plastic wire to weave netting together
- Wrap ties with paper tags for labeling each leaf packet (ties used for bulk groceries are good for writing on)
- Sharpie pens for labeling
- Tools for the experiment on site
- Wire coat hangers, each bent into a square; when the hook is bent down and anchored with a rock or brick the hanger can hold the leaf packs in place. (1 hanger per student team)
- Student notebooks for recording information and/or Rotting leaves data sheet
- Pie tins or other flat containers for carrying leaf packets prior to weighing
- Six-sided dice cubes for random choice of leaf packs
- Small plastic sandwich bags

Weighing Station:
Postal or kitchen scale to weigh leaves
Paper towels to dab leaves before weighing
Small paintbrushes to brush away debris on wet leaves
Pencils for recording weights to data sheets

For Students:
S12A. Protocol for a Rotten Experiment
S12B. Rotting Leaves Data Sheet
S12C. Leaf Decomp Graphs

Activity 12: A Rotten Experiment

12A.
Study design

Students are introduced to elements of the experiment that will measure rates of leaf decomposition, including a sample of a leaf packet pinned together in netting, that will be placed on moist ground for several weeks.

Students consider what affects the rates at which leaves decompose. The factors they suggest are converted into possible questions to study in this experiment.

Possible factors: different kinds of leaves, live vs. fallen leaves, leaves in wet habitat vs. dry habitat, leaves on the ground vs. those in a stream.

These factors could be written into questions such as:
1. Do leaves from different species of plants decompose at different rates? (soft leaves decompose faster, tough leaves and needles are very slow)
2. Do leaves still on the tree (green leaves) decompose at the same rate as dried, fallen leaves?
3. How do moisture conditions affect the rates of decay?
4. Does exposure to soils increase the speed of decay?

Students discuss how each question could be answered in their particular schoolyard location and choose a question to answer. The chosen question is noted at the top of their Rotting Leaves data sheet (S12B).

How many replicates of the same condition will we have? Each "condition" (particular leaf species, greenness or dryness of leaves, three conditions of moisture; five soil conditions) is a treatment in the experiment.

Students are reminded about the importance of replication as experienced in the "Full of Beans" game (Activity 9). They consider the numbers of teams they will have in the class, and decide on how many replicates per condition will be included in their study.

Student teams are assigned one replicate, and members specify the assigned condition on their Rotting Leaves data sheet (S12B).

How many leaves should we collect?
Answering any single question requires quite a few leaves. For each condition, the unit to be weighed will be a packet of leaves (not single leaves). To allow for variation in that condition there should be multiple packets for each condition.

Example:
If the question is *How does the rate of decomposition vary between maple leaves and alder leaves?*, there are two conditions (maple and alder).
To test for differences there might be eight tests for maple and eight tests for alder. These are the "replicates" of the experiment; one replicate assigned to each team.

To measure the change in weight over four weeks, each team would need one packet per week, or four packets, with two extras to allow for unexpected surprises.

Finally, several leaves will be needed per packet (e.g., ten leaves per experimental packet).

Students use S12A Protocol for a Rotten Experiment to calculate the numbers of leaves they will need.

12B.
Running the Rotten Experiment

Follow the For Student, S12A: Protocol for a Rotten Experiment, to proceed with collecting, soaking, weighing and setting leaves out for decomposition.

Additional tips for running the Rotten Experiment:
Observing leaching before leaf packs are made:
Leaves are soaked for at least twenty-four hours before the experiment to help decomposition begin. Soaking will encourage colonization of bacteria and fungi. After the leaves have been soaking for at least twenty-four hours, students will observe a change in the color of the water.

What is happening to leaves in the water?
Dissolved organic chemicals are leaching out of the leaves—these are called "leachates."

Where have students seen this same phenomenon?
Making tea.
On the edges of ponds or streams where leaves are held— and flow hasn't carried away the leachate.

This is the first step in decomposition. Besides mechanical breakdown on logs, chemicals like acids produced by lichens slowly work at decomposing wood.

Initial packet weigh-in:
Cutting netting before weighing begins may speed efficiency as handling the netting may be messy. The steps for making packets (#5-9) might be streamlined by having each team work in an "assembly-line" arrangement.

Choosing packets randomly:
After one week, or after the designated time to allow rotting to begin, each team chooses (at random) one packet per treatment to weigh. This will be repeated each week of the experiment. The order in which the packs will be picked up is decided at the beginning of the experiment. To choose randomly:

One dice cube can be used by each team to determine the order in which packets would be collected. This randomization will avoid potential bias that can occur in picking up packets as their appearances change unevenly during the experiment.

For example, in an experiment comparing alder leaves with willow leaves the following sequence might appear for one replicate of each treatment (one team could pick up alder, another pick up willow):

Week 1: Packet #2, Alder; Packet # 6 Willow
Week 2: Packet #4, Alder; Packet # 3 Willow
Week 3: Packet #1, Alder, Packet #2 Willow
Week 4: Packet #5, Alder, Packet #4 Willow

The packet numbers labelled ahead of time by each team are entered onto page two of their Protocol sheet. At the field site, packets are collected by placing the appropriate one into a pie tin or another shallow container to retain all the pieces of decomposing leaves.

Weighing the packets:
In the lab, retrieved packets are examined in the pie tin that was used for collection. Students remove any small insects or invertebrates held in the leaves; these can be recorded and examined under microscopes after weigh-in. Sand or grit that might have been collected in the leaf packets should be gently brushed off before weighing. If the leaf packs are very soggy, they might be gently dabbed with a paper towel, though the leaves may be fairly fragile and leaf material might be lost.

All the leaves from one packet and the safety pin can be weighed in the pie tin. After the packet weight is recorded, material can be saved into a plastic sandwich bag in case reweighing is necessary. The pie tin is weighed empty, as a "tare" weight that needs to be subtracted to determine final packet weight. Alternatively the packet can be transferred to a light, flat container that has already been weighed prior to packet weigh-in. Plastic Petri dishes or cottage cheese container lids would work well. This second protocol will work best if leaves are relatively intact.

The teams who complete weighing first help design a data matrix for teams to enter results on the blackboard or whiteboard.

12C.
Assessment Opportunity:
Evaluating the Experiment
(Students can share results and graphs of their experiment at ElliesLog.org)

Before graphing activity begins, the most effective ways of displaying the data are reviewed (See also Activity 10G). Because of the complexity of this experiment, the following questions should be discussed:
How can more than one treatment be displayed?
How is time incorporated into the graph?

Comparing graphs (For Student S12C):
The line graph connects weight from the same leaf type each week; the differences in rates are clear over the period of the experiment. In contrast, the bar graph displays the weights for each week, and the reader must mentally connect the bars to understand change.

Activity 12: A Rotten Experiment

However, differences between leaf types for any one week are clear in either graph.
Each student graphs their team's results, and after the class data is combined, graphs of the class results are also made. The class reviews the original question, and students suggest how the results answer the question.

Each student carefully labels the graphs he or she has drawn. The student chooses one of the graphs drawn and writes a paragraph beginning with the question and describing the answer found by evidence in the experiment.

Related Activities in this guide:
Theme Two, Activity 4 Change in a Flipbook Journal
Theme Four, Activity 9: Critter Hunt
Theme Four, Activity 10: Trees as Treasures

Related Resources
Fredericks, Anthony D. *Under One Rock: Bugs, Slugs and other Ughs.* Dawn Publications 2001. An engaging story combining scientific fact and tales about critters living under rocks. Grades PreK-5.

Lavies, Bianca. *Compost Critters*. Duttons Children's Books 1993. Description of the creatures that live in a compost pile, from microbes to millipedes and earthworms, and what they do to aid decomposition. Grades 3-7.

Milne, Lorne. *A Shovelful of Earth*. Holt 1987. Describes different types of soil and the kinds of plants and animals that live in them. Grades 5-7.

S12A. Protocol for A Rotten Experiment

1. Define the experiment.
The question we will answer is:

_____

_____

The condition (or treatment) our team will be measuring is:

_____

_____

2. Collect Leaves.

   Each team will be in charge of packets placed in one location; each packet will have several leaves in it. Fallen leaves are preferable. If they are picked from trees or bushes, take care not to damage the source plant. After class discussion, each team will be assigned a location and a particular treatment.

L = Number of leaves in each packet (e.g., 5)
N = Number of times each team will picking up packets to weigh. (This is the number of packets needed for each treatment per location.
L x N = number of leaves needed for each team

Team Goal for leaves to collect: L x N =

_____

3. Soak leaves in a bucket for at least 24 hours.

Date and Time leaves put into bucket: _____

Date and Time leaves taken out: _____

4. Meanwhile, cut bird netting into rectangles, about 5”x10”. These will be folded to make “envelopes” over the leaves.Number of rectangles = number of pick-up dates +2 (If you are picking up packets 4 times, then you will need 6 packets, to be sure there are 2 extras in case something unexpected happens during the experiment.)

5. Gently dab dry each leaf with paper towels before weighing.

6. Using a large safety pin, pin together 5 leaves. The leaves may tear easily when wet, so treat them carefully.

7. Weigh each leaf packet on the scale. Record the initial weight for each packet.

8. Fold bird netting over pinned packet, weave edges of netting with a pipe cleaner or wire.

9. Label each packet with location, treatment, and packet replicate numbers 1 to 6 (e.g., side yard, alder leaves, #1).

10. Deliver packets to your assigned study site and secure the packet on corners with wire coat hanger and rocks or other weights to prevent them from blowing away.

11. Assign the order of how packets will be retrieved during the experiment randomly, by rolling dice according to instructions by your teacher.

Pick Up Schedule for Leaf Packets

Day One. Packet Number: _____

Day Two. Packet Number: _____

Day Three. Packet Number: _____

Day Four. Packet Number: _____

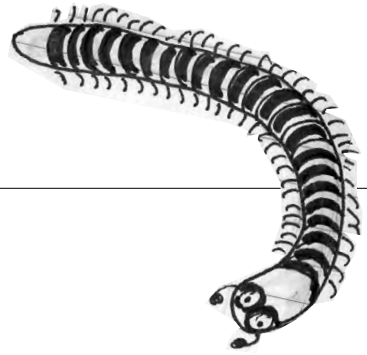
12. Place the packet into a pie pan or other small, flat container to bring into the classroom.

If the leaves are wet, dab them dry, brushing away extra soil particles. Capture and record the number of small invertebrates that might also be in the packet.

13. Weigh all the leaves together, with the pin in the pie tin (Total Weight). This will be compared to the initial pinned packet. Remove leaf material (store in a sandwich bag in case it must be reweighed).
    Reweigh empty pie tin. Subtract tin weight from Total Weight = packet weight.

14. Record packet weight on team datasheet. Also note the team member who was responsible for the weighing each time.

S12B. Rotting Leaves Data Sheet



Our Study Question:

Team Members:

Experimental Condition for our Team: (for example leaf type, soil type, moisture condition)

Our Site:

Initial Weight = leaves and pin *Total Weight* = pie tin, leaves and pin *Packet Weight* = Total – pie tin weight

For Notes: list insects or other living materials found on leaves, relative condition, texture of leaves, the degree to which soft parts of leaves are missing.

	Initial Date	Initial Weight	Collection Date	Total Weight	Pie Tin	Final Packet Weight	Recorder
Packet 1							

Notes:

Packet 2							

Notes:

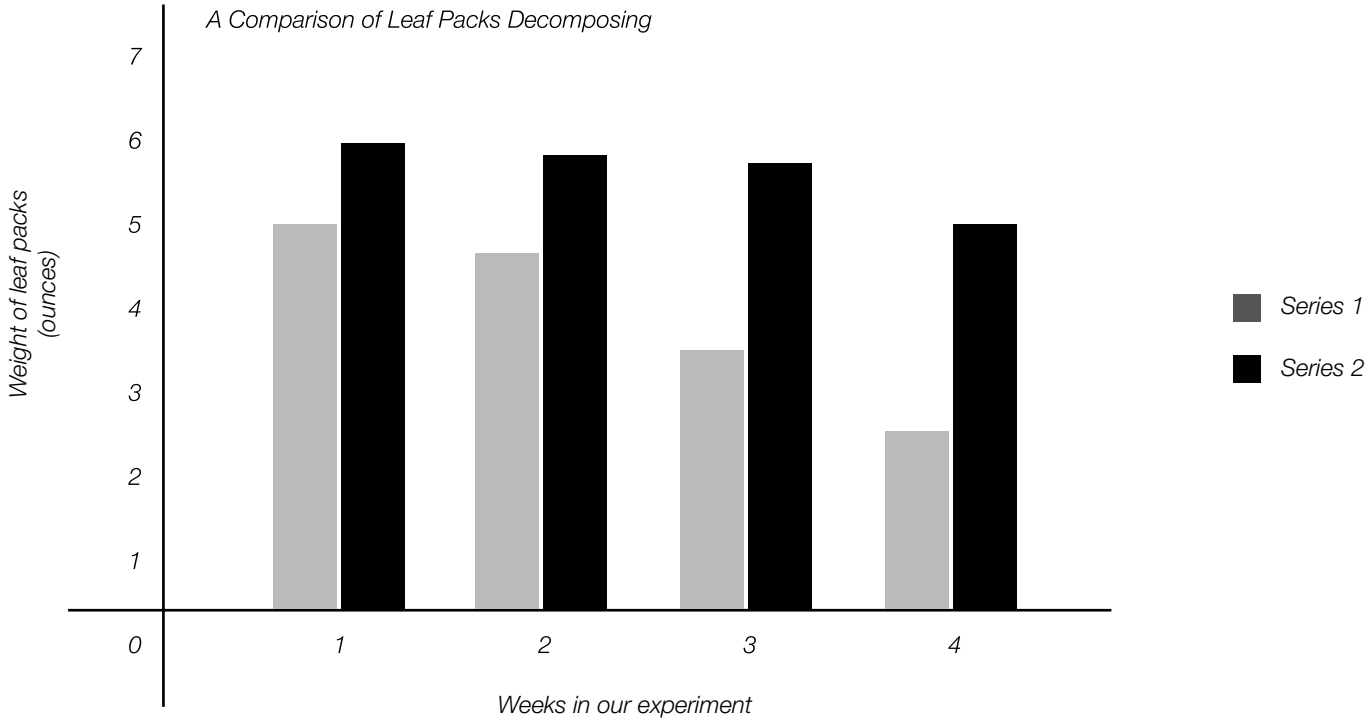
Packet 3							

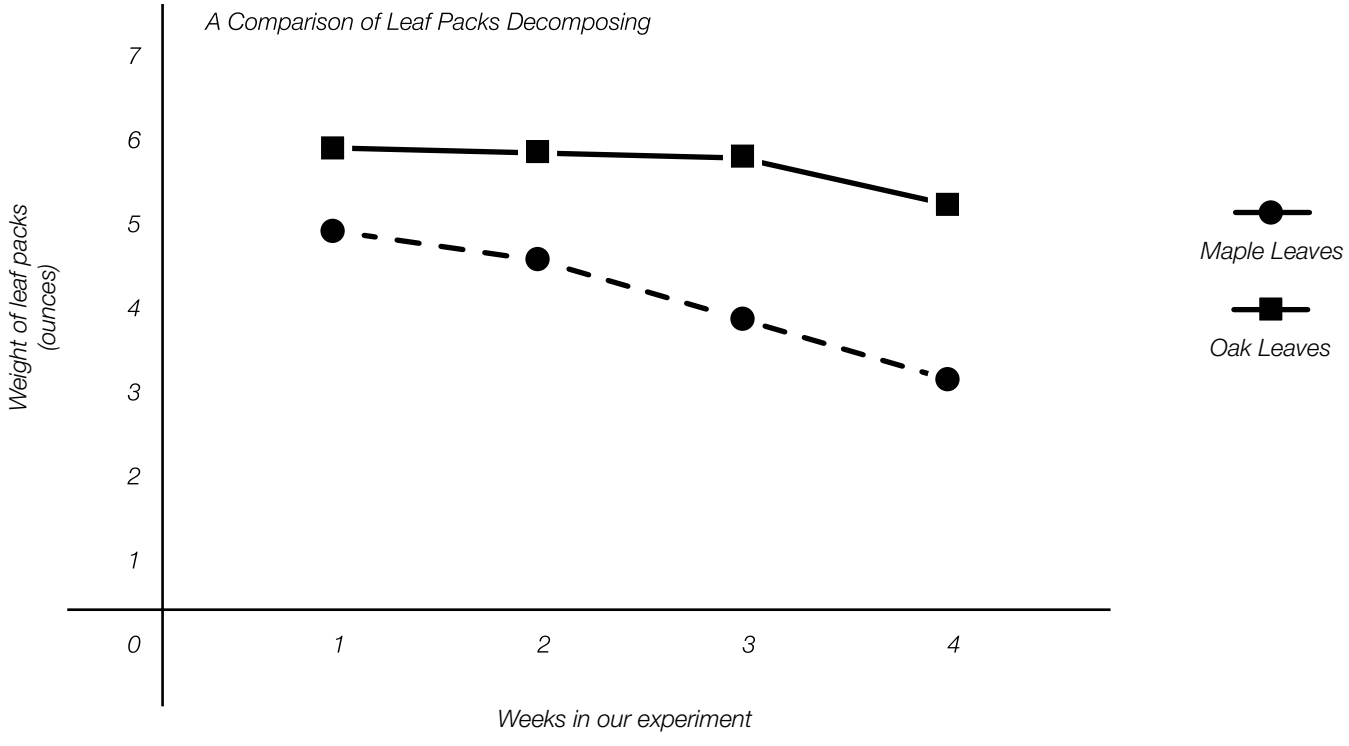
Notes:

Packet 4							

Notes:

S12C. Leaf Decomp Graphs





Theme Six: Forest Connections

Concept:
Forest food chains link up into food webs.

Background:
A food chain describes the connection between a food resource and its consumer, such as a plant and an herbivore, or prey and its predator. Several examples are provided in *Ellie's Log*. Though simple examples, such as a caterpillar and its leafy food, are easy to conjure, empirical evidence linking organisms in this way is often difficult. As with Derek Homesly's explanation about how red tree voles strip fir needles for food and nesting, observations and experimentation to verify these links can require much patient effort. A food web expands these connections by integrating multiple food chains within an environment. Students will consider real biological relationships as they reexamine "data" provided in the book.

See Web of Life in Project Learning Tree as a possible pre-activity for this theme.

Teaching Standards for Theme 6
OR Science Standards: Structure and Function; Interaction and Change
CCSS: Speaking and Listening

Activity 13: Building Chains and Webs

Preparation time: Copying handouts: 10 minutes
Class time: 30 minutes; Modifying food webs: 15 minutes
Assessment: Drawing food webs: 15 minutes; Modifying food webs: 20 minutes

Objective:
Students will identify food chains encountered in *Ellie's Log*, and explore internet and guidebook resources to suggest how chains become webs of interconnectedness. Implications of how life cycles of particular organisms can affect food webs will be explored in the second part of this activity.

13A.
Building webs
Students copy these simple food chains.

Pollen	Bees
Mouse	Hawk
Worm	Robin
Huckleberry	Deer

How could we extend these links?
What energy resources do those on the left of the list rely upon?

Sun's Energy: Pollen
Seeds: Mouse
Decaying Leaves: Worm
Sun's Energy: Huckleberry

Where might the energy from those on the right go?

Bees: Bird
Hawk: Disease, Mortality to decompose
Robin: Hawk
Deer: Cougar

These look like straight lines, but they might be interconnected into a web.
What would the new networks look like?
Students draw possible networks among these organisms on their handouts.

Activity 13: Building Chains and Webs

13B.
Food chains and networks in *Ellie's Log*

In the book, Ellie and Ricky discover some simple chains. Students in small groups list forest food chains described in the book, using tables from previous lessons (particularly S5A). They may want to refer to the book again.

Short Chains:

Chapter 2: Douglas squirrel: Doug fir seeds
Chapter 4: Chipmunk: Doug fir cones/seeds
Chapter 5: Caterpillar: Swainson's Thrush
rock-cased caddisfly: dipper
Chapter 6: Rodents: screech owl
bark, leaves, fruit: porcupine
mushrooms: flying squirrels

Longer Chains:

Chapter 3: springtails, other small invertebrates: pseudo scorpions, beetles
other larger invertebrate predators: birds, mammals and other insectivores
Chapter 4: wood-beetles: slender salamander
Chapter 5: tiny invertebrate prey: net spinning caddisfly: trout: kingfisher, salamander

Where might the food chains overlap in the forest?
Students discuss these chains in the context of where these organisms live.
Answers: on logs, in tree canopies, in moss

13C.
Assessment opportunity:
Drawing food webs

Students choose a food web or food chain of at least five links to illustrate with their own drawings. Students could also construct a mobile using members of a food web.

13D.
Expanding the web

Discussion: Web interactions
Organisms can interact when they are living in the same habitat. Some animals are very mobile so they inhabit a variety of places within the same season, while others stay most of their lives in one place.

Which organisms in the story have a mobile lifestyle?
Douglas squirrels, chipmunks move between trees
Swainson's Thrush flies through the forest canopy.
Screech owls perch up high and fly through the forest searching for prey.
Porcupines lumber on the ground, climb trees.
Beetles can fly or crawl between habitats.
Kingfishers swoop through the stream corridor.

Which organisms stay in one place a long time?
Caterpillars may stay on one bush or tree.
Caddisflies can crawl, but larvae stay within a small area of a stream.
Moss invertebrates don't move far.

Some organisms in Ellie's forest food web have life cycles in which a change in life stage results in leaving the habitat. For example, some birds migrate into the forest during spring, then leave; aquatic insects are larvae in the stream, then emerge into the air.

Students look at the animals in the food web, and consider the changes that will happen when animals leave the habitat because they have reached a different stage of life.

Caterpillar pupates, becomes a butterfly (changes in diet, in habitat)
Swainson's Thrush (migrates into the forest as an adult, raises young, migrates south in the late summer)
Trout (young trout seek refuge in quiet side pools, move into the faster flow when they are larger, some species swim out to the ocean)

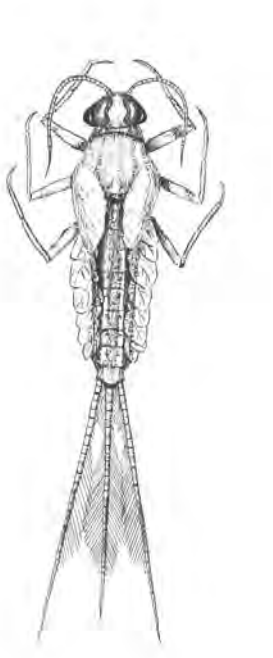
13E.
Assessment Opportunity:
Modifying food webs

Students choose an organism that is mobile, either by lifestyle or by changes in life stage, and diagram the possible changes in food webs it participates in within an ecosystem.
For example, a kingfisher dives into and out of pools with different prey and becomes part of different food chains.

How can diversity in the habitats make these varied opportunities possible?

Related Activity:
"Web of Life" in Project Learning Tree pp. 194. This might make a good pre-activity to Activity 13. Includes a popular activity in which each student represents a plant or animal. They become connected when a ball of string is passed between organisms that are connected to one another. Changes in the structure of the food web occur when the string is pulled, or organisms drop out.

Related Resources
McGinty, Alice. *Decomposers in the Food Chain*. PowerKids Press 2002. Illustrates how the "last" link of the food chain is connected to primary producers that begin the cycle again. Grades K-5.



Glossary

Biological diversity (also biodiversity): takes into account the numbers, kinds, and relative abundance of things.

Community of organisms: made up of many different taxa who live in one location.

Decay: see Decomposition.

Decomposition: the process whereby bacteria and fungi break down organic materials into dissolved and small particulate components.

Diversity: see Biological diversity

Ecosystem: contains multiple habitats, characterized by vegetation type, typography, and climate.

Emigrate: to move away from a habitat or environment.

Food chain: unilinear links of energy passing between organisms; can describe relationships of herbivory, predation, omnivory, or parasitism.

Food web: interconnected relationships of energy exchange between organisms that incorporates many food chains.

Foraging: searching activity, particularly for food.

Habitat: the home where an animal lives.

Immigrate: to move into a habitat or environment.

Leachate: dissolved organic substances that derive from plant materials decomposing in water.

Photosynthesis: the process in which plants, with the aid of chlorophyll, convert carbon dioxide and water, in the presence of the energy from light, into organic tissue.

Replicate: a set of conditions fully repeated in a field or laboratory experiment.

Scientific evidence: information systematically collected and recorded that includes quantitative measurements, detailed observations, and specific details of time and place.

Taxa: a generic term for the name of an organism that can identify it to a variety of taxonomic levels, such as species, family or order, denoting a scientific or common name.

Taxa richness: numbers of kinds of biota in a place.