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 <u>amount</u> 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 <u>value</u> 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

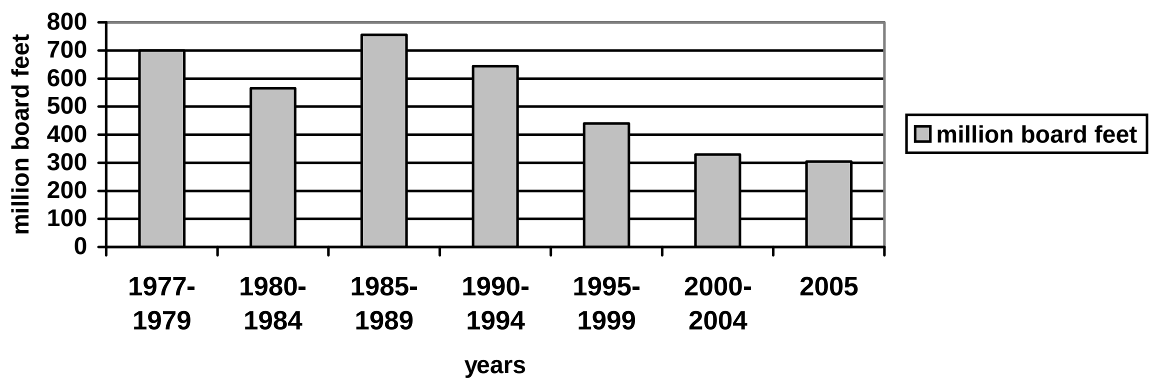
Harvest Statistics: 5-Year Averages
(Based on California Redwood Harvest Statistics provided by the California State Board of Equalization, Timber Tax division)

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:

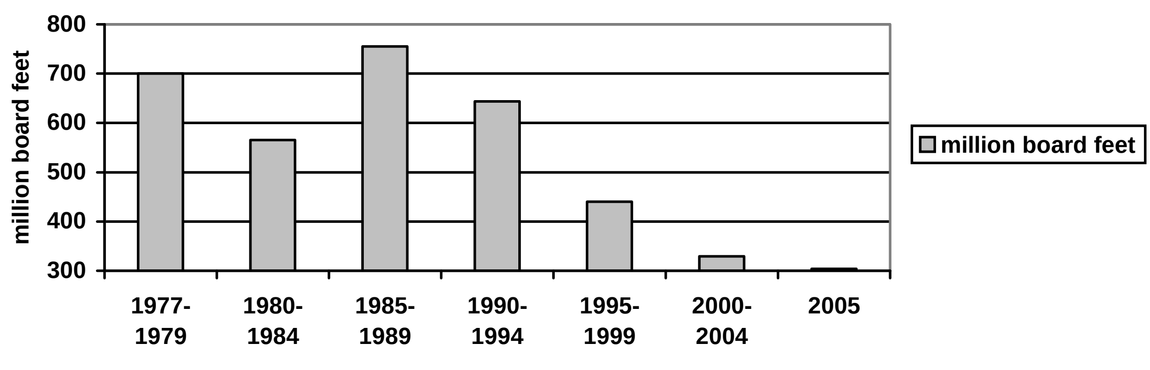
Vertical axis starting at zero board feet:

Million Board Feet of Redwood Harvested Per Year (Average for Time Span)



Vertical axis starting at 300 million board feet:

Million Board Feet of Redwood Harvested Per Year (Average for Time Span)



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:
  - o Cameras
  - o Measuring devices
  - o Magnifiers
  - o Thermometers
  - o Pans
  - o Forceps
  - o Labeling materials such as tags available from garden supply stores
  - o Books including keys and field guides (see Appendix IV and V)
  - o Notebooks
  - o Colored pencils or crayons
  - o 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 **<u>not</u>** 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.

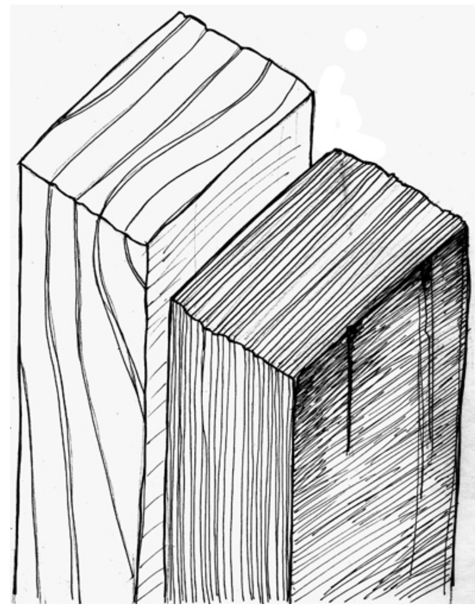


Figure 118

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.

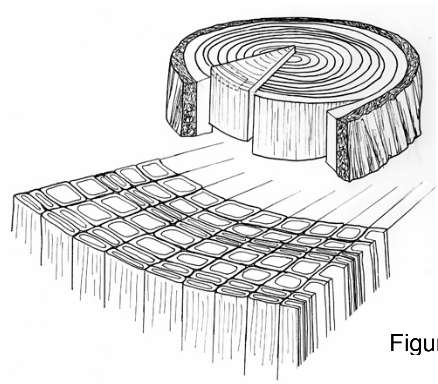


Figure 119

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.

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.

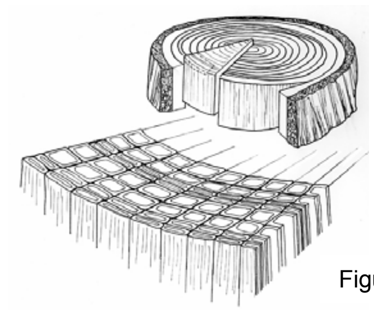


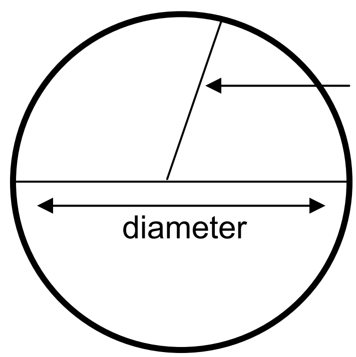
Figure 120

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 all the way across. Your measurement is only from one side of the tree (part of a radius), so to determine a four inch diameter growth, you would count the rings in 2 inches of radius and double that number.



1) How long did the old-growth tree (Sample A) take to grow four inches in diameter?
2) How long did the tree at the left (Sample B) take to grow four inches in diameter?
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 <u>portions</u> 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 <u>Data Table</u>

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 <u>Graph</u>

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?

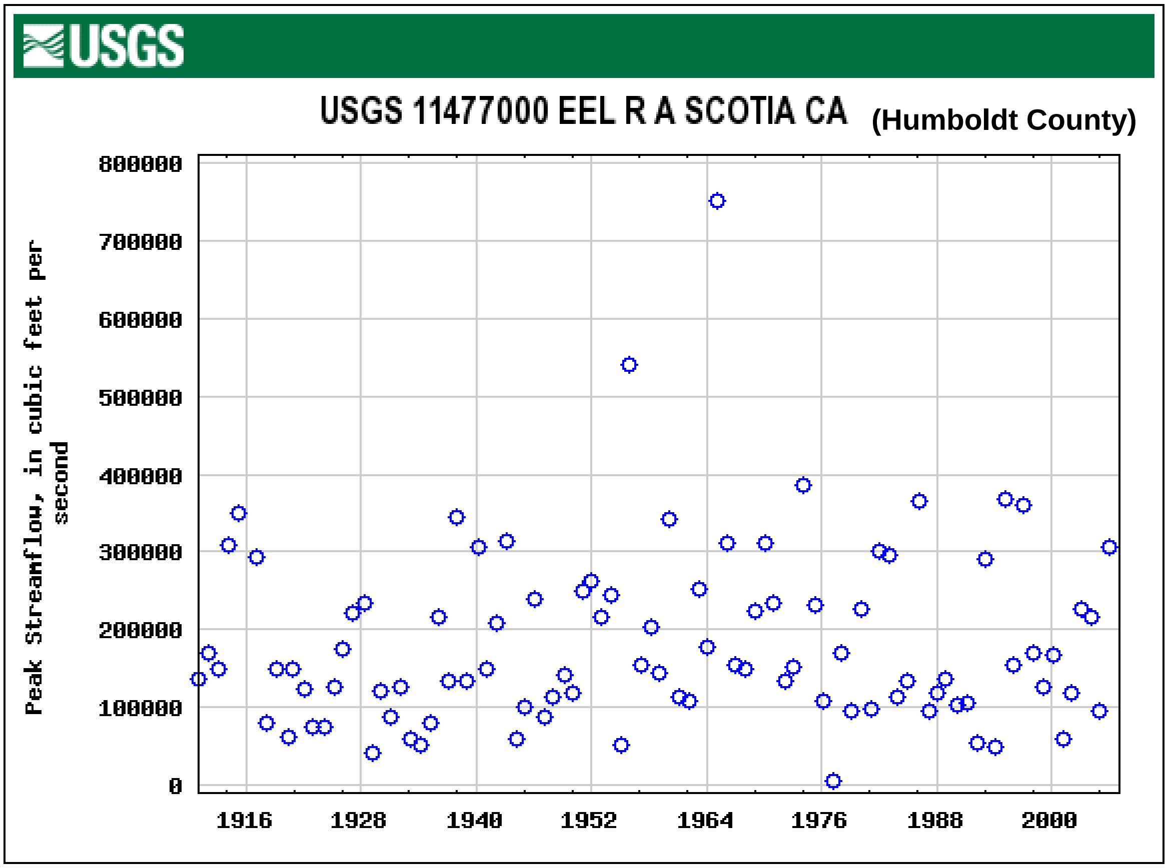
Peak Streamflow for California
USGS 11477000 EEL R A SCOTIA CA

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

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
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 >