Section IV
LESSONS AND ACTIVITIES FOR TEACHING AND LEARNING ABOUT THE COAST REDWOODS

The following lessons and activities are grouped into four categories; or chapters

Chapter 1: Activities are best done before a trip to the redwoods.
Chapter 2: Activities are intended to be done in the woods.
Chapter 3: Lessons are intended to be used after a trip to the redwoods.
Chapter 4: Lessons and activities that might be done at any time.

Within each chapter, the lessons are arranged alphabetically.

If you do pre-trip lessons, plan how to refer to them while on the trip. If you do post-trip lessons, be aware of ways to prepare the students while on the trip by making observations or asking questions.

While *Redwood Ed* is written for use in teaching about the coast redwoods, most lessons could be used to teach about any kind of tree.

What are “Anticipated Outcomes?”

For each lesson in *Redwood Ed*, I list one or more Anticipated Outcomes. These outcomes are similar to goals or objectives, but are generally not written in the language that teachers would used to write goals or learning objectives. Each user of *Redwood Ed* may have different specific goals and objectives, and may want the students or other learners to demonstrate their understanding in different ways. Classroom teachers may have different goals from docents, who may have different goals from home-schooling parents or park naturalists. The Anticipated Outcomes can help users develop more specific goals to meet their specific needs.

California State Content Standards
Each lesson or activity can help students master one or more of the California State Content Standards in science, math, social studies, or English. In general, these lessons are NOT meant to teach standards to mastery by themselves, but they can be useful in helping students learn the standards.

The California State Content Standards are grouped into "Standard Sets." Each set contains several Content Standards. Some of the lessons in *Redwood Ed* can be used to help teach an entire Standard Set, while others address specific standards within a Standard Set. If an entire Standard Set is addressed by the lesson or activity, that set is indicated with the letters "S.S." If the entire set is not addressed by the lesson, the standard is listed without the "S.S."

Most lessons address more than one standard. Standards (or Standard Sets) that a lesson addresses particularly well are listed as "Focus Standards." Most lessons can

be used to help teach or reinforce additional standards, which are listed as "Other Standards." The Focus Standards are listed by number and paraphrased. The Other Standards are listed only by number. See Appendix I for California State Standards addressed in *Redwood Ed.*

Project Learning Tree has published a series of booklets that correlate the activities in the 2006 *Pre K-8 Environmental Education Activity Guide* with California Content Standards in Science, English-Language Arts, and History/Social Science. See Appendix III: Organizations, and go to < www.plt.org/cms/pages/21_21_43.html > for updated versions.

Environmental Principles and Concepts
In addition to State Content Standards, California has adopted Environmental Principles and Concepts (EP&C). The EP&C are intended to compliment the standards to provide assistance in teaching Content Standards from an environmental perspective. The EP&C are listed in Appendix I, along with California State Content Standards. The lessons in *Redwood Ed* include references, in abbreviated form, to the Environmental Principles and Concepts that the lessons can help address.

Some activities have potential safety issues such as the use of glass. Always warn students of such issues and insist on safe behavior. Watch for the *Redwood Ed* caution icon.

It is very important for the teacher or group leader to try out activities before asking students to do them, especially in the case of experiments. Always test the activities to be sure that your particular equipment will work and that the instructions are understood.

A word about assessment:
In general, assessment tools have <u>not</u> been provided. Different teachers may wish to assess for different things in different ways. In some cases, suggestions are made regarding assessment tools. In others, criteria, or the content for which one should probably assess are suggested. When using these suggestions to develop assessment tools, be sure that the assessments align with the goals and objectives that you have developed for the lesson or activity.

Chapter 1
Pre-Trip Activities

The activities in Chapter 1 are generally best done prior to a visit to a redwood park or forest. They teach concepts and information that will make the visit more beneficial and provide background information that will increase the students' learning.

A Reminder
All activities should be tried out by the teacher prior to having students do them in order to be sure that the directions are understood and that they can be done with your particular equipment and materials. This is important not only to be sure that the activities will work, but to be sure that they can be done safely.

Such details as time estimates are only approximate; as the teacher, you know your students best.

Be sure to consider the activities in Chapter 4: Activities for Any Time.

The Anatomy of a Giant

ACTIVITY SUMMARY
Students learn the basic anatomy of a redwood tree in the classroom. They then study the anatomy of a real redwood tree.

CONCEPTS TO BE LEARNED
1. Plants such as redwood trees have different parts that have different functions.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences 2.a: Plants are the primary source of matter and energy. Science Investigation and Experimentation 6.a: Students make observations and inferences.

Grade 5: Life Sciences S.S. 2: Plants and animals have structures for various life processes.

Grade 6: Ecology (Life Sciences) S.S. 5: Organisms exchange energy and nutrients among themselves and with the environment.

Grade 7: Life Science: Structure and Function in Living Systems S.S. 5: anatomy and physiology

Other Standards:

Grade 7: Life Science…Evolution 3.1
Life Science…Evolution 3.4

Environmental Principles and Concepts

Principle I: Humans depend on natural systems.
Concept a: Humans depend on natural systems for goods and materials.

ANTICIPATED OUTCOMES
1. Students will increase their knowledge of tree anatomy.
2. Students will increase their knowledge of tree physiology.
3. Students will increase their ability to make and record accurate observations.

GROUPING
Individuals

TIME
Part 1: 30-60 minutes
Part 2: Varies. Can be completed over the course of a field trip

MATERIALS
- ❒ Study Guide: "The Anatomy of a Giant" (one per student)
- ❒ Reference books that show basic plant anatomy
- ❒ Drawing materials and paper
- ❒ Optional: samples of redwood branches, cones, bark, seeds

TEACHER PREPARATION

1. Obtain the materials listed on the previous page.
2. Make transparencies of the Study Guide.

PROCEDURE

1. Have the students use reference books and the Study Guide to learn basic plant anatomy and physiology.
2. While on a field trip to a redwood park, have the students compare the idealized plant anatomy drawings from the reference(s) to a real redwood. Have them note any differences.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. If you have a redwood tree on campus, it can be used, but it is better for the students to see the variation found among several trees.
2. You might bring in samples of branchlets, bark, and needles for students to observe in class, or visit a tree on the campus.
3. You might want the students to learn about the xylem and phloem, the sapwood.

ASSESSMENT

1. Can the students identify the major parts of a tree orally in the field and on a diagram?
2. The study guide can be used for assessment.

ANSWERS TO SELECTED STUDY GUIDE QUESTIONS

1. Students should notice such things as burls, misshapen needles, incomplete cones, twisted trunks, spike top trees, flat top trees, and other variations.

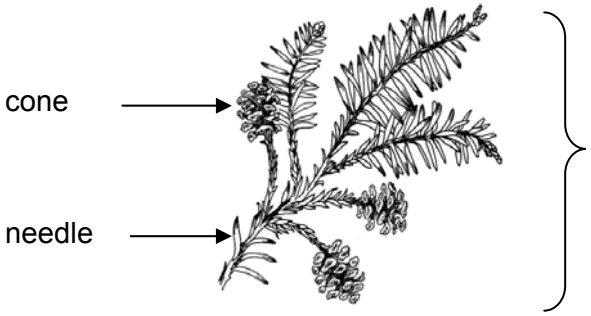


Figure 109

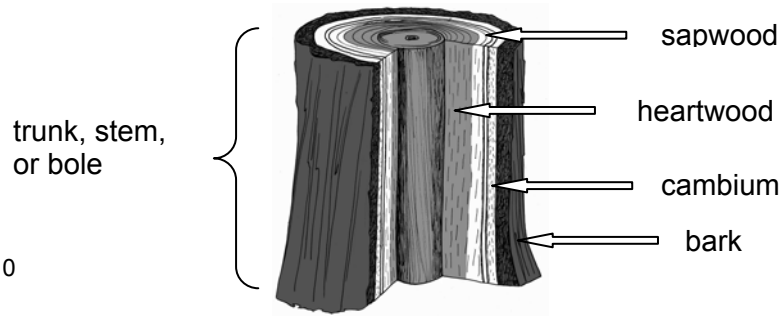


Figure 110

REFERENCES AND RESOURCES

Any basic science text should have information on plant anatomy and physiology.

The Anatomy of a Giant
Study Guide

You already know that plants, including trees, have different parts. They have leaves, stems (trunks or boles), and roots. They may have flowers, or they may produce cones.

Each of those parts has parts, too. A leaf may have a blade and a stem. A flower may have petals and a variety of other parts. Even roots usually have microscopic "root hairs."

If we look at the end of a log, or at a slice of a tree stem, we will see that even the stem of a tree has different parts.

In this activity, you will learn the names of some of the main parts of a redwood tree and what they do to help the tree live.

Procedure:
Part 1: At home or school:

1. Your teacher will provide you with books or other materials that will help you identify the parts of the redwood tree on the diagrams. You might also use resources found on the Internet.

2. As you find out the names of the parts, be sure to find out what they do for the tree (their function).

3. Label the parts of the redwood tree diagrams.

4. As you identify the parts, write their functions (jobs) in the spaces provided. A table has been provided for you.

5. Complete the crossword puzzle.

Part 2: Someplace where you can see some actual coast redwood trees.

You have learned about the main parts of a redwood tree. You have also seen drawings of a "typical" redwood tree. Sometimes actual trees aren't exactly like the "typical" or idealized drawings that we see in books.

Look at actual redwood trees and note (in words and sketches) some ways in which they differ from the idealized drawings that you have seen in books.

Anatomy of a Giant

The diagrams below represent a typical coast redwood tree. Label the bark, cambium, sapwood, heartwood, cone, needle (leaf), branchlet, and stem (trunk or bole).
In the table at the bottom, tell each part's function (what it does to help the tree live).

Figure 111

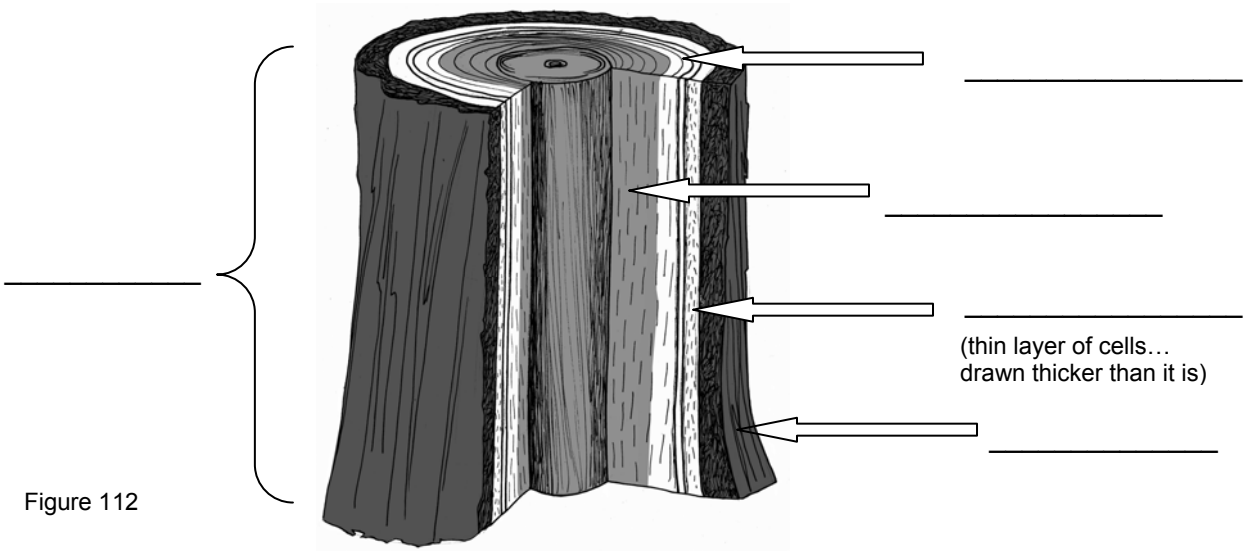
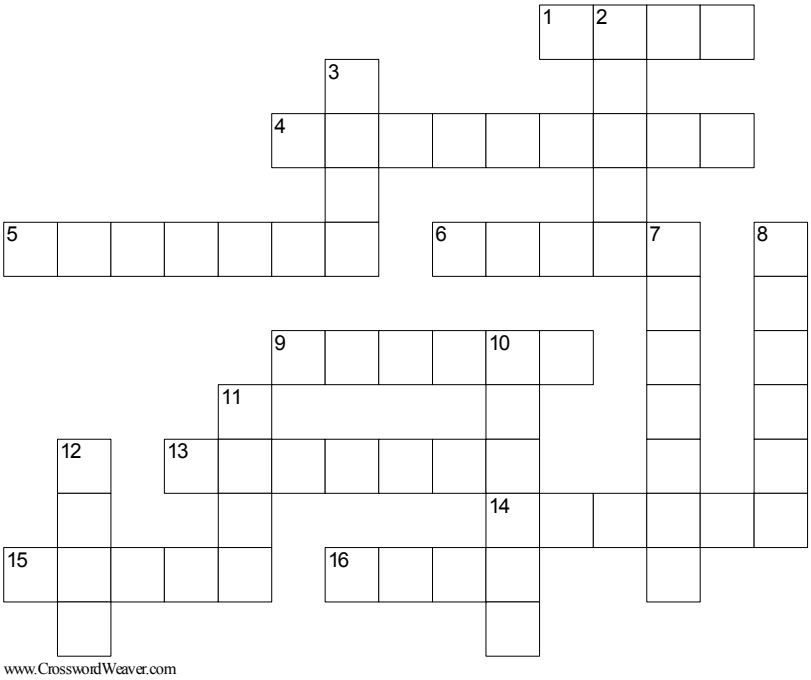


Figure 112

Leaf (needle)	**Branchlet with needles**	**Stem (trunk or bole)**
Cone	**Bark**	**Sapwood**
Heartwood	**Cambium (shown thicker than it really is)**	**Root (not drawn)**

Anatomy of a Giant Crossword Puzzle

Use the words from Anatomy of a Giant and other terms that have to do with the coast redwoods to complete the puzzle below.



Across

1 Fog __ provides water in the summer.
4 non-living center of tree, is dark in color because it has lots of tannins
5 living wood
6 *Sequoia sempervirens* live near the __.
9 redwood leaf
13 produces new wood
14 supports the leaves
15 supports the branches
16 where redwood seeds are produced

Down

2 absorb water and minerals
3 produces a new tree
7 __ are chemicals that help the redwoods resist termites and rot.
8 A __ ring indicates a year's growth.
10 Redwoods provide beautiful __ that is used for building decks.
11 protects redwoods from fire and insects
12 Trees can sprout from this.

Anatomy of a Giant Crossword Solution

The Case of the Runaway Topsoil

ACTIVITY SUMMARY
Students construct stream tables and test the effects of differing slopes and ground covers on erosion rates.

CONCEPTS TO BE LEARNED
1. Running water can erode topsoil.
2. Other things being equal, a greater slope increases erosion rates.
3. Differing types of ground cover can result in different erosion rates.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences S.S. 3: Living organisms depend on one another and their environment.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 5: Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 6: Earth Science S.S. 2: Topography is reshaped by weathering and transportation of sediment.
Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Grade 7: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Other Standards:

Grade 4: History 4.1
History 4.3.3

Grade 5: Earth Sciences S.S. 3

Grade 6: History 6.1.3

Environmental Principles and Concepts

Principle II: Humans affect natural systems.

- Concept a: Human populations and consumption affect natural systems.
- Concept b: Human extraction, harvesting, and use of resources affect natural systems.
- Concept c: Expansion and operation of human communities affect natural systems.
- Concept d: Human social systems affect natural systems.

ANTICIPATED OUTCOMES

1. Students will increase their understanding of the causes and effects of topsoil erosion and will understand some ways to reduce erosion.

GROUPING

Two to six students per group, depending on availability of materials

TIME

30-60 minutes

MATERIALS

- ❒ Stream tables: available commercially, or they can be made in a variety of ways with pans approximately 12-16" wide, 16-24" long, 3.5-7" deep (plastic, aluminum, nursery trays lined with plastic, or wooden (caulked and painted)
- ❒ Pieces of wood or bricks with which to create a slope
- ❒ Diatomaceous earth…available from swimming pool supply stores (Diatomaceous earth from garden supply stores may not work as well.) The amount will depend on the size of the stream tables. (It can be dried and used again next year.)
- ❒ Sprinkling can or coffee can with holes punched, or spray bottle
- ❒ Water
- ❒ Towels, sponges for cleaning up
- ❒ A variety of ground cover materials…redwood needle duff, leaves, straw, grass clippings, or? A landscaping company may provide some turf.

TEACHER PREPARATION

1. Obtain materials above.
2. Mix water with diatomaceous earth…

Wearing a dust mask is recommended as diatomaceous earth may irritate your nose. Add enough water so that water sprinkled on the surface runs off, forming a gully, instead of soaking in.

PROCEDURE

1. Always try experiments before having students do them!

2. Prepare the damp diatomaceous earth. Prepare a "hillside" so that the earth slopes towards one end of the pan.

3. Review the water cycle with the students. (See Appendix IV, Sources of Materials, for sources of water cycle posters.)

4. Have students predict what effect different slopes and different types of ground cover will have on the amount of earth that erodes when sprayed with water.

5. Have the students develop data tables that include their predictions, observations, and conclusions.

   Simple data tables might look like the ones below, but it is best if students develop their own for their own experiments.

Slope	Runoff (fast, medium, slow)
Gentle	
Medium	
Steep	

Ground cover	Evidence of erosion (earth at the bottom of the slope…none, a little, lots)
Bare	
Straw	
Live grass	

6. Students use watering cans or spray bottles to create "rain" on the "hillsides." Have them test varying slopes and different types of ground cover.

7. Students look for evidence of runoff or erosion and record their data on the data tables that they developed.

8. While visiting the redwood forest, look for places to point out erosion and hillsides that are and are not eroding.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Try to find hillsides near your school where you can do similar experiments.

ASSESSMENT

1. Do the students provide accurate and detailed observations, clearly recorded, and are conclusions based on observations?
2. Can students explain the relationship between slope, ground cover, and erosion?

REFERENCES AND RESOURCES

American Forest Foundation: *Project Learning Tree Pre K-8 Environmental Education Activity Guide:* "Water Wonders."

Kaufmann, Jeffrey et al.: *River Cutters.*

Shinkle, Jill: *Creek Watchers: Exploring the Worlds of Creeks & Streams.*

See Appendix IV, Sources of Materials, for sources of water cycle posters.

The Great Tree Cookie Mystery

ACTIVITY SUMMARY

Students examine a variety of rounds ("tree cookies") that show various growth patterns and events in the life of the tree and try to explain the patterns observed.

CONCEPTS TO BE LEARNED

1. Trees grow at different rates during different seasons and under different environmental conditions.
2. One can learn about a tree's growth and life history by studying the annual growth rings.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences 3.a: In any environment, some organisms survive well, some less well, and some don't survive.
Science Investigation and Experimentation 6: Students ask meaningful questions and conduct careful investigations.

Grade 5: Life Sciences S.S. 2: Plants and animals have structures for various life processes.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 6: Ecology/Life Sciences 5.a: Energy enters ecosystems as sunlight.
Ecology/Life Sciences 5.e: Numbers and types of organisms in an ecosystem depend on abiotic factors.
Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Grade 7: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Other Standards:

Grade 4: Mathematics Number Sense S.S. 3.0
Grade 5: Mathematics Number Sense S.S. 1.0, 2.0
Grade 6: Mathematics Number Sense S.S. 1.0, 2.0
Grade 7: Life Sciences 5.b
Mathematics Mathematical Reasoning S.S. 2.0

Environmental Principles and Concepts

Principle I: Humans depend on natural systems.
- Concept a: Humans depend on natural systems for goods and materials.

Principle II: Humans affect natural systems.
- Concept a: Human populations and consumption affect natural systems.
- Concept b: Human extraction, harvesting, and use of resources affect natural systems.

Principle III: Natural systems have cycles on which humans depend and that can be altered by humans.
Concept c: Human practices can alter natural cycles and processes.
Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.
Concept a: Effects of human activities on natural systems depend on the quantities of resources used and the quantity and characteristics of the byproducts of use.

ANTICIPATED OUTCOMES

1. Students will understand that environmental factors such as sunlight (and competition for sunlight), drought, and fire affect the growth rate of plants.
2. Students will be able to compare the growth rates of trees based on the size of the growth rings in wood samples.
3. Students will describe some possible causes of different growth rates and patterns as indicated by the growth rings.
4. Students will understand some factors that affect the growth of trees and the ways that those factors affect the growth of trees.

GROUPING

Depends on the number of rounds available (preferably 1 or 2 students per round)

TIME

30-60 minutes

MATERIALS

- ❒ Tree rounds that show various growth patterns as described on The Great Tree Cookie Mystery Clue Sheet. The rounds should be numbered by securely stapling a card to them or by a permanent marking pen.
- ❒ Magnifiers
- ❒ Rulers
- ❒ The Great Tree Cookie Mystery Study Guide (one per student or per team)
- ❒ Overhead transparency of The Great Tree Cookie Mystery Clue Sheet (or copies for student teams)
- ❒ The Life Story of a Tree (one per student)

TEACHER PREPARATION

1. Obtain materials listed above.
2. Make a transparency of The Great Tree Cookie Mystery Clue Sheet.
3. Duplicate The Great Tree Cookie Mystery Study Guide and (optional) the Clue Sheet.

PROCEDURE

1. Use a transparency and/or student copies of The Great Tree Cookie Mystery Clue Sheet to explain to students what tree rings are and how to find the age of a round.

2. Use the transparency of the clue sheet, or student copies, to explain some things in addition to age that can be determined by studying tree rounds.

3. Issue the rounds and Study Guides to the students.

4. Have the students complete the Study Guides.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. While on a field trip, look for cut logs or stumps and try to interpret the story told by the rings.
2. Students can make up and illustrate their own stories, including drawing the "cookie."
3. Christmas trees can be cut up to provide rounds that show some of the patterns.
4. See the activity "Slow Growth and Fast Growth in Redwoods."
5. See the activity "Fence Post Study."

ASSESSMENT

1. The activity sheet "The Life Story of a Tree" can be used for assessment.
2. Have students explain orally or in writing what they can deduce from a tree round.
3. The Study Guide can be used for assessment.

ANSWERS TO SELECTED STUDY GUIDE QUESTIONS

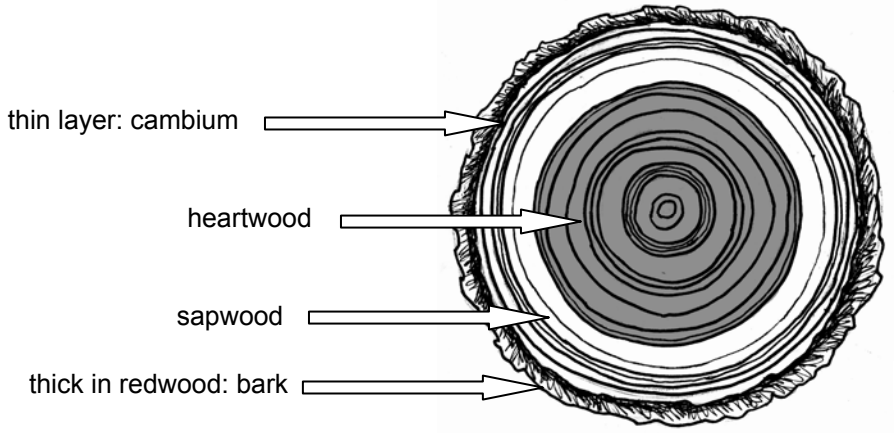
1. Depending on whether cambium is counted, the tree was 18-20 years old when cut.
2. 

Figure 113

3. Average annual growth: With a <u>diameter</u> that was 9 inches achieved in 18 years, 9 inches ÷ 18 years = 0.5 inches average growth in <u>diameter</u> per year. Be sure to point out that this is an average; it doesn't mean that it grew that much <u>each</u> year.

4. Sketches and observations should show the growth patterns, and the explanations should be reasonable and correspond to the information from the Clue Sheet.

REFERENCES AND RESOURCES

Tree cookies can be purchased from various sources. See Appendix IV.

American Forest Foundation: Project Learning Tree: *Pre K-8 Environmental Education Activity Guide*: "Tree Cookies"

The Great Tree Cookie Mystery Clue Sheet

Just like a detective, you can learn to read clues found in evidence. In this activity, you will examine and interpret the evidence provided by "tree cookies," which are slices cut from a tree trunk or branches. Each cookie, or round, provides information about the life of the tree.

As trees grow, a group of cells called the cambium layer produces the cells that become new wood. If the tree is growing rapidly, as it may do in the moist growing season, it produces large cells that form light colored rings. If the tree is growing slowly, as it may do in the late summer and fall, it produces rings of cells that are smaller and darker. A redwood tree will typically produce a light and a dark growth ring each year. Therefore, by counting the rings, you can determine the age of the tree. By measuring the width of the rings, you can tell how rapidly it was growing. (Remember, a year's growth is a light and a dark ring!)

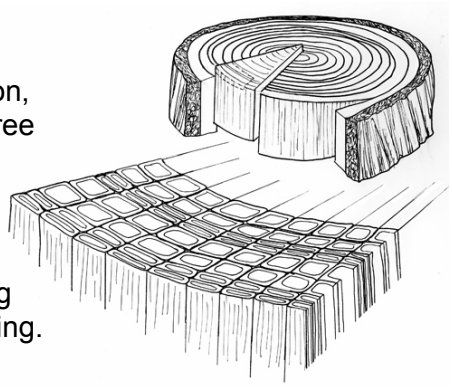
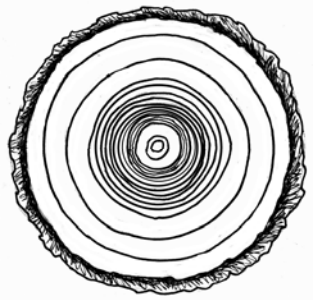
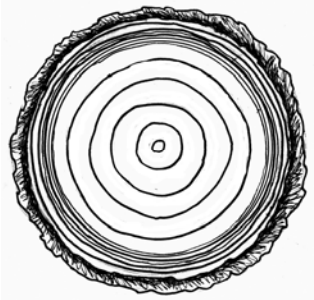


Figure 114

Tree cookies can also tell you about events in the life of a tree. A dark, charred area indicates a fire. A knot is formed when a tree grows around a branch. Sometimes a stub of a broken branch may be found in the cookie, and the tree may have grown over the stub. If a redwood grows on a steep hillside, it may grow more rapidly on the downhill side, which provides extra support. Such a tree will show an asymmetrical growth pattern, possibly forming a "flatiron" shape. Insect attack or drought may slow growth, resulting in suppressed growth with narrow rings. Logging of other trees, a storm, or other factors may open up the forest canopy and result in more sunlight and rapid growth or "release." Some of these growth patterns are shown below.



slow growth, then fast (release)

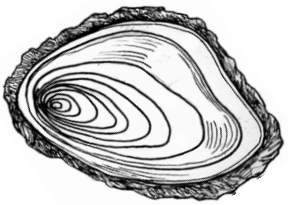


rapid growth, then slow (suppression)

fire scar/rot… healed over

bark damage… healing

parts of branches around which tree grew



buttressing, resulting in a "flat-iron" tree with more rapid growth on the downhill side, resulting in an anvil or (flat) iron shape

Figure 115

The Great Tree Cookie Mystery
Study Guide

1. How old was the tree at the right when it was cut?
2. Identify the following parts of the tree cookie:
   bark, sapwood, heartwood, cambium

   (thin layer of cells): _____

   _____

   _____

   (thick in redwood): _____

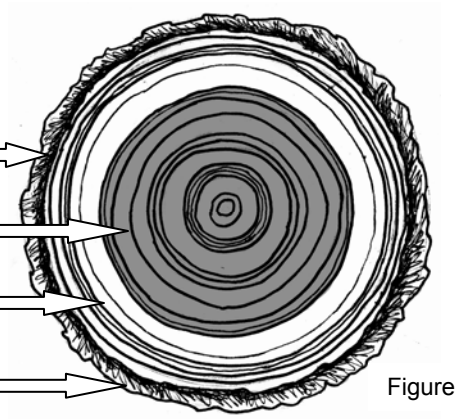


Figure 116

3. If the diameter of the tree drawn above was 9 inches, what was its average annual (yearly) growth rate? Show how you determine the answer.

4. Your teacher will provide you with several "tree cookies." For each one:
   a. Record the number of the cookie.
   b. Sketch the cookie, including any special patterns that it may show. You do not need to sketch every ring, but if some are close together and some are farther apart, show that pattern. Also describe your observations.
   c. Provide an explanation for your observations.

#__ Observation: Explanation:	#__ Observation: Explanation:	#__ Observation: Explanation:
#__ Observation: Explanation:	#__ Observation: Explanation:	#__ Observation: Explanation:

The Life Story of a Tree

A redwood tree's life story is told below. The small circle below represents the tree's first year of growth. Draw rings to indicate the tree's growth pattern. (You might want to draw the rings very lightly in pencil to be sure that you have enough space for 30 annual rings.)

The redwood tree started to grow in a sunny spot near a creek. For the first 5 years, the tree grew very rapidly because there was plenty of sunlight and water and the soil provided plenty of nutrients. Lots of other young redwoods were also growing along the stream, and after 5 years their tops all merged, creating a very shady canopy. The shade slowed down the tree's growth in the crowded forest for the next 7 years. A fire then burned through the forest, but the tree's thick moist bark allowed it to survive with only a scar on the one side where lots of dead branches had piled up. Some of the tree's neighbors, however, were killed, and the forest canopy opened up, allowing more sunlight for the next 4 years. After 4 years of rapid growth, a drought hit the area, and the tree's growth slowed for 3 years. The drought was so severe that more of the tree's neighbors were killed, and when favorable weather returned, the tree started to grow rapidly again. After 6 years of rapid growth, the canopy again closed in, and the tree grew slowly in the shade for the next 3 years. Loggers then came through the area and cut down many of the other trees, resulting in another growth spurt that lasted for 2 years. After 2 years, when the tree was 30 years old, loggers came through the stand again and cut the tree down to make lumber. Before the tree was cut into lumber, though, a tree cookie was cut from the base of the tree and that cookie is drawn below!

The Higher the Fewer

ACTIVITY SUMMARY
By participating in a relay game, students discover that energy and material transferred between organisms in food chains is less than 100 percent efficient.

CONCEPTS TO BE LEARNED
1. As energy passes through a food chain, some is lost to the environment.
2. As material passes through a food chain, some is lost to the environment.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences S.S. 2: All organisms need energy and matter to live and grow.
Life Sciences S.S. 3: Living organisms depend on one another and their environment.

Grade 5: Life Sciences 2.f: Plants use CO_2 and energy from sunlight to build molecules and release oxygen.

Grade 6: Ecology (Life Sciences) S.S. 5: Organisms exchange energy and nutrients among themselves and with the environment.

Environmental Principles and Concepts

Principle III: Natural systems have cycles on which humans depend and that can be altered by humans.
- Concept a: Natural systems have cycles.
- Concept b: Humans depend on and utilize natural cycles and processes.

ANTICIPATED OUTCOMES
1. Students will increase their understanding of food chains, webs, and pyramids.
2. Students will increase their understanding of the impact of their dietary choices.

GROUPING
Whole class in teams of five to seven students

TIME
30-45 minutes, including discussion

MATERIALS
- ❒ Popcorn: about 1 quart per team, plus some to eat after the activity
- ❒ Cones or other objects with which to mark the start and end points
- ❒ Transparencies of the food chain, food web, and pyramid of numbers diagrams from Section I, Chapter 2

TEACHER PREPARATION
1. Obtain the materials listed above.

PROCEDURE

1. It would be helpful if the students have done the food chain activity "Who's for Dinner?," and the food web activity "We're All In This Together" from *Redwood Ed* before doing this activity.

2. Form teams of five to seven students each. If the teams are not equal, have some students run twice.

3. Within each team, assign each student a trophic level such as plant, herbivore, first carnivore, second carnivore, scavenger, decomposer, etc. Assign the student with the largest hands to represent the sun and be first in line.

4. Have the students line up in order behind the sun…sun – plant – herbivore, etc.

5. Discuss the trophic levels represented by each student. Explain that the popcorn represents energy and materials that are to be passed from one level to another.

6. Explain the rules.
   a. The suns will be given as much popcorn as they can hold in their two hands. They may NOT make a pouch out of their shirts, nor may they press the popcorn to their bodies, using their bodies to help hold it.
   b. They are to hold the popcorn only in their hands as they run to the marker or cone, circle it, and return to the next person in the food chain.
   c. The popcorn (energy and materials) is passed to the next person in the food chain, who then runs to the marker, runs around it, returns, and passes the popcorn to the next person in the food chain.
   d. Continue until the entire food chain has completed the relay (including any who need to run a second time because of uneven numbers in the teams).
   e. When the entire team has run the relay, the last person holds the remaining popcorn above his or her head to indicate that the team has completed the relay.
   f. Remind them to run quickly but carefully and not to eat the popcorn that falls on the ground. Tell them that clean popcorn will be provided for eating later.
   g. Discuss the activity. Be sure to relate it to the "pyramid of numbers."
      - Where was most of the "energy" lost? (at exchanges)
      - What would be the effect of having a shorter food chain? (more energy available for the last organism/top carnivore/people)
      - What happens to the energy that is "lost?" (goes into environment, mostly as heat or as chemical energy in waste products)
      - What does this activity imply about people eating as vegetarians? (Vegetarians eat low on the food chain, so agricultural land could support more people eating a vegetarian diet than one that includes meat. Caution the students, though, that a healthy vegetarian diet requires knowledge and careful planning so that it includes the proteins and other requirements of a healthy diet.)

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. This activity can be done indoors. Be sure to have cleanup materials ready.
2. Other materials can be used instead of popcorn. Balls are not recommended because they present a hazard to people running.
3. Play another round with uneven teams. This will help emphasize the idea that energy and material are lost at each level, so a shorter food chain results in more energy being available for the last organism… the top carnivore or humans.

ASSESSMENT

1. During the discussion, can students explain what the dropped popcorn represents?
2. Can students tell what happens to the material that is not added to an organism's body?

REFERENCES AND RESOURCES

Roa, Michael. *Environmental Science Activities Kit.*

Ideas for Using Historic Images

ACTIVITY SUMMARY
Ideas for the use of historic photographs in *Redwood Ed* are presented.

CONCEPTS TO BE LEARNED
1. Human activities are undertaken to fulfill wants and needs.
2. Attitudes towards the environment have changed over time and will continue to change.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: History 4.2.1: Describe how the physical environment affects human activities.
History 4.3.3: Analyze effects of the Gold Rush on the physical environment.
Grade 5: History 5.8: Trace settlement patterns with emphasis on the effects of the physical geography.
Grade 6: History 6.1.3: Discuss human modifications of the physical environment.

Other Standards:

Grade 4: Life Sciences 3.a; History 4.2.5, 4.4.2
Grade 6: Earth Science 2; History 6.1.3
Grade 7: Life Science 3.5

Environmental Principles and Concepts

Principle I: Humans depend on natural systems.
- Concept a: Humans depend on natural systems for goods and materials.

Principle II: Humans affect natural systems.
- Concept a: Human populations and consumption affect natural systems.
- Concept b: Human extraction, harvesting, and use of resources affect natural systems.
- Concept c: Expansion and operation of human communities affect natural systems.
- Concept d: Human social systems affect natural systems.

Principle III: Natural systems have cycles on which humans depend and that can be altered by humans.
- Concept c: Human practices can alter natural cycles and processes.

Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.
- Concept a: Effects of human activities on natural systems depend on quantities of resources used and the quantity and characteristics of the byproducts of use.
- Concept b: Byproducts of human activities affect natural systems.
- Concept c: The ability of natural systems to adjust to human-caused alterations depends on several factors.

ANTICIPATED OUTCOMES

1. Students will understand that human activities have impacts on the environment, and that many of those impacts may be viewed as good or bad, depending on one's perspective, or they may be neutral.

GROUPING

Whole class

TIME

Varies

MATERIALS

- ❒ Illustrations from *Redwood Ed* or other sources of historic photos
- ❒ *Redwood Ed* Compact Disc

TEACHER PREPARATION

Preferably, use the *Redwood Ed* CD and a laser printer to make overhead transparencies of illustrations. Alternatively, you might either photocopy the illustrations from a print copy of *Redwood Ed* or make overhead transparencies from them (or from other historic photos). When printing, use the highest print quality/resolution/number of dots per inch possible.

PROCEDURE…some options:

1. Show the photos, with captions, one at a time and discuss.

2. Show the photos without the captions…ask the students to tell what they see.

3. Discuss wants versus needs.

4. In many old logging photos, the background shows a lot of waste and bare soil that would be susceptible to erosion. In many of those images, the people seem to be proud of their hard work but oblivious to the environmental damage done. Discuss and contrast this to modern attitudes towards the environment. What were the beneficial and harmful consequences of such logging practices? Given the knowledge and equipment available to them, did they have alternatives? How are modern practices and attitudes different? If so, why? Does everybody share the same attitudes and values?

5. If machinery is included in the photograph, ask students to discuss modern machinery and practices.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. When you visit a park or museum, be sure to have the students look at any historic images on display.
2. Consider preparing a worksheet to guide their viewing. The worksheet might include a photocopy of the image (reduced in size) with space for note taking.

3. *Redwood Ed* is available on a compact disc. Obtain the CD and use it to project images.
4. If the images do not photocopy clearly or do not make good overhead transparencies, try tracing around the main parts of the image with a fine pen, either before or after making the transparency.

ASSESSMENT

1. Present a different photograph and ask students to describe what they see, either orally or in writing.

REFERENCES AND RESOURCES

Many of the references cited in Appendix V contain historic images. Local museums, parks, resource companies, and others may also have images. The following books include many historic images:

Andrews, Ralph W: *Glory Days of Logging*
Andrews, Ralph W: *Redwood Classic*
Carranco, Lynwood and John Labbe: *Logging the Redwoods*
Keyworth, C.L.: *The First Americans: California Indians*
Leydet, Francois: *The Last Redwoods*
Nixon, Stuart: *Redwood Empire: An illustrated History of the California Redwood Country*
Schubert, John C.: *Guerneville Early Days: A History of the Lower Russian River*
Williams, Richard: *The Old West: The Loggers*

Making a Forester's Diameter Tape

ACTIVITY SUMMARY
Students make a measuring tape that measures circumference and converts circumference to diameter.

CONCEPTS TO BE LEARNED
1. The relationship between a circle's circumference and its diameter
2. Foresters and scientists use the diameter of a tree when studying stands of trees.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Mathematics Number Sense 3.0: Solve problems Mathematics Measurement and Geometry 1.0: Understanding perimeter and area Mathematics Statistics 1.0: Organize and represent data Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 5: Mathematics Number Sense 1.0: Computation, rounding Mathematics Statistics 1.0: Display and interpret data sets Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 6: Mathematics Number Sense 1.0: Solving problems Mathematics Number Sense 2.0: Calculate and solve problems Mathematics Measurement and Geometry 1.0: Measurement, including the use of pi Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Grade 7: Mathematics Mathematical Reasoning 2.0: Using estimation Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Environmental Principles and Concepts

Principle I: Humans depend on natural systems.
- Concept a: Humans depend on natural systems for goods and materials.

Principle II: Humans affect natural systems.
- Concept a: Human populations and consumption affect natural systems.
- Concept b: Human extraction, harvesting, and use of resources affect natural systems.
- Concept c: Expansion and operation of human communities affect natural systems.
- Concept d: Human social systems affect natural systems.

ANTICIPATED OUTCOMES

1. Students will be able to calculate diameter if given a circumference.
2. Students will make a measuring tape and be able to use it to measure the circumference and diameter of a tree.

GROUPING

Groups of two to three students (or individual)

TIME

30-45 minutes

MATERIALS

- ❒ Light colored ½" - 1" wide ribbon: 15 or more feet per group.
- ❒ (If the ribbon is made of nylon or a similar material, consider using a candle or other heat source to melt the ends to keep them from unraveling.)
- ❒ Fine tip permanent markers: 1 per group
- ❒ Ruler, meter stick, or tape measure (preferred): 1 per group
- ❒ Making a Forester's Diameter Tape Study Guide
- ❒ Optional: an actual diameter tape, available from forestry supply sources such as those found in Appendix IV, or borrow one from a local forester

TEACHER PREPARATION

1. Obtain the above materials. (A parent might be enlisted to melt the ribbon ends.)

PROCEDURE

1. Discuss with the students reasons why a forester or scientist might want to know the diameter of a tree. (to calculate how much wood it contains, lumber it might produce, or to study its growth over time)

2. Review how to calculate the diameter of a circle if the circumference is known.

3. Issue the Study Guide and demonstrate/review how to complete the conversion table. Before students actually use their data, it should be checked for accuracy.

4. After completing the table and having it checked, students use permanent markers to make their own tapes.

5. Have the students use their tapes to measure the circumferences and diameters of trees on campus and/or while on a field trip.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. See the *Redwood Ed* activity "Redwood Pi."
2. The tape could be made using metric units.
3. Students could calculate diameters from given circumferences.

ASSESSMENT

1. The Study Guide can be used for assessment, as can the tape made by the students.

Making a Forester's Diameter Tape
Study Guide

Foresters and scientists want to know the size of trees in the forest. One important measurement is the diameter, which can be used to calculate the approximate amount of wood in a tree. If one is studying a tree or a stand of trees over a period of time, it might be important to know how rapidly the trees are growing, and diameter measurements can be used for this, too.

In order to determine a tree's diameter, foresters use a special tape that measures circumference and diameter at the same time. In this activity, you will make your own Forester's Tape.

When you use the tape to measure a tree's circumference and diameter, you should make the measurement 4.5 feet above the ground on the uphill side of the tree. This is called the "diameter at breast height," or dbh.

Question: Why is it important for all foresters and scientists to measure a tree's diameter in the same way (i.e., 4.5 feet above ground level on the uphill side of the tree)?

Procedure:
1. For each of the following diameters, calculate the corresponding circumference.

2. Use the permanent marker to mark the diameters and circumferences on the tape provided by your teacher. If the tape is wide enough, put both diameters and circumferences on the same side. If the tape is not wide enough, put the diameters on one side and circumference son the other.

Use the formula $c = \pi \times d$ Use 3.14 for π Round to the nearest inch.

Diameter	Formula with values	Circumference (inches)
6 in	C = 3.14 x 6	19
12 in		
18 in		
24 in		
30 in		
36 in		
42 in		
48 in		
54 in		

Diameter	Formula with values	Circumference (inches)
60 in		
66 in		
72 in		
78 in		
84 in		
90 in		
96 in		
102 in		
108 in		

Name That Plant

ACTIVITY SUMMARY
This activity has two parts. In Part 1, students give descriptive names to plants, based on examination of their leaves, and then make up a "dichotomous key" with which the plants can be identified by others. In Part 2, students use commercially available keys to identify plants found in the redwood region.

CONCEPTS TO BE LEARNED
1. The names of organisms may or may not be descriptive of the organism.
2. Identification guides or keys can be used to identify organisms.
3. Different kinds of organisms have different physical characteristics.

STANDARDS ADDRESSED
Focus Standards:
Grade 4: Science Investigation and Experimentation 6.a: observations and inferences
Grade 5: Life Sciences 2.a: Plants and animals have structures for various processes.
Science Investigation and Experimentation 6.a: classify objects
Grade 7: Science Investigation and Experimentation 7.a: Use tools to collect data.

ANTICIPATED OUTCOMES
1. Students will increase their ability to observe and describe anatomical details.
2. Students will be able to use a simple dichotomous key to identify common plants.
3. Students will be able to identify some common redwood region plants.

GROUPING
Groups of two to four students

TIME
Part 1: 30-40 minutes
Part 2: 30-40 minutes

MATERIALS
For each group:
- ❒ Paper and pencils
- ❒ Commercially available keys or guides to redwood region plants (see Appendix IV: Sources of Materials and Appendix V: Resources Cited)
- ❒ Leaves, cones, bark samples from 8-10 plants, either from the school ground or a redwood forest.

TEACHER PREPARATION
1. Obtain the materials listed above.

Leaf specimens might be fresh, or they may be dried specimens mounted on tag board so that both sides of sample leaves are visible. Such dried specimens can be covered with clear plastic shelf liner material.

Fresh specimens are generally preferable. Keep them fresh-looking by storing in a re-sealable plastic bag with damp paper towel until used.

Be sure to include cones, bark samples, or other parts that may be needed in using the guide to identify the plant.

Try out the keys with your specimens to be sure that you have the required plant parts and typical leaves.

PROCEDURE

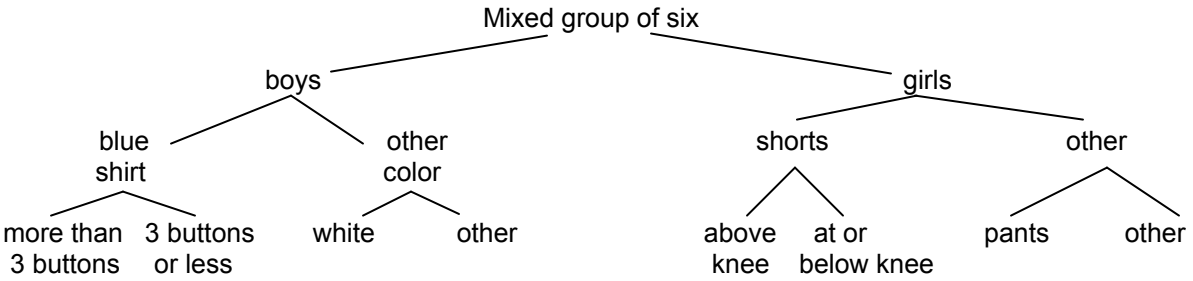
Part 1.

1. Tell students that you are going to describe some animals and that they are to try to identify them from your description. Tell them to write down the words that helped them to identify the animal. Then describe several animals, (using only physical characteristics as opposed to sounds or behaviors) starting with easy ones like zebra, elephant, giraffe and proceeding to ones that may not be so easy such as cow, deer, dog, or others.

Discuss how they were able to identify the organism through descriptive words.

2. Ask for 6 volunteers. Select students with different appearances and clothing. **Avoid selecting students who are sensitive about their appearance or clothing.**

3. Have the class create a "key" for the six students by listing on the board a series of steps that repeatedly divide the group into two groups, for example:



Discuss how such a key might be used to identify someone from the group. Point out the importance of using objective characteristics such as hair color, over 5 feet tall, whether they wear glasses, clothing type, etc., as opposed to subjective descriptors such as tall, thin, smart, etc.

4. Have the students form groups of 2-4 students each. Give each group a set of leaves.

5. Have the students make up names for the leaves. Encourage them to use descriptive names: pointy leaf tree, fuzzy top, circle plant, saw tooth plant, white bottom, arrow leaf, etc.

6. Select a leaf type and discuss what sorts of descriptors might be used to make a key. Emphasize objective descriptors such as overall shape, length, edge shape, vein patterns.

7. Have the students create keys that could be used by someone else to identify each type of leaf.

8. Have groups exchange keys and try to identify each others' leaves. Allow the groups to change their keys so that they can be used by the other students to correctly identify the leaves.

Part 2.

1. Give the students sets of leaves from plants that can be identified using commercially available keys or guides.

2. Use two different types of leaves (e.g., a plant with needles such as redwood or Douglas-fir and a non-needle leaved plant such as black oak or madrone) to demonstrate the use of the key:

   a. Look through the key…point out measuring tools, definitions, maps, etc.
   b. Discuss the importance of being careful when making choices.
   c. Discuss the importance of reading the description after arriving at an "answer." Does their answer match the description?

3. Have the students use the keys to identify their leaf sets.

4. Have the students check themselves by holding up a specimen and asking students to tell what it is. If they make mistakes, go through the keying steps with them.

5. Discuss that such keys only work if the plant is in it. A key for redwood region wild flowers, for example, would not be much use in the desert or in Africa.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Cover the keys with plastic shelf lining material to protect them from water both in the classroom and when used in the field.
2. Students can make up keys to school yard plants and teach others to use them.
3. Students can bring in leaves from plants that grow in their yards or neighborhood.
4. In preparation for a trip to a redwood park, students can become "experts" in identifying ferns, conifers, flowers, berries, etc.
5. Students can make and use keys for identifying rocks, animals, or other things.
6. See the activity "Who am I?"

ASSESSMENT

1. Present a student or a group with an "unknown" leaf type and have them use a key to identify it. (Be sure that the plant is in the key.)

REFERENCES AND RESOURCES

Most "field guides" can be used to identify organisms from pictures or drawings. The use of dichotomous keys enables users to identify organisms by making a series of choices. See Appendix IV for sources.

The Nature Study Guild, of Berkeley, publishes a series of Nature Finder Guides, including:

Pacific Coast Berry Finder by Glenn Keator
Pacific Coast Bird Finder by Roger Lederer
Pacific Coast Fern Finder by Glenn Keator and Ruth Hardy
Pacific Coast Mammals by Ron Russo
Pacific Coast Tree Finder by Tom Watts
Redwood Region Flower Finder by Phoebe Watts

Two more technical keys to plants in the redwood region are:

Pocket Flora of the Redwood Forest, by Rudolf Becking
and
Flora of the Santa Cruz Mountains of California, by John Hunter Thomas

Redwood Pi

ACTIVITY SUMMARY
Students measure various cylindrical objects and use the measurements to derive an approximate value for pi.

Students are given some values and calculate circumferences from diameters and diameters from circumferences.

CONCEPTS TO BE LEARNED
1. The ratio of a circle's circumference to its diameter is a constant called *pi*.

2. How to use the circumference formula

2. How to derive the formula for diameter from the formula for circumference

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Mathematics: Number Sense S.S. 3.0 Solve problems
Mathematics: Measurement and Geometry S.S. 1.0: Understanding perimeter
Grade 5: Mathematics: Number Sense S.S. 1.0: Computation
Grade 6: Mathematics: Number Sense S.S. 1.0: Calculate and solve problems
Mathematics: Measurement and Geometry S.S. 1.0: Measurement of plane…shapes, including the use of *pi*.
Grade 7: Mathematics: Mathematical Reasoning S.S. 2.0: Using estimation

ANTICIPATED OUTCOMES
1. Students will learn to calculate the circumference of a circle if they are given the diameter.

2. Students will learn to calculate the diameter of a circle if given the circumference.

3. Students will learn to derive the formula for finding diameter if given circumference.

GROUPING
Groups of two and whole class.

TIME
60 minutes

MATERIALS
- ❒ Study Guide: Using *pi*
- ❒ A variety of cylindrical objects such as cans and jars: one per team of two students
- ❒ Tape measures: one per team

(Tape measures used in sewing are commonly 60 inches long. Such a tape can be cut into 20 inch lengths and a permanent marker can be used to renumber as necessary.)

- ❒ Calculators: one per team

TEACHER PREPARATION

1. Obtain a variety of cylindrical objects. Use a permanent marker or masking tape to number each.
2. Obtain a tape measure for each team of two students.
3. Duplicate the Study Guides.

PROCEDURE

1. Give each student a copy of the Redwood Pi Study Guide.

2. Give each team of students a tape measure and a cylindrical object.

3. Define diameter and circumference (or remind students of the meanings).

4. Have students follow directions on the Redwood Pi Study Guide.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. A simple way to do this is to use a can with a seam, such as a juice or soup can. Have the student place the can on a piece of paper with the seam down and mark the spot. The can is then rolled until the seam is again downward and that spot marked. The distance between the marks will be the circumference. The diameter can be measured directly, but be sure to have the students find the greatest distance across the circle/cylinder.
2. String can be used instead of a tape measure by wrapping the string around the cylinder and laying it on or beside the ruler. Caution students not to stretch the string.
3. See the activities "How Big?" and "Making a Forester's Diameter Tape."
4. Consider having students use metric measurements in addition to inches.

ASSESSMENT

1. Check for accuracy in calculations.
2. The Study Guide can be used for assessment.
3. Students can be given tape measures and cylinders to measure.

ANSWERS TO SELECTED STUDY GUIDE QUESTIONS

(1) 6.8" diameter = 21.35 " circumference
(2) 9.2' diameter = 28.89' circumference
(3) 15 cm diameter = 47.1 cm circumference
(4) 24.7 yd diameter = 77.56 yd circumference

(5) 82.4' circumference = 26.24' diameter
(6) 56 cm circumference = 17.83 diameter
(7) 6.2 m circumference = 1.97 m diameter

<u>redwoods:</u>
(8) 5' circumference = 1.59' diameter
(9) 18.5' circumference = 5.89' diameter
(10) 34.2' circumference = 10.89' diameter
(11) 26.8' circumference = 8.54' diameter

Redwood Pi
Study Guide

The distance across a circle is called the diameter, and the distance around a circle is called the circumference. Your teacher will provide each team with a cylindrical object and a tape measure.

1. Record the number of your cylinder. Measure the diameter and circumference of your cylinder and record them in the table below. Measure to the nearest eighth of an inch. Use the table below to convert eighths to decimals.

1/8 = .125	2/8 = ¼ = .25	3/8 = .375	4/8 = ½ = .5
5/8 = .675	6/8 = ¾ = .75	7/8 = .875	

2. After you have measured your cylinder, trade cylinders with other groups until each team has measured four objects.

3. After you have measured the diameters and circumferences of four objects, compare the diameters and circumferences by dividing the circumferences by the diameters.

For example, <u>if</u> a circumference is 22 and the diameter is 7, the ratio would be 22 ÷ 7 = 3.14 (rounded to the nearest hundredth).

object #	**Diameter** (nearest 1/8")	**Circumference** (nearest 1/8")	**<u>circumference</u> radius**

What do you notice about the ratio (comparison) of the circumference and the radius?

It should be close to 3.1428. Thousands of measurements have determined that the ratio of a circle's circumference to its diameter is always 22/7, which is called *pi*. The symbol for *pi* is π, and *pi* is approximately (but not exactly) equal to 3.1428.

- ❒ Since the circumference of a circle and its diameter are always related in a constant way, if you know one, you can determine the other. The following formula can be used to find a circle's circumference if you know its diameter:

Circumference = π x diameter or $c = \pi d$

continued next page

Practice determining circumferences by completing the table below. Check your answers with your teacher. Use 3.14 for π.

#	diameter	Work (Write the value in the formula, then do the calculation.)	Circumference (round to nearest .01) (include units!)
e.g.	4.25 in.	C = π x 4.25 in. = 3.14 x 4.25 in.	13.35 in
1.	6.8 in.		
2.	9.2 feet		
3.	15 cm.		
4.	24.7 yards		

If you know the circumference of a circle, you can also find the diameter. If you divide both sides of the circumference equation by *pi*, you get:

$c = \pi d$ equals $\frac{c}{\pi} = \frac{\pi d}{\pi}$ so $\frac{c}{\pi} = d$ and $d = \frac{c}{\pi}$

Practice determining diameters by completing the following table. Check your answers with your teacher. Use 3.14 for π.

#	circumference	Work (Write the value in the formula, then do the calculation.)	diameter (round to nearest .01) (include units!)
e.g.	12.5 in.	d = 12.5 in. ÷ π = 12.5 in. ÷ 3.14	3.98 in.
5.	82.4 feet		
6.	56 cm.		
7.	6.2 m.		

When foresters want to know how much wood can be obtained from a tree, they need to determine its diameter. Using the diameter, they can use tables in books to find how much lumber might be obtained from the tree. Measuring the diameter is difficult, so they measure the circumference instead. Find the diameters of the following trees:

#	circumference	Work (Write the value in the formula, then do the calculation.)	diameter (round to nearest .01) (include units!)
8.	5 feet		
9.	18.5 feet		
10.	34.2 feet		
11.	26.8 feet		

Washing a Watershed

ACTIVITY SUMMARY

Students use crumpled paper to model a watershed. Colored pens, some water soluble and some not, are used to indicate various types of ground cover. Water from a spray bottle is used to model rain, and students observe the effects of runoff.

CONCEPTS TO BE LEARNED

1. Water runs downhill and can carry materials and chemicals as it does so.
2. Some types of land use discourage pollution of streams and others increase pollution.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences 3. a: Ecosystems are characterized by living and non-living components.
Science Investigation and Experimentation 6: Students ask meaningful questions and conduct careful investigations.

Grade 5: Earth Sciences S.S. 3: Water moves between oceans and land
Science Investigation and Experimentation 6: Students ask meaningful questions and conduct careful investigations.

Grade 6: Earth Sciences S.S. 2: Topography is reshaped by weathering and transportation of sediment.
Science Investigation and Experimentation 7: Students ask meaningful questions and conduct careful investigations.

Grade 7: Science Investigation and Experimentation 7: Students ask meaningful questions and conduct careful investigations.

Environmental Principles and Concepts

Principle I: Humans depend on natural systems.
- Concept a: Humans depend on natural systems for goods and materials.
- Concept b: Humans depend on ecosystems.
- Concept c: The health of ecosystems affects their usefulness for people.

Principle II: Humans affect natural systems.
- Concept a: Human populations and consumption affect natural systems.
- Concept b: Human extraction, harvesting, and use of resources affect natural systems.
- Concept c: Expansion and operation of human communities affect natural systems.
- Concept d: Human social systems affect natural systems.

Principle III: Natural systems have cycles on which humans depend and that can be altered by humans.
- Concept a: Natural systems have cycles.
- Concept b: Humans depend on and utilize natural cycles and processes.
- Concept c: Human practices can alter natural cycles and processes.

Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.
- Concept a: Effects of human activities on natural systems depend on quantities of resources used and the quantity and characteristics of the byproducts of use.
- Concept b: Byproducts of human activities affect natural systems.
- Concept c: The ability of natural systems to adjust to human-caused alterations depends on several factors.

ANTICIPATED OUTCOMES
1. Students will understand some effects of runoff on streams and communities.
2. Students will understand some ways of reducing erosion and runoff.

GROUPING
Groups of two to four students

TIME
15-30 minutes

MATERIALS: for each group:
- ❒ One to three sheets of white paper
- ❒ Water base pens: brown, black
- ❒ Permanent markers: green, blue, red (or crayons)
- ❒ Spray bottle with water
- ❒ Sponges or towels for cleanup
- ❒ Optional: plastic or newspaper to cover desks/tables

TEACHER PREPARATION
1. Obtain materials above.

PROCEDURE
1. Demonstrate crumpling piece of paper into a tight ball, then gently opening it without completely flattening it.

2. Show the students how the high points can represent mountains and the low points can represent the bottoms of valleys where streams flow.

3. Direct teach that each of those valleys represents a watershed.

4. Ask the students where there would be a good place to build a town. Lead them to the idea that it is easiest to build on relatively level areas near streams.

5. Use the pens to color the following features:
   - ✓ Blue for streams and lakes (permanent markers)
   - ✓ Green for forests (permanent markers)

- ✓ Brown for dirt roads on hillsides and hillsides that have had the vegetation removed by fire, road builders, logging, clearing for building, landslides, or other factors (water soluble)
- ✓ Black for roads and parking lots (water soluble)
- ✓ Red for buildings, houses, towns (permanent markers)

5. Have the student teams make and color their own watersheds, including towns and roads.

6. Ask the students to predict what might happen if rain fell on the hills. What would happen to the soil on the hillsides? What would happen to the rivers, streams, and lakes?

7. Then have the students use the spray bottles to simulate light rain on the watersheds.

8. Have the students observe the erosion of the exposed soil (brown), and runoff from the roads (oil and other chemicals…black). Ask where the runoff ends up and what effects it might have on the streams and lakes, and the organisms, including people, that depend on them.

9. Discuss with students what might be done to reduce or eliminate soil erosion from fire, logging, or clearing of land. (Point out that there are now laws and regulations intended to minimize or eliminate erosion.)

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. If crayons are used for the trees, buildings, and rivers, they may tend to flatten the paper more than felt tip markers.
2. Students can make flour and salt relief maps of the local watershed. Water will dissolve the map if too much is used, so caution the students not to spray too much.
3. This activity can be used in conjunction with teaching about topographic mapping.
4. Some parks have relief models of their watersheds. Be sure to have the students study the relief map when you visit.

ASSESSMENT

1. Students should be able to define a watershed and describe what happens to soluble materials when rain falls on them.

REFERENCES AND RESOURCES

Kids in Creeks: An Interdisciplinary Creek Exploration Program

We're All in This Together

ACTIVITY SUMMARY
After learning about food chains, students form a model of a food web, showing the interconnectedness of organisms with each other and with the physical environment.

CONCEPTS TO BE LEARNED
1. Plants and animals depend on each other and on the physical environment.
2. If something affects one part of the environment, it will affect other parts.
3. A food web is a simplified model of the interconnectedness of organisms.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences S.S. 2: All organisms need energy and matter to live and grow.
Life Sciences S.S. 3: Living organisms depend on one another and their environment.

Grade 6: Ecology (Life Sciences) S.S. 5: Organisms exchange energy and nutrients among themselves and with the environment.

Other Standards:

Grade 5: Life Sciences S.S. 2

Grade 7: Life Science Structure and Function in Living Systems S.S. 5

Environmental Principles and Concepts

Principle I: Humans depend on natural systems.
- Concept a: Humans depend on natural systems for goods and materials.
- Concept b: Humans depend on ecosystems.

Principle II: Humans affect natural systems.
- Concept a: Human populations and consumption affect natural systems.
- Concept b: Human extraction, harvesting, and use of resources affect natural systems.
- Concept c: Expansion and operation of human communities affect natural systems.
- Concept d: Human social systems affect natural systems.

Principle III: Natural systems have cycles on which humans depend and that can be altered by humans.
- Concept a: Natural systems have cycles.
- Concept b: Humans depend on and utilize natural cycles and processes.
- Concept c: Human practices can alter natural cycles and processes.

ANTICIPATED OUTCOMES
1. Students will understand that all organisms depend on the physical environment.
2. Students will understand the concept of food webs.
3. Students will know about the niches and foods of various organisms.

GROUPING
About eight to twelve students will form the food web. The rest of the class can observe.

TIME
10-30 minutes, including discussion

MATERIALS
- ❒ Drawings or pictures of organisms and abiotic environmental factors, preferably from the coast redwood ecosystem, approximately 8" x 8" in size, mounted on tag board, with strings for hanging around students' necks
- ❒ Include pictures that represent (for example):

Water (cloud, fog, stream)	Sunlight	Minerals (soil or rocks)
Decomposers (bacteria)	Producer (grass)	Producer (blackberry)
Herbivore (grasshopper)	Herbivore (deer)	Omnivore (black bear)
Omnivore (raccoon)	Carnivore (fox)	Scavenger (Steller's jay)

- ❒ Also have one card represent people. On one side label the person something like "Wasteful Wally" and on the other side draw and label "Wonderful Wally."
- ❒ Strong cord (approximately 50')

TEACHER PREPARATION
1. Obtain pictures or drawings of the above. Pictures or drawings used in the "Who's for Dinner?" activity might be used. Pictures can be obtained from magazines, old calendars (donated by parents?), the Internet, or students can draw them. Students can also color illustrations from Section I of *Redwood Ed*.

2. Mount the pictures on tag board. Laminate. Attach a 2-foot length of string so that each picture can be worn around a student's neck.

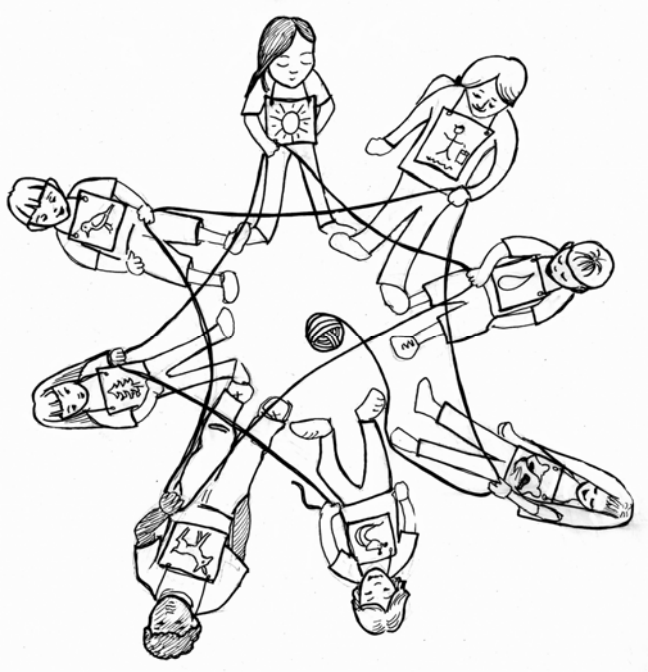
PROCEDURE
1. Select eight to ten students to represent the parts of the environment listed under Materials above. Have the students form a circle, facing inward.

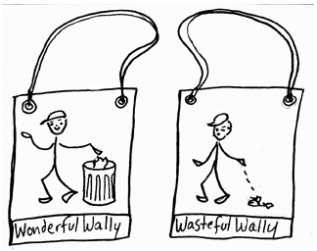
2. Give the students their role cards and have them hang them around their necks. The human card should have "Wasteful Wally" facing outward. Be sure to issue the role cards in such a way that a web will form. (For example, have the producer across the circle from the sun, rather than next to the sun.)

3. Have the "sun" student hold the end of the string.

4. Pass the cord back and forth across the circle of students forming a web-like pattern, instructing students to hold the cord securely. Continue until all eight to ten students, including "Wasteful Wally" are connected. The last one connected should be the "sun."

5. Securely tie the ends of the cord.





"Wally's" sign, front and back

Figure 117

6. Now have all of the students hold their cord firmly in one hand and pull the string taut. A web should be formed among the organisms and the non-living parts. Point out that everything is connected (or "hitched to everything else," as John Muir said).

7. Have each student tell how he or she (or, rather, their part of the web) is connected to two other parts. For example:

   "I'm a plant and I'm connected to the sun because I need light for photosynthesis. I'm connected to the banana slug because the banana slug eats my leaves."

   "I'm the water, and I'm connected to the deer because the deer drinks me, and it also eats plants that need water. I'm connected to the sun because the sun evaporates me, and on cloudy or foggy days I block some of the sun from reaching the plants."

8. Tell the students that you are going to tap a student and tell something that happened to that part of the environment.

9. Instruct the students to hold their cord firmly, and to tug gently when they feel a tug.

10. Walk around the circle and tap a student on the shoulder and tell something that happened to the organism. This is the initial event. The tapped student is to give a

tug on the string. (The deer was eaten by a cougar, or the minerals washed into the stream during a severe storm, or the bear died and began to decompose, returning minerals to the soil, etc.) (The sun itself may not be affected, but the amount of sunlight available to organisms is affected by plants as they produce shade.)

11. This should start a chain reaction, and every part of the environment should soon have been affected by the initial event. Have each affected student (or someone in the class) tell how they were affected.

12. Do this several times, with different initial events, pointing out that if one part of the environment is affected, all parts are affected.

13. In one or two cycles, have the human be "Wasteful Wally," who does damage to the environment. (e.g.: "Wally has polluted the stream." or "Wally threw an aluminum can or plastic wrapper into the bushes.")

14. Then be sure to have "Wonderful Wally" do a couple of things that help the environment. (e.g.: "Wally chose to recycle his plastic water bottle." or "Wally used a cloth sack for his lunch rather than a paper bag.")

In the ensuing discussion, be sure to discuss how we all affect the environment, and that we can make choices that will help improve and protect the environment. Discuss how people affect the environment with their jobs and their daily habits.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. If you use a strong cord, you can tie the ends **securely**, then have students lean back until the cord web is supporting them. Ask the students what would happen if the cord were cut or broke while they were leaning on it. This emphasizes that the different parts of the environment don't merely affect each other, they depend on each other.

ASSESSMENT

1. Have students tell how different organisms depend on each other and on the physical environment.
2. Have students tell ways that Wasteful Wally can be Wonderful Wally.

REFERENCES AND RESOURCES

Roa, Michael. *Environmental Science Activities Kit.*

Who's For Dinner?

ACTIVITY SUMMARY

Students learn about organisms of the redwood forest and how they are related in food chains. (It is recommended that this activity be followed by the food web activity "We're All in this Together.")

CONCEPTS TO BE LEARNED

1. Living things depend on the non-living environment.
2. Living things depend on other living things.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences S.S. 2: All organisms need energy and matter to live and grow.
Life Sciences S.S. 3: Living organisms depend on one another and their environment.

Grade 6: Ecology (Life Sciences) S.S. 5: Organisms exchange energy and nutrients among themselves and with the environment.

Other Standards:

Grade 5: Life Sciences S.S. 2

Grade 7: Life Science Structure and Function in Living Systems S.S. 5

Environmental Principles and Concepts

Principle I: Humans depend on natural systems.
- Concept a: Humans depend on natural systems for goods and materials.
- Concept b: Humans depend on ecosystems.

Principle II: Humans affect natural systems.
- Concept a: Human populations and consumption affect natural systems.
- Concept b: Human extraction, harvesting, and use of resources affect natural systems.
- Concept c: Expansion and operation of human communities affect natural systems.
- Concept d: Human social systems affect natural systems.

Principle III: Natural systems have cycles on which humans depend and that can be altered by humans.
- Concept a: Natural systems have cycles.
- Concept b: Humans depend on and utilize natural cycles and processes.

ANTICIPATED OUTCOMES

1. Students will understand that all organisms depend on the physical environment.
2. Students will understand the concept of food chains.
3. Students will know about the niches and foods of various organisms.
4. Students will improve their research skills.

GROUPING
Four to six students per food chain

TIME
Research: varies (15-30 minutes or more)
Doing the activity and discussion: 15-30 minutes

MATERIALS
- ❒ Reference books or other resources such as the Internet
- ❒ White paper or tag board, approximately 8" x 8" (1 per student)
- ❒ Either colored pencils, pens, or crayons with which students can draw organisms, or pictures of organisms from magazines, calendars, or Section I of *Redwood Ed.*
- ❒ Tape or glue with which to attach pictures to tag board

TEACHER PREPARATION
1. Consider having a parent volunteer mount and laminate pictures.
2. Prepare either a drawing or a picture to represent the physical environment, including sunlight, water and minerals. This might be a river with rocks and the sun visible.
3. Group the food chains into groups of 4-6 students. Have some optional organisms in case some students are absent. Some examples of groups are:

Abiotic Factors	Producer	Herbivore (first degree consumer)	Carnivore (second degree consumer	Carnivore or Omnivore	Next Step
sun, water, and minerals	wild oats (grass)	grasshopper	red legged frog	raccoon	fox
	Douglas-fir seed	tree vole	spotted owl	barred owl	bacteria
	blackberry	banana slug	giant salamander	salmon	fisherman
	tanbark oak	back tailed deer	cougar	deer hunter	bacteria
	algae in a stream	mosquito larva	young salmon	bear	bacteria
	algae in a stream	stonefly larva	trout	kingfisher	bacteria
Other types of organisms to consider: dead organisms, mosquitoes, Steller's jays, worms, skunks					

PROCEDURE
1. Assign one organism to each student.

2. The student does research to find out what their organism eats and what eats it. For plants, students can find out what plants need to survive—light, CO_2, water, minerals.

3. Unless a picture is provided, the student draws a picture of the organism.

4. The student then gets together with his or her food chain group and decides the order of the food chain, starting with the physical environment.

5. Students line up in food chain order, holding their organism pictures.

6. For each chain, the teacher holds up the large physical environment card and reminds students about the importance of sunlight, minerals, and water for all food chains. This is the start of the food chain.

7. When all food chains are formed, students explain to the rest of the class why they are in that order. They might hold up their picture and say something like "I'm a grasshopper. I eat plants and birds eat me."

8. Tell the students that when they see an organism in the redwoods, they should be ready to tell what it eats and what eats it.

9. Remind the students that most organisms eat many things and that many things eat each organism. See the activity "We're All in this Together."

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. After the students line up, ask them if there are any other food chains into which they fit.
2. Place food chain pictures on the bulletin board with arrows indicating what is eaten by what. Then use arrows or yarn to show what organisms eat organisms in other chains, thus forming a food web.
3. To keep the groups of food chain pictures together, you might mount them on different colored paper or card stock.

ASSESSMENT

1. Ask students to explain why they placed themselves where they did in their food chains.

REFERENCES AND RESOURCES

Roa, Michael. *A Guide to the Side of the Sea*.

Roa, Michael. *The Environmental Science Activities Kit.*

Other Pre-Trip Activities

Virtual Field Trip

While you are previewing the trip, you might take slides or make a video. These can be used to help prepare the students for the trip through a "virtual field trip," in which the students see pictures of many of the organisms or other features that they will see on the actual trip. This preview will help the students know what to expect without diminishing their excitement and interest. Students enjoy seeing an organism in real life after seeing it in pictures, and they are more likely to remember it.

The preview can also be used to point out safety issues such as poison oak, steep trails (remind students not to take shortcuts on switchbacks), or slippery areas.

A virtual field trip can also be used to review what was seen on the trip. You might have the students prepare a slide show of their trip for parents—maybe a digital slide show using Power Point.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences S.S. 3.a: Ecosystems are characterized by living and non-living components.

Grade 5: Life Sciences Standard Set S.S. 2: Plants and animals have structures for various life processes.

Grade 6: Earth Science Standard Set S.S. 2: Topography is reshaped by weathering and transportation of sediment.

Grade 7: Life Science Standard Set S.S. 5: Anatomy and physiology

Environmental Principles and Concepts

Principle I: Humans depend on natural systems.

Concept a: Humans depend on natural systems for goods and materials.

Principle II: Humans affect natural systems.

Concept a: Human populations and consumption affect natural systems.

Concept b: Human extraction, harvesting, and use of resources affect natural systems.

Principle III: Natural systems have cycles on which humans depend and that can be altered by humans.

Concept b: Humans depend on and utilize natural cycles and processes.

Concept c: Human practices can alter natural cycles and processes.

Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.

Concept a: Effects of human activities on natural systems depend on quantities of resources used and the quantity and characteristics of the byproducts of use.

Concept b: Byproducts of human activities affect natural systems.

Concept c: The ability of natural systems to adjust to human-caused alterations depends on several factors.
Principle V: Decisions affecting natural resources and systems are based on many factors.
Concept a: Students need to understand the spectrum of factors that are considered in making decisions about natural resources.
Concept b: Students need to understand the decision making process and how it changes with time.

REFERENCES AND RESOURCES
Roa, Michael: *A Guide to the Side of the Sea*

Notebooks and Journals: Redwood Logs

Students can prepare for the trip by making notebooks or journals in which to record their observations.

Notebook covers can be decorated beforehand or after the trip. Clear adhesive shelf lining material can be used to cover the front and back covers. This will help protect it from soil and moisture. "Decorations" might consist of:

- student drawings of the site or organisms
- prints of photos taken before or during the trip
- pictures from magazines or brochures
- dry redwood branchlets with needles
- dried leaves or flowers from the redwood region…**Do not pick within a state or national park!**

STANDARDS ADDRESSED
Focus Standards:
Grade 4: English: Writing 2.3: Write information reports.
Grade 5: English: Writing 2.3: Write research reports.
Grade 6: English: Writing 2.3: Write research reports.
Grade 7: English: Writing 2.3: Write research reports.

REFERENCES AND RESOURCES
Roa, Michael: *A Guide to the Side of the Sea*

Checklists

Teachers can provide checklists of things for the students to look for. Two examples are given below. The lists provided include items found throughout the redwood region. Blank spaces are provided for the addition of other items that might be found in your area.

Teaching Idea

Discuss with students whether or not people should be included on the check list as redwood ecosystem organisms.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences 3.a: Ecosystems are characterized by living and non-living components.
Investigation and Experimentation 6.a: Observation and inferences

Grade 5: Life Sciences S.S. 2: Plants and animals have structures for various life processes.
Investigation and Experimentation 6.a: Classify objects.
Investigation and Experimentation 6.g: Make and interpret graphic representations of data.

Grade 6: Ecology (Life Sciences) 5.e: Numbers and types of organisms in an ecosystem depend on abiotic factors.
Investigation and Experimentation 7.d: Communicate in written and oral presentations.

REFERENCES AND RESOURCES

Roa, Michael: *A Guide to the Side of the Sea*

Redwood Ecosystem Organism Checklist

Which of these organisms have you seen before going on the field trip to the redwoods?

Which organisms do you see on the trip?

Organism	Have seen before trip.	See on trip.	Notes or Sketches:
Coast redwood tree			
Douglas-fir tree			
Tanoak tree			
Madrone tree			
Live oak tree			
Black oak tree			
California bay (laurel) tree			
Big-leaf maple			
Moss			
Horsetail/scouring rush			
Sword fern			
Bracken fern			
Maidenhair fern			
Five-finger fern			
Stinging nettle			
Poison oak			
Redwood sorrel			
California blackberry			
Millipede			
Centipede			
Banana slug			
Acorn woodpecker			
Steller's jay			
Black-tailed deer			

Redwood Ecosystem Observations

Which of these things have you observed before? Which do you observe on the trip?

Observation	Observed before trip.	Observe on trip.	Notes or Sketches:
Coast redwood cone			
Douglas-fir cone			
Tanoak acorn			
Live oak acorn			
Black oak acorn			
Black oak tree			
Smell of a laurel tree leaf			
Big-leaf maple seed			
Moss spore capsule			
The feel of a horsetail (scouring rush)			
Sword fern spore cases			
Maidenhair fern spore cases			
Banana slug slime			
Growth rings on a log			
A rotting log			
Redwood sorrel leaves drooping in the sunlight			
Acorn woodpecker holes in a tree			
Deer scat (droppings)			
Smell of redwood needles			
Smell of Douglas-fir needles			

Sensory Awareness

We tend to be very sight oriented. Students can be encouraged to use other senses. One way to do this is to have students complete a Sensory Awareness Chart. This can, of course, be extended to other environments, including the classroom, playground, home, or other places. Space has been left in the charts below for adding items. Before your field trip, be sure that students don't have known allergies to things that they're likely to encounter. If you do the taste activity, consider bringing something with which to wash the item(s), and don't require tasting.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Science Investigation and Experimentation 6.a: Observations.

Grade 7: Science Investigation and Experimentation 7.b: Use a variety of resources to collect data.

REFERENCES AND RESOURCES

Roa, Michael: *A Guide to the Side of the Sea*
Snively: *Once Upon a Seashore*

Sense of Touch

How many of these have you felt?	Before the field trip?	On the field trip?	Notes or Sketches:
The end of a coast redwood needle			
The end of a Douglas-fir needle			
Humus or soil under the duff layer			
The edge of a live oak leaf			
Temperature of soil in the shade and sun			
Coast redwood bark			
Douglas-fir bark			
Madrone or manzanita bark			

Sense of Hearing

How many of these have you heard?	Before the field trip?	On the field trip?	Notes or Sketches:
Wind in the coast redwoods			
Wind in an oak tree			
Water in a creek			
Footsteps on duff-covered ground			
Footsteps on pavement			
Acorn woodpecker making holes			
Steller's jay call			
A squirrel chattering			

Sense of Smell

How many of these have you smelled?	Before the field trip?	On the field trip?	Notes or Sketches:
Coast redwood needles			
Douglas-fir needles			
Coast redwood bark			
Douglas-fir bark			
Decaying leaf litter			
California Bay tree leaf			

Sense of Taste

How many of these have you tasted?	Before the field trip?	On the field trip?	Notes or Sketches:
A coast redwood needle			
A Douglas-fir needle			
A redwood sorrel stem			
A ripe (black) blackberry			
An unripe (red) blackberry			
A ripe thimbleberry			

Sense of Sight

How many of these have you seen?	Before the field trip?	On the field trip?	Notes or Sketches:
A coast redwood seed (not the cone)			
A Douglas-fir seed			
The bracts sticking out between the scales of a Douglas-fir cone			
Lichens on redwood bark			
The sand grains in a piece of sandstone			
Fern spore cases			
A millipede's 2 legs per segment			

Chapter 2
Activities for the Trip

See also Section III: Field Trips

The activities in Chapter 2 are intended to be done during a visit to a redwood park or forest. They generally require the space or the organisms found there.

It is extremely important to visit the site prior to bringing students there. Park rangers, naturalists, interpreters, docents, museum staff, or others can point out suitable places to do activities, suggest other activities, and inform you of safety and environmental concerns. Even if you plan to lead your own trip, a greeting by park personnel can help set an appropriate tone for the trip. Some recommended activities may require you to leave the usual paths, pick leaves, or do other things for which you should get permission.

Reminder
All activities should be tried out by the teacher prior to having students do them in order to be sure that the directions are understood and that they can be done with your particular equipment and materials. This is important not only to be sure that the activities will work, but to be sure that they can be done safely.

Such details as time estimates are only approximate; as the teacher, you know your students best.

Be sure to consider the activities in Chapter 4: Activities for Any Time.

Creek Studies

ACTIVITY SUMMARY
Students investigate stream temperatures, velocities, and amounts of suspended material.

CONCEPTS TO BE LEARNED
1. Faster flowing water can carry more suspended solids.
2. Faster flowing water is often cooler than slowly moving water.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences 3.a: Ecosystems are characterized by living and non-living components.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.
Mathematics Number Sense 3.0: Solve problems

Grade 5: Earth Sciences 3: Water moves…
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.
Mathematics Number Sense 1.0: Computation
Mathematics Number Sense 2.0: Calculating and solving problems

Grade 6: Earth Science 2: Topography is reshaped by weathering and transportation of sediment
Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.
Mathematics Number Sense 1.0: Solving problems
Mathematics Number Sense 2.0: Calculate and solve problems.

Grade 7: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Environmental Principles and Concepts

Principle II: Humans affect natural systems.
- Concept a: Human populations and consumption affect natural systems.
- Concept b: Human extraction, harvesting, and use of resources affect natural systems.
- Concept c: Expansion and operation of human communities affect natural systems.
- Concept d: Human social systems affect natural systems.

ANTICIPATED OUTCOMES
1. Students will understand that stream velocity is a major factor in the amount of material carried by the stream.

GROUPING
Groups of six

TIME
15-30 minutes

MATERIALS: per group:
- ❒ Stop watches or watches with second hands
- ❒ Thermometer (preferably with carrying case)
- ❒ Tape measure (minimum 10 feet)
- ❒ Clipboards
- ❒ Pencils (work better than pens if the paper gets damp)
- ❒ Plastic gallon jar or bucket
- ❒ Coffee filter paper and funnel or filter holder
- ❒ Ruler (suitable for measuring stream depth)
- ❒ Towel
- ❒ Creek Studies Study Guide

TEACHER PREPARATION
1. When previewing the trip, locate sites where students can access a stream safely and without damaging the shoreline or vegetation. (Look for areas with varying velocities and conditions such as exposed shoreline, shoreline with vegetation, rocky shores, sandy shores, etc.)
2. Obtain the materials. If you use a plastic gallon jar (from the cafeteria or a restaurant?), carefully remove the "lip" that protrudes into the opening. Such a lip will keep some of the suspended solids from pouring from the jar with the water.
3. Try out the suspended solids collection in various sites. How many gallons or buckets does it take to obtain enough suspended material for the students to see?

PROCEDURE
1. Each team will be doing two studies: stream velocity and sediment load.

2. Assign the following jobs to team members:
   a. recorder
   b. launcher
   c. finish line observer
   d. water collector
   e. timer
   f. temperature and depth taker

3. Explain the procedures on the Study Guide and how to use the materials.

4. 

Caution the students **not to go into the stream.** accidentally or intentionally. Walking in the stream is likely to damage organisms living in or under rocks, and will stir up sediments.

   Also caution them about slippery rocks and logs.

5. After the data are collected, have the teams share and compare their data.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. You may want to attach a bucket to a pole for collecting water away from the shore.
2. Plankton nets can be purchased from some of the sources listed in Appendix IV. (If collecting plankton, be sure to obtain a plankton key or guide for identification.)
3. Some sites may have rocks, logs, or low bridges that provide safe access to the center of the stream.
4. 

   If the stream is rarely visited or little used, you might consider having students enter the stream wearing shoes or waders to protect their feet. They can collect water/sediment samples and might use plankton nets or other nets to collect organisms that float downstream when rocks or logs are overturned. **I do not encourage doing this in heavily used streams, as the organisms in them already get disturbed too much.**
5. Some jobs such as finish line observer and temperature taker can be combined.

ASSESSMENT

1. Do students follow directions?
2. Do students make good observations and record data accurately?

ANSWERS TO SELECTED STUDY GUIDE QUESTIONS

1. Fast moving streams will usually contain more suspended material. As water loses energy, it slows down and doesn't have enough energy to carry suspended material.

   In general, shallow, slow moving water will be warmer.
2. When dams slow or stop the flow of the water, suspended materials settle out and form sediments.
3. When dams slow or stop the flow of the water, the surface waters generally become warmer. Deep water may remain cool.
4. In general, deeper water will be cooler. (Cool water can hold more dissolved gases, such as the oxygen that fish need. An example of this can be seen when a glass of cold water is allowed to sit in the sun. Gas bubbles soon form on the side of the glass as air comes out of solution.)
5. If the dam results in warmer water, or fine sediments, salmon may not be able to successfully reproduce.
6. Plants provide shade, which helps cool the water. They also attract insects, which provide food for fish. Logging companies are now required to leave plants along streams to help provide suitable fish habitat.

REFERENCES AND RESOURCES

Shinkle, Jill: *Creek Watchers*

Creek Studies
Study Guide

Today you are part of a team of scientists that will collect some data about a stream.

- Be sure to follow directions and make and record your observations carefully.
- Ask your teacher if you have any questions.
- **DO NOT go into the creek!** Walking in streams can harm plants and animals that live in the sand and under rocks.

Team Members and Jobs:

Recorder:_____ Timer:_____ Temperature/Depth Taker:_____

Launcher:_____ Finish Line Observer:_____ Water Collector: _____

Site description: Shore/edge: rocky, sandy, covered by plants, or? _____
Shady, sunny, or?_____

Stream bottom: rocky, sandy, algae covered, mixed, or? _____

Stream flow: slow and smooth, splashing around rocks, or?_____

Other:

- ✓ Find the starting point for your velocity test. This is the **launcher's** station.
- ✓ Find the ending point for the velocity test. The **timer** and **finish line observer** are here.
- ✓ Determine where the water sample will be collected. The **water collector, temperature and depth taker,** and **recorder** will be here.
  (This should be a place where the sample can be collected **safely and without knocking sand or debris into the water.)**

Measure the distance the stream flows between the starting and ending points (from the launcher to the timer/finish line observer). It should be at least 10 feet. Distance: _____ feet.

To determine the stream velocity (speed):

a. When the timer says "go," the launcher drops a small stick into the stream.
   (Use a 2" - 4" stick from the ground. Do not pick a twig from a living tree.)
b. When the stick reaches the end point, the finish line observer says "stop" and the timer notes the time that the stick took to travel the measured distance.
c. The recorder records the data on the data table (other side of this page.)
d. If the stick gets stuck on a rock, washes ashore, etc., disregard that trial and repeat.
e. Calculate the stream velocity by dividing the distance by the time.
   Example: If it took 5 seconds to travel 20 feet: 20 ft. ÷ 5 sec = 4 ft. per sec.
f. Use the same stick to repeat the process 4 times and find the average.

To determine the suspended materials carried by the stream:

a. Your teacher will tell you how much water to sample.
b. Fold the filter paper so that it fits snugly into the funnel or filter holder.
c. Use a bucket or jar to collect the proper amount of water. Be careful not to knock sand or other material into the stream, or to stir up the bottom by stepping into the stream, as this will affect your results.
d. **Carefully** pour the water through the filter. Gently swirl the water as you do this so that material doesn't stay in the bucket. Material that was being carried by the water will be trapped by the filter. This is suspended material.

To determine the temperature and depth: At the place where the water is collected, carefully dip the end of the thermometer into the stream. Hold the thermometer in place for 2 minutes, being careful not to drop it or break it by bumping it on the bottom or a rock. Use the ruler to measure the depth where the water is collected. Record the temperature and depth.

Stream Velocity

Distance (include units)	**Time** (seconds)	**Speed** Distance ÷ time	Calculate **average**	**notes**
			Add the 4 speeds and divide by 4.	

Temperature:_____ º ___ (note: are these Fº or Cº ?) **Depth**: _____ in.

Suspended Solids

Describe the **amount** of material collected on the filter.

Describe the **types** of materials collected on the filter…mud, sand, gravel, leaves, sticks, or?

Describe the **sizes** of the materials that you collected…all one size, varying. How big?

Questions:

1. Compare the data collected by different teams.
   - ✓ Which had more suspended material—fast moving water or slowly moving water?
   - ✓ Which was warmer?
2. If a stream is dammed, what do you think will happen to the suspended material?
3. If a stream is dammed, what do you think will happen to the water temperature?
4. How does depth affect temperature?
5. Salmon need cool, oxygen rich water to live. They need gravel (not sand or mud) in which to lay their eggs. What affect do you think a dam is likely to have on the salmon population?
6. If fire, landslides, logging or something else removes the plants from the side of the stream, what affect do you think that would have on water temperatures?

   On salmon?

Duff Dwellers

ACTIVITY SUMMARY
Students observe organisms that live in the leaf litter or duff on the forest floor.

CONCEPTS TO BE LEARNED
1. Many organisms live in the leaf litter or duff on the forest floor.
2. Decomposers break down the leaf litter into soil components.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences 2.c: Decomposers recycle matter.
Life Sciences S.S. 3: Living organisms depend on one another and their environment.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 5: Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 6: Ecology (Life Sciences) S.S. 5: Organisms exchange energy and nutrients among themselves and with the environment.
Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Grade 7: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Other Standards:

Grade 5: Life Sciences 2

Environmental Principles and Concepts

Principle II: Humans affect natural systems.
- Concept a: Human populations and consumption affect natural systems.
- Concept b: Human extraction, harvesting, and use of resources affect natural systems.
- Concept c: Expansion and operation of human communities affect natural systems.
- Concept d: Human social systems affect natural systems.

Principle III: Natural systems have cycles on which humans depend and that can be altered by humans.
- Concept a: Natural systems have cycles.
- Concept b: Humans depend on and utilize natural cycles and processes.
- Concept c: Human practices can alter natural cycles and processes.

ANTICIPATED OUTCOMES
1. Students will increase their understanding of the diversity of life.
2. Students will increase their understanding of the importance of food chains, food webs, and especially the role of decomposers.

GROUPING
Groups of two to five students, depending on equipment availability

TIME
30-45 minutes

MATERIALS: for each group:
- ❒ A litter sifter (see below for various options)
- ❒ White plastic pan such as a dish pan
- ❒ Magnifier, two-way magnifier, or "bug box"
- ❒ Plastic spoon
- ❒ Forceps
- ❒ 3"x5" card
- ❒ Clear plastic cup(s), or cups with white insides
- ❒ Optional: trowel, clipboard and paper and pencil

Making a litter sifter:
1. Use duct tape to attach "hardware cloth"* screening material to a half-gallon milk carton, large juice can, coffee can, or #10 can (from a cafeteria or restaurant) from which the bottom and top have been cut**.
   or
2. Use duct tape to attach "hardware cloth"* screening material to a three to four-inch section of large (six to ten-inch) diameter plastic pipe**.

* Hardware cloth is available with various sizes of openings. If you only use one size, half-inch is recommended. Consider making sifters with various sized openings ranging from ¼ to ¾ inch.

**If you use a can, cover any sharp areas on the open top end with duct tape to prevent cuts. Also be careful with the cut edges of hardware cloth.

TEACHER PREPARATION
1. Make, or have parents or students make, "Litter Sifters."
2. Obtain the other materials.
3. Locate a site where there is ample duff or leaf litter accessible to the students.

PROCEDURE
1. While on the field trip, have teams of students sift through some leaf litter.

   ➢ As they find different organisms, have the teams place them in plastic cups and show to the other teams.

Warn the students not to pick up spiders or centipedes with bare hands…they should use forceps, plastic spoons, or cards.

2. Since green plants are not part of the leaf litter, discuss where these duff dwellers obtain their food. Discuss their role as decomposers.

3. Discuss the importance of decomposers and decomposition to the ecosystem.

4. Discuss the fact that bacteria, which are too small to be seen without a microscope, are present by the millions in the leaf litter and are very important in the decomposition process.

5. After the students are finished with the litter, it should be returned to the collection site.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. The simplest way to do this lab is to have students dump the duff into a light colored plastic pan and remove large objects such as leaves and look for organisms as they sift through the remaining duff.

2. Have students compare the types and quantities of duff dwellers in different areas such as under redwood, tanoak, and madrone trees or in damp, shady areas as compared to dry, sunny areas.

3. Students can also examine leaves and twigs (detritus) from the bottom of a creek.

4. If organisms cannot be identified, have students sketch them in as much detail as possible for future identification.

5. If electricity is available, a "Berlese funnel" can be constructed. Use tag board and masking tape to make a funnel with a bottom "mouth" one to two inches in diameter. Cover the bottom opening with nylon or plastic window screening held in place with masking tape. Place the funnel over the mouth of a jar. Place duff, decaying leaf litter, or soil into the funnel, and place the funnel and jar under a warm light or in the sunlight. Soil and duff-dwelling organisms will move downward into the jar to escape the light and heat.

ASSESSMENT

1. Ask students to explain the importance of decomposers to the ecosystem.

REFERENCES AND RESOURCES

American Forest Foundation: *Project Learning Tree: Pre K-8 Activity Guide: "Nature's Recyclers"*

Outdoor Biology Instructional Strategies (OBIS): "*Litter Critters"*

Hunting for Treasure in the Redwoods

ACTIVITY SUMMARY
While on a field trip, students look for various things on a list.

CONCEPTS TO BE LEARNED
1. Being alert and making careful observations can help one enjoy one's environment.
2. Scientists must make careful observations.
3. Other concepts, depending on the Hunting for Treasure in the Redwoods list

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Science Investigation and Experimentation 6.a: observations
Others, depending on the teacher-generated list

Grade 5: Life Sciences S.S. 2: Plants and animals have structures.
Science Investigation and Experimentation 6.a: classify objects
Others, depending on the teacher-generated list

Grade 6: Depends on the teacher-generated list

Grade 7: Life Science Structure and Function In Living Systems S.S. 5: Anatomy and physiology
Others, depending on the teacher-generated list

ANTICIPATED OUTCOMES
1. Students will increase their ability to observe natural phenomena and objects.
2. Students will increase their ability to describe their observations.

GROUPING
Individual or groups of whatever size the teacher decides

TIME
Varies

MATERIALS (per group/team)
- ❒ Hunting for Treasure in the Redwoods Study Guide
- ❒ Hand lens/magnifier/"bug box"
- ❒ Clipboard and pencil (Pencils work better than pens when the paper is damp.)
- ❒ Plastic bag for collecting litter
- ❒ Optional: bag or other container for collecting items from the list

TEACHER PREPARATION
1. During a pre-trip visit, work with a ranger, interpreter, naturalist, or docent to develop the Hunting for Treasure in the Redwoods list.
2. Create and duplicate the Hunting for Treasure in the Redwoods list

PROCEDURE
1. Issue the Hunting for Treasure in the Redwoods Study Guide.

2. Tell the students the boundaries, time allowed, and any other limits.

3. Remind the students to be aware of poison oak, yellow jackets, etc.

4. Remind the students not to damage or kill anything.

5. Remind the students not to take anything home unless they have permission and a specific intended use. If the trip is to a park, remind the students not to take anything home.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Some teachers like to encourage competition. Others do not. Use your judgment.
2. This can be done over the course of the trip, for a short time and space (15 minutes, within sight of the teacher, for example), or during a large part of the trip (after lunch, for example).

ASSESSMENT

1. Do the students follow directions?
2. Do the students describe, collect, point out, or? the items on the list?

REFERENCES AND RESOURCES

Cornell: *Sharing Nature With Children*.

Council for Environmental Education: *Project WILD® K-12 Activity Guide:* "Microtrek Treasure Hunt"

Hunting for Treasure in the Redwoods
Study Guide

There is treasure to be found in the redwood forest. Listed below are a number of things that you may be able to find in the forest.

Follow your teacher's directions about whether to collect, describe, draw, or point out each of the things on the list.

Remember not to damage anything! Remember to return all natural things to the forest.

Be careful of such things as poison oak, stinging nettles, yellowjackets, etc.

Teachers: The following list is just a starting point. Work with park staff or volunteers to develop a list that will work at your site.

Suggestions for things to collect **from the ground**:

- ❒ Cones: redwood, Douglas-fir
- ❒ Acorns: tanbark oak, other oak
- ❒ A seed from a different plant (maple, berry, or?)
- ❒ Leaves: redwood, Douglas-fir, tanbark, other
- ❒ A feather
- ❒ Something round
- ❒ Something fuzzy
- ❒ Something sharp
- ❒ Something that you consider beautiful
- ❒ Something that you consider interesting (and be prepared to explain why)
- ❒ A leaf that has been chewed on (not by a person.)
- ❒ Something white, blue, red, black or?
- ❒ Two pieces of litter

Suggestions for things to point out, describe and/or draw:

- ❒ Evidence of animals (droppings, spider webs, gopher hole, bird or wood rat nest, a gnawed cone, the animal)
- ❒ Evidence of ways that humans have changed the area in the last five years
- ❒ Evidence of something that happened over 50 years ago
- ❒ Evidence of camouflage

I Never Knew That!

ACTIVITY SUMMARY
Students observe individual or groups of organisms for an extended period of time, recording their observations.

CONCEPTS TO BE LEARNED
1. Careful observation can reveal things about organisms that had not been previously known to the observer.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 5: Life Sciences S.S. 2: Plants and animals have structures for various life processes.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 6: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Grade 7: Life Science…Structure and Function in Living Systems S.S. 5: Anatomy and physiology
Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

ANTICIPATED OUTCOMES
1. Students will increase their ability to observe and record both anatomical and behavioral characteristics of organisms.

GROUPING
Individual or groups of two

TIME
Introduction: five minutes
Observation and recording time: varies…15-30 minutes

MATERIALS
- ❒ Pencils and notebooks or clipboards with paper
- ❒ Photocopies of the I Never Knew That! Study Guide
- ❒ Optional: magnifiers or binoculars

TEACHER PREPARATION
1. While previewing the field trip, find a place where students might be likely to be able to find insects, banana slugs, birds, fish, or other animals to observe. If there's any doubt, check with the park personnel to be sure that it is okay for students to sit in the area while they make their observations.

PROCEDURE

1. Discuss with the students the importance of careful observation when studying organisms.

2. Discuss the idea that scientists can observe both physical characteristics such as markings, color, number of legs, or body shape, and behavioral characteristics such as how an organism moves, how it reacts to sound, or how it feeds.

3. Pass out the I Never Knew That! Study Guide and explain that the students are to make and record careful observations of an organism.

4. Discuss safety issues such as staying in the study area, poison oak, etc.

5. Inform the students of the time limits.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. This activity can be done in any environment, including the home, neighborhood, or school grounds.

ASSESSMENT

1. Are observations accurately recorded?
2. Were both physical and behavioral observations recorded?
3. Were the objective terms used in the descriptions (as opposed to subjective terms)?
2. Did students follow instructions?

ANSWERS TO SELECTED STUDY GUIDE QUESTIONS

Will vary according to the students' observations.

REFERENCES AND RESOURCES

Roa, Michael: *A Guide to the Side of the Sea*

I Never Knew That!
Study Guide

Careful observation and accurate recording of observations are extremely important for scientists. For the next few minutes, you are going to be a scientist studying an animal more carefully than you have ever studied an animal before. Be sure to record your observations carefully and accurately. Drawings may help.

Also, be careful…some animals can bite or sting, and don't get into poison oak!

Hint #1: Drawings may help…You don't have to be an artist to sketch your animal

Hint #2: When you record your observations, try to use terms that everyone will understand. Using numbers may help with this. Think about these examples:

Clear	Not so clear
Has 6 oval shaped spots on its back	Has spots on its back
Crawled 2 feet in 3 minutes	Crawled slowly
Is 3 inches long	The biggest slug I've ever seen!
Body gray in color with brown on stomach	Grayish with some brown

Hint #3: Be sure to include observations about how the animal looks **and** how it acts.

Hint #4: It may be useful to record your observations every 10 or 20 seconds, every minute, or ?

Observations (continue on the back if necessary):

What kind of animal are you observing? _____

What does this animal looks like….**physical** observations. Look carefully and try to notice something that you have never noticed before.

Drawing Description…things that I notice:

Observations of **behaviors**:

Something that I observed that I hadn't observed before is:

A question that I have is:

Micro-hiking

ACTIVITY SUMMARY
Students make observations while "hiking" by crawling for a short distance, keeping their heads no more than a foot above the ground.

CONCEPTS TO BE LEARNED
1. Careful and close observation can reveal things that we don't normally notice.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences S.S. 3: Living organisms depend on one another and their environment.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 5: Life Sciences S.S. 2: Plants and animals have structures for various life processes.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 6: Ecology (Life Sciences) 5: S.S. Organisms exchange energy and nutrients among themselves and with the environment. Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Grade 7: Life Science…Evolution 3.a: Biological evolution accounts for diversity.
Life Science…Structure and Function in Living Systems S.S. 5: Anatomy and physiology
Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

ANTICIPATED OUTCOMES
1. Students will increase their ability to observe and describe their observations.
2. Students will observe things that they have not previously noticed.

GROUPING
Teams of two

TIME
10-30 minutes

MATERIALS: for each team of two students:
- ❒ 5' of string
- ❒ Clipboard, paper, pencil
- ❒ Optional: hand magnifier

TEACHER PREPARATION

1. Obtain the materials above.

2. While on a pre-trip visit to the site, find an area where students can crawl along the ground safely.

PROCEDURE

1. Give each team the materials.

2. Tell them to spread their strings along the ground (or across a log, on a tree, over a rock, or?) in such a way that they won't interfere with other groups. Encourage them to look for things that they have never before noticed.

3. One student crawls along the ground (either on "all fours" or on their belly), keeping his or her head no more than 1 foot above the ground. As the student crawls, he or she describes what is seen.

4. The second student records the observations of the first. Of course, the second student is encouraged to check out for himself/herself what the first student describes.

5. After the first student has "hiked" the string, the students place the string in another area and trade roles.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Rather than "hiking" along a string, students can explore a small area determined by tossing a loop of string.

ASSESSMENT

1. Do students look closely and describe accurately?

REFERENCES AND RESOURCES

Cornell, Joseph: *Sharing Nature with Children*

The Only Constant is Change: Succession in Action

ACTIVITY SUMMARY
Students observe examples of succession, or changes in dominant species, in the field.

CONCEPTS TO BE LEARNED
1. Environments change over time.
2. Over time, the dominant organisms living in a place will change.
3. Different organisms inhabit a place at different successional stages.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences S.S. 3: Living organisms depend on one another and their environment.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 5: Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 6: Earth Science 2.d: Landslides and floods change human and wildlife habitats.
Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Grade 7: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

ANTICIPATED OUTCOMES
1. Students will increase their understanding of succession in biological communities.

GROUPING
Whole class and individuals

TIME
varies

MATERIALS
- ❒ Paper and pencils
- ❒ clipboards

TEACHER PREPARATION
1. When you do the pre-trip site visit, locate places where students can see various stages of succession such as:
   - Bare earth or rock
   - Grasses (on earth) or lichens (on rock)
   - Non-woody herbaceous plants
   - Small woody plants
   - Trees

It would be ideal if you can locate an area where a fire, landslide, logging, or other disturbance has obviously set succession back. Also, look for places such as a meadow or field where the forest was cleared some time ago. Look for bushes or forest trees growing along the edge of the meadow.

PROCEDURE

1. While on the field trip, point out to students different plants growing in different areas.
   - Discuss the concept of succession, wherein a group of plants and animals affect and change their environment, resulting in other plants and animals becoming dominant.
   - Discuss how such things as fire, road clearing, landslides, or logging can set succession back to an earlier stage.
   - Discuss the idea that the plants and animals in a successional stage don't just appear. They are present but not dominant during the previous stage. Often, shade-tolerant plants survive and thrive in the shade of less shade-tolerant plants, eventually becoming dominant.

2. Have students draw and label the different vegetation types from bare soil to a forest with a canopy, sub-canopy, and understory.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. *Project Learning Tree* has a classroom succession activity called "Nothing Succeeds Like Succession." See American Forest Foundation, *Project Learning Tree: Pre K-8 Activity Guide*, 2006.

2. Succession can be observed in the classroom by simply obtaining some unpurified water, perhaps from a creek or pond while on a field trip (or adding some straw or other "contaminant" to some tap water), and keeping it in an aquarium or jar on a windowsill and observing the changes over time as different groups of organisms grow.

ASSESSMENT

1. Look for various stages in the students' drawings.

REFERENCES AND RESOURCES

American Forest Foundation: *Project Learning Tree: Pre K-8 Activity Guide.*

The Other Senses

ACTIVITY SUMMARY
While seated in the redwoods, students use senses other than sight to make observations.

CONCEPTS TO BE LEARNED
1. Senses other than sight can be used to make observations.

STANDARDS ADDRESSED
Focus Standards:
Grade 4: Science Investigation and Experimentation 6.a: observations

ANTICIPATED OUTCOMES
1. Students will increase their ability to use senses other than sight to make observations.
2. Students will increase their appreciation of the sense of sight.
3. Students will increase their ability to describe what they sense.

GROUPING
Individual

TIME
10-30 minutes

MATERIALS
- ❒ Notebook, 3”x5" card, or clipboard and pencil

TEACHER PREPARATION
1. Obtain the materials
2. On a pre-trip site visit, locate an area where the students can be safely and comfortably seated (preferably on the ground or logs, as opposed to picnic tables).

PROCEDURE
1. Call on a couple of students to make an observation and tell it to the class. Ask the students what sense they used. Students will almost always make a visual observation.

2. Ask students to name the other senses besides sight.

3. Tell them that they are going to use their other senses to experience the redwoods.

4. Tell the students how long they will be sitting and whether they will be writing down their observations afterwards.

5. Tell them to remember one thing that they sense so that they can describe it to the group afterwards.

6. Either lead students to their sites, or have them select their own.

7. Students should be comfortably seated and close their eyes.

8. After the allotted time, have students open their eyes, write down one or two things that they noticed, and then get the group together to share.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Working in partners, students can be led to a tree, bush, rock, or other natural object while blindfolded. They then describe the tree or other object without using their sense of sight.

Be sure to caution students to be careful while leading the blindfolded student, and also to avoid poison oak, stinging nettles, eye level branches, etc.

2. If <u>you</u> pick out the leaves, students can taste various plants and attempt to describe their taste.

Of course you must be sure of what you're picking!

ASSESSMENT

1. Do students cooperate by keeping their eyes closed?
2. Do students use senses of touch, hearing, and smell?

People Pictures

ACTIVITY SUMMARY
Students "take pictures" by pointing their partner's eyes towards something that they find interesting.

CONCEPTS TO BE LEARNED
1. Natural objects can be very interesting when viewed close-up.

STANDARDS ADDRESSED

Focus Standards:

Grade 5: Life Sciences S.S. 2: Plants and animals have structures for various life processes.

Grade 7: Life Sciences…Structure and Function in Living Systems S.S. 5: Anatomy and physiology

Other Standards:

Grade 4: Science Investigation and Experimentation 6.a: observations

ANTICIPATED OUTCOMES
1. Students will increase their ability to observe and describe details.

GROUPING
Teams of two students

TIME
10-20 minutes

MATERIALS
- ❒ Index card or notebook and pencil

TEACHER PREPARATION
1. Obtain the materials

PROCEDURE
1. Tell the students that they are about to become nature photographers: One will be the camera, and one will be the photographer. They will then change roles.

2. Demonstrate how to "take a picture:"
   a. The "camera" closes his or her eyes.
   b. The photographer carefully leads the "camera" to the place where the photographer finds something interesting to "photograph."
   c. The photographer then carefully points the camera at the subject and tells the subject whether this will be a close up, medium, or long-distance photograph. (This helps the camera to focus quickly on the subject.)

d. When the camera is ready, the photographer taps the camera on the shoulder and says "click."

e. When the camera hears "click," he or she opens his or her eyes and takes in the site visually. (No talking…cameras don't talk!)

f. Once that picture is taken, the camera then closes his or her eyes and is guided to another picture site.

g. After a number of pictures (five to ten), or about five to ten minutes, the photographer and camera switch roles.

h. After both students have taken their pictures, have them sketch the favorite picture that they took. They may do this from memory, or they might return to the site.

Note:

Be sure to warn the students to be careful as they guide their "cameras," and not to position the camera where he or she might poke an eye. Also tell them of any "off limits" subject matter such as trash cans, roads, or other people.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Students can "pan" their cameras by moving the student's head slowly from side to side or up or down.

2. Students can write stories about one or more of the scenes that they saw.

ASSESSMENT

1. Do students cooperate and are they careful?
2. Do their drawings and/or stories show attention to detail?

REFERENCES AND RESOURCES

Cornell, Joseph: *Sharing the Joy of Nature*

Poetrees

ACTIVITY SUMMARY
Either during or after a trip to the redwoods, students create poems.

CONCEPTS TO BE LEARNED
1. Poetry can be used to express feelings and thoughts.
2. There are various kinds of poetry.

STANDARDS ADDRESSED
Focus Standards:
Grade 4: English Written and Oral Language Conventions 2.2.4: Recite brief poems.
Grade 5: English Listening and Speaking Strategies Standard Set
Grade 6: English Listening and Speaking Strategies Standard Set
Grade 7: English Listening and Speaking Strategies Standard Set

ANTICIPATED OUTCOMES
1. Students will increase their willingness and ability to write various types of poetry.

GROUPING
Individual

TIME
Varies

MATERIALS
- ❒ Notebook or clipboard, paper and pencil
- ❒ Copies of Poetrees Study Guide (two-sided)

TEACHER PREPARATION
1. Before the trip, introduce various types of poetry. The Poetrees Study Guide may be useful for this.
2. Obtain the above materials.
3. Find a place where students can sit quietly to write.

PROCEDURE
1. Use the Poetrees Study Guide to review various types of poetry and to prepare to write.

2. Have the students find a comfortable place, apart from each other, where they can write. Tell them that they will need to spend at least (10? 15? 20?) minutes at their site, so they should take their time rather than rush through this writing assignment.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Students can practice writing poetry before the field trip.

2. Students can write their poems on drawn or cut-out shapes such as trees or animals.

3. Student poems can be compiled into a booklet or on a tree-shaped bulletin board display.

4. Consider saving some samples of student poems to use as examples.

ASSESSMENT

1. Do the students follow the conventions (if any) of the poetry styles?

REFERENCES AND RESOURCES

American forest Foundation: *Project Learning Tree Pre K-8 Environmental Education Activity Guide: "Poet-Tree."*

Shinkle, Jill: *Creek Watchers: Exploring the Worlds of Creeks and Streams*

Poetrees
Study Guide

Just as carpenters use boards and nails to build houses, and bakers use spices and other ingredients to make cakes, poets use words to create poems. Today you are going to write one or more poems about the redwood forest. First, though, you will need to collect your tools—words. To get you started, a few examples have been given below.

List eight nouns (things) that have to do with the redwood forest:

trees air fog

List seven adjectives (words that describe things) that have to do with the redwood forest:

green gigantic wet

List six verbs (action words) that have to do with the redwood forest:

fall grow whisper

List five adverbs (words that describe verbs, other adverbs, or adjectives) that have to do with the redwood forest:

slowly quietly majestically

There are many different kinds of poems. Several types are described below. Use the words above **or others** to write a poem that shows something about how you feel about the redwoods.

Haiku poems, which originated in Japan, have very a particular structure. Haiku poems have three lines: the first has five syllables, the second seven, and the third has five. Haiku usually are nature poems, and the last line is often surprising or strong.

Reaching for the sky
Green needles growing, tall tree
Look – the wet fog comes!

Continued on the other side

Cinquain poems have five lines and have a specific structure. Each line has a specific purpose or structure:

Line 1: title line in two syllables or two one-syllable words	Tall Trees
Line 2: four syllables or words, describe the first line	Red, green, and brown
Line 3: six syllables or words, describe action	Growing slowly in sun
Line 4: eight syllables or words, describe a feeling	Soft shade makes us smile as we rest
Line 5: another word for the first line/title in two words	Redwood!

Diamante poems are shaped like a diamond. An example of a diamante poem structure might be:

Noun	tree
adjective adjective	tall green
participle participle participle	sprouting growing dying
noun noun noun noun	roots stems needles cones
participle participle participle	reaching holding feeding living
adjective adjective adjective	strong plentiful alive
noun	redwood

An **acrostic** is a series of words or phrases that begin or end with the letters of a word written vertically or horizontally.

Strong
Enriching
Quiet
Upright
Overgrowing
Inspiring
Awesome!

T R E E
a e v x
l d e c
l r e
g l
r l
e e
e n
n t

Free verse has no set formula or style.

We grow
tall, strong, silent.
We live
years – hundreds, thousands.
Hear us.
We welcome you!

Prints of the Redwoods

ACTIVITY SUMMARY
Students make leaf prints, leaf and/or bark rubbings, and/or plaster casts of animal tracks.

CONCEPTS TO BE LEARNED
1. Plants and animals have various anatomical features that enable them to live.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Science Investigation and Experimentation 6.a: Observations and inferences Science Investigation and Experimentation 6.b: Measure and estimate.

Grade 5: Life Sciences S.S. 2: Plants and animals have structures for various life processes.
Science Investigation and Experimentation 6.a: classify objects

Grade 7: Life Science ... Structure and Function in Living Systems S.S. 5: Anatomy and physiology
Science Investigation and Experimentation 7.a: Use tools to perform tests, collect data, and display data.
Science Investigation and Experimentation 7.d: Construct scale models to communicate knowledge.

Other Standards:

Grade 6: Science Investigation and Experimentation 7.g

ANTICIPATED OUTCOMES
1. Students will increase their knowledge of plant and animal anatomy.

GROUPING
Individual or groups of two to three

TIME
Five -Fifteen minutes per rubbing or print

MATERIALS

Part 1: Leaf Prints

- ❒ Tempra paint (Carry plastic bottles in re-sealable plastic bags.)
- ❒ Paint brushes and/or brayer, stored in re-sealable plastic bags
- ❒ White or colored paper—construction paper works well
- ❒ Water and towels for cleanup (carry in re-sealable plastic bag)
- ❒ Leaves of various plants, possibly leaves that have fallen
- ❒ Newspaper (with a large plastic bag for carrying back for recycling)

Part 2: Leaf and/or Bark Rubbings

- ❒ Plain white paper (Typing/copy paper works better than construction paper.)
- ❒ Dark colored crayons with paper peeled off. Large "primary' crayons will be less likely to break.

Part 3: Plaster Casts

- ❒ Plaster of Paris (from hardware store) (If it doesn't come in a plastic container, transfer it to a plastic container with a tightly sealing lid.)
  The amount will depend on the number of tracks you want each student to make. Plan for about ½ cup per track.
- ❒ Water (water bottle or water from a creek, in which case you'll need a cup, plastic bottle, or some such thing with which to scoop it from the creek)
- ❒ Cups in which to mix the plaster
- ❒ Spoons with which to mix the plaster
- ❒ Baby powder
- ❒ Something with which to form a "dam" to hold the plaster:
  A three-inch section of a milk carton or…
  A three inch x ten inch strip of plastic or cardboard + two small binder clips or some masking tape
- ❒ Plastic pan(s) with lids, or boxes with which to transport casts
- ❒ A five-gallon plastic bucket can carry the materials, leftovers, and waste.

TEACHER PREPARATION

1. Talk with a park ranger about if and where you might pick leaves for prints and where animal tracks might be found.
2. Obtain materials as needed.
3. Find a place with flat surfaces such as picnic tables where the prints can dry, perhaps during lunch.
4. Test the materials that you plan to use to be sure that they will work with the types of leaves or bark that you have available.
   If you are making plaster of Paris casts, practice with your particular material to determine the amount of water needed to make a mixture that has the consistency of a thick cream – about two parts plaster to five parts water. If it is too thin, it will take longer to set up. If it is too thick, it won't flow into the details of the track. Mix the plaster by adding the plaster to the water rather than the water to plaster.

PROCEDURE

Part 1: Leaf Prints:

1. Spread the newspaper on a flat surface such as a picnic table.
2. Place a leaf on the newspaper with the veined side upward.
3. Use a paint brush or brayer to apply an even coat of paint to the leaf.
4. Carefully lift the leaf and press the painted side on the paper. Spread the leaf flat.
5. Carefully lift the leaf from the paper and set the paper aside to dry. Use a rock or piece of wood to keep the paper from blowing away.

Part 2: Leaf or Bark Rubbings:

1. Leaf and Bark
   a. Leaf: Find a leaf with prominent veins and place it on a hard flat surface, vein side upward.
   b. Bark: Place the paper over the bark. Have a partner help hold it flat and smooth against the bark.
2. Gently but firmly rub the side of the crayon over the paper so that the texture of the leaf or bark shows up on the paper.

Part 3: Plaster Casts of Tracks

1. Gently blow or brush away any sticks, rocks, or leaves that are in the track.
2. Dust the track and soil around it with baby powder. This should help dry the area and help keep the plaster from sticking to the dirt or sand.
3. Surround the track with a dam made from a section of a milk carton or a strip of plastic or cardboard that has been clipped or taped to form a ring.
4. Use a spoon to mix the plaster of Paris in a cup as indicated.
5. Gently pour the plaster evenly into and over the track until about one inch deep.
6. Let the plaster harden for at least 30 minutes. The time will depend on how wet the ground is, the mixture that you created, humidity, etc. You might consider setting up a couple of test casts to remove before removing the actual track casts.
7. When the plaster is hard, gently lift it straight up. Carefully dust off any dirt. (You may want to let it cure (harden) for a while more before cleaning it.)
8. **It may take a couple of days for the plaster to completely cure. It will be fairly fragile until then. Place the cast(s) in a plastic pan with newspaper packing or use some other way to protect the casts while being taken home or to school.**

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

All parts:

1. Consider teaching and practicing the techniques at school before the trip.

Part 1: Leaf Prints

1. Students can use different contrasting colored paints and paper.
2. Students can make prints of different species on one page.
3. Students can make booklets with prints from several species.
4. A piece of cord and clothes pins can be used to hang prints to dry.

Part 2: Leaf or Bark Rubbings

1. Students can make booklets with rubbings of different types of bark or leaves.
2. Orally or as a writing assignment, have the students try to describe the different bark or leaf patterns and textures so that others can identify the leaf or bark being described from the rubbing or print.
3. Leaf prints can be made after the leaves have been used for rubbings.

4. Several bark rubbings can be glued or taped to a cylindrical tube such as a carpet roll so that they simulate a tree trunk.

Part 3: Plaster Casts of Tracks

1. A paper clip can be inserted through a slit in the "dam" so that ¾ of it projects into the plaster to serve as a hanger.
2. Students can also make leaf prints in plaster.
3. Use these casts when you discuss the formation of fossils.
4. The cast is an impression of the foot of the animal that made the track. To make another track (which would be similar to a fossilized track or leaf impression), coat the cast with petroleum jelly, place a dam around it, and pour one to one and a half inches of plaster into the dam. (Sometimes the original cast will stick to the track being made, so don't do this unless you don't mind "sacrificing" the cast.)
5. Casts can be painted, lacquered, or left natural.
6. Other casting materials will produce harder, more durable casts, but are more expensive. See Appendix IV: Sources, or check at a hardware or craft store.
7. Some of the sources listed in Appendix IV sell rubber or plastic replicas of animal prints (or even animals) that can be used to create tracks or molds. Some of the sources also sell kits for casting and field guides of tracks.

ASSESSMENT

1. Are the prints or casts done as directed?
2. Can the students identify the plant parts and describe characteristics shown in the prints or casts?

REFERENCES AND RESOURCES

There are numerous resources available for teaching and learning about tracks and other signs of animals. See the resources in Appendix IV: Sources of Materials.

Some useful books include:

- Burt, William and Richard Grossenheider: *Peterson Field Guides: Mammals*
- Elbroch, Mark: *Mammal Tracks & Sign: A Guide to North American Species*
- Farrand, John: *National Audubon Society Pocket Guide: Familiar Animal Tracks of North America*
- Lowery, James: *The Tracker's Field Guide*
- McDougall, Len: *The Encyclopedia of Tracks and Scats*
- Olaus, Murie, Mark Elbroch, and Roger Tory Peterson: *Peterson Field Guides: Animal Tracks*
- Sheldon, Ian: *Animal Tracks of Northern California*
- Stall, Chris: *Animal Tracks of Northern California*
- Whitaker, John: *National Audubon Society Field Guide to North American Mammals*

The Root of the Matter

ACTIVITY SUMMARY
While in a stand of redwoods, students examine the root system of a fallen tree.

CONCEPTS TO BE LEARNED
1. Roots are used to anchor plants and to absorb water and nutrients.
2. Coast redwood trees have a relatively shallow root system.
3. Coast redwoods have evolved the ability to form new layers of roots if their roots are buried by sediments.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences 3.a: Living and non-living components
Life Sciences 3.b: Some survive well; some don't.

Grade 5: Life Sciences S.S. 2: Plants and animals have structures for various processes.

Grade 7: Life Science 5.b: Organisms depend on properly functioning organs and organ systems.

Other Standards:

Grade 5: Earth Sciences 3
Grade 6: Earth Science 2
Grade 7: Life Science…Evolution 3

ANTICIPATED OUTCOMES
1. Students will increase their understanding of the importance of roots.
2. Students will increase their understanding of redwoods' adaptations to living in flood-prone alluvial flats.

GROUPING
Whole class

TIME
A few minutes while in the field

MATERIALS
- ❒ Specimen of downed redwood tree showing root system
- ❒ (optional) trowel

TEACHER PREPARATION
1. While previewing the field trip, talk to a ranger, naturalist, docent, or other person familiar with the site and locate a large downed redwood tree that shows the root system. Look for a tree that shows more than one layer of roots, indicating the growth of new layers in response to covering by sediments during flood events.

Be aware of whether the students are going to be able to view the roots without trampling other plants.

2. Ask about digging up a plant (preferably a non-native plant with a large tap root, such as a dandelion) to show the students a root system. If this is not possible, show a plant's root system before the trip so that students have a better understanding of how extensive some plant roots are.

PROCEDURE

1. If you have obtained permission to do so, dig up a plant such as a dandelion and show the students the root system. Discuss:
   a. the functions of roots (anchoring the plant, absorbing nutrients)
   b. what would happen if a plant's roots died
   c. the idea that roots need air as well as water and that compaction of soil can kill a plant's roots
   d. the value of roots in holding soil in place, thereby reducing erosion
2. Compare the size of the root system to the above ground portion of the plant.
3. Have the students predict how deep they think a 300-foot-tall redwood's roots might go into the soil.
4. Have the students observe the roots of a fallen redwood. Point out that:
   a. The roots are broken, so they aren't seeing the whole system, but the whole system for a tree several hundred feet tall only went down six to twelve feet, and may have a spread of 50 feet in all directions.
   b. When the tree was alive, the roots probably intertwined with neighboring trees, which gave it added support.
   c. Different layers of root systems are formed after floods cover lower layers.
   d. Measurements of a tree's height change not only as a tree grows, but also as the base is buried with sediments.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. If fallen trees of other species are visible, have the students compare their roots to redwood trees' root systems.
2. If the park has built boardwalks, fences, or other ways to prevent compaction or other damage to plants, be sure to point out those to the students and discuss why they are needed.
3. Discuss root functions besides absorption and anchoring – like storage of food in beets, carrots, and potatoes.

ASSESSMENT

1. Can students tell two functions of roots and how redwoods are adapted to living in areas where floods deposit sediments?

Similar, But Not the Same!

ACTIVITY SUMMARY
Students compare Douglas-fir trees with coast redwood trees.

CONCEPTS TO BE LEARNED
1. Careful examination can reveal anatomical differences between species of trees.

STANDARDS ADDRESSED
Focus Standards:
Grade 4: Science Investigation and Experimentation 6.a: observations
Science Investigation and Experimentation 6.b: measure
Grade 5: Life Sciences 2.a: structures for various life processes.
Science Investigation and Experimentation 6.a: classify objects
Grade 7: Life Science 3.4: Classification
Life Science S.S. 5: Anatomy and Physiology
Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

ANTICIPATED OUTCOMES
1. Students will increase their ability to make detailed observations.
2. Students will learn to tell the difference between coast redwood and Douglas-fir trees.

GROUPING
Individuals or teams of two

TIME
10-20 minutes

MATERIALS
- ❒ Notebooks or Similar But Not the Same! Study Guide
- ❒ Pencils

TEACHER PREPARATION
1. During a pre-trip site visit, locate an area where students will have access to both Douglas-fir trees and coast redwood trees.

PROCEDURE
1. At the site, ask students to suggest what they might look at to tell the differences between various kinds of trees. Elicit such things as leaf/needle appearance, bark, cones, and overall growth pattern (shape).

2. Point out the Douglas-fir and redwood trees. Have students compare the two by writing observations and making drawings in their notebooks, or use the Study Guide below.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Similar comparisons can be done with other species.
2. This activity can lead to the use of dichotomous keying activities.

ASSESSMENT

1. Do the students accurately describe the differences and similarities?

ANSWERS TO SELECTED STUDY GUIDE QUESTIONS

	Coast redwood	Douglas-fir
Bark	Fibrous (stringy-looking), soft, fibers run up and down the trunk May have lichens growing on it	Not fibrous, looks like jigsaw puzzle, flaky-appearing and hard May have lichens growing on it
Leaves: Individual	Needles end in sharp points Leaves are needle-like, ¾" - 1" long	Needle ends are blunt Leaves are needle-like, ¾" - 1" long
Leaves: arrangement on the twig	Needles of lower branches stick out to the side…flat, like a fan Needles from the top of a tall tree may lie close to the twig, scale-like.	Needles go around the twig, like a brush
Cones	About the size of an olive (less than an inch long) Hang down from ends of branchlets	1.5 inches or more in length, with soft 3-forked "bracts" protruding from the cone Hang downward from branches
other		

REFERENCES AND RESOURCES

Guiney, Miriam: *Redwood Parks Activity Book*

Similar But Not the Same!
Study Guide

Sometimes it is easy to tell the difference between different kinds of trees. Coast redwood trees and oak or madrone trees, for example, look very different.

Sometimes, however, it is not so easy. Coast redwood and Douglas-fir trees are similar in many ways. They are both "evergreen," meaning they don't lose their leaves (needles) in the winter. They both produce cones that have seeds in them. Both are important lumber trees and can grow very tall.

Use the table below to compare coast redwood and Douglas-fir trees. Look for both similarities (how they are the same) and differences.

Sketches might be very helpful!

	Coast redwood	Douglas-fir
Bark		
Leaves: Individual		
Leaves: arrangement on the twig		
Cones		
other		

Other Activities for During the Trip

Trash Patrol

Before leaving the parking lot at the start of the field trip, provide each group with a five-gallon plastic bucket or trash bag. (The bucket is more easily reusable and can be used to carry other things.) So that one person doesn't feel "stuck" carrying the container, determine a rotation system. Consider using two containers, one for trash and one for recyclable materials.

Caution the students about sharp glass or metal, poison oak, etc. After the litter has been collected, the students can sort it into categories, including recyclable, decomposable, and other. Discuss what people could have done rather than bring these things to the redwoods and leave them behind, including alternatives to disposable packaging. Dispose of the material properly, recycling what you can.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Mathematics 3.1: Using addition and subtraction.

Grade 6: Mathematics 1.4: Calculate percentages.

Environmental Principles and Concepts

Principle II: Humans affect natural systems.

- Concept a: Human populations and consumption affect natural systems.
- Concept b: Human extraction, harvesting, and use of resources affect natural systems.
- Concept c: Expansion and operation of human communities affect natural systems.
- Concept d: Human social systems affect natural systems.

Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.

- Concept a: Effects of human activities on natural systems depend on quantities of resources used and the quantity and characteristics of the byproducts of use.
- Concept b: Byproducts of human activities affect natural systems.
- Concept c: The ability of natural systems to adjust to human-caused alterations depends on several factors.

Redwood Log Activities

Plan time in the trip for the students to have some alone time. Find a place where they can be spread out far enough to discourage talking, but where they can be observed for safety reasons. If students have made journals or notebooks ("Redwood Logs"), they can be given a simple assignment such as:

- Sketch your favorite redwood forest organism and tell why it is your favorite.
- Write a brief note to a redwood organism. Tell the organism what you liked or what you learned in the redwoods, or what you wonder about.
- Write a brief poem about what you saw or learned today.
- Write a note to your parents or family. Tell them something interesting about the redwoods.
- Sit quietly, close your eyes, listen and smell. Arrange to have an adult tell you when five minutes are up. Write down what you heard, felt, and smelled.
- Go to a spot that is "natural" (not a parking lot or picnic table). Spend 5 minutes looking as closely as you can at an area half the size of a piece of binder paper. Write and sketch what you see. Write down five questions about what you see.

A commercially available book called *My Nature Journal*, by Adrienne Olmstead, includes numerous ideas for nature writing and other activities.

REFERENCES AND RESOURCES

Olmstead, Adrienne: *My Nature Journal*
Roa, Michael: *A Guide to the Side of the Sea*

End of the Trip Activities

As a class, discuss what was seen and learned while it is still fresh in the students' minds.

- What was most interesting?
- What was most surprising?
- What would they like to see again, or what did they miss?
- What do redwood organisms do: (These will require some thought and conjecture. Are the students' responses logical and reasonable?)
  - ✓ At night?
  - ✓ When it rains?
  - ✓ When a fire approaches?
  - ✓ When a stand is logged?
- What can they as individuals, and as a class, do to help protect the park?

REFERENCES AND RESOURCES

Roa, Michael: *A Guide to the Side of the Sea*

Before leaving the lunch area or parking lot, have students do a litter patrol. Recycle whatever is possible. Leave the area cleaner than you found it.

Chapter 3
Post-Trip Activities

The activities in Chapter 3 are generally best done after a visit to a redwood park or forest. They reinforce and expand upon concepts and information taught while on the trip.

A field trip should not be an isolated event. Connecting what the students see and do "in the field" will make the trip more meaningful. Activities done before and during a field trip can provide information about **what**. Discussion of the significance of the activities provides the **"so what?"** Follow-up activities provide the very important **"now what?"**

Reminder
All activities should be tried out by the teacher prior to having students do them in order to be sure that the directions are understood and that they can be done with your particular equipment and materials. This is important not only to be sure that the activities will work, but to be sure that they can be done safely.

Such details as time estimates are only approximate; as the teacher, you know your students best.

Be sure to consider the activities in Chapter 4: Activities for Any Time.

Global Warming

ACTIVITY SUMMARY
Students model the "greenhouse effect," which contributes to global warming or global climate change.

CONCEPTS TO BE LEARNED
1. Energy can be converted from one form to another, including from light to heat.
2. The greenhouse effect can cause significant increases in temperatures.
3. Photosynthesis results in the removal of carbon dioxide from the environment.
4. An actively growing forest removes and stores (sequesters) a lot of carbon from the atmosphere, thereby reducing global climate change.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences S.S. 3: Living organisms depend on one another and their environment.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.
Mathematics Statistics, Data Analysis, and Probability S.S. 1.0

Grade 5: Life Sciences 2f: photosynthesis
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.
Mathematics Statistics, Data Analysis, and Probability S.S. 1.0

Grade 6: Ecology (Life Sciences) 5.a: Energy enters ecosystems as sunlight.
Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.
Mathematics Statistics, Data Analysis, and Probability S.S. 1.0

Grade 7: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Other Standards:

Grade 5: Earth Sciences 4

Grade 7: Life Science…Evolution 3.5

Environmental Principles and Concepts

Principle II: Humans affect natural systems.
- Concept a: Human populations and consumption affect natural systems.
- Concept b: Human extraction, harvesting, and use of resources affect natural systems.
- Concept c: Expansion and operation of human communities affect natural systems.
- Concept d: Human social systems affect natural systems.

Principle III: Natural systems have cycles on which humans depend and that can be altered by humans.
- Concept a: Natural systems have cycles.

Concept b: Humans depend on and utilize natural cycles and processes.
Concept c: Human practices can alter natural cycles and processes.
Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.
Concept a: Effects of human activities on natural systems depend on quantities of resources used and the quantity and characteristics of the byproducts of use.
Concept b: Byproducts of human activities affect natural systems.
Concept c: The ability of natural systems to adjust to human-caused alterations depends on several factors.
Principle V: Decisions affecting natural resources and systems are based on many factors.
Concept a: Students need to understand the spectrum of factors that are considered in making decisions about natural resources.
Concept b: Students need to understand the decision making process and how it changes with time.

ANTICIPATED OUTCOMES

1. Students will increase their understanding of energy conversions.
2. Students will increase their understanding of the process of photosynthesis.
3. Students will increase their understanding of the greenhouse effect/global warming.

GROUPING

Teams of two to three students

TIME

45-60 minutes

MATERIALS: for each team:

- ❒ Two clear two-liter bottles, with labels removed, with the tops cut off about 4" from the bottom
- ❒ Two six inch thermometers with scale on metal, plastic, or cardboard backings
- ❒ One piece of plastic wrap or plastic bag
- ❒ Two pieces of thin cardboard, about two inches X two inches (tag board or halves of a 3"x5" card)
- ❒ Plastic ruler
- ❒ Two rocks, approximately 2 inches in diameter, clean, dry, of the same type
- ❒ Masking tape
- ❒ Either sunny area or light source with 100-watt bulb
- ❒ Graph paper

TEACHER PREPARATION

1. Since the bottles can be difficult to cut, it is recommended that they be cut before class.
2. Prepare a demonstration set-up and test the activity.

PROCEDURE

1. Prior to the activity, discuss photosynthesis, respiration, and the production of carbon dioxide by the burning of fuels. Also discuss the role of carbon dioxide in the greenhouse effect and global warming.

2. Have each team construct their global warming model as follows:
   a. Using masking tape, attach the thermometers to the inside of the cut bottles (at the same height in each). The bottom of the thermometer should be about two inches above the bottom of the bottle.
   b. Tape the small cardboard pieces on the outside of the bottle so that they cover the thermometers' bulbs so that they are not exposed directly to the light source.
   c. Place a clean, dry rock in the bottom of each bottle to keep it from tipping over.
   d. Cover one of the bottles with clear plastic held in place with tape. This is the "greenhouse."
   e. The other bottle remains uncovered and is the "control" for the experiment.

3. Have the students record the starting temperatures in each bottle and then set them in the sun or where a light shines on each equally.

4. Students should record the temperatures in each bottle every two minutes for 20-30 minutes.

5. Temperatures can be graphed with time on the horizontal axis and temperatures on the vertical axis.

6. Discuss the following:
   a. When trees photosynthesize, they remove carbon dioxide from the atmosphere and store (sequester) the carbon in their tissues. What would be the affect of replacing forests with parking lots, shopping centers, and roads?
   b. While cutting mature trees temporarily reduces the photosynthesis in an area, young, vigorously growing trees sequester more carbon than mature, slowly growing trees.
   c. Burning of trees (or anything else, such as gasoline) produces carbon dioxide, which increases the greenhouse effect when it enters the atmosphere.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Many variables can be tested. Students can test these questions, among others:
   a. What would be the effect of having soil in the bottles?
   b. What would be the effect of water in the bottles?
   c. What would be the effect of plants in the bottles?
   d. Does the color of the bottle affect the results?
   e. Are the results the same if the bottles are in the shade?

2. See "The Global Climate," Activity #84 in the Project Learning Tree Pre K-8 Activity Guide.

ASSESSMENT

1. Do students follow directions?
2. Can students tell the result of the greenhouse effect on temperatures?
3. Can students tell the role of photosynthesis, respiration, burning of fuels, and plants in global warming?

REFERENCES AND RESOURCES

Roa, Michael: *Environmental Science Activities Kit*

The U.S. Environmental Protection Agency has produced a "Toolkit for Teachers and Interpreters" called *Climate Change, Wildlife, and Wildlands*. This kit has been available for free and includes a CD (with 26 fact sheets, case studies, outlines and visual aids, puzzles and coloring sheets, a slide show, and ordering information for brochures and a poster), a videotape, a wheel with which one can determine greenhouse gas emissions and actions that one can take to reduce emissions, and a set of cards that describe how climate change affects various plants and animals. The kit is being revised and will probably be available again in 2008. See Appendix IV, Sources of Materials.

Harvest Math

ACTIVITY SUMMARY

Data is provided on the amount of redwood harvested annually. Students use the data to practice such math skills as finding averages, rounding off, and graphing.

CONCEPTS TO BE LEARNED

1. Math skills: finding averages, rounding off, graphing, interpreting graphs
2. Graphs can be useful, and can also be misleading.
3. The volume of redwood harvested annually has generally decreased for the last 30 years, while the price per board foot has generally increased.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Mathematics Statistics S.S. 1.0: Organize, represent, and interpret numerical data.

Grade 5: Mathematics Number Sense S.S. 1.0: Computation, rounding
Mathematics Statistics S.S. 1.0: Display, analyze, compare, and interpret data sets, including graphing.

Grade 6: Mathematics Number Sense S.S. 2.0: Calculate and solve problems
Mathematics Statistics S.S. 2.0: Use data samples, including bias and validity

Grade 7: Mathematics Statistics S.S. 1.0: Collect, organize, and represent data sets.

Environmental Principles and Concepts

Principle I: Humans depend on natural systems.
- Concept a: Humans depend on natural systems for goods and materials.
- Concept b: Humans depend on ecosystems.
- Concept c: The health of ecosystems affects their usefulness for people.

Principle II: Humans affect natural systems.
- Concept a: Human populations and consumption affect natural systems.
- Concept b: Human extraction, harvesting, and use of resources affect natural systems.
- Concept c: Expansion and operation of human communities affect natural systems.
- Concept d: Human social systems affect natural systems.

Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.
- Concept a: Effects of human activities on natural systems depend on quantities of resources used and the quantity and characteristics of the byproducts of use.
- Concept b: Byproducts of human activities affect natural systems.
- Concept c: The ability of natural systems to adjust to human-caused alterations depends on several factors.

Principle V: Decisions affecting natural resources and systems are based on many factors.
- Concept a: Students need to understand the spectrum of factors that are considered in making decisions about natural resources.
- Concept b: Students need to understand the decision making process and how it changes with time.

ANTICIPATED OUTCOMES
1. Students will increase their ability to round off, find averages, and make and interpret graphs.

GROUPING
Individuals, small groups, or whole class

TIME
30-90 minutes

MATERIALS
- ❒ Copies or overhead transparency of data table: "California Redwood Harvest Statistics"
- ❒ Copies or overhead transparency of data table: "California Redwood Harvest Statistics: 5-Year Averages"
- ❒ Copies of Harvest Math Study Guide
- ❒ Graph paper and/or graphing program for computer

TEACHER PREPARATION
1. Decide whether to provide the data on paper or on an overhead transparency.
2. Decide whether to revise the data from the table with rounded off values to simplify students' work.
3. Duplicate Harvest Math Study Guide and table(s) or revised table(s).

PROCEDURE
1. After teaching the math skill(s) that you want the students to use, provide the students with the "California Redwood Harvest Statistics" and/or "California Redwood Harvest Statistics: 5-Year Averages" data tables (below). Have them use the statistics and the Study Guide to practice the math skills.

2. Discuss the meaning of a "board foot" as a measurement unit for lumber. (It is an amount of wood in a board that is one inch thick, and 12 inches by 12 inches, or 144 cubic inches. However, most lumber is sold as smooth or surfaced wood, which results in a loss of some wood when they plane or surface the wood. Thus, a "two by four" board, if it's surfaced, is actually only about 1.5" x 3.5," and a "one by twelve" is actually only about ¾" x 11 1/2". As a consequence, when purchasing a thousand board feet of lumber, one usually doesn't end up with an actual thousand board feet if the lumber is surfaced.)

3. Note that "mbf" stands for "thousand board feet." You might want to point out that a millennium is 1000 years and a meter has a thousand millimeters in it. A million is a thousand thousand, so in 2005, for example about 304,000 mbf were harvested, which is about 304 thousand thousand board feet, or 304 million board feet.

4. Using the 5-Year Average data is simpler.

5. It is interesting to make two bar graphs, one with the vertical axis (board feet) starting at zero and the other with the vertical axis starting at 300 million board feet. When the axis starts at 300 million, the decline looks much more precipitous than it appears when the axis starts at zero. This can lead to a discussion of how statistics can be used to mislead. (Sample graphs are provided below. You might reproduce those graphs to use in the discussion, or use student-generated graphs.)

6. Use the data and graphs to discuss possible reasons for:
   a. the general decline in amounts of redwood harvested (large old-growth trees have been harvested, increasing costs of harvesting timber and running mills, including increasing regulations and costs of compliance)
   b. the relationship between amount of wood harvested and the value (supply and demand)

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. The data from the tables can be modified or simplified by rounding off.
2. Have students experiment with various types of graphs.
3. International Paper Company has a free set of “Life of the Forest” posters, teaching guides, and a 16-page booklet on forests and forest products. Go to www.internationalpaper.com and perform a search for “education.”

ASSESSMENT

1. Student graphs should be neatly and accurately done and should include labeled axes, units, and a title.

ANSWERS TO SELECTED STUDY GUIDE QUESTIONS

1. "mbf" stands for "thousand board feet."
   301,000 mbf would be 301,000 thousand board feet, which would equal 301,000,000 board feet or 301 million board feet.

2.b. In 2005, there were about 303,949,000 board feet harvested, or about 304 million. The only year in the table in which less redwood was harvested was 2001.

3.b. In 2005, the value of the redwood harvest was about $207,079 thousand dollars, or $207,079,000 (about 207 million dollars).

4. In general, the amount of redwood harvested each year has declined since the mid-1970s. This is due to a variety of factors, including regulations, lack of large trees,

and imports of woods from other places. Point out to the students that the harvest goes up and down. This is also an opportunity to discuss the change from harvesting old-growth trees in earlier years to the current harvesting of almost entirely second-growth trees, which have some different qualities from old-growth lumber.

5. In general, the dollar value of a given amount of redwood has steadily increased, i.e., a board foot of redwood (or a thousand board feet of redwood) costs more today than it has in the past. Again, this is a general trend, and the cost rises and falls. It would be interesting for students to try to determine the reason(s) for the spike in both production and value in 2000.

REFERENCES AND RESOURCES

California State Board of Equalization, Timber Tax division

Harvest Math
Study Guide

Use the California Redwood Harvest Statistics table to answer the following questions.
Be sure to show your work where appropriate.

1. What does the abbreviation "mbf" stand for?

   If a million is a thousand thousand, 301,000 mbf would equal how many million board feet?

2. In what year were you born? _____

   a. How many board feet of redwood were harvested in the year in which you were born?

   b. How many board feet of redwood were harvested in 2005?

   c. How does the 2005 harvest compare to the year in which you were born?

3. Notice that the value of the harvested redwood is given in thousands. That means that in 1978, for example, the value was 225,641 x 1000 dollars. Since a thousand thousand is a million, that would equal $225,641,000 dollars, or over 225 million dollars.

   a. What was the value of redwood harvested in the year in which you were born?

   b. What was the value of redwood harvested in 2005?

   c. How does the value of the 2005 harvest compare to the value of the harvest in your birth year?

4. What is the general trend of the amount of redwood harvested each year? In general, is more redwood harvested each year, has it stayed about the same, or has the amount harvested annually gone down since 1978? Can you think of any reasons for this?

5. What is the general trend of the average value of a given amount of board feet of redwood since 1978? Has the value gone up, down, or stayed the same? Can you think of any reasons for this?

California Redwood Harvest Statistics			
YEAR	**VOLUME** (mbf)	**VALUE** (thousands)	**AVERAGE** ($/mbf)
1977*	630,838	$95,232	$150.96
1978	806,887	$225,641	$279.64
1979	647,373	$241,878	$373.63
1980	528,910	$178,530	$337.54
1981	535,676	$156,786	$292.69
1982	487,512	$113,025	$231.84
1983	592,435	$128,714	$217.26
1984	676,860	$138,111	$204.05
1985	674,009	$141,323	$209.68
1986	771,967	$168,966	$218.88
1987	796,492	$173,481	$217.81
1988	782,082	$175,776	$224.75
1989	749,353	$195,858	$261.37
1990	747,155	$242,152	$324.10
1991	528,011	$184,913	$350.21
1992	533,289	$249,267	$467.41
1993	514,501	$333,942	$649.06
1994	498,475	$312,783	$627.48
1995	476,475	$250,974	$526.73
1996	513,139	$295,014	$574.92
1997	506,878	$267,210	$527.17
1998	433,869	$235,754	$543.38
1999	370,654	$226,643	$611.47
2000	376,174	$390,118	$1,037.07
2001	301,390	$219,910	$729.65
2002	319,278	$140,046	$438.63
2003	338,918	$164,876	$486.48
2004	309,397	$178,530	$577.03
2005	303,949	$207,079	$681.30
TOTAL	**15,751,946**	**$6,032,532**	**$382.97**
* partial year			

mbf = thousand board feet.

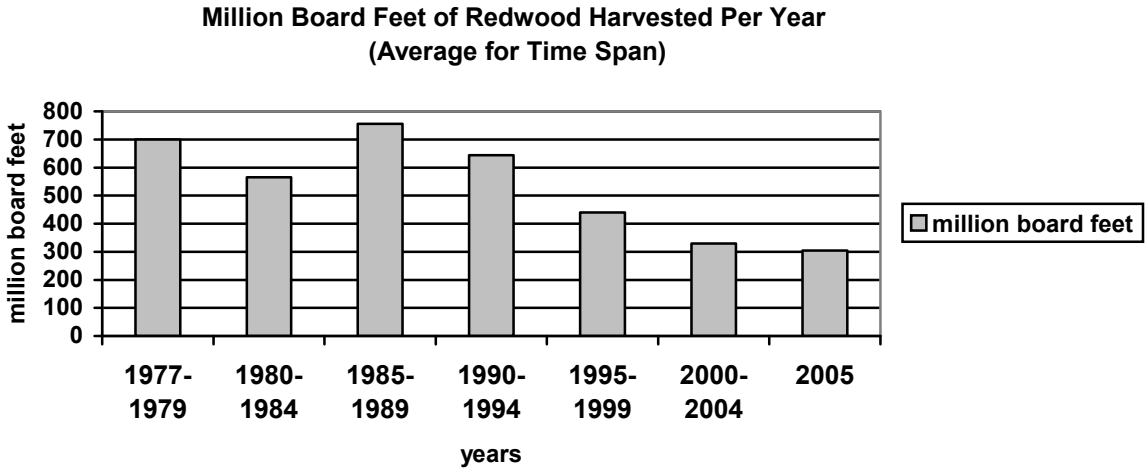
Source: California State Board of Equalization, Timber Tax division

Harvest Statistics: 5-Year Averages
(Based on California Redwood Harvest Statistics provided by the California State Board of Equalization, Timber Tax division)

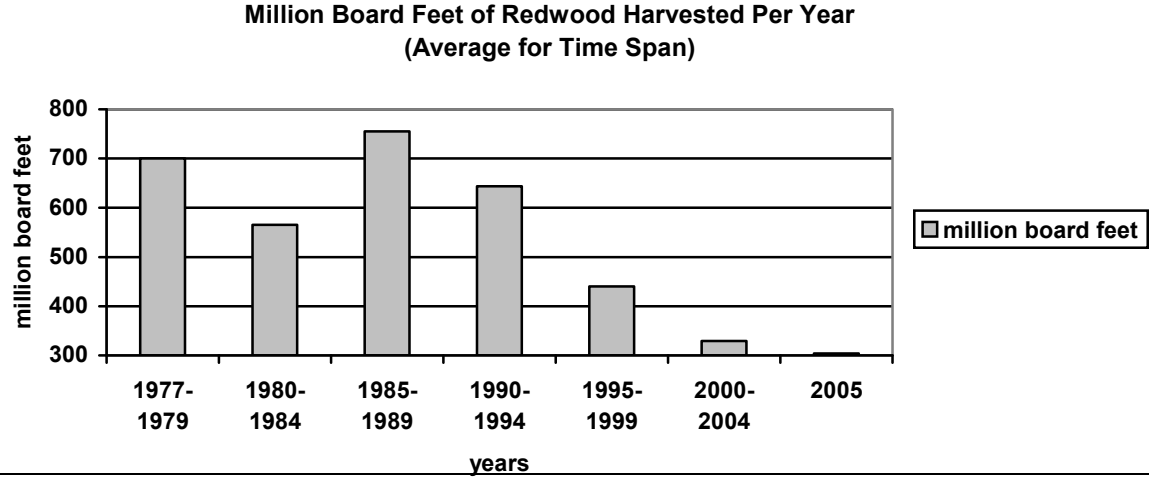
1977-1979: averaged more than 700 million board feet per year
1980-1984: averaged about 565 million board feet per year
1985-1989: averaged about 755 million board feet per year
1990-1994: averaged about 644 million board feet per year
1995-1999: averaged about 440 million board feet per year
2000-2004: averaged about 329 million board feet per year
2005: about 304 million board feet

Sample graphs:

Vertical axis starting at zero board feet:



Vertical axis starting at 300 million board feet:



Paper Making

ACTIVITY SUMMARY
Students make new paper from scraps of used paper. (While other species of tree are used for most paper making, some redwood is used at a pulp mill on Humboldt Bay.)

CONCEPTS TO BE LEARNED
1. Paper is made from plant fibers.
2. Paper can be made from recycled paper.
3. We use many products from the forests.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 5: Life Sciences S.S. 2: Plants and animals have structures for various life processes.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 6: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Grade 7: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Environmental Principles and Concepts

Principle I: Humans depend on natural systems.
- Concept a: Humans depend on natural systems for goods and materials.
- Concept b: Humans depend on ecosystems.
- Concept c: The health of ecosystems affects their usefulness for people.

Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.
- Concept a: Effects of human activities on natural systems depend on quantities of resources used and the quantity and characteristics of the byproducts of use.
- Concept b: Byproducts of human activities affect natural systems.
- Concept c: The ability of natural systems to adjust to human-caused alterations depends on several factors.

ANTICIPATED OUTCOMES
1. Students will increase their understanding of the importance of forest products.
2. Students will understand that paper is usually made from wood fibers.
3. Students will increase their understanding of the value and importance of recycling.

GROUPING
Varies according to materials available

TIME
Preparation: 30 minutes
Actual paper making process: two 30-50 minute sessions

MATERIALS
- ❒ Scraps of fibrous paper such as construction paper, paper towels, or toilet paper. Newspaper with ink will work, but the ink will discolor the paper. Glossy paper such as binder paper and magazine paper doesn't work well; it has less fiber and more glue and clay.
- ❒ Large bowl or plastic tub
- ❒ Hot water or means for heating water
- ❒ Wooden frame (5" x 7"?)
- ❒ Nylon or wire screen
- ❒ Stapler
- ❒ Large plastic tub into which the wooden frame will fit
- ❒ Cloth dishtowels or other blotting material
- ❒ Kitchen strainer
- ❒ Kitchen blender
- ❒ Sponge
- ❒ Plywood
- ❒ Optional: Rubber gloves
- ❒ Optional: starch
- ❒ Optional: leaves, thread, dried flowers, herbs

TEACHER PREPARATION
1. Obtain the materials needed, including "deckles" (see Procedure step 2)
2. Try out the process.

PROCEDURE
1. Discuss with students where paper comes from, what it is used for, and the advantages and disadvantages of recycling.

2. Make, or have students or a parent make, "deckles," which are wooden frames covered with tightly stretched and securely stapled or taped nylon or wire screening.

3. Have students remove any staples or plastic and tear the paper into 1-inch scraps.

4. Soak the paper scraps in hot water for at least 30 minutes, preferably overnight.

5. Blend the scraps at medium speed until the pulp has a thick, soupy consistency.

6. Pour the mixture into the large tub and add warm water, stirring until the ingredients are evenly mixed. Adding a little starch will make the paper more firm.

7. Slide the deckle into the basin and put pulp on top of the screen, moving it back and forth until the layer of fibers is evenly distributed on the screen.

8. Lift the deckle out of the mixture, keeping it flat while most of the water drips off.

9. Gently press out any remaining water. Use a sponge to remove water from below.

10. Place a dish towel, newspaper, or other blotting material on a flat surface such as a piece of plywood or counter top.

11. Turn the deckle upside down so that the paper-containing side is against the dish towel. Gently lift the screen, leaving the paper behind; gently tap the screen as necessary to help loosen the paper.

12. Cover the paper with another piece of cloth or blotter and place a piece of plywood on top to further flatten the paper and help squeeze out any remaining water.

13. Let the paper dry overnight (or longer, depending on the humidity, blotter, thickness, etc.)

14. Gently peel the new paper from the blotter.

15. Left over pulp can be saved for future use by freezing it, or it can be recycled.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Thread, dried flowers, bits of colored paper, herbs, or other items can be added to the paper either at the blending stage or immediately after placing on the blotter.

2. Students can design experiments to test various recipes for such characteristics as strength, absorbance, how well they work as writing paper, etc.

3. Embroidery hoops can be used as deckles.

4. A simpler process is to just spread the pulp over the exterior bottom of a baking pan or other smooth surface, then turn the pan over so that the pulp is on several layers of newspaper. Then close the newspaper over the pulp and use a rolling pin to squeeze out the extra water. Finally, open the newspaper and let the new paper completely dry.

ASSESSMENT

1. Do the students follow directions?
2. Can the students explain the paper making process?
3. Can the students describe advantages and disadvantages of recycling paper?

REFERENCES AND RESOURCES

American Forest Foundation: *Project Learning Tree: Pre K-8 Activity Guide: "Make Your Own Paper"*

Red's Woods: Tough Choices

ACTIVITY SUMMARY
Students role play as they discuss various options for the use of a tract of forest land.

CONCEPTS TO BE LEARNED
1. Land use choices are usually complex.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: History 4.1: Physical and human geographic features define places and regions.
English Listening and Speaking Standard Set
Grade 5: English Listening and Speaking Standard Set
Grade 6: English Listening and Speaking Standard Set
Grade 7: English Listening and Speaking Standard Set

Environmental Principles and Concepts

Principle I: Humans depend on natural systems.
- Concept a: Humans depend on natural systems for goods and materials.
- Concept b: Humans depend on ecosystems.
- Concept c: The health of ecosystems affects their usefulness for people.

Principle II: Humans affect natural systems.
- Concept a: Human populations and consumption affect natural systems.
- Concept b: Human extraction, harvesting, and use of resources affect natural systems.
- Concept c: Expansion and operation of human communities affect natural systems.
- Concept d: Human social systems affect natural systems.

Principle III: Natural systems have cycles on which humans depend and that can be altered by humans.
- Concept a: Natural systems have cycles.
- Concept b: Humans depend on and utilize natural cycles and processes.
- Concept c: Human practices can alter natural cycles and processes.

Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.
- Concept a: Effects of human activities on natural systems depend on quantities of resources used and the quantity and characteristics of the byproducts of use.
- Concept b: Byproducts of human activities affect natural systems.
- Concept c: The ability of natural systems to adjust to human-caused alterations depends on several factors.

Principle V: Decisions affecting natural resources and systems are based on many factors.
- Concept a: Students need to understand the spectrum of factors that are considered in making decisions about natural resources.

Concept b: Students need to understand the decision making process and how it changes with time.

ANTICIPATED OUTCOMES

1. Students will increase their understanding of the complexity of land use choices.

GROUPING

Whole class

TIME

Day 1: 20-30 minutes (possibly more time on the same or different days for research)
Day 2: 30-60 minutes for the "hearing"
Subsequent days: time for writing of articles or letters to the editor (or as homework)

MATERIALS

- ❒ Internet access
- ❒ Newspaper accounts of local land use discussions
- ❒ Study Guide: Red's Woods: Tough Choices

TEACHER PREPARATION

1. Copy the Study Guide for student use.
2. Modify role cards as needed, copy, cut up.
3. Identify Internet sites that may have useful information.
4. Select students for the various roles.

PROCEDURE

1. While on a field trip to a redwood park or forest, discuss the idea that different people might use the same land differently.

2. Issue individual students or, alternatively, teams of two to three students, the background information/role cards provided below. You may want to modify these or make up others.

3. Discuss the factors discussed in the scenarios, including:
   a. what taxes are and where they come from (including businesses)
   b. how businesses provide money to the local economy (jobs, taxes)
   c. what a city council or county commission is
   d. what a hearing is
   e. economic realities of parks—they cost money to operate
   f. what a second-growth forest is

4. Allow students time to prepare their presentations. If only the information cards provided are used, 10-15 minutes may be enough time. Students might also be given several days to do background research.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. It might be possible to have one or more guest speakers present information on actual land use choices that have been made locally. Landowners, planning department representatives, or representatives of citizen groups are possibilities.

2. Encourage the students to dress for their roles in appropriate attire.

3. Adapt the cards to reflect a real situation in your community and your students' knowledge and abilities.

4. Students can use maps (real or made-up) in their presentations.

5. Students can record their "hearing" and edit it for a "newscast."

6. Some students can serve as newspaper reporters who will write articles about the meeting.

ASSESSMENT

1. Are students able to represent various perspectives?

REFERENCES AND RESOURCES

Roa, Michael: *Environmental Science Activities Kit*

Red's Woods: Tough Choices
Study Guide

Background Information:

When someone owns property, such as a stand of redwoods, they must make choices about its use. Should it be sold to someone else, or kept? Should it be developed for housing or a shopping center, or should it be kept the way it is? There are many other choices, of course, and each has advantages and disadvantages for the landowner and the community.

In this activity, students play the roles of various people as they debate or discuss what should happen to a ficticious tract of forest land known as Red's Woods, which is right next to the town of Treeville, in Redwood County. In reality, the size and location of the land would be an important factor, as would surrounding land uses, the local economy and other things.

For the sake of this activity, we are going to assume that:

Ole "Red" Svensen has died and left 100 acres of second-growth redwood forest to Redwood County, to be used as the county commissioners decide. The property was logged many years ago, but some of the trees are now 3 feet in diameter and 150 feet tall, with some large trees growing near the creek that flows through the property.

Various proposals have been put forth, including:

- ✓ Donating the land to the County Department of Parks and Recreation for hiking and camping, but not hunting or fishing, requiring money for insurance and maintenance,
- ✓ Selling the land to developers for housing (The county needs money for maintaining roads, schools, and public safety.),
- ✓ Selling the land to developers for a shopping center,
- ✓ Keeping the land for a county open space area where citizens can use it in a variety of ways, including hiking, camping, hunting and fishing. (This would cost the county money for insurance and maintenance.)

Six students will play the roles of **county commissioners** who will eventually decide what will happen to the land. The **teacher** will be the **chairperson** of the county commissioners and will run the hearing.

Seven other students will play the roles of people who have different ideas about what the land should be used for. These **hearing participants** have character cards.

Some students will play the roles of **newspaper reporters**. Those students won't actually participate in the discussion, but they will write newspaper articles about the proceedings.

Other students will play the roles of **citizens** from the community who don't participate in the discussion, but may write letters to the editor of the local newspaper, the *Redwood Reader*.

On day 1, roles will be assigned and hearing participants will begin to prepare their cases.

On day 2, the hearing participants will present their cases to the county commission.

On day 3, the newspaper reporters and letter writers read their articles or letters to the class.

Maria or Miguel Mercado: grocery store owner (COUNTY COMMISSION MEMBER)

You have lived in Redwood County all of your life. You own the only grocery store in Treeville, but the new freeway has made it easier for people to travel farther to the larger town that has discount stores. Since you work so much, you have little time to enjoy the out-of-doors.

✂

Stuart or Susan Sellahouse: realtor (COUNTY COMMISSION MEMBER)

You sell real estate, mostly residential. You moved to Redwood County from the big city because you like the small town atmosphere of Treeville and the easy access to the forest. There are, however, very few homes for sale in the area, so you are worried about your job.

✂

Chris Coldwater: owner of Chris' Carvings (COUNTY COMMISSION MEMBER)

You have lived in Redwood County all of your life. Your father was a logger. You own a small business making carvings from redwood, which you sell to tourists. Red Svensen lets you cut a few trees from his property each year.

✂

Bob or Betty Bibliophile: retired librarian and local activist (COUNTY COMMISSION MEMBER)

You retired to Treeville 10 years ago because you love the small town and the surrounding forests. You have been a strong supporter of controlling growth, generally voting against any development that would bring in more people or result in loss of forests.

✂

Tom or Teresa Teachemall: high school teacher (COUNTY COMMISSION MEMBER)

You are a local high school science teacher who frequently takes your classes on field trips to Red's Woods. You have, in fact, been doing scientific studies of a stream in Red's Woods and hope to publish a scientific article after one more year of study. You are concerned about your job because no new housing has been built in the last few years, so few families with children are moving to Treeville.

✂

Don or Dorothy Domestica: homemaker (COUNTY COMMISSION MEMBER)

Your spouse earns a good living selling gasoline, and you are able to stay home to take care of your two children. You love the small town atmosphere of Treeville, but worry about possible changes if the town grows too much.

Bob or Betty Bigbucks: resident of Treeville

You love living in Treeville and have just inherited quite a bit of money. You would like to be able to purchase about two acres of Red's Woods to build your dream home.

✂.....

Carl or Carly Caresalot: resident of Treeville

You are involved in causes that benefit the less fortunate people in Treeville. There is very little low income housing in Treeville, and few jobs are available for unskilled workers. You would like to see part of Red's Woods developed into low income housing and a shopping mall that would include some discount stores where people could shop and also get jobs.

✂.....

Ranger Robin: park ranger at Big Burl State Park

Big Burl State Park is right next to Red's Woods. Over the years you have witnessed the increased pressure on the park, which is mostly due to more and more people visiting it. You would like to see Red's Woods become part of the park both to provide a buffer from the town and to provide more area where people can hike and camp.

✂.....

Wanda or Wallie Woodworker: employee of Forest Resources Company, Inc.

Your company follows all of the state and local regulations and harvests redwood in a responsible way. In fact, your company has repaired poorly designed roads and creek crossings in Red's Woods. You would like to either have the county allow your company to log in Red's Woods, or for your company to purchase the property for logging.

✂.....

Charlie or Cherie Citizen: local resident

You have been hiking in Red's Woods for years and have been a volunteer at Big Burl State Park, where you often lead groups of schoolchildren on field trips. You suspect that endangered species might be living in Red's Woods, and you want to try to protect the woods from development and logging.

✂.....

Hal or Harriet Hikesalot: local resident

You have lived in Treeville for all of your 45 years, and you consider yourself an environmentalist and outdoors person. Sven allowed you to hike and hunt in Red's Woods, and you would like to continue to do so.

✂.....

Sam or Sally Student: 11-year-old resident of Treeville

You like hiking in Red's Woods, but sometimes you wish the town had a skate park and a shopping center within biking distance.

Study Plots

ACTIVITY SUMMARY
Students collect and study data collected over a long period of time.

CONCEPTS TO BE LEARNED
1. Plants and ecosystems change over time.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences S.S. 3: Living organisms depend on one another and their environment.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 5: Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.
Life Sciences S.S. 2: Plants… have structures for life processes.

Grade 6: Ecology/Life Sciences S.S. 5: Organisms exchange energy and nutrients among themselves and with the environment.
Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Grade 7: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Other Standards:

Grade 4: Mathematics: Number Sense 3.0
Mathematics: Measurement and Geometry 1.0
Mathematics: Statistics 1.0

Grade 5: Mathematics: Measurement and Geometry 1.0:
Mathematics: Statistics 1.0

Grade 6: Mathematics: Number Sense 1.0, 2.0

Grade 7: Mathematics: Mathematical Reasoning 2.0

ANTICIPATED OUTCOMES
1. Students will increase their understanding of how plants and animals interact with each other and with their environment.
2. Students will increase their ability to make, record, and interpret observations.

GROUPING
Depends on the availability of study sites. Ideally, teams of two to four students for each site.

TIME
Varies

MATERIALS
- ❒ Varies with the types of data to be collected.

- ❒ Depending on the site, such tools as:
  - ○ Cameras
  - ○ Measuring devices
  - ○ Magnifiers
  - ○ Thermometers
  - ○ Pans
  - ○ Forceps
  - ○ Labeling materials such as tags available from garden supply stores
  - ○ Books including keys and field guides (see Appendix IV and V)
  - ○ Notebooks
  - ○ Colored pencils or crayons
  - ○ Files

TEACHER PREPARATION

1. Obtain the materials needed for the types of studies to be conducted.
2. Arrange for security of study area(s.)
3. Study areas might be on the school grounds or at a field site in a park or forest. A single tree or bush can be a site. It might be interesting to study a coast redwood, a giant Sequoia, and a dawn redwood growing on the school grounds, especially if the study starts when the trees are planted.

PROCEDURE

1. Once the study site has been selected, the first objective is to collect baseline data—What is present at the start of the study. After the baseline data have been collected, students can periodically revisit the site and record any changes that have occurred.

2. Have the students develop a system and forms for recording data.

3. Record such things as types and numbers of organisms, ground cover, sizes of plants (diameter of stem, height), general health of plants, shade cover at various times of day, air temperature, soil temperature, etc.

4. Students should draw, as accurately as possible, the whole plot and major plants.

5. As changes are observed, students try to figure out what might have caused the changes and what might happen next.

6. Photographs taken from the same viewpoint can be an important part of the record.

7. Continue with the study as long as possible, possibly for several years. Invite students to come back to visit the site after they have left the class or school.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Student teams can either study similar sites or different types of sites.

2. Arrange to exchange and compare data with students who live in other areas.

3. Students can do bark rubbings, leaf prints, or draw plants and animals.

4. Students can write poetry or short stories about the study plot.

REFERENCES AND RESOURCES

For more detailed ideas and suggestions for long-term plot studies, see:

Firehock, Karen. *Hands-on Save Our Streams*

Miller, Bob et al. *Forest Ecosystem: A Science-Based, Multi-Disciplinary Instructional Unit for Grades 5-6*

Murdoch, Tom et al. *Streamkeeper's Field Guide*

Other Activities for After the Redwood Trip

Letter Writing

- After the trip, every student should write a letter of appreciation. Letters should go to parent volunteers and helpers and to park personnel or volunteer docents. (Be sure to get names and addresses before or during the trip.)

- Students can write letters to organizations that are working to protect and improve the environment, such as organizations listed in Appendix III.

- Students can write letters to natural resource management companies or to users of redwood products such as artists, builders, or lumber companies. (See Appendix III.)

- Students can write letters to newspapers. They might express concern about environmental isues, support and appreciation for good work being done, or express appreciation for those who helped with the trip.

Some suggestions for letter writing:

1. Have the students use the complete writing process that you use as part of your language arts program: brainstorming, mind mapping, writing and editing drafts, etc.
2. Check spelling, especially of names and addresses.
3. Keep the letters brief. If it's a letter to a legislator, it probably won't get read by the legislator himself or herself, but it will be tallied.
4. Be sure that the student makes a point, rather than just complaining. What does he or she want done?
5. Look for opportunities to write positive letters praising individuals, groups, agencies, or companies doing good things.
6. Be sure to request a response and supply a name and address, perhaps c/o the teacher at the school. (Students should **not** give their home addresses.)

Additional suggestions for letter writing can be found in the *Environmental Science Activities Kit*, by M. Roa

Focus Standards:

Grade 4-7: English Writing S.S. 1: Writing Strategies
English Writing S.S. 2: Writing Applications
English Written and Oral English Language Conventions S.S.1: Written and Oral English Language Conventions

Grade 4: History/Social Studies 4.5.4: Explain structures and functions of state governments

Grade 5: History/Social Studies 5.7.3: Understand the fundamental principles of American constitutional democracy…

Storytelling

California Indians, like all people, wondered about the causes of natural phenomena such as the creation of the earth, seasons, moon phases, and the origins of humans.

The following books may be useful in teaching about California Indian stories:

- Caduto, Michael and Joseph Bruchac. *Keepers of the Earth*. Golden, CO: Fulcrum Publishing, 1988.
- Clark, Ella. *Indian Legends of the Pacific Northwest*. Berkeley, CA: University of California Press, 1953.
- Gifford, Edward et al. *California Indian Nights*. Lincoln, NB: University of Nebraska Press, 1990.
- Kroeber, Theodora. *The Inland Whale – Nine Stories Retold from California Indian Legends.* Berkeley, CA: University of California Press, 1959.
- Lake-Thom, Bobby. *Spirits of the Earth*. New York, NY: Penguin Books, 1997.
- Margolin, Malcom, ed. *The Way We Lived – California Indian Reminiscences, Stories, and Songs*. Berkeley, CA: Heyday Books, 1993.
- Monroe, Jean Guard and Ray Williamson. *They Dance in the Sky*. Boston, MA: Houghton Mifflin, 1988.
- Sarris, Greg. *Keeping Slug Woman Alive*. Berkeley, CA: University of California Press, 1993.

Have the students make up and illustrate their own stories. Some topic ideas:

- How/why the coast redwood is so tall
- Why the wood or bark of the redwood is red in color
- Why madrone bark peels
- Why madrone bark changes color from green to red
- Why poison oak leaves change to red in the fall
- Why some trees lose their leaves in the fall and others don't
- How the spotted owl got its spots. (skunk its stripes, raccoon its mask)
- Why raccoons "wash" their food
- Why redwoods sprout new trees from stumps
- Why does fog form in the region
- How Native Americans learned to use fire to encourage oak growth

Students can ask their own questions and make up their own topics.

Focus Standards:

Grade 4-7:	English Writing S.S. 1: Writing Strategies English Writing S.S. 2: Writing Applications English Written and Oral English Language Conventions S.S.1: Written and Oral English Language Conventions
Grade 4:	History/Social Studies 4.2.1: Discuss …CA Indians…legends
Grade 5:	History/Social Studies 5.1.2: Describe ... customs and folklore traditions
Grade 6:	History/Social Studies 6.1.1: Describe the hunter-gatherer societies…

Chapter 4
Activities for Anytime

The activities in Chapter 4 might be done before or after a trip to the redwoods or, in some cases, during the trip. Consider when would be the most appropriate time to do them.

Reminder
All activities should be tried out by the teacher prior to having students do them in order to be sure that the directions are understood and that they can be done with your particular equipment and materials. This is important not only to be sure that the activities will work, but to be sure that they can be done safely.

Such details as time estimates are only approximate; as the teacher, you know your students best.

Determining Density

ACTIVITY SUMMARY
Students measure density of various objects, including different types of wood.

CONCEPTS TO BE LEARNED
1. Density is a comparison of an object's mass with its volume and can be calculated using the formula:

   Density = mass ÷ volume

2. An object will float in a fluid if the object is less dense than the fluid, and an object will sink if its density is greater than the fluid's density.
3. When dry, most wood is less dense than water. When water fills a wood's cells, however, the saturated wood may become more dense than water.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.
Mathematics Number Sense S.S. 3.0: solve problems

Grade 5: Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.
Mathematics Number Sense S.S. 1.0: computation
Mathematics Number Sense S.S. 2.0: calculating
Mathematics Measurement and Geometry S.S. 1.0: computing volumes

Grade 6: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.
Mathematics Number Sense S.S. 2.0: calculate and solve problems
Mathematics Measurement and Geometry S.S. 1.0: measurement of plane and solid shapes

Grade 7: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

ANTICIPATED OUTCOMES
1. Students will increase their ability to measure volume and mass.
2. Students will increase their ability to calculate density.

GROUPING
Teams of two to four students, depending on availability of balances

TIME
45-90 minutes

MATERIALS

- ❒ Balances—triple beam or electronic
- ❒ Rulers with millimeter scale
- ❒ Graduated cylinders
- ❒ Samples of wood and other materials, including redwood that is saturated with water
- ❒ Try to have at least five different materials, including some that will float and some that won't float.
- ❒ Highly recommended: density block set (See Appendix IV: Sources.)
- ❒ Samples of other types of wood, including dry redwood
- ❒ Recommended: a sample of "iron wood" or other very dense wood from a lumber yard
- ❒ Pieces of various metals (aluminum, brass, copper, iron)
- ❒ Pieces of various other materials: different plastics, glass, rocks, rubber
- ❒ Clean-up materials—towels, sponges

TEACHER PREPARATION

1. Obtain samples of redwood that has absorbed water and sunk in a stream (wood saturated with water). Store the samples in a jar of water so that they stay saturated.
2. Obtain other materials for density measurements and calculations. A set of "density blocks" is highly recommended. (See Appendix IV for sources.)

PROCEDURE

1. Teach students about the concept of density, the relationship of mass to volume.

2. Have the students measure the masses of their objects and record them on the Study Guide/data table.

3. If you have rectangular samples such as a density block set, have the students measure and compute the volumes of the various blocks by measuring and multiplying length x width x height of the rectangular solids.

If you have irregularly shaped samples, which will probably include the saturated redwood, teach the students to measure the volume using displacement. (See the Study Guide.)

4. Discuss how logs were sometimes floated downstream to mills and/or stored in mill ponds until sawn.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Electronic balances are much easier to use than triple beam balances and generally give more accurate results. If your school doesn't have them, a junior high school or high school may be willing to lend some.
2. Use an overhead transparency or a whiteboard or chalkboard to share class data and find average densities of the materials.

3. You may be able to arrange to visit and tour a saw mill. If so, ask about the use of mill ponds.
4. This activity can accompany activities in which students determine why some materials float and some sink in a given fluid.

ASSESSMENT

1. The Study Guide can be used in assessment.
2. Have students measure and calculate densities of "unknown" samples.

ANSWERS TO SELECTED STUDY GUIDE QUESTIONS

5. Objects will float if they are less dense then the fluid in which they are placed. Objects with a density of less than 1 g/cc (1g/ml) will float in water. Note that it is the density of the whole object that matters. Iron is much more dense than water, but iron boats will float because the air contained in the hull helps displace water and is essentially part of the object. Dry wood floats because the cells contain air. When the air is replaced with water, the combination of water in the cell and the cell walls is more dense than water alone, so saturated wood sinks.

REFERENCES AND RESOURCES

See Appendix IV: Sources of Materials for some companies that sell density block sets. Some also sell samples of wood that is more dense than water.

Determining Density
Study Guide

An important characteristic of materials is their density. Density is a comparison of a material's mass and its volume. Different types of material have different densities. Gold, for example, has a density of 19.32 grams per cubic centimeter at room temperature, while aluminum has a density of 2.70 grams per cubic centimeter.

To determine density, you need to know the mass of a sample and its volume.

1. Determining mass: Use the balance as demonstrated by your teacher to determine the masses of the samples.

2. Determining volume:
   a. To determine the volume of a rectangular solid, measure its length, width, and height in centimeters. Then multiply those lengths to obtain the volume in cubic centimeters.

   b. To determine the volume of an irregularly shaped object, use the water displacement method:
      1) Use a graduated cylinder into which the object can be placed.
      2) Place enough water in the cylinder to cover the object. Record the water level (start level).
      3) Place the object in the water in the cylinder. Use a paper clip or other thin object to push down on the object until it is barely under water.
      4) Record the new water level on the graduated cylinder.
      5) Subtract the start level of the water from the new level to determine the volume of the object.

3. Determining density: To determine the object's density, divide the mass by the volume.

4. Use the materials provided by your teacher to determine the densities of a variety of samples. Complete the table below.

Sample (what is it?)	Mass (g)	Volume (ml or cc)	Calculation mass ÷ volume	Density (g/ml = g/cc)	Float in water?
1.					
2.					
3.					
4.					
5.					

5. What can you say about an object's density and whether it will float in water? (**Note**: Water has a density of 1 g/ml or 1 g/cc at room temperature.)

Fantastic Photosynthesis

ACTIVITY SUMMARY
Students observe oxygen production in an aquatic plant.

CONCEPTS TO BE LEARNED
1. Plants produce oxygen through the process of photosynthesis.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences S.S. 2: All organisms need energy and matter to live and grow.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 5: Life Sciences S.S. 2: Plants and animals have structures for various life processes.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 6: Ecology/Life Sciences S.S. 5: Organisms exchange energy and nutrients among themselves and with the environment.
Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Grade 7: Life Science 5.b: Organisms depend on properly functioning organs and organ systems.
Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

ANTICIPATED OUTCOMES
1. Students will increase their understanding of photosynthesis.
2. Students will increase their ability to conduct experiments and make observations.

GROUPING
Whole class or groups depending on availability of materials

TIME
Setup: 10-30 minutes
Observations: One or more ten-minute observations over one to three days

MATERIALS
For each group:
- ❒ Large (two to four qt.) glass or plastic jar or other container like an aquarium
- ❒ Clear glass or plastic wide-mouth bottle or drinking glass
- ❒ Two to four quarts of water with a teaspoon of baking soda dissolved in it, or soda water, or club soda (source of carbon dioxide)
- ❒ Lamp or area where containers can be exposed to sunlight
- ❒ Aquatic plants such as *Elodea*
- ❒ Hand lenses (optional)

TEACHER PREPARATION
Obtain the materials listed above

PROCEDURE
1. This activity can be done either before or after teaching about photosynthesis.
   a. If done before, let the composition of the bubbles remain a mystery until photosynthesis is taught.
   b. If done after, students should be able to suggest that the bubbles are oxygen.

Note: Gases dissolve more readily in cold water; the dissolved air and carbon dioxide will come out of solution as the water warms. To obtain a higher percentage of oxygen, let the water sit in the warm light for 30 minutes before inserting the plant.

2. Fill the large jar with water. Add baking soda. (Or use soda water or club soda.)

3. Place a sprig of an aquatic plant in the glass or wide mouth bottle.

4. Lower the glass sideways into the water so that it fills with the mixture and no air bubbles remain in the glass.

5. Invert the glass so that it is upside down without allowing air to enter. Let the glass rest on the bottom of the large jar.

6. Aim the light towards the glass or place the bowl on a sunlit windowsill.

7. Have the students observe the plant at the start and periodically during the day and over the next day or two. Do the leaves on the sunlit side give off more bubbles?

VARIATIONS, ADAPTATIONS, DIFFERENTIATION
1. An inverted funnel can be used to collect the oxygen and direct it into an inverted test tube full of water. When the tube is full of oxygen, light and blow out a wooden splint or craft stick. Immediately insert the glowing tip of the splint into the gas in the test tube. It should re-light or at least glow more brightly, indicating the presence of oxygen.

2. Use different types of plants. Try leaves from algae or different land plants.

3. Students can use hand lenses to look for stomata on the leaves.

ASSESSMENT
1. When you have taught about photosynthesis, ask the students to explain the bubbles produced by the plant, either in writing or orally.

REFERENCES AND RESOURCES
American Forest Foundation: *Project Learning Tree Pre K-8 Environmental Education Activity Guide*

Hone *et al*.: *A Sourcebook for Elementary Science*

Fence Post Studies

ACTIVITY SUMMARY
Students compare an old redwood fence post with new redwood fence post lumber. They also compare the advantages and disadvantages of different types of fence post materials.

CONCEPTS TO BE LEARNED
1. Growth rings indicate the growth rate of a tree.
2. Trees growing in sunny conditions grow more rapidly than trees in shady conditions.
3. Different building materials each have advantages and disadvantages.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Mathematics: Number Sense S.S. 3.0
English: Writing 2.3: Write information reports.

Grade 5: Life Sciences 2.a: Plants and animals have structures to support transportation of materials.
Life Sciences 2.b: materials transported in a vascular plant
Mathematics: Number Sense S.S. 1.0: computation
Mathematics: Number Sense S.S. 2.0: calculating
English: Writing 2.3: Write research reports

Grade 6: Mathematics: Number Sense S.S. 2.0: calculate and solve problems
English: Writing 1.4: Use electronic text to locate information.
Writing 1.5: Compose documents.
Writing 2.3: Write research reports.

Grade 7: Mathematics: Mathematical Reasoning S.S. 2.0: using estimation
English: Writing 2.3: Write research reports.

Environmental Principles and Concepts

Principle I: Humans depend on natural systems.
- Concept a: Humans depend on natural systems for goods and materials.
- Concept b: Humans depend on ecosystems.
- Concept c: The health of ecosystems affects their usefulness for people.

Principle II: Humans affect natural systems.
- Concept a: Human populations and consumption affect natural systems.
- Concept b: Human extraction, harvesting, and use of resources affect natural systems.
- Concept c: Expansion and operation of human communities affect natural systems.
- Concept d: Human social systems affect natural systems.

Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.
- Concept a: Effects of human activities on natural systems depend on quantities of resources used and the quantity and characteristics of the byproducts of use.

Concept b: Byproducts of human activities affect natural systems.
Concept c: The ability of natural systems to adjust to human-caused alterations depends on several factors.
Principle V: Decisions affecting natural resources and systems are based on many factors.
Concept a: Students need to understand the spectrum of factors that are considered in making decisions about natural resources.
Concept b: Students need to understand the decision making process and how it changes with time.

ANTICIPATED OUTCOMES

1. Students will increase their understanding of plant anatomy and how sunlight affects the growth rate of trees.
2. Students will increase their ability to conduct research and write reports.
3. Students will increase their ability to plan and conduct experiments.
4. Students will increase their ability to measure accurately.
5. Students will increase their ability to multiply and divide.

GROUPING

Part 1: Individual or teams of two to four students
Part 2: Teams of about three to six students (one or two teams for each of the fence post material types)

TIME

Part 1: Redwood fence post comparison: 30 minutes
Part 2: Fence post material research and experiments: varies

MATERIALS

- ❒ Part 1: samples of an old redwood fence post (Post A) and new redwood fence post lumber (Post B)
  - ✓ magnifying glasses
  - ✓ rulers
  - ✓ Fence Post Studies Study Guide: one per student or per group
- ❒ Part 2: varies…see Teacher Preparation and Procedure

TEACHER PREPARATION

Part 1:

1. Obtain samples of old and new redwood fence posts and cut them into sections about 1 inch thick. (Your local junior high or high school wood shop teacher might help with this.)

2. For old redwood fence posts, try to obtain posts cut 60 or more years ago so that they are likely to be from old growth forests. Try contacting wood recycling companies. Solid waste disposal sites ("dumps") often have wood recycling

programs and may have old fence posts. Look for posts that have very closely spaced rings.

3. When you buy new fence post material, look for posts with the widest rings that you can find. With some looking, you may be able to find posts with rings ½ - ¾ inches apart.

4. Make copies of the Fence Post Studies Study Guide: one per student or per group.

Part 2:

1. Visit local building supply stores to find out what kinds of fence post materials are available. Ask for brochures and samples. Try to get samples of:
   a. redwood
   b. treated fir
   c. steel/iron
   d. vinyl
   e. recycled plastic composite

2. If the building supply store won't give you samples, they will probably give you brochures. You might check the yellow pages for fence builders who might have left over materials, or manufacturers of fence materials might provide samples.

3. Obtain web addresses for various manufacturers of fence materials and either contact them for information or plan to have students contact them

PROCEDURE

Part 1:

1. Label the old redwood post samples "Sample A" and the new samples "Sample B."

2. Have the students use the magnifying glasses to examine the rings in the wood. Have the students use the Fence Post Studies Study Guide to record and interpret their observations.

Part 2:

1. Students conduct research using brochures or information obtained from building supply dealers, fencing contractors, or the Internet to compare the advantages and disadvantages of various types of fence post materials. They then present their findings in writing and/or orally.

2. Consider having two teams do research on each material type. (If the teams are too large, some students won't be very involved.)

3. Students can present their findings as a report, in a brochure, as an advertisement, and/or orally.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

Part 1:

1. Larger samples can be used to make a display comparing redwood that grew rapidly and redwood that grew slowly.

   Local redwood parks may be interested in adding such a display to their visitor center or museum. See "Slow Growth and Rapid Growth in the Coast Redwood" and "All Fence Posts Are Not Created Equal" below.

   Note that you will need to fill in some information that depends on the samples that you have.

   Make the samples about 4-8 inches long and cut them at an angle.

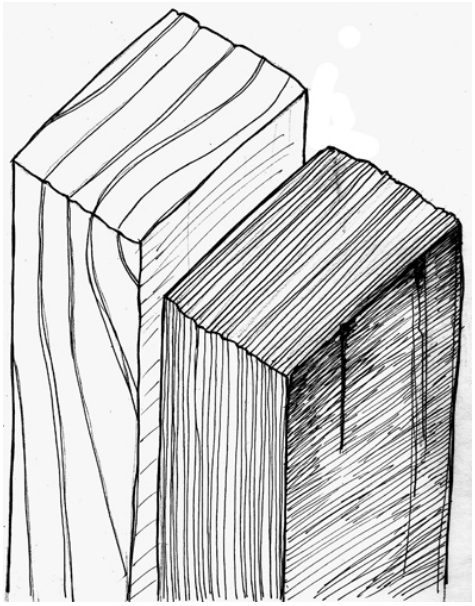


Figure 118

2. See the activity "The Great Tree Cookie Mystery."

Part 2:

1. Students can prepare displays to be placed at building supply centers.
2. If done at the start of the year, students can do a school-year long experiment by placing samples of materials in the ground at the beginning of the year and comparing them at the end of the year.
3. Groups can combine their findings in a bulletin board display showing the advantages and disadvantages of each material.

ASSESSMENT

Part 1: Use the Fence Post Studies Study Guide to check for understanding, or ask students to explain differences observed.

Part 2: Reports should include such information as cost, durability, appearance, and environmental advantages and disadvantages.

ANSWERS TO SELECTED STUDY GUIDE QUESTIONS

1. In general, wood with more tannins will be more resistant to decay and insects, so wood from an old, slow-growing tree would tend to be more resistant. (Redwood cut from slow-growing trees in old growth forests earned the tree a reputation as an excellent wood for fence posts.)

2. To grow as much wood as possible, one would want to have the trees spaced far enough apart that each tree could receive enough sunlight for maximum growth.

3. To maximize wood growth, one would probably harvest some trees (or all of the trees in a stand) when they began to compete with each other for sunlight.

4. Advantages and disadvantages in the table will depend on the students' research. Some possible advantages and disadvantages are indicated below.

Type of post	Advantage	Disadvantage
Redwood	Renewable resource Appearance (matter of taste) Accepts stains and paint well May produce less pollution and use less energy than some others	Depending on quality of wood, may decay or attract termites
Treated fir	May last longer than redwood Fir trees more common than redwood Renewable resource	Appearance (matter of taste) Chemicals used as preservative May not accept stains or paints as well as redwood
Steel/iron	May last longer than wood Can be made from recycled metal	Pollution in manufacturing Energy used in manufacturing New iron is non-renewable resource
Vinyl	Appearance (matter of taste) Won't decay or attract termites Durable	Appearance (matter of taste) Uses non-renewable petroleum resource Energy used in manufacturing Pollution from manufacturing
Recycled plastic composite	Appearance (matter of taste) Won't decay or attract termites (which would reduce long-term cost) Uses recycled materials/supports recycling industry	Initial cost Toxic chemicals if burned Pollution from manufacturing

Fence Post Studies
Study Guide

When trees grow in the sun, they generally grow more rapidly than when they grow in the shade, other things being equal. In dense, dark forests, redwood trees may grow as slowly as 1/20 inch or less in radius in a year. In a sunny location, a redwood tree may grow as much as an inch in radius in a year…twenty times as fast!

When a tree grows rapidly, as it does in the spring and early summer, it produces wood with large, thin-walled cells that are light in color. In the late summer and fall, the slowly growing tree produces wood with smaller, thick-walled cells that are darker.

During a year's growth, a tree will usually produce some dark and some light cells, which results in growth rings. If you start at the outside of the dark part of a ring and measure to the outside of the part of the next dark ring, that's a year's growth.

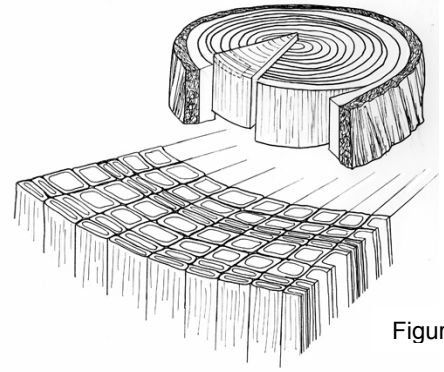


Figure 119

Redwood is valued for such uses as fence posts because the same chemicals that give the wood its red color also make it resistant to fungus that causes rot and to insects such as termites. In general, the darker the wood, the more resistant it is. These chemicals, called **tannins**, accumulate as the tree grows older, so wood from older trees tends to have more tannins and be more resistant to decay and insects than rapidly growing young trees.

Examine the two redwood fence post samples and record your observations below.

	Sample A	Sample B
Did this sample probably grow in the sun or in the shade?		
Which sample is darker, indicating the presence of more insect-resistant and decay-resistant tannins?		
About how long did it take this tree to grow 1 inch in radius?		
About how long did it take this tree to grow 1 inch in diameter?		
About how many inches in diameter did this tree grow in 20 years? (assuming a constant growth rate)		
Which tree grew faster?		
Do you notice any other differences between the two posts?		

continued next page

Questions:

1. Which would probably make a better fence post—redwood that grew slowly and had lots of tannins, or redwood that grew rapidly and didn't have much tannin deposited, and why?

2. If you wanted to grow as much wood as possible on your land, would you want to grow trees close together or space them farther apart, and why?

3. If you were growing trees and wanted to grow as much wood as possible, would you let trees keep growing after their canopies grew together to produce shade, or would you harvest them when they started to produce shade?

4. For each type of fence post material, give one advantage and one disadvantage.

Type of post	Advantage	Disadvantage
Redwood		
Treated fir		
Steel/iron		
Vinyl		
Recycled plastic composite		

Slow Growth and Rapid Growth in the Coast Redwood Forest

The fence post labeled Sample A is from a redwood tree that grew very slowly. The tree was probably cut down in the 1950s or 1960s , when **"old-growth"** redwoods were still being logged. The post was made by cutting the tree into sections and splitting the sections to make posts. Most trees in the old growth forests grew in a shady environment, so they grew very slowly.

The wood labeled Sample B is from a redwood tree that grew very rapidly. The tree was cut in 2005, and must have grown in a sunny environment, as indicated by the large amount of growth each year. It probably came from a **second- or possibly a third-growth** forest—a forest that was logged for the second or third time. Most redwood fence posts are now made by sawing the logs on all four sides.

Note the **dark color** in the old growth wood. This indicates lots of the chemical **tannin**, which helps redwood resist both insects and rotting, and small cells with thick cell walls due to the slow growth. The lighter colored wood doesn't have as much tannin, or such thick walls, so it is less resistant to insects such as termites and would probably rot faster.

Knots in wood are branches that have been surrounded by wood as the tree grew in diameter. As redwood trees grow, the branches at the top of the tree shade the lower branches, which die and fall to the ground. This **"natural pruning"** results in subsequent lower wood growing without knots. Lumber without knots is called **"clear,"** and it is much more valuable than wood with knots.

Since old-growth redwood produces more "clear" lumber, and second growth grows so much more rapidly, there is a strong incentive to harvest any old-growth trees that the lumber companies own. Not only do they obtain the high quality (valuable) old-growth wood, but the **opening of the forest canopy increases the growth rate** of remaining trees or trees that are planted or that sprout from the stumps. Since about 95% of the original old growth redwoods have been logged, and about 97% of the few remaining old growth trees are in parks or other preserves, it is unlikely that old growth fence posts will be available for purchase any more.

Removing the old-growth trees, of course, changes the forest **ecosystem**. Unless the logging is done with very careful planning, a logged redwood forest will take many years before it can support the communities of plants and animals that the original forest supported. Some companies are trying to harvest trees by managing their forests without greatly disrupting the original ecosystems. California has regulations that are intended to help protect the ecosystems.

All fence posts are not created equal!

When a tree is growing rapidly, it produces large cells with thin cell walls. This generally happens in the spring and early summer, and produces light colored "early" wood without much tannin.

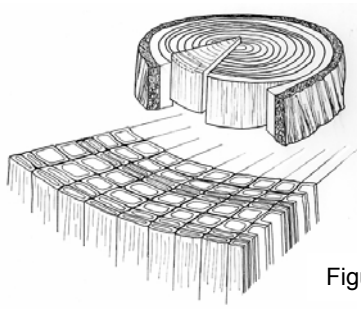


Figure 120

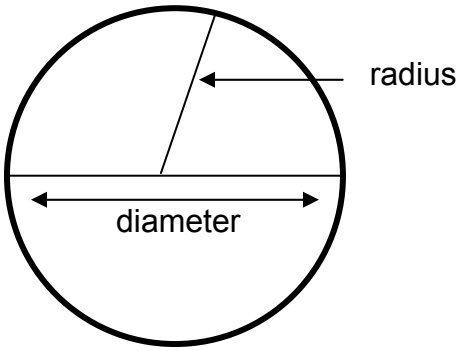
In the late summer and fall, the growth slows and small cells with thick cell walls and lots of tannin are produced. This fall "late" wood is darker.

A year's growth consists of a light (spring/summer growth) and a dark (fall/winter growth) ring.

Close rings indicate slow growth; widely spaced rings indicate rapid growth.

Use the ruler and the magnifying glass to answer the following questions. (Answers are given below.)

Remember: The **diameter** of the tree is the distance <u>all the way across</u>. Your measurement is only from one side of the tree (part of a radius), so to determine a <u>four</u> inch <u>diameter</u> growth, you would count the rings in 2 inches of radius and <u>double that number</u>.



1) How long did the old-growth tree (Sample A) take to grow four inches in <u>diameter</u>?
2) How long did the tree at the left (Sample B) take to grow four inches in <u>diameter</u>?
3) About how many inches in diameter did Sample A grow in ten years?
4) About how many inches in diameter did Sample B grow in ten years?

Answers:

(The exact answer will vary depending on where on the wood you measured.)

1. The old-growth tree (Sample A) took about ____ years to grow two inches in radius or four inches in diameter.
2. The tree for Sample B took about ____ years to grow two inches in radius or four inches in diameter.
3. The Sample A tree grew about 0._____ inch in radius in ten years, so it would grow about 0.____ inch in diameter in ten years.
4. The Sample B tree only shows about ___ years' growth. If it grew at this rate, its radius would increase by about ____inches in ten years, resulting in____ inches growth in diameter. This tree was growing about ____times as fast in the sun as the other tree was growing in the shade.

Flood Math

ACTIVITY SUMMARY

Data is provided on the peak streamflow for the Eel River at Scotia. Students can use this data (or data from other sites) to practice such math skills as finding averages, rounding off, graphing, and interpreting graphs.

CONCEPTS TO BE LEARNED

1. Math skills: finding averages, rounding off, graphing, interpreting graphs
2. Graphs can be useful in visually interpreting data from a table.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Mathematics Statistics S.S. 1.0: Organize, represent, and interpret numerical data.

Grade 5: Mathematics Number Sense S.S. 1.0: Computation, rounding
Mathematics Statistics S.S. 1.0: Display, analyze, compare, and interpret data sets, including graphing.

Grade 6: Mathematics Number Sense S.S. 2.0: Calculate and solve problems
Mathematics Statistics S.S. 2.0: Use data samples…including bias and validity

Grade 7: Mathematics Statistics S.S. 1.0: Collect, organize, and represent data sets.

Environmental Principles and Concepts

Principle I: Humans depend on natural systems.
- Concept a: Humans depend on natural systems for goods and materials.
- Concept b: Humans depend on ecosystems.
- Concept c: The health of ecosystems affects their usefulness for people.

Principle III: Natural systems have cycles on which humans depend and that can be altered by humans.
- Concept a: Natural systems have cycles.
- Concept b: Humans depend on and utilize natural cycles and processes.
- Concept c: Human practices can alter natural cycles and processes.

Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.
- Concept a: Effects of human activities on natural systems depend on quantities of resources used and the quantity and characteristics of the byproducts of use.
- Concept b: Byproducts of human activities affect natural systems.
- Concept c: The ability of natural systems to adjust to human-caused alterations depends on several factors.

Principle V: Decisions affecting natural resources and systems are based on many factors.
- Concept a: Students need to understand the spectrum of factors that are considered in making decisions about natural resources.

Concept b: Students need to understand the decision making process and how it changes with time.

ANTICIPATED OUTCOMES

1. Students will increase their ability to round off, find averages, graph, and interpret graphs.

GROUPING

Individuals, small groups, or whole class

TIME

30-90 minutes

MATERIALS

- ❒ Copies or overhead transparency of data table: "Peak Streamflow for the Eel River at Scotia" (or another site…see Variations below)
- ❒ Copies or overhead transparency of the graph of "Peak Streamflow for the Eel River at Scotia" (or another site…see Variations below)
- ❒ Copies of student handout(s):
- ❒ Flood Math Study Guide for Peak Streamflow Data Table
- ❒ Flood Math Study Guide for Peak Streamflow Graph
- ❒ Graph paper and/or graphing program for computer
- ❒ Colored pencils, pens, or crayons (optional)

TEACHER PREPARATION

1. Decide whether to provide the data on paper or on an overhead transparency.
2. Decide whether to revise the data from the table with rounded off values to simplify students' work.
3. Duplicate Flood Math Study Guide and table(s) or revised table(s).

PROCEDURE

1. After teaching the math skill that you want the students to use (rounding off, averaging, graphing), provide the students with the "Peak Streamflow for the Eel River at Scotia." Have them use the statistics and the Flood Math Study Guide to practice the math skills.

2. Discuss implications of the data and ways to compare different time periods.

   (During and after the 1964 flooding in the redwood region, some people claimed that clear-cut logging was a major cause of the flooding. While clear-cutting may have contributed, this graph shows that the peak streamflow returned to near normal levels in the following years.)

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. The data from the tables can be modified or simplified by rounding off.
2. Use the data to develop a different study guide.
3. Have students experiment with various types of graphs.

4. The Internet site listed under References and Resources provides streamflow data for thousands of sites. Obtain data from other rivers of interest to your students.
5. Students can also compare portions of the data, for example, the average for the decade before the December, 1955 flood compared to the average for the next 8 years, and that eigh-year average with the average for the decade after the December, 1964 flood.

ASSESSMENT

1. Student graphs should be neatly and accurately done and should include labeled axes, units, and a title.

ANSWERS TO SELECTED STUDY GUIDE QUESTIONS

The answers will vary depending on which streamflow station is selected. The answers below are for the Eel River at Scotia data.

Answers: Study Guide for Peak Streamflow Data Table

1. The answers are for the **Eel River**, in **Humboldt** County.
2. December 1922 was part of the winter (water year) of 1923. A "water year" starts on July 1 and includes the winter season that starts late in one calendar year and continues into the next year.
3. c. 5,790 cubic feet per second.
   d. February 4, 1929: 41,000 cfs; January 24, 1994: 48,500 cfs
   e. December 23, 1964: 752,000 cfs
   f. December 22, 1955: 541,000 cfs; January 16, 1974: 387,000 cfs
4. a. 35.5 feet above sea level
5. b. highest: 72 feet on Dec. 23, 1964; next highest: 671.9 feet on Dec. 22, 1955; lowest: 12.71 feet on Mar 10, 1977; next lowest: 21.3 feet on Feb. 4, 1929

Answers: Study Guide for Peak Streamflow Graph

1. The measurements were taken in the **Eel River** in **Humboldt** County.
2. A "water year" starts on July 1 and includes the winter season that starts late in one calendar year and continues into the next year.
3. Streamflow is measured in cubic feet per second. This is a measure of how many cubic feet of water passes a given point (the gage) in a second.
4. 7.48 gallons would round to 7.5 gallons or 7 gallons
6. a. 1928-1964: 5 years with a peak streamflow greater than 300,000 cfs
   b. 1965-2000: 7 years with a peak streamflow greater than 300,000 cfs
   c. 1928-1964: 9 years with a peak streamflow less than 100,000 cfs
   d. 1965-2000: 6 years with a peak streamflow less than 100,000 cfs
   e. The data show a slight increase in the number of years with peak streamflows higher than 300,000 cfs and a decrease in the number of years with peak streamflows less than 100,000 cfs. It appears that peak streamflows may be higher since 1964. These data alone do not prove anything, but may indicate higher peak streamflows. It gives no indication of what, if anything, might be causing the increase in peak streamflows.

REFERENCES AND RESOURCES

United States Geological Survey: < http://nwis.waterdata.usgs.gov/nwis/peak>

Flood Math
Study Guide for Peak Streamflow Data Table

Use the Peak Streamflow Data Table provided by your teacher to answer the following questions.

1. These measurements were taken in the _____ River in _____ County.

2. The data represent the peak or highest streamflow during a winter season. Why is December 28, 1922 given as the peak flow for the 1923 water year?

3. The units for streamflow are in cubic feet of water per second passing the monitoring station.
   a. In what year were you born? _____

   b. What was the date and the amount of streamflow in the year in which you were born? (Be careful—were there two peaks in that year? See question 2 above.)

      date: _____ peak streamflow: _____ cubic feet per second

   c. What was the peak streamflow in 1977? date: _____ _____cfs.

   d. What are the two other lowest peak streamflow years besides 1977?

      Next lowest date: _____ peak streamflow: _____cfs

      Next lowest date: _____ peak streamflow: _____cfs

   e. When and what was the highest recorded peak streamflow on the data table?

      Date:_____ peak streamflow of _____ cfs

   f. What were the two other highest peak streamflow years besides 1965?

      Next highest date: _____ peak streamflow: _____cfs

      Next highest date: _____ peak streamflow: _____cfs

4. The table also gives information about the depth. The Gage Datum is given at the top of the table along with the location and other information. The Gage Datum gives the height of the gage above sea level.
   a. How far above sea level is the gage for this station? _____ feet above sea level.

5. In the table, a column is given for Gage Height, which is the depth of the water above the gage.
   a. What was the maximum depth of the water during the year of your birth? _____ft.

   b. What were the two highest and two lowest depths given in the table?

      Highest Gage Height (depth):_____feet on _____ (date)

      Next highest:_____feet on _____ (date)

      Lowest Gage Height (depth): _____feet on _____ (date)

      Next lowest: _____feet on _____ (date)

Flood Math
Study Guide for Peak Streamflow Graph

Use the Peak Streamflow graph provided by your teacher to answer the following questions. This kind of graph is called a "scattergram" or "scattergraph."

1. These measurements were taken in the _____ River in _____County.

2. The data represent the peak or highest stream flow at the site of the gage for each "water year." A water year is not the same as a calendar year. What do you think the difference is?

3. What are the units of the streamflow?
   In your own words, explain what you think that represents.

4. A cubic foot equals about 7.48 gallons. Rounded to the nearest tenth of a gallon, that would be _____ gallons. Rounded to the nearest whole gallon, that would be _____ gallons.

5. On the graph, color the circles as indicated below:
   a. the year in which you were born: green
   b. the year in which the streamflow was highest: red
   c. the year in which the streamflow was next highest: yellow
   d. the year in which the streamflow was lowest: blue
   e. the year in which the streamflow was next lowest: brown

6. The horizontal axis is divided into 12 year increments or sections.

   a. During the 36 years before 1964, in how many years was the peak streamflow 300,000 cfs or more?
      _____ years

   b. During the 36 years after 1964, in how many years was the peak streamflow 300,000 cfs or more?
      _____ years

   c. During the 36 years before 1964, in how many years was the peak streamflow 100,000 cfs or less?
      _____ years

   d. During the 36 years after 1964, in how many years was the peak streamflow 100,000 cfs or less?
      _____ years

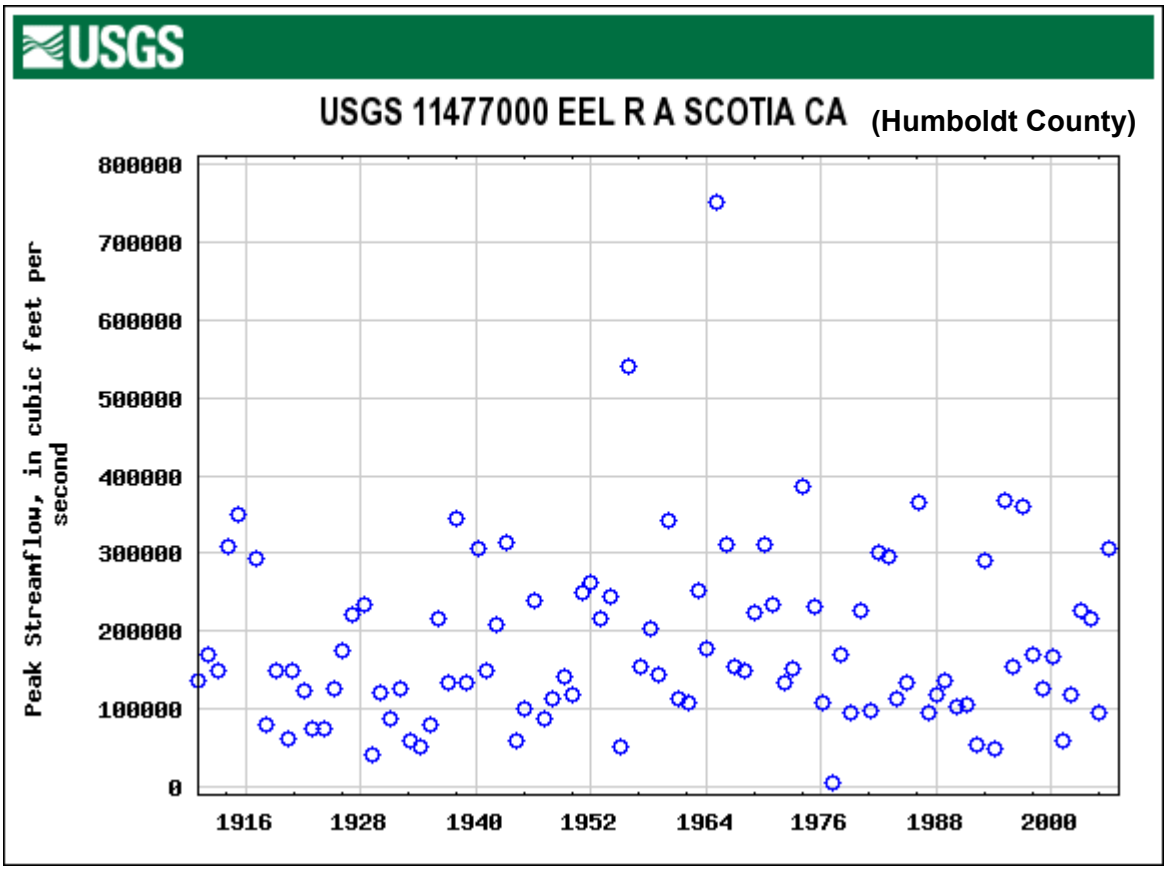
   e. Based on your answers to a-d above, what generalization might you make about peak streamflows in this river between 1928 and 2000?

Peak Streamflow for California
USGS 11477000 EEL R A SCOTIA CA

Humboldt County, California
Hydrologic Unit Code 18010105
Latitude 40°29'30", Longitude 124°05'55" NAD27
Drainage area 3,113 square miles
Gage datum 35.50 feet above sea level NGVD29

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
1911	Jan. 20, 1911		136,000
1912	Jan. 26, 1912		170,000
1913	Jan. 18, 1913		150,000
1914	Jan. 22, 1914	52.50	309,000
1915	Feb. 02, 1915	55.50	351,000
1917	Feb. 25, 1917	51.25	292,000
1918	Feb. 07, 1918	27.70	78,600
1919	Jan. 17, 1919	38.30	149,000
1920	Apr. 16, 1920	25.00	62,000
1921	Nov. 19, 1920	38.20	148,000
1922	Feb. 19, 1922	34.50	123,000
1923	Dec. 28, 1922	26.90	73,400
1924	Feb. 08, 1924	26.90	73,400
1925	Feb. 06, 1925	35.20	127,000
1926	Feb. 04, 1926	42.20	176,000
1927	Feb. 21, 1927	45.20	221,000
1928	Mar. 27, 1928	46.30	233,000
1929	Feb. 04, 1929	21.30	41,000
1930	Dec. 15, 1929	34.10	120,000
1931	Jan. 23, 1931	29.00	87,000
1932	Dec. 27, 1931	36.10	127,000
1933	Mar. 17, 1933	26.10	58,100
1934	Mar. 29, 1934	24.80	50,900
1935	Apr. 08, 1935	29.62	79,900
1936	Jan. 16, 1936	44.70	216,000
1937	Feb. 05, 1937	37.00	134,000
1938	Dec. 11, 1937	55.10	345,000
1939	Dec. 03, 1938	35.90	133,000
1940	Feb. 28, 1940	52.25	305,000
1941	Dec. 24, 1940	36.40	150,000
1942	Feb. 06, 1942	42.20	209,000
1943	Jan. 21, 1943	50.75	315,000
1944	Mar. 04, 1944	24.60	57,800
1945	Feb. 03, 1945	30.55	99,100
1946	Dec. 27, 1945	44.60	239,000
1947	Feb. 12, 1947	29.02	86,100
1948	Jan. 08, 1948	32.60	114,000
1949	Mar. 18, 1949	35.40	140,000
1950	Jan. 18, 1950	32.85	117,000
1951	Jan. 22, 1951	45.39	249,000
1952	Dec. 27, 1951	46.50	262,000
1953	Jan. 09, 1953	42.98	215,000
1954	Jan. 17, 1954	45.20	245,000
1955	Dec. 31, 1954	23.29	52,400
1956	Dec. 22, 1955	61.90	541,000
1957	Feb. 25, 1957	36.11	153,000
1958	Feb. 25, 1958	40.35	202,000
1959	Jan. 12, 1959	34.58	145,000
1960	Feb. 08, 1960	51.45	343,000
1961	Feb. 11, 1961	31.45	113,000
1962	Feb. 14, 1962	29.92	107,000
1963	Feb. 01, 1963	47.00	252,000
1964	Jan. 21, 1964	39.40	178,000
1965	Dec. 23, 1964	72.00	752,000
1966	Jan. 05, 1966	45.47	311,000
1967	Dec. 05, 1966	32.95	154,000
1968	Jan. 15, 1968	32.36	148,000
1969	Jan. 13, 1969	39.00	223,000
1970	Jan. 24, 1970	46.98	310,000
1971	Dec. 04, 1970	41.29	234,000
1972	Jan. 23, 1972	31.77	133,000
1973	Jan. 16, 1973	33.84	152,000
1974	Jan. 16, 1974	52.31	387,000
1975	Mar. 18, 1975	40.97	231,000
1976	Feb. 26, 1976	29.03	109,000
1977	Mar. 10, 1977	12.71	5,790
1978	Jan. 17, 1978	35.47	169,000
1979	Jan. 11, 1979	27.51	96,100
1980	Jan. 14, 1980	40.57	226,000
1981	Jan. 28, 1981	27.83	98,700
1982	Dec. 20, 1981	46.30	300,000
1983	Jan. 27, 1983	46.03	296,000
1984	Dec. 09, 1983	29.44	112,000
1985	Nov. 12, 1984	31.76	133,000
1986	Feb. 17, 1986	51.08	364,000
1987	Mar. 13, 1987	28.35	94,500
1988	Dec. 10, 1987	31.05	118,000
1989	Nov. 23, 1988	33.15	137,000
1990	Jan. 08, 1990	29.35	102,000
1991	Mar. 05, 1991	29.28	105,000
1992	Feb. 20, 1992	22.80	54,200
1993	Jan. 21, 1993	46.03	290,000
1994	Jan. 24, 1994	21.87	48,500
1995	Jan. 09, 1995	51.30	368,000
1996	Dec. 12, 1995	37.09	155,000
1997	Jan. 01, 1997	54.97	360,000
1998	Jan. 17, 1998	38.61	170,000
1999	Feb. 08, 1999	33.78	125,000
2000	Feb. 14, 2000	38.25	166,000
2001	Mar. 05, 2001	24.97	59,000
2002	Jan. 02, 2002	33.02	119,000
2003	Dec. 16, 2002	44.15	226,000
2004	Feb. 18, 2004	45.26	217,000
2005	Dec. 08, 2004	29.95	93,800
2006	Dec. 31, 2005	52.71	307,000

Source: < http://nwis.waterdata.usgs.gov/ca/nwis/peak?site_no=11477000 >



Source: < http://nwis.waterdata.usgs.gov/ca/nwis/peak/site_no=11477000 >

Have a Foggy Idea

ACTIVITY SUMMARY
Either as a student activity or a demonstration, "fog" is created in a bottle.

CONCEPTS TO BE LEARNED
1. Fog forms when relatively warm, moist air is cooled, causing the water vapor to form droplets.
2. In northern California, the cool ocean currents provide cooling for fog formation.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences 3.a: Ecosystems are characterized by living and non-living components.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 5: Earth Sciences S.S. 3: Water moves between oceans and land via evaporation and condensation.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 6: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Grade 7: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Other Standards:

Grade 6: Ecology (Life Sciences) 5.b

ANTICIPATED OUTCOMES
1. Students will understand how fog forms in northern California.

GROUPING
If done as a demonstration, whole class.
Student groups may be from two to six students.

TIME
20-30 minutes, including discussion

MATERIALS
- ❒ Electric hotplate, electric teapot or coffee pot, or other source of hot water
- ❒ Beaker or pan in which to heat water
- ❒ Ice—approximately one to two cups per group
- ❒ Thin aluminum pie pan
- ❒ 500-1000 mL beaker, clear milk bottle, or canning jar
  (NOT a mayonnaise jar or similar type of jar, as it may break when hot water is poured into it!)

TEACHER PREPARATION

1. Obtain the materials listed above.

PROCEDURE

1. Discuss the importance of fog as a water source for the coast redwoods.

2. Ask the students if they know how fog is formed.

3. Tell them that fog is formed the same way that clouds are formed, except that fog is a cloud at ground level.

4. Ask if there is water in the air. Point out that they have all seen "steam" from their breath on cold mornings, condensation on windows and mirrors, and even on glasses or cans of cold drinks on warm days.

5. Ask if they have ever been to the ocean beach in northern California. Point out that even on a hot day, the ocean water in northern California is very cold. (The ocean currents off of the northern California coast come from the cold north Pacific.)

6. <u>If you are doing this as a demonstration:</u>
   - Heat about a cup of water almost to the boiling point.
   - While the water is heating, place the ice on the aluminum pie tin to allow the tin to start to cool.
   - When the water is hot, pour it into the beaker or jar. Tell the students that the hot water is now evaporating, making warm moist air.
   - Ask the students to predict what will happen if the cold pie tin is placed on top of the jar. Place the cold pie tin with ice on top of the jar.
   - The warm, moist air should form a cloud or fog as the water droplets cool and condense.
   - Carefully bring the jar of fog around the class for students to observe, or have them file past the demonstration.

   <u>If students are doing this as an activity</u>:
   - **CAUTION** THE STUDENTS ABOUT HANDLING HOT WATER SAFELY AND THE USE OF GLASS!

   - Explain the process and write the steps on an overhead transparency, a handout, or the board.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Some people do this activity by placing an ice cube in the opening of a milk bottle containing hot water.

2. On a foggy day, place a cup beneath a redwood branch and observe and collect the water that drips from it.

ASSESSMENT

1. Call on students to explain how this experiment is similar to fog forming along northern California's coastal area.

How Big?

ACTIVITY SUMMARY
Students learn about the size of redwoods by painting a life-size tree on the school grounds.

CONCEPTS TO BE LEARNED
1. Redwood trees can grow to great sizes.
2. Not all redwood trees are huge.
3. Scale drawings can represent large or small things.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Mathematics Number Sense S.S. 3.0: Solve problems
Grade 5: Mathematics Number Sense S.S. 1.0: Computation
Mathematics Number Sense S.S. 2.0: Calculate and solve problems
Grade 6: Mathematics Number Sense S.S. 1.0: Solving problems
Mathematics Number Sense S.S. 2.0: Calculate and solve problems
Grade 7: Mathematics Mathematical Reasoning S.S. 2.0: Using estimation

Other Standards:

Grade 4: Mathematics: Measurement and Geometry S.S. 1.0
Grade 5: Mathematics: Measurement and Geometry S.S. 1.0
Grade 6: Mathematics: Measurement and Geometry S.S. 1.0

ANTICIPATED OUTCOMES
1. Students will comprehend the size of coast redwoods and, possibly, other trees.
2. Students will increase their understanding of scale illustrations.

GROUPING
Whole class

TIME
Varies

MATERIALS
- ❒ Paint brushes…size and number vary
- ❒ Rags and water for cleanup
- ❒ Exterior latex (water base) paint (for a tree shaped like the one drawn in the grid that follows, assuming one coat coverage):
  - For a 360' tall redwood tree on the school yard:
    - 20-25 gallons of green
    - two to three gallons of red-brown
    - ½-1 pint of some other color(s) for a person
  - For a 6-foot scale painting on the classroom door or wall:
    - ½ pint each of red-brown and green
    - (less than) ½ pint of some other color(s) for a person

- ❒ Gloves
- ❒ Newspapers or paper plates on which paint cans can be placed

TEACHER PREPARATION

1. Get permission from your principal and buildings and grounds department.

2. Obtain the paint and brushes and cleanup materials. Paint stores often have cans of "mistints" that they will donate, but are unlikely to have large quantities of a given color. You might be able to obtain one-gallon cans of several shades of brown (or green) and mix them. Parents or school district buildings and grounds departments can often be helpful with this.

3. Prior to, or while on a field trip to a redwood park, find out the size of the largest tree that the students are likely to see.

PROCEDURE

1. To paint on the playground:
   a. Arrange to have a portion of the blacktop cleaned well, possibly with a power washer. Your buildings and grounds department or a parent may do this for you.
   b. Outline the tree in chalk on the blacktop. Since each tree has a different shape, there is no "perfect" shape for the tree. You may use the following drawing with a grid system. For a 360' tall playground tree, one side of a grid square would equal 30 feet.
   c. Assign a team of responsible students to paint two- to three-inch-wide outlines of the green and brown sections. This will provide "lines" for other students to paint within. Arrange for supervision while the outlines dry.
   d. When the outlines have dried, assign teams of students to paint within the outlines. Arrange for supervision while the painting dries.

2. To paint on the classroom door:
   a. Thoroughly clean the door. Place newspaper or a tarp under the door.
   b. Outline the tree in pencil. Since each tree has a different shape, there is no "perfect" shape for the tree. You may use the following drawings with a grid system.
   c. Assign a team of responsible students to paint 1/2" wide outlines of the green and brown sections. This will provide "lines" for other students to paint within. Arrange for supervision while the outlines dry.
   d. When the outlines have dried, assign students to paint within the outlines.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Paper can be used to make a scale illustration indoors.
2. Students can make scale drawings of various organisms to add to the indoor tree.
3. Students can figure out the scale for various size representations on walls or on the playground.
4. Students can paint circles to represent the circumferences of trees.

ASSESSMENT

1. Do students follow directions?
2. If students calculate the sizes of representations, are they accurate?

ANSWERS TO SELECTED STUDY GUIDE QUESTIONS

1. If three inches equals 360 feet, a half-inch square would be 60 feet on a side.

2. The giant sequoia base is about half of a square across, or about 30 feet.

3. Since a half-inch square represents 60 feet and the giant sequoia drawing is about five squares tall, the giant sequoia would be about 300 feet tall.

4. If you want to enlarge the drawing of the 360' tall tree using 12 squares, each square in the grid would represent 30' of tree height.

5. Since a half-inch square represents 30 feet, and the base of the coast redwood is about a third of a square, the base of the coast redwood tree would be about 10' in diameter.

Coast redwood tree for enlarging to paint:

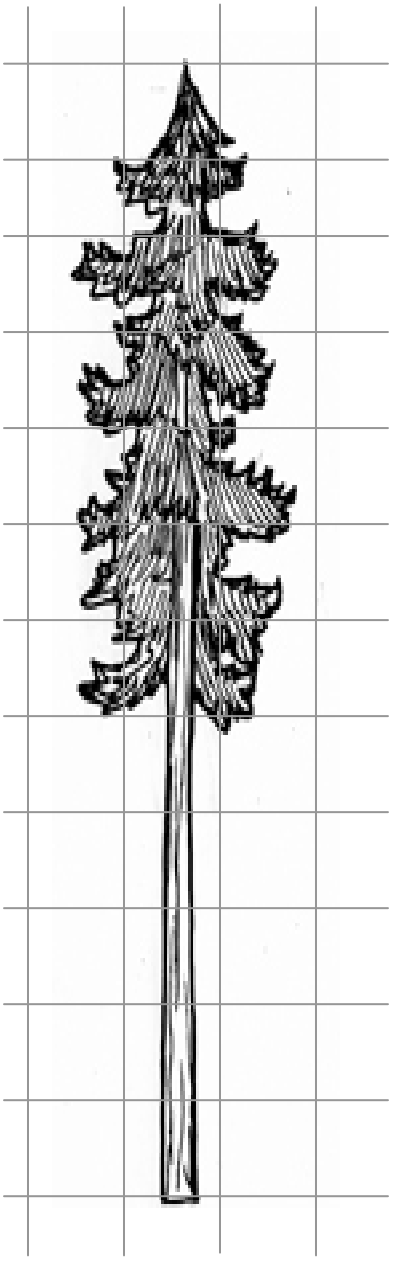


Figure 121

If this tree is 360' tall, each box of the grid is 30' on a side.

If the tree is six feet tall (as on a classroom door), each box would be six inches on a side.

Figure 122

To estimate how much paint it would require to paint the tree on a play-ground, for example, one could divide the tree into geometric shapes and calculate their areas. The top of the tree is a triangle, and the rest of the foliage could be considered a rectangle, as could the trunk (bole).

If the drawing is on a 30' grid, the triangle would have a base of about 30' and a height of about 30'. Its area would be about 450 square feet.

The rest of the foliage would be a rectangle about 60' wide and 150' tall. The area of that rectangle would be 9000 square feet.

The sum of the foliage would be about 9,450 square feet. If a gallon of paint covers about 400 square feet, about 23 gallons would be required to cover this area. However, not all of the foliage reaches the edge of the rectangle, and some of the bole or trunk is visible, so one might be able to get by with 20 gallons of green paint. To be safe, though, one should probably buy 25 gallons in case a gallon doesn't actually cover 400 square feet.

The trunk below the foliage would form a rectangle about 10' wide and 50' tall, or 500 square feet. This would require about a gallon and a quarter, but some of the trunk and some branches are visible within the foliage, so one ought to consider buying two or three gallons of brown paint.

Since every tree has a different shape, the precise shape of the tree isn't as important as illustrating the size that coast redwoods can reach. Students should be reminded, though, that while most redwoods are less than 300 feet tall, some are over 370 feet tall!

How Big?
Study Guide

How can you accurately draw something that is very large on a small paper? One way is to use a system of grids. The same method can be used to enlarge an illustration.

If you have an illustration that you want to **enlarge**, draw a series of grid lines on the original illustration. Draw similar but larger grid lines on the paper on which you want to make the enlarged drawing. Or, you might use graph paper with different sized grids.

Then simply copy the part of the image from the small grid to the corresponding larger grid.

To **reduce** the size of a picture, use similar but smaller grid lines on the paper and copy the part of the image from the larger original grid to the corresponding smaller grid.

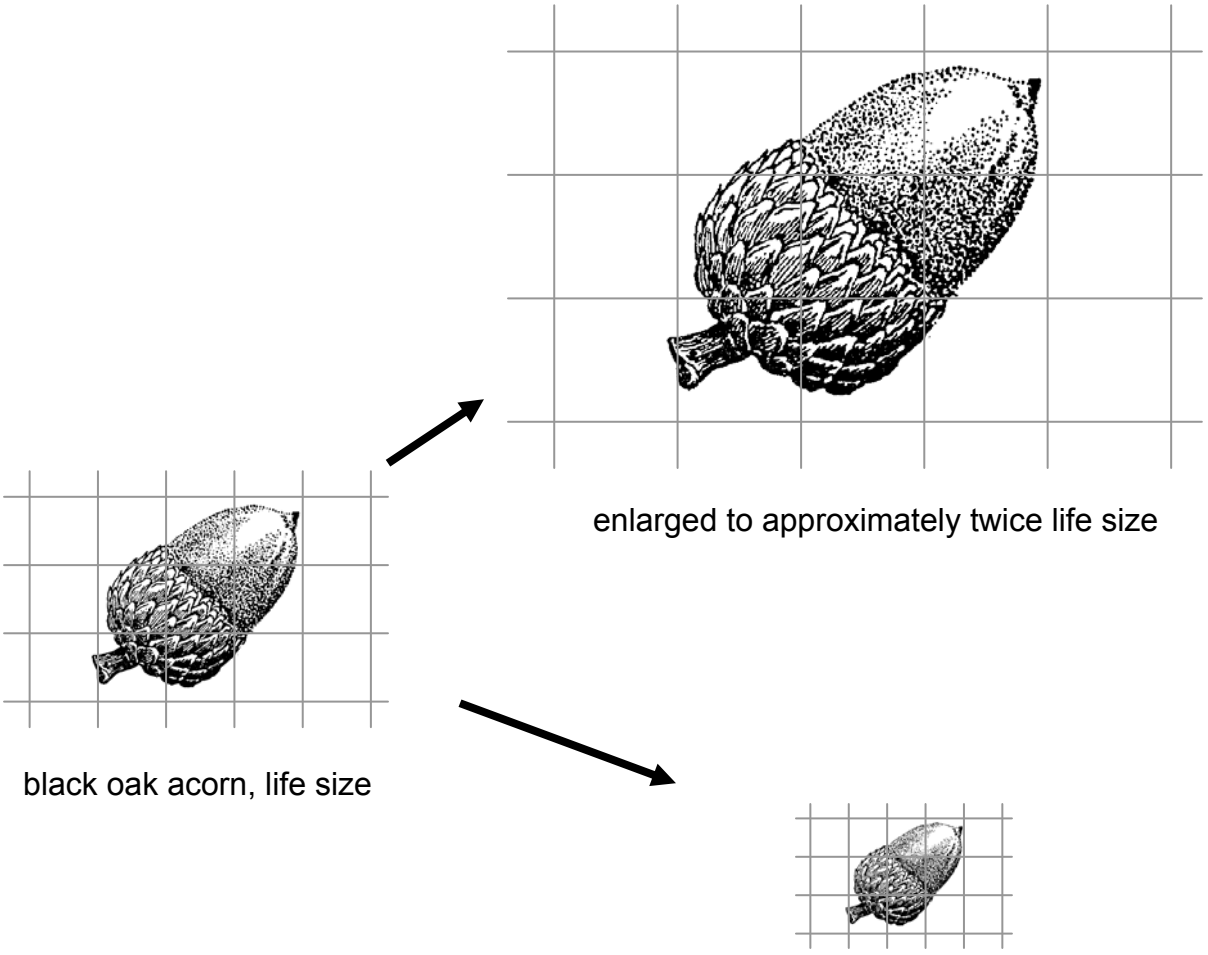


Figure 123

How Big?
Questions

1. If the coast redwood tree drawn below is actually 360 feet tall, how many feet does each one-half inch square on the drawing represent?

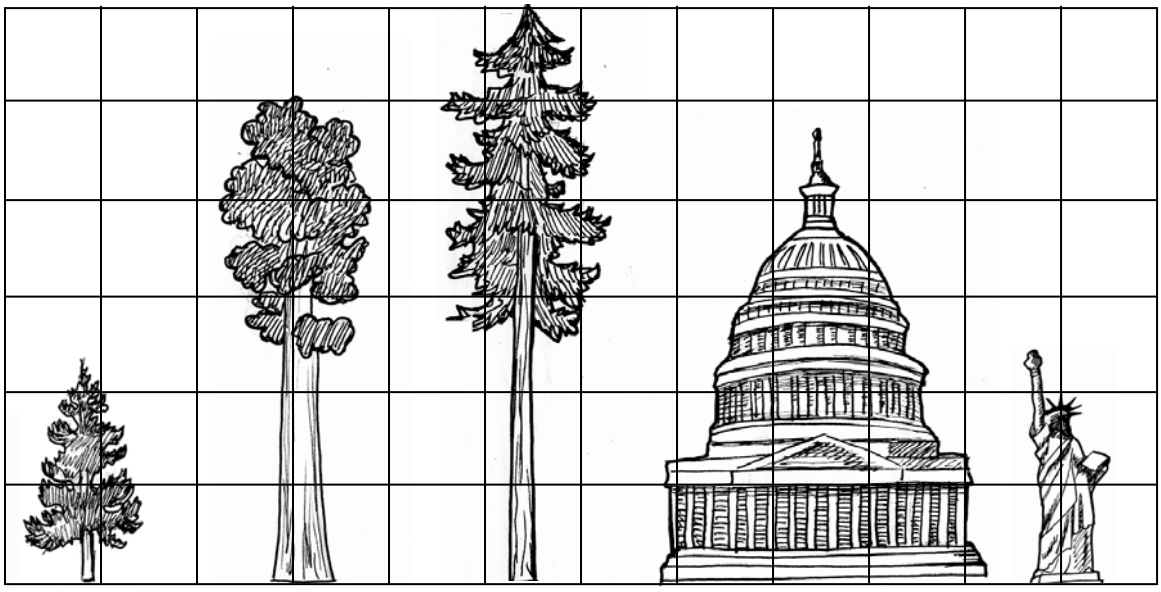
2. If the coast redwood tree is 360 feet tall, how wide is the giant sequoia tree at its base?

3. If the coast redwood tree is 360 feet tall, how tall is the giant sequoia?

4. If you wanted to use a 12 square tall grid to draw the 360' coast redwood on a 6' door, how many feet would each square represent?

5. If you want to draw the coast redwood tree life-sized, how wide would the base be?

Most coast redwoods are shorter than 360 feet, but some are more than 370 feet tall, and many are over 250 feet tall, especially in the streamside alluvial flats.



dawn redwood (140' tall) | giant sequoia | coast redwood (360' tall) | Capitol Building (287' tall) | Statue of Liberty (151' from feet to torch)

Figure 124

Let's Stick Together!

ACTIVITY SUMMARY
Students learn about some properties of water through experiments and observations of cohesion, adhesion, surface tension, and capillary action.

CONCEPTS TO BE LEARNED
1. Water molecules tend to stick together, to be attracted to each other.
2. Trees have cells that are arranged like tubes and transport water throughout the tree.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 5: Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.
Life Sciences S.S. 2: Plants . . . have structures for life processes.

Grade 6: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Grade 7: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Other Standards:

Grade 5: Earth Sciences 3

Grade 6: Ecology (Life Sciences) 5.b

ANTICIPATED OUTCOMES
1. Students will increase their ability to conduct experiments and make accurate observations.
2. Students will increase their understanding of water molecules, cohesion, adhesion, surface tension, transpiration, and the importance of humidity for redwood trees.

GROUPING
Groups of two to four students

TIME
30-60 minutes

MATERIALS
- ❒ Water: approximately two cups for each group
- ❒ Three- to four-inch rectangular glass or plastic plates (flat sheets, not dinner plates!): two per group (Look in the yellow pages under "plastics" for companies that sell sheet plastic. They may well donate scraps that can be cut on a table saw. Window and mirror companies may cut glass squares. Be sure to get the edges beveled and that the glass is thicker than normal window glass.)

- ❒ Plastic cup (preferably clear)
- ❒ Pie tin or shallow pan to catch spilled water and into which plates can be placed in the capillary action observation
- ❒ Paper clips or pennies: 25 per group
- ❒ Rubber band
- ❒ Approximately four inches of masking tape per group
- ❒ Small pieces of tag board: approximately ¾" wide and as long as the glass plates or microscope slides
- ❒ Plastic or glass capillary tubing or other tubing with a small inside diameter
- ❒ Sponges or towels for cleanup
- ❒ "Pop beads" (about 10"-12" chain) (or small paper clips)
- ❒ Tubing through which the pop beads (or paper clips) can pass
- ❒ Optional: food coloring to color the water

TEACHER PREPARATION

1. Obtain the materials above.
2. Duplicate the Let's Stick Together Study Guide.
3. It is extremely important that you try out these experiments to be sure that they will work with your particular materials!
4. 

   Caution! If you use glass tubing or plates, be sure to warn the students not to break them. Be sure that edges of glass plates are beveled. (A local window or mirror company may do this for you, or you can simply sand them with sandpaper.)

PROCEDURE

1. Ask students how water can get to the top of a blade of grass. Of a rose bush? Of a 300-foot-tall redwood tree?
   (The answer seems to be a combination of various properties of water molecules and physical processes. Leaves have tiny holes called stomata through which water evaporates. Due to their chemical structure, water molecules tend to stick together. This is called cohesion. When a molecule evaporates from a leaf, it tends to tug its neighbors upward. Also, water molecules tend to stick to things (adhesion), which contributes to their upward movement through the xylem cells of plants. In small tubes such as xylem tubes, this upward movement, caused by a combination of adhesion and cohesion, is called capillary action. Another factor may be osmotic pressure; water from the soil may enter root cells, pushing water upward. Capillary action seems to be the main way that water is moved upward in plants, but it doesn't fully explain how water can reach the top of a tall tree.)

2. Issue the Study Guides and show the students the materials and explain how the lab is to be conducted—moving from station to station or each group to complete all of the experiments at their own station.

3. After the students have done their experiments, demonstrate adhesion and transpiration:
    a. Use pop beads or a paper clip chain to represent water molecules attracted to each other (cohesion).

    b. Pass the chain through a tube or straw, which represents the xylem of a plant.

    c. At the top end, remove one bead or clip, which represents evaporation of water from the leaf—transpiration. As you do so, show that the "water molecule" pulls on the next molecule in the chain, which pulls on the next one, etc.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. This activity can be done as a series of stations to which student groups move, or each group can have the materials to do all parts. Station labs require less material, but require the students to move.

2. Rather than pop beads or paper clips for the teacher demonstration of transpiration, a chain of connected circles can be cut from paper. Each circle represents a water molecule, and the chain is pulled through the tube and "molecules" are removed by tearing them off, which represents evaporation.

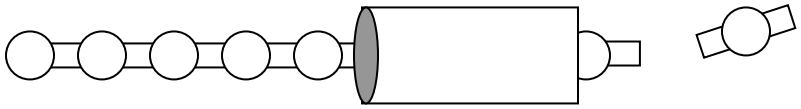


Figure 125

3. Have students use a dry sponge to try to clean up some spilled water, then use a damp sponge. The damp sponge tends to pick up the water better partly due to cohesion with the water molecules on the sponge. (Another factor is the flexibility of the sponge, allowing more of it to come in contact with the spilled water.)

4. See the activity "Transpiration."

ASSESSMENT

1. The Study Guide can be used for assessment.

2. Students can design, conduct, and report on other experiments of their own design or experiments that they find on the Internet or in other resources.

ANSWERS TO SELECTED STUDY GUIDE QUESTIONS

1. The tendency of water molecules to stick together and form a layer at the top surface is called surface tension.

4. The students should observe that the water rises higher on the end of the plates where the glass is closest together, and their drawings should show this.

5. Transpiration (evaporation) would happen more or faster when the air is warm and dry. Fog increases the humidity, which reduces water loss through transpiration. It also tends to cool the air, further reducing water loss. Some use the term "evapotranspiration" for this process.

REFERENCES AND RESOURCES

Hone, et al: *A Sourcebook for Elementary Science*.

The Watercourse and the Council for Environmental Education. *Project WET: Water Education for Teachers.* Bozeman, MT: Project WET, 1995.

Science supply companies listed in Appendix IV sell capillary tubing.

Let's Stick Together
Study Guide

Water is necessary for life, and trees need to get water to all of their branches and leaves. How can water travel from the soil, through the roots, and to the top of a 300-foot tall redwood tree?

Water has several properties that enable trees to move water to their uppermost limbs and leaves. To help understand water's special properties, some vocabulary will be helpful.

> **Adhesion** is the tendency of water molecules to be attracted to other materials. You have seen adhesion when you have observed water droplets stick to a mirror or window, or when you have seen water being soaked up by a sponge or paper towel.
>
> **Cohesion** is the tendency of water molecules to be attracted to each other. You have seen cohesion when you have observed that water forms little droplets or “piles” on a counter top or waxed paper.
>
> **Surface tension** results from the cohesion of water molecules at the surface of a liquid. It results in a skin-like layer of water molecules at the surface. In this activity you will do some experiments and make some observations of surface tension.
>
> **Capillary action** is the movement of water through small spaces such as tiny tubes or plant cells as a result of cohesion and adhesion.
>
> **Transpiration** is the loss of water from a plant, primarily through the leaves, which have small holes called stomata (or stomates) through which gases such as carbon dioxide, oxygen, and water vapor can enter and leave the plant.

As you do the following experiments, record your observations in the space provided.

1. Observing Surface Tension:

Place a plastic cup in a pie tin or shallow pan and add water until the cup barely overflows.

View the cup from the side. Does the water bulge upward from the top of the cup? Sketch the appearance of the water at the top of the cup.

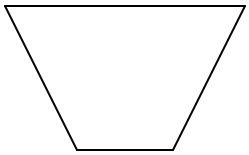


Figure 126

Do you think that you can add paper clips or pennies to the full cup? Predict how many you think you can add, then try it!

I predict that ____ can be added before the water will spill.

a. What do we call the tendency of the water molecules to stick together and form a layer at the top surface? (Answer with a complete sentence.)

2. Observing Cohesion

Dip your finger tip into the cup of water. Withdraw your finger and hold it in front of your eye. Draw what you see.

Are the molecules of water sticking together? This is an example of **cohesion**.

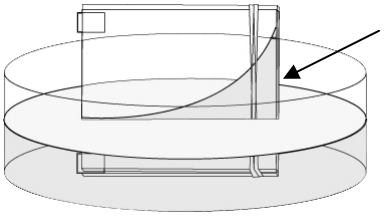
3. Observing Adhesion:

In the cohesion experiment above, the water molecules not only stuck to each other, but they stuck to your finger. When something adheres or sticks to something else, that is called **adhesion**. When you soak up a spill with a sponge or paper towel, the molecules of water that were spilled adhere or stick to the sponge or paper towel.

4. Observing Capillary Action Be careful with glass!

a. Place the tip of the small tube in the water. Observe what happens. Draw what you see.

b. Use masking tape to attach a piece of tag board (or two if the plates are large) to one edge of one of the glass or plastic plates. (The tag board serves as a thin spacer between the plates.)



Grasp and gently squeeze here.

Figure 127

Wet one of the plates or slides.

Use a rubber band to secure the plates together.

Carefully lower the edge of the plates into a bowl or pan of water to which food coloring has been added.

(Because the layer of water between the plates is so thin, it may be difficult to see. Dark food coloring will make it easier to see, especially if the plates are viewed against the sides of a white bowl.)

Gently squeeze the glass plates.

Observe and draw what happens.

The movement of water through such small spaces is called **capillary action**.

5. Teacher Demonstration of Transpiration

Plants need to obtain carbon dioxide from the air. They also need to get rid of gases such as oxygen and water vapor. To accomplish this, they have small holes or pores in their leaves. Those pores are called stomata. This process of water loss or evaporation through leaves is called **transpiration**.

When a water vapor molecule evaporates from a leaf, it tends to pull its neighbors with it. As millions of water vapor molecules leave the plant through transpiration, more water is pulled up from below.

a. Do you think that water would evaporate or transpire more when it is warm or when it is cool?

b. Do you think that water would evaporate or transpire more if there is lots of water already in the air, as on a foggy day, or when the air is dry?

c. Redwoods live best where the summers have many foggy days. How might fog help redwoods reduce water loss through transpiration?

Microhabitats

ACTIVITY SUMMARY
Students study and compare small areas.

CONCEPTS TO BE LEARNED
1. Within a large area such as a stand of redwood trees, there are a variety of microhabitats, each of which has its own physical conditions and communities of organisms.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences S.S. 3: Living organisms depend on one another and their environment.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 5: Life Sciences S.S. 2: Plants and animals…have structures for life processes.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 6: Ecology/Life Sciences S.S. 5: Organisms exchange energy and nutrients among themselves and with the environment.
Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Grade 7: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Other Standards:

Grade 4: Mathematics: Number Sense S.S. 3.0
Mathematics: Measurement and Geometry S.S. 1.0
Mathematics: Statistics S.S. 1.0

Grade 5: Mathematics: Measurement and Geometry S.S. 1.0:
Mathematics: Statistics S.S. 1.0

Grade 6: Mathematics: Number Sense S.S. 1.0
Mathematics: Number Sense S.S. 2.0

Grade 7: Mathematics: Mathematical Reasoning S.S. 2.0

ANTICIPATED OUTCOMES
1. Students will increase their understanding of how plants and animals interact with each other and with their environment.
2. Students will increase their ability to make, record, and interpret observations.

GROUPING
Depends on the availability of study sites. Ideally, teams of two to four students for each site.

TIME
Varies

MATERIALS
- ❒ Varies with the types of data to be collected. Depending on the site, such tools as:
  - ○ Cameras
  - ○ Measuring devices
  - ○ Magnifiers
  - ○ Thermometers
  - ○ Pans
  - ○ Forceps
  - ○ Books including keys and field guides (see Appendix IV and V)
  - ○ Notebooks
  - ○ Colored pencils or crayons

TEACHER PREPARATION
1. Arrange for the sites. Be aware of such issues as damaging the microhabitats, staying on trails, trampling plants, etc.
2. Obtain the materials listed above, or others as needed.
3. Study areas might be on the school grounds, or at a field site in a park or forest. Some possible study sites might be logs in various states of decay, bark of various species of trees, rocks (on the rock and under it), different parts of a stream (stream bank, sandy area, rocky area, area where water moves slowly or rapidly, etc.)

PROCEDURE
1. Have the students develop a system and forms for recording data.

2. Record such things as a description of the microhabitat, types and numbers of organisms, air or water temperature, moisture availability, etc.

3. Students should draw, as accurately as possible, the whole site and any organisms found.

4. Photographs can be helpful.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION
1. Student teams can either study similar sites or different types of sites.

2. Students can compare the physical and biological data that they collect from different microhabitats.

3. Consider setting up a variety of microhabitats such as decaying logs, rocks, and various types of plants on the school grounds for ongoing studies over several years.

Mystery Objects

ACTIVITY SUMMARY
Various objects from a redwood forest are placed in boxes or bags. Students describe and try to identify the objects without seeing them.

CONCEPTS TO BE LEARNED
1. All senses can be useful in gathering information.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Science Investigation and Experimentation 6.a: observations and inferences

Grade 5: Science Investigation and Experimentation 6.a: classify objects
Life Sciences 2.a: Plants and animals have structures for life processes.

Grade 6: Science Investigation and Experimentation 7a: develop a hypothesis

ANTICIPATED OUTCOMES
1. Students will increase their ability to use their sense of touch.
2. Students will increase their ability to identify various objects from a redwood forest.

GROUPING
Individual

TIME
Depends on the number of objects. Approximately one to three minutes per object.

MATERIALS

Remember that it is illegal to take materials from state or national parks.

Also tell the students <u>not</u> to use their sense of taste!

- ❒ Various objects from a redwood forest. Examples include:
  - ✓ Cones: coast redwood, Douglas-fir, alder, others
  - ✓ Pieces of bark: coast redwood, Douglas-fir, others
  - ✓ Leaves: coast redwood, Douglas-fir, sword fern, tanbark oak, others
  - ✓ Deer or elk antlers, jawbones, fur (from a taxidermist?)
  - ✓ Rocks: sandstone, serpentine, shale, other
  - ✓ Leaf litter/duff: from beneath a redwood, fir, oak
  - ✓ Litter: plastic water bottle, soda can, candy wrapper
  - ✓ Other objects?

- ❒ For each object: a box such as a shoebox, with a hole cut in the end, through which a student can insert his or her hand. Possibly attach a cloth flap to the inside to serve as a "door" and prevent peeking.

- ❒ Cloth or even paper bags can be used instead. Bags are easier to store, but students seem to take the activity more seriously if "mystery boxes" are used.

- ❒ Mystery Object Study Guide for each student

TEACHER PREPARATION

1. Create the boxes and obtain suitable objects.
2. Be sure to have extras in case the object becomes damaged.

PROCEDURE

Note: If possible, ascertain whether any students have allergies to items in the mystery boxes, including redwood bark.

1. This activity can be done either before or after the students have been taught about the objects.
    a. If they have been taught about the objects, students try to identify them without seeing them.

    b. If the students have not yet been taught about the objects, they should describe them in as much detail as they can tell from feeling them. They can then make up a name for the object.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Consider giving the students a list of objects, making it a multiple choice activity.

2. This activity can be used with objects from any environment.

3. Mystery objects can be displayed in the classroom, perhaps on a tray, before or after a trip to the redwoods.

ASSESSMENT

1. The Study Guide can be used for assessment.
2. Have students read their descriptions; encourage students to use precise adjectives and similes.

ANSWERS TO SELECTED STUDY GUIDE QUESTIONS

Will vary according to the objects.

Mystery Objects
Study Guide

For each mystery object, first write down the number of the mystery box or bag.

Then, carefully reach into the opening and feel the object. **BE CAREFUL NOT TO DAMAGE THE MYSTERY OBJECT!**

Describe the object in as much detail as possible.

- Is it hard? How hard? Hard as a rock, hard as a piece of wood, or?
- Is it flexible? How flexible? Flexible like a hose? A straw? A hair? A paper?
- Is it smooth? How smooth or how rough? Smooth like a ___, rough as ___?
- Does it have different parts, or is it all one piece? Are all parts the same?
- Based only on feel, can you draw the object?
- What else can you tell?

If you don't know what it is, make up a name that describes the object.

Record your observations below.

#	Description	Made-up name	Actual name

The Mystery of the Disappearing Leaf!

ACTIVITY SUMMARY
Students place different materials in various soils and observe decomposition (or lack thereof) over time.

CONCEPTS TO BE LEARNED
1. Some materials will decompose and some won't.
2. Different soil types and conditions can either support or inhibit decomposition.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences S.S. 2: All organisms need energy and matter to live and grow.
Life Sciences S.S. 3: Living organisms depend on one another and their environment.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 5: Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 6: Ecology (Life Sciences) S.S. 5: Organisms exchange energy and nutrients among themselves and with the environment.
Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Grade 7: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

ANTICIPATED OUTCOMES
1. Students will increase their understanding of the process of decomposition.
2. Students will increase their ability to conduct scientific investigations.
3. Students will understand that not everything decomposes readily.

GROUPING
Groups of two to four students

TIME
Start: 15-30 minutes
Then: 10-15 minutes, observing every two to three days for an indeterminate amount of time

MATERIALS: for each group
- ❒ One clear two-liter soda bottle (or something similar), with five to ten ¼" holes drilled in the bottom
- ❒ Plastic/nylon screening: circle approximately the size of the bottle's bottom
- ❒ Pie tin or other device to catch water draining from the bottle

- ❒ Masking tape
- ❒ Measuring cup, graduated cylinder, or similar measuring device for measuring liquid volumes
- ❒ Approximately 1 quart (1 liter) of soil
- ❒ Various materials such as leaves, glass, plastic, aluminum, fruit, paper
- ❒ The Mystery of the Disappearing Leaf! Study Guide

TEACHER PREPARATION

1. Obtain materials above.
2. Cut off the top of the bottle so that it is about eight inches tall.
3. Drill five to ten ¼" holes in the bottom.
4. Place the screen in the bottom of the bottle to retain the soil and allow drainage.
5. This investigation can be as simple or as complex as you (and the students?) decide:
   - ✓ All can use the same soil, or they can investigate decomposition in various soil types such as redwood forest, potting soil, backyard soil, compost, etc.
   - ✓ Only one type of leaf may be used, or various types of leaves and other materials such as orange peels, aluminum cans, plastics, or other materials can be used.
   - ✓ All samples can receive the same amounts of water, or students can investigate various watering amounts and timing.
   - ✓ Samples can be in the dark, in the light, or in varying conditions.
   - ✓ For a longer-term experiment, students can use small samples of different types of wood.

PROCEDURE

1. Ask the students what happens to a leaf that falls to the forest floor. Introduce the term decomposition and discuss its meaning and importance to the forest (or any other) ecosystem.

2. Ask the students how they might design an experiment to see how long it takes a leaf to decompose. Elicit the idea of placing the leaf in some soil and checking it periodically. Discuss the idea that the living things that cause decomposition need moisture and some air to effectively decompose materials.

3. Decide on variables—types of soils, materials, moisture, etc.

4. Students place leaves and, possibly, other materials in soil in the 2-liter bottles so that the leaf is about three inches from the bottom and has about three to five inches of soil on top of it, and so that the leaf and/or other item is visible through the side of the bottle.

5. Bottles are placed in the pie tins and watered so that the soil stays damp but not soggy. (The microorganisms need air and moisture.) All bottles can be given the same amount of water with the same frequency, or water can be an experimental variable.

6. Students observe their bottles every two to three days, recording their observations on the Study Guide.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Many variations are possible. Consider having the students all do the same experiment (same soil type, same leaf type, same watering schedule) for two to four weeks, and then let them design other variables such as leaf types, amount of water, and frequency of watering, soil types, etc.)

ASSESSMENT

1. Do students follow directions?
2. Questions on the Study Guide can be used for assessment.

ANSWERS TO SELECTED STUDY GUIDE QUESTIONS

2. Decomposition depends on living organisms such as bacteria, which require moisture to survive. They also need air (oxygen), so too much water will kill them.

3. Without decomposition, nutrients would not be returned to the soil for new organisms to use.

4. Buried deep under a soil cover (to prevent access by rats and birds, and reduce leaching of chemicals from rains), the garbage was cut off from air and moisture,so microorganisms couldn't live and decompose it.

5. Plastic bags cut off the supply of air and water that microorganisms need to effectively decompose the garbage.

The Mystery of the Disappearing Leaf!
Study Guide

- ❒ Your teacher will provide you with a 2-liter bottle with a screen in the bottom, a leaf, and some soil.
- ❒ Use masking tape to put your name on your bottle.
- ❒ Place about three to five inches of soil in the bottom of the bottle.
- ❒ Then place the leaf (paper, plastic, or other item to be observed) so that you can see it through the bottle.
- ❒ Add three inches more of the soil on top.
- ❒ Place your experiment in the pie tin and water as directed by your teacher.
- ❒ Record your observations in the table below. You will observe your experiment over several days, so be sure to make accurate observations each time.

Soil type: _____ Watering:_____ every _____days
(amount)

Other conditions being tested:

Date	Item being observed	Observations of the item	Other observations

Questions:

1. What changes did you observe in the leaf or other item?

2. Why is it important to keep the soil moist, but not too wet?

3. Why is decomposition important in a natural ecosystem?

4. Some years ago scientists dug up a garbage dump and were surprised to find newspapers that were 20 years old that had not decomposed. Why do you think the papers had not decomposed?

5. Many people put their garbage into plastic bags before placing it in the garbage can. What effect might this have on the decomposition of the garbage?

6. What is composting, and how can it help the environment?

Organism of the Year

ACTIVITY SUMMARY
Students do research on an organism and prepare a poster, brochure, or other presentation telling why that organism should be the "Organism of the Year."

CONCEPTS TO BE LEARNED
1. Every organism has a role in the environment and has value.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences S.S. 3: Living organisms depend on one another and their environment.
English: Writing 2.3: Write information reports.
English Listening and Speaking Standard Set

Grade 5: English: Writing 2.3: Write research reports.
English Listening and Speaking Standard Set

Grade 6: Ecology (Life Sciences) S.S. 5: Organisms exchange energy and nutrients among themselves and with the environment.
English: Writing 1.4: Use electronic text to locate information.
English: Writing 1.5: Compose documents…use word processing skills
English: Writing 2.3: Write research reports.
English Listening and Speaking Standard Set

Grade 7: Life Science…Evolution 3.1: Biological evolution accounts for diversity.
English: Writing 1.4: Research and Technology
English: Writing 1.5: Citing sources
English: Writing 1.6: Creating documents using word-processing skills
English: Writing 1.7: Revising
English: Writing 2.3: Write research reports.
English Listening and Speaking Standard Set

ANTICIPATED OUTCOMES
1. Students will improve their research and writing skills
2. Students will increase their knowledge about a particular organism.
3. Students will increase their knowledge of ways that organisms interact.

GROUPING
Individuals or groups of two to three

TIME
Introduce assignment: 10-20 minutes
Research, production, and presentation of poster, brochure, or other product: varies

MATERIALS
- ❒ Depends on presentation method: materials for making posters or brochures, computers for PowerPoint presentations, video recorder, or?

TEACHER PREPARATION

1. Obtain pictures or slides of various types of organisms of the redwood forest. Sources might include *Redwood Ed*, the Internet, calendars, and magazines.
2. Obtain materials needed for the type of presentation planned.
3. Decide on group size and time to be allocated.
4. Duplicate the Organism of the Year Study Guide.
5. Optional: Obtain books for student use.

PROCEDURE

1. Show students pictures of various organisms of the redwood forest. As you show the pictures, tape them on the wall or write their names on the board.

2. Have the students "vote" for their "favorite" organism. Generally, mammals and large "charismatic" species will receive more votes.

3. Ask students why they voted as they did.

4. Discuss the idea that <u>all</u> organisms are important in an ecosystem.

5. Give the students the Organism of The Year Study Guide.

6. Have the students select their organism (or assign them). Some possibilities include the following, but many others are possible. Consider resources available, but information on most can be found on the Internet. Not assigning "charismatic" species such as mountain lions, black bears, raccoons, or organisms of obvious value such as trout, salmon, redwood trees or Douglas-fir trees makes it more interesting and challenging, and may be more useful.

poison oak	stinging nettle	spikenard	miner's lettuce	horsetail
hound's tongue	manzanita	madrone	wild cucumber	coltsfoot
skunk cabbage	big-leaf maple	alder	bay (laurel)	willow
moss	mushrooms	algae	various ferns	lichens
earthworms	mosquito	crane fly	yellowjacket	mayfly
stonefly	caddis fly	termite	bottle fly	millipede
centipede	sow bug	tick	black widow	wolf spider
snail	banana slug	newts	salamanders	tailed frog
tree frog	red-legged frog	pond turtle	rattlesnake	garter snake
rubber boa	gopher snake	fence lizard	ringneck snake	skink
alligator lizard	Steller's jay	scrub jay	red tailed hawk	winter wren
woodpecker	marbled murrelet	crow	snowy plover	spotted owl
flying squirrel	gray squirrel	chickaree	wood rat	voles

7. After completing their research and poster or other product, students present their products to the class.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Consider students' abilities when forming groups.

ASSESSMENT

1. Does the product show knowledge of the organism?

REFERENCES AND RESOURCES

Roa, Michael: *Environmental Science Activities Kit: "Endangered Species II – Who Cares?"*

Council for Environmental Education: *Project WILD K-12 Activity Guide: "Interview a Spider"*

Organism of the Year
Study Guide

It is easy to care about cute animals such as raccoons and spectacular plants like the coast redwood trees. But what about other plants and animals? Are mosquitoes, worms, poison oak, and moss important and worth caring about?

In this activity, you will prepare an advertisement to convince the class that your organism is an important part of the coast redwood community. Your teacher will provide details, but be sure that your advertisement includes the following:

- the name of your organism

- a picture or drawing of the organism
  - ✓ Include information about its size.

- its range—Where in the world is it found? A map might help.

- its habitat within the forest—Where in the forest does it live?

- its niche—its role in the forest
  - ✓ What does it eat?
  - ✓ What eats it?
  - ✓ How else is it important?

- some other interesting or important information

and, especially…

- **Why does this organism deserve to be the Organism of the Year?**

Be sure to give the source(s) of your information—author, title, publisher, date.

Redwood Crosswords

ACTIVITY SUMMARY
Four crossword puzzles are provided:

- Basic Redwood Ecology
- Advanced Redwood Ecology
- Redwood Forest Organisms
- Humans and the Redwoods

CONCEPTS TO BE LEARNED
Vocabulary

STANDARDS ADDRESSED
Vocabulary is useful in discussing all Standards and Environmental Principles.

ANTICIPATED OUTCOMES
1. Students will increase their knowledge of vocabulary.

GROUPING
Individual or any other configuration

TIME
Varies

MATERIALS
- ❒ Copies of crossword puzzles
- ❒ Transparencies of crossword puzzles and answers

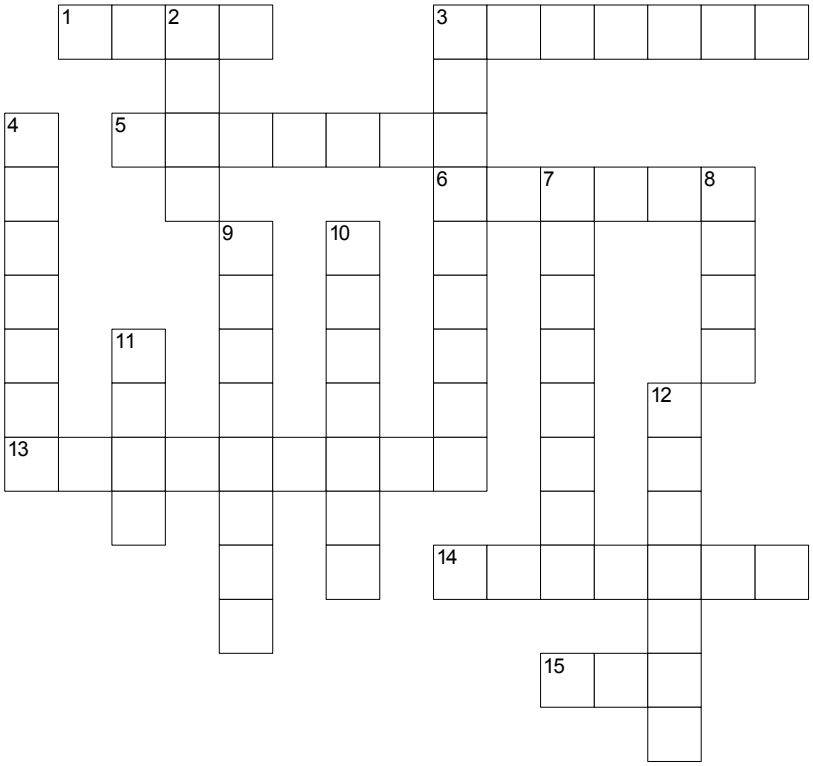
TEACHER PREPARATION
1. Duplicate crossword puzzles and make transparencies.

PROCEDURE
1. Crossword puzzles can be given as homework or class work.
2. Transparencies can be used to go over the answers.

ASSESSMENT
1. The puzzles can be used to assess vocabulary knowledge.

SOLUTIONS TO CROSSWORD PUZZLES FOLLOW THE PUZZLES

Basic Redwood Ecology Crossword Puzzle



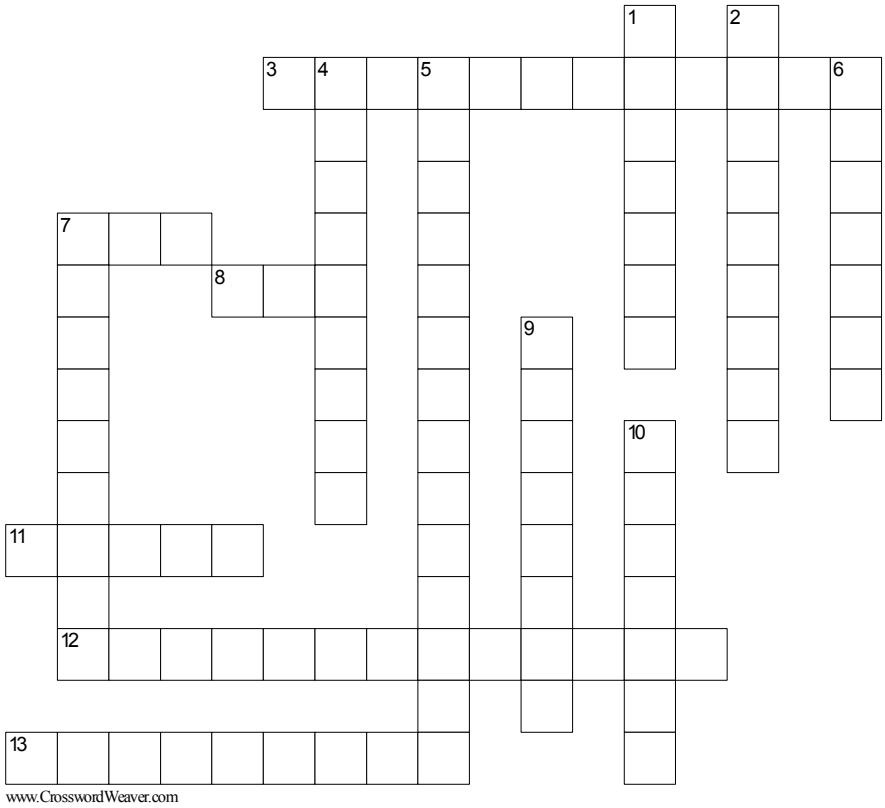
Across

1 I'm thick and I help protect redwoods from fire and insects.
3 A place where an organism grows is its __.
5 A tree that produces seeds in a cone is a __.
6 __ factors include plants and animals.
13 I like to eat animals for dinner!
14 Redwood leaves are called __.
15 I'm wet, I drip, and I help redwoods grow.

Down

2 I absorb minerals and water from the soil.
3 I like to eat plants for dinner!
4 __ factors include air, water, sunlight, and minerals.
7 I'll eat plants and animals.
8 Redwoods produce their seeds in a __.
9 There's not much of this in a dense redwood forest, but plants need it.
10 The coast __ is the world's tallest tree.
11 Redwoods may sprout from me, especially if the tree is injured.
12 The study of organisms and how they interact with each other and the environment

Advanced Redwood Ecology Crossword Puzzle



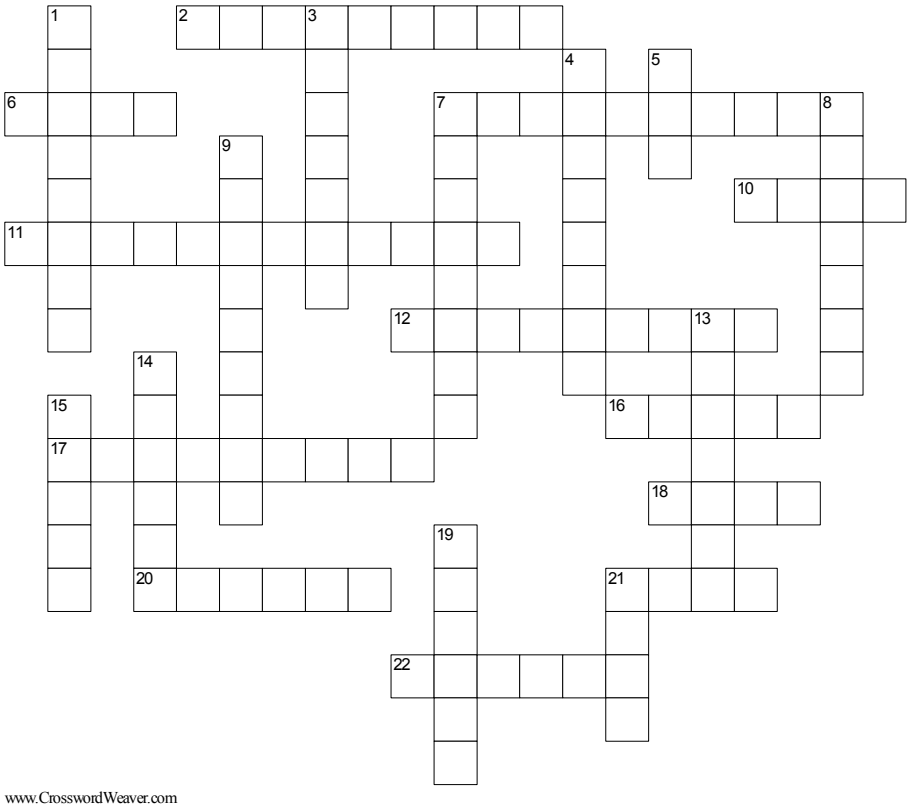
Across

3 Species of coast redwood
7 A food __ shows what eats what.
8 __ drip provides water for redwoods in the summer.
11 A food__ is a simple way to show what eats what.
12 Why fallen trees and leaves don't stay on the forest floor forever
13 __ trees lose their leaves in the winter.

Down

1 Trees help remove carbon __ from the atmosphere.
2 Has lots of insect- and rot-resisting tannin, and is the non-living center of the tree.
4 __ trees don't lose their leaves in the winter.
5 Produces oxygen
6 Genus of coast redwood
7 The land from which water flows into creeks and rivers
9 Carrying __ tells how many can live in a place.
10 The study of organisms and their relationships with each other and the environment

Redwood Forest Organisms Crossword Puzzle



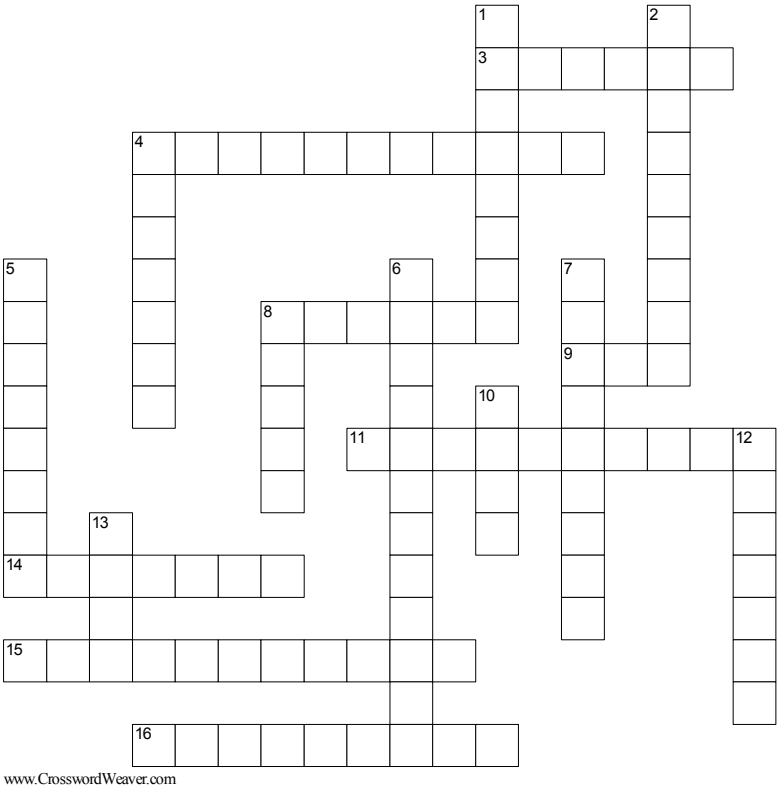
Across

2 Leaflets three, leave me be!
6 I'm green, I reproduce with spores, and I can get pretty big.
7 Pacific giant __
10 Blood sucker, spider relative
11 Species of the coast redwood
12 Two pairs of legs per segment
16 Smelly and striped
17 One pair of legs per segment
18 I may look like a banana, but I'm not!
20 I need clean, cold water.
21 I need a damp place to live, I'm small, and I reproduce with spores.
22 I look like a large clover.

Down

1 I'm a jaybird with a pointed crest.
3 Genus of coast redwood
4 I'm tiny, but I can get rid of the largest dead plant or animal.
5 Some call me pepperwood or laurel. My leaves have an odor, and I can be used in soups.
7 Nettle
8 I look like a bandit.
9 Scouring rush
13 They call me a fir, but I'm not.
14 Mushroom
15 Listen for the sound of an __ woodpecker.
19 My acorns were used for food by Native Americans, and my bark was used to make leather.
21 I'm a deer with big ears.

Humans and the Redwoods Crossword Puzzle



Across

3 Boards
4 Platform for lumberjacks
8 Redwood's ability to stump __ helps it regrow rapidly after logging.
9 Old time tree cutter
11 Redwood's __ to insects and rot is one of the things that makes it valuable
14 A long hand saw
15 Taking care of the forest
16 With __ yield forestry, trees are planted for future generations.

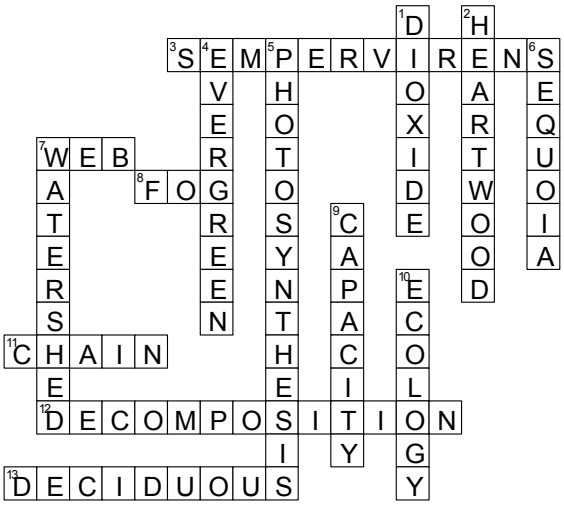
Down

1. Cutting all of the trees in an area
2. In __ logging, only a few trees are taken from a stand.
4. White colored wood; becomes heartwood
5 Modern tree cutter
6 Using resources wisely
7 Who put the red in redwood?
8 Leftover branches
10 Where trees become boards
12 May result without proper care and planning
13 Can kill trees, but in nature helps remove competition

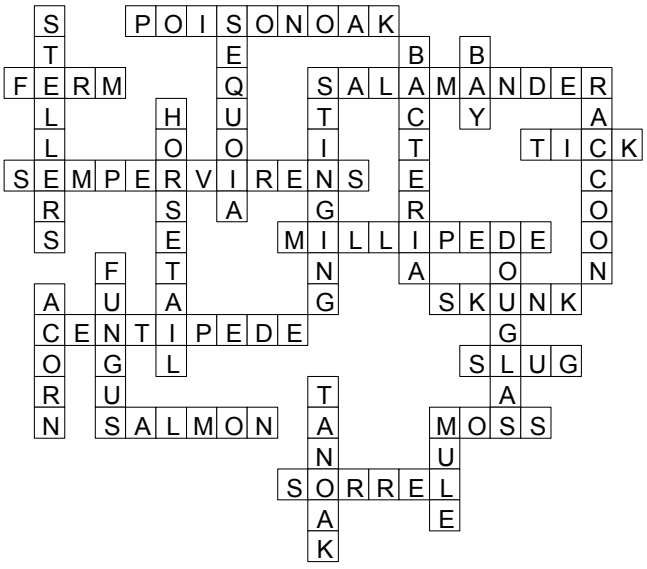
Crossword Puzzle Solutions

Basic Redwood Ecology

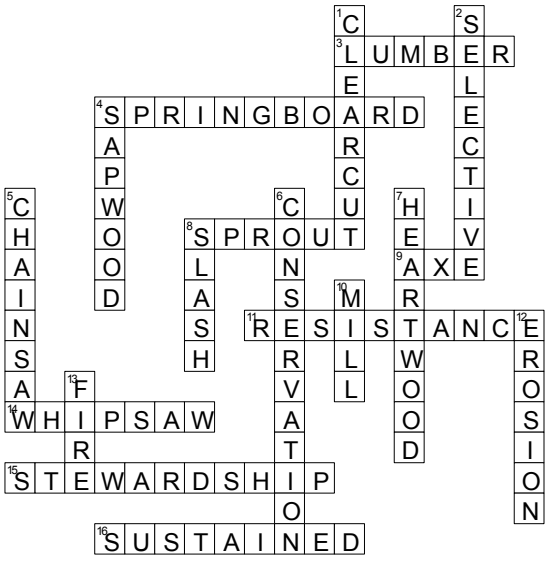
Advanced Redwood Ecology



Redwood Forest Organisms



Humans and the Redwoods



Slow Growth or Fast Growth?

ACTIVITY SUMMARY
Students compare samples of wood that show different growth rates.

CONCEPTS TO BE LEARNED
1. Depending on environmental conditions, trees grow at different rates.
2. As trees grow, cells are added by the cambium.
3. When a tree is growing rapidly, large cells are formed. When a tree is growing slowly, smaller cells are added. These different-sized cells form growth rings in the wood.
4. Growth rings in wood indicate the growth rate and age of a tree.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Life Sciences 3.a: In any environment, some organisms survive well, some less well, and some don't survive.
Science Investigation and Experimentation 6.a: observation and inferences
Science Investigation and Experimentation 6.b: measure and estimate
Grade 5: Life Sciences 2.a: Plants…have specialized structures
Grade 6: Science Investigation and Experimentation 7.a: develop a hypothesis

Other Standards:

Grade 4: Mathematics Number Sense S.S. 3.0
Grade 5: Mathematics Number Sense S.S. 1.0
Mathematics Number Sense S.S. 2.0
Grade 6: Mathematics Number Sense S.S. 1.0
Mathematics Number Sense S.S. 2.0
Grade 7: Life Sciences 5.b
Mathematics Mathematical Reasoning S.S. 2.0

ANTICIPATED OUTCOMES
1. Students will understand that environmental factors such as sunlight (and competition for sunlight) affect the growth rate of plants.
2. Students will be able to compare the growth rates of wood samples based on the size of the growth rings.
3. Students will describe some possible causes of different growth rates of trees as indicated by the size of growth rings.

GROUPING
Two or three students per group

TIME
30 minutes

MATERIALS

For each team, provide at least two samples of wood. One sample should have close growth rings, indicating slow growth and the other should have widely spaced rings, indicating rapid growth. The wood samples might be tree rounds ("cookies") or they might be samples cut from boards.

TEACHER PREPARATION

1. Obtain the wood samples. A lumber yard, builder, or parent may have scraps from boards. Rounds might be obtained from sawmills, a tree-trimming service, a state or county forester, or a firewood company.

2. If you don't have the resources to cut and sand the samples, a local junior high or high school wood shop teacher, or a parent, might help.

PROCEDURE

1. Give the teams the wood samples and ask them to describe what they see.

2. Discuss the process by which rings are formed. (See the activity "The Great Tree Cookie Mystery." Consider making an overhead transparency.)

3. For various samples, have the students determine:
    a. how many years it took the tree to grow 1 inch in radius,
    b. how many years it took the tree to grow 1 inch in diameter (half as long as an inch in radius, since the diameter is two radii),
    c. how many years' worth of growth is represented by the sample,
    d. the average growth rate represented by the sample: x inches per year.

4. Discuss why trees might have different growth rates. (The main factor in the growth of coast redwoods is usually the availability of sunlight.)

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Obtain samples of different types of wood (fir, redwood, oak, etc.). Have students compare the growth rates of the different samples.
2. See the activity "The Great Tree Cookie Mystery."
3. See the activity "Fence Post Studies."

ASSESSMENT

1. Give an individual student or a group of students a wood sample showing a change in growth rate, either speeding up (release) or slowing down (suppression), and ask them to explain what might have caused the change.

REFERENCES AND RESOURCES

Tree cookies can be purchased from various sources. See Appendix IV.

American Forest Foundation: Project Learning Tree: *Pre K-8 Environmental Education Activity Guide*: "Tree Cookies"

Transpiration

ACTIVITY SUMMARY
Students conduct experiments to see that transpiration results in the loss of water from a plant's leaves.

CONCEPTS TO BE LEARNED
1. Plants have cells that are arranged like tubes and transport water throughout the tree.
2. Plants lose water through their leaves in a process called transpiration.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 5: Life Sciences S.S. 2: Plants . . . have structures for life processes.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 6: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Grade 7: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Other Standards:

Grade 5: Earth Sciences 3

Grade 6: Ecology (Life Sciences) 5.b

ANTICIPATED OUTCOMES
1. Students will increase their ability to conduct experiments and make accurate observations.
2. Students will increase their understanding of transpiration and of the importance of humidity for redwood trees.

GROUPING
Groups of two to four students

TIME
Part 1: 30 minutes to set up the experiment
15 minutes to observe it at the end of the day
30 minutes to observe it and answer questions the next day

Part 2: 15-30 minutes to set up the experiment
15 minutes to observe it at the end of the day
30 minutes to observe and dismantle it the next day and answer the question

MATERIALS

- ❒ For each student: Transpiration Study Guide

Part 1: For each group:

- ❒ Three stalks of celery, with leaves
- ❒ A beaker or cup (250 mL or more)
- ❒ Food coloring
- ❒ Petroleum jelly (a small amount - a half teaspoon or less)
- ❒ Metric ruler
- ❒ Paper towels for cleaning petroleum jelly from fingers
- ❒ Sharp knife (or an adult to do the cutting)
- ❒ Materials for cleaning up—sponge or towel

Part 2: For each group:

- ❒ Two sandwich size plastic bags
- ❒ Six inches of masking tape
- ❒ Petroleum jelly (a small amount…a half teaspoon or less)
- ❒ Two branchlets or large leaves on living plants

TEACHER PREPARATION

1. Obtain the materials listed above.
2. Duplicate the Transpiration Study Guide.

PROCEDURE

Be sure to try both experiments before having students do them.

Part 1:

1. Depending on the age and abilities of the class, consider cutting the celery yourself or having another adult cut it.
2. Issue the materials, including the Study Guide. Go through the procedure, demonstrating what the students are to do, with emphasis on being safe with the knife if the students are to do their own cutting.
3. Students should observe at the end of the period or day, and again the next day.
4. Discuss the observations and Study Guide questions.

Part 2:

1. Take the class outdoors to the plant(s) that you have selected and go over the procedure.
2. Have the students begin the experiment.
3. Observe at the end of the period or day, and again the next day.
4. Discuss the observations and Study Guide questions.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Part 2 can be done with potted plants in the classroom, which might be preferable if the outdoor plants are not secure from vandalism or because of weather.

2. Both experiments can be tried with different types of plants.

3. See the activity "Have a Foggy Idea."

ASSESSMENT

1. The Study Guide can be used for assessment.

ANSWERS TO SELECTED STUDY GUIDE QUESTIONS

Part 1:

Data Table: We would expect the colored water to rise the most in the stalk with leaves and no petroleum jelly, as the stomata are open, allowing more transpiration. We would expect that the water would rise the least in the stalk without leaves.

Question 1: Removing the leaves should reduce the height to which the water rose.

Question 2: Covering the leaves with petroleum jelly should reduce the height to which the water rose.

Question 3: Desert plants generally have their leaves reduced in size. In cacti, the leaves are reduced to spines. Others have few leaves. Most have leaves covered with a waxy coating to reduce water loss.

Part 2:

Data Table: The leaves without the petroleum jelly would be expected to lose more water through transpiration.

Question 4: Foggy days have high humidity, which reduces evaporation and transpiration. Fog also helps keep the air cool, which further reduces evaporation and transpiration.

REFERENCES AND RESOURCES

Miller, Kenneth and Joseph Levine. *Prentice Hall Biology.*

Transpiration
Study Guide

Part 1: Transpiration Through Celery Stalks and Leaves

1. Pay attention as your teacher demonstrates the procedure for this activity.

2. a. **Carefully** cut about 1 cm (1/2 inch) from the bottom of all three celery stalks. Try to end up with stalks that are about the same size.

   b. Remove the leaves from one stalk. (This is stalk #1)

   c. Use your finger to apply petroleum jelly to both sides of all of the leaves of stalk #2.

   d. Place all 3 stalks in a beaker or cup with an inch of water with food coloring.

   e. Place the beaker in a sunny area. Record your observations on the data table at the start of the experiment, at the end of the day or period, and on the next day.

	Height of colored water (indicate units…cm, mm, in. or?)		
	At the start	End of period/day	Next day
Stalk 1 (no leaves, no petroleum jelly)			
Stalk 2 (leaves with petroleum jelly)			
Stalk 3 (leaves, no petroleum jelly)			

Part 2: Transpiration In a Living Plant

1. Pay attention as your teacher demonstrates the procedure for this activity.

2. Write your name or group number on two 1-inch pieces of masking tape. Attach the tape to the two plastic bags.

3. Place one of the plastic bags around a leaf or branchlet of the selected plant, bunching the opening up and wrapping the opening securely with a couple of inches of masking tape.

4. Use your finger to apply petroleum jelly to both sides of the leaf (or leaves) of a second branch of the same plant. Then enclose the leave(s) with the second bag as in step 3. **Try to use branches with the same number and sizes of leaves.**

5. Record your observations on the data table at the start of the experiment, at the end of the day or period, and on the next day.

	Observations…including water in the plastic bag		
	At the start	End of period/day	Next day
On branchlet/leaves **without** petroleum jelly			
On branchlet/leaves **with** petroleum jelly			

Continued next page

Transpiration Questions

Answer the following questions with complete sentences.

In **Part 1**, the colored water moved up through special water-transporting cells called xylem cells. These cells form long tubes to bring water and minerals from the roots to the leaves. Leaves have special openings called stomata or stomates (singular: stomate) through which water vapor is given off to the environment by the plant.

1. In Part 1 (celery stalks), what was the effect of removing all of the leaves on the movement of the colored water? (Compare to stalk #3.)

2. In Part 1, what was the effect of coating the leaves with petroleum jelly? (Compare to stalk #3.)

3. If you were designing a plant to live in the desert, would you make a plant with large leaves with lots of stomata, or a plant with small leaves with few stomata? Explain.

In **Part 2**, you observed water loss through leaves, which is called transpiration. Warm, dry air increases evaporation of water, and, therefore, it also increases transpiration.

4. Redwoods live best in areas where there is lots of fog, especially in the summer. How might fog reduce water loss through transpiration? (Hint: Discuss both temperature and humidity (the amount of water vapor in the air.))

Water Cycle in a Jar (or Two)

ACTIVITY SUMMARY
Students observe evaporation, condensation, runoff, and infiltration as parts of the water cycle.

CONCEPTS TO BE LEARNED
1. Water moves around in the environment in the water cycle.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 5: Earth Sciences S.S. 3: Water moves between oceans and land via evaporation and condensation.
Science Investigation and Experimentation S.S. 6: Students ask meaningful questions and conduct careful investigations.

Grade 6: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Grade 7: Science Investigation and Experimentation S.S. 7: Students ask meaningful questions and conduct careful investigations.

Other Standards:

Grade 4: Life Sciences 2

Grade 5: Earth Sciences 4

Grade 6: Earth Science 2

Environmental Principles and Concepts

Principle I: Humans depend on natural systems.
- Concept a: Humans depend on natural systems for goods and materials.
- Concept b: Humans depend on ecosystems.
- Concept c: The health of ecosystems affects their usefulness for people.

Principle III: Natural systems have cycles on which humans depend and that can be altered by humans.
- Concept a: Natural systems have cycles.
- Concept b: Humans depend on and utilize natural cycles and processes.
- Concept c: Human practices can alter natural cycles and processes.

Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.
- Concept a: Effects of human activities on natural systems depend on quantities of resources used and the quantity and characteristics of the byproducts of use.
- Concept b: Byproducts of human activities affect natural systems.
- Concept c: The ability of natural systems to adjust to human-caused alterations depends on several factors.

ANTICIPATED OUTCOMES
1. Students will increase their understanding of the water cycle.

GROUPING
Either teacher demonstration or
Groups of two to five students

TIME
Begin: 15-30 minutes
Activity: 30-60 minutes or more

MATERIALS
- ❒ Large clear container such as gallon jar, deep glass bowl, or plastic tub
- ❒ Aluminum foil
- ❒ Masking tape
- ❒ Ice cubes
- ❒ Salt water (mix about four teaspoons of salt in two cups of water. The amount varies depending on the size of the jar, bowl, or tub)
- ❒ Cup, glass, jar, or plastic tub such as margarine or cream cheese might come in
- ❒ Lamp with flexible "neck" with 100 watt bulb, preferably clear, or a sunny windowsill
- ❒ About one cup of sand or soil. The amount varies depending on the container size.

TEACHER PREPARATION
1. Obtain the materials above for each group or for the demonstration.

2. To determine the time needed, try out the activity before having students do it.

PROCEDURE
1. Place about two cups of salt water in the bottom of the jar. Explain to students that this represents the ocean. (Or ask the students what it might represent.)

   (As you go through the steps, diagram and label the water cycle on the board or on a piece of chart paper.)

2. Place the sand or soil into the "ocean" in the jar, off center. Add enough so that the sand rises above the ocean. Explain (or elicit) that this represents the land.

3. Place an empty cup, glass, jar, or tub in the jar, off center. Explain (or elicit) that this represents a lake. (If you use a plastic tub, you may need to weigh it down with a rock.)

4. Place a strip of masking tape across the top of the jar so that it bisects the opening.

5. Cover the top opening of the jar with aluminum foil. Extend the foil far enough down the side of the jar so that it is held firmly in place. Press down on the cover on either side of the tape so that some of the condensing water will drip into the cup/lake and some will drip onto the sand/soil.

4. Shine the light directly on the "ocean." Explain that this represents the sun. (Or place the jar on a sunny windowsill.) Ask the students what effect the sun will have on the water in the ocean. Elicit the response of evaporation.

5. Place about six to ten ice cubes on top of the (indented) cover. Explain that this represents the cooling that happens as air rises.

6. After a while, some water should begin to condense on the underside of the foil and run down the indentations so that some drips into the cup (lake) and some drips onto the land. Ask the students what this represents (precipitation). They will probably say rain, but point out that snow, hail, and fog are other forms of precipitation. Add more ice cubes if necessary. Point out that the dripping water is not from the ice cubes, but rather from condensation of water that is evaporating from the ocean.

7. Ask the students what happens to the rain that falls on the land. (It may soak in, collect in ponds or lakes, or run off the land. If it soaks in, it may be used by plants or may flow downhill in the underground water system known as the aquifer. If it collects in a lake or pond, it may be used by plants or animals, it may soak in, or it may run off into a creek or river.)

8. Discuss how plants and animals fit into the water cycle as they use water and give off waste water as urine, perspiration, water vapor in breath, or through transpiration. Add these to the diagram.

9. After some water has collected in the cup, ask the students whether it is salt water or fresh water. After they have guessed, have a volunteer or two taste it. Discuss the idea that the salt is left behind as the water evaporates.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION

1. Rather than bisecting the top with tape, two jars can be set up, one with a cup/lake and one with sand/soil/land.

2. Plastic animals can be placed in the jar. Plastic or real plants can be placed in the jar.

ASSESSMENT

1. Have the students draw and label a water cycle.

REFERENCES AND RESOURCES

Allen, Maureen et al.: *All About Water*

American Forest Foundation: *Project Learning Tree Pre K-8 Activity Guide: "Water Wonder"*

The Watercourse and the Council for Environmental Education: *Project WET* (several activities)

Water Environment Federation: *Water Sourcebook*

Council for Environmental Education: *Project WILD Aquatic Education K-12 Activity Guide: "Where Does Water Run?"*

Contact your local water agency for additional resources. Many have posters and student activity guides.

Who Am I?

ACTIVITY SUMMARY
Students are each given an "identity" by having a picture of something from the redwood forest either pinned to the back of their shirt or by having the picture mounted on a string which is hung around the neck with the picture on the student's back. The student then asks other students yes/no/maybe questions to try to determine their identity.

CONCEPTS TO BE LEARNED
1. Plants, animals, and other things can be described and can be identified by their descriptions.

STANDARDS ADDRESSED

Focus Standards:

Grade 4: Science Investigation and Experimentation 6.a: Students ask meaningful questions.

Grade 5: Life Sciences 2.a: Plants and animals have structures for various life processes.
Science Investigation and Experimentation 6: Students ask meaningful questions.
English Listening and Speaking Standard Set

Grade 6: Science Investigation and Experimentation 7: Students ask meaningful questions.

Grade 7: Science Investigation and Experimentation 7: Students ask meaningful questions.

ANTICIPATED OUTCOMES
1. Students will increase their ability to describe and identify objects, including plants and animals of the redwood forest.

GROUPING
Whole class

TIME
30 minutes

MATERIALS
For each class member, a picture or specimen mounted on a string long enough to go around a student's neck so that the picture hangs on the student's back. (24"-32") The illustrations in Section I of *Redwood Ed* might be used.

TEACHER PREPARATION
1. Obtain pictures or drawings of various plants and animals of the redwood forest.

2. Affix the pictures to cardboard or tag board, or laminate.

3. Leaves or other specimens can be mounted on cardboard and covered with clear plastic or inserted into a re-sealable plastic bag.

4. Punch holes in the two top corners and tie a piece of string (24 to 32 inches long) so that the picture will hang on the student's back when the string is around the student's neck.

PROCEDURE
This activity can be done in two ways.

1. Students can be called to the front of the class and then given their identity while their back is turned to the class. (Be sure that the student doesn't see the picture.) They then ask yes/no/maybe questions and the class responds. (If there is a question that the class can't answer, or answers incorrectly, the teacher can help.) When the student has guessed his/her identity, or has given up, it is another student's turn.

2. All students can be given their identities at once. They then circulate, asking each other the questions. When students have correctly determined their identity, they turn the picture so that it is on their chest.

VARIATIONS, ADAPTATIONS, DIFFERENTIATION
1. This activity can be done with pictures or specimens from any ecosystem.

2. It can be used to teach the names of plants and animals in other languages.

ASSESSMENT
1. Teachers can provide descriptions of plants or animals and students can try to identify the described organism.

2. Students can be shown or given a specimen or illustration and asked to describe it using appropriate vocabulary.

REFERENCES AND RESOURCES
Cornell, Joseph: *Sharing Nature With Children*

Several sources of posters and pictures that can be used are included in Appendix IV.

Pictures of organisms can be found on the Internet.

Illustrations found in Section I of *Redwood Ed* might be colored and laminated.

NOTES