



Sixth Grade

How Trees Tell Time



INTRODUCTION

Hello everyone, my name is _____, and I work for the _____ National Forest. I was asked to come here today to talk to you about time, how time can be measured, and how this can help us to better understand the natural world around us.

LESSON

(Note: Parts of this program were adapted from “Activities 5-1. For Elementary: Tree Stories,” and “Activity 5-2. For Middle and High School: Tree Stories,” from “Fireworks Curriculum: Featuring Ponderosa, Lodgepole, and Whitebark Pine Forests,” http://www.fs.fed.us/rm/pubs/rmrs_gtr65.pdf)

How can you tell how old a person is or how much time a person has been alive? (Write their responses on the blackboard. Some ways they might come up with: A birth certificate – this shows exactly how old a person is; or, you can just ask a person how old they are; the way a person looks can tell you about how old they are.) What about a person with wrinkles and white hair – does that sound like a young person or an older person? Right, an older person. So, as you can see, there are several ways to tell if a person is young, middle-aged, or older.

But, how can you tell how old a tree is? (Write the responses on the board.) Does a tree have a birth certificate? No. Can you ask a tree how old it is? You can, but it’s not going to answer you! What about a short, bushy, skinny tree? Probably a young tree. What about a tall, skinny tree? Kind of hard to tell, huh? Maybe it’s a young tree or maybe it’s an older tree that has been

crowded by other trees and hasn’t gotten enough water, minerals and sunlight. So, you can’t really tell how old a tree is, right?

Well, there is a way to tell how old a tree is. Can anyone tell



FOREST SERVICE MESSAGES

- A-1:** Fire has a natural role in the ecosystem.
- C-1:** Prior to European settlement, Southwestern ponderosa pine forests had far fewer trees than today and had frequent, low-intensity surface fires.
- C-2:** Infrequent, high-intensity fires – like those seen in mixed conifer forests of the Pacific Northwest – were not normal in ponderosa and pinyon-juniper forests before 1900.
- C-8:** Doing nothing is not always the right answer. The Forest Service alone cannot know the right answer, but by collaborating with the public, we can come closer to it.
- C-9:** Prescribed fire is one tool the Forest Service uses to meet ecosystem goals.



ACADEMIC STANDARDS



Arizona Standards

MATH

- 2M-E3:** Display and use measures of range and central tendency (i.e., mean, median and mode)
- PO 2:** Find the mean, median, mode and range of a data set
- PO 3:** Choose appropriate measures of central tendencies to describe given or derived data
- 1M-E1:** Read, write and order integers, whole numbers and rational numbers
- PO 1:** Compare and order using concrete or illustrated models
- D. Rational numbers** (e.g., -5, 1.2, 1 3/4, square root of 16)
- PO 2:** Represent place value using concrete or illustrated models
- B. Rational numbers** (millions to millionths)
- PO 3:** Read and write whole numbers, integers, common fractions and decimals using real-world situations
- B. Rational numbers** (millions to millionths)
- 1M-E3:** Demonstrate proficiency with the operations of multiplication and division of whole numbers
- PO 1:** Calculate multiplication/division
- E:** Two-digit divisor, with remainders and rounding in context (e.g., percentages and money)
- PO 2:** Calculate multiplication and division problems using contextual situations

GEOGRAPHY

- GSC-E4:** Provide evidence of how life and environmental conditions have changed

me? We can tell by counting the rings that are inside the tree. We can learn all kinds of things by studying tree rings – how old a tree is, climate changes through the tree’s life, and the history of fires in the area. This science is called **DENDROCHRONOLOGY** – a long word that means the study of tree time. That’s what we are going to do today – study tree time. We will see how natural events such as drought and fire are recorded by the life of a tree.



We can learn all kinds of things by studying tree rings – how old a tree is, climate changes through the tree’s life, and the history of fires in the area. This science is called dendrochronology – a long word that means the study of tree time. Photo courtesy of the Ecological Restoration Institute, Northern Arizona University.

(Display the Ancient Tree Poster on the wall or blackboard. Get the Demonstration Tree Cookie out – this is a cross-section that has no fire scars. You will use this cookie to introduce the kids to tree growth rings. Set out the fire-scarred tree cookies – use 5 ponderosa and 5 lodgepole cookies, the species is written on the bottom of each cookie. Do not use the “challenge” cookie, as this cookie is very difficult to assess.)

- Get with the students and examine the growth rings on the Demonstration Cookie.
- Explain to the kids that a tree ring is formed nearly every year as the tree grows, so you can estimate how old a tree is by counting its rings. Pass the Demonstration Cookie around for the kids to examine.
- Show the kids the Ancient Tree Poster and tell them that this cookie came from a ponderosa pine tree in Montana. Have the kids gather around and examine its growth rings and the scars that form little notches along the left edge. Tell them that this tree was much older than the Demonstration Cookie tree when it died – nearly 600 years old!
- Now examine the scars on the Ancient Tree. Each scar was made by a fire. Ask the students if they have a scar or have seen a scar on someone. People become scarred when

GSC-E8: Describe and model large-scale and local weather systems

SOCIAL STUDIES

1SS-E1: Understand and apply the basic tools of historical research, including chronology and how to collect, interpret, and employ information from historical materials.

PO 1: Place key events on a timeline and apply chronological terms correctly, including B.C.E. (B.C.), C.E. (A.D.), decade, century, and generation

PO 3: Interpret historical data in the form of simple graphs and tables

3SS-E2: Describe the impact of interactions between people and the natural environment on the development of places and regions in Arizona, including how people have adapted to and modified the environment, with emphasis on:

PO 4: How people have depended on the physical environment and its natural resources to satisfy their basic needs, including the consequences of Arizonans’ adaptation to, and modification of, the natural environment

3SS-E7: Explain the effects of interactions between human and natural systems, including the changes in the meaning, use, and distribution of natural resources, with emphasis on:

PO 2: Consequences to humans of earthquakes, hurricanes, tornadoes, flash floods, and other natural hazards

PO 3: How and why humans modify ecosystems, including deforestation and desertification

PO 7: Changing ideas and disagreements on the best use of natural resources

SCIENCE

2SC-E6: Demonstrate how Science is an ongoing process of gathering and evaluating information, assessing evidence for and against theories and hypotheses, looking for patterns, and then devising and testing possible explanations.

PO 1: Compare and contrast the evidence of a hypothesis

PO 2: Compare and contrast the evidence of a theory

PO 3: Analyze a hypothesis

PO 4: Analyze a theory

4SC-E7: Explain and model the interaction and interdependence of living and non-living components within ecosystems, including the adaptation of plants and animals to their environment

PO 1: Explain the role of living/non-living components in an ecosystem

their skin receives a deep injury. Ask the kids how they got some of their scars. Tell them that trees also become scarred for a similar reason – when part of a tree’s outer wood, called the cambium, is killed by heat from a surface fire, it develops a scar.

• Before we go on, let’s take a look at a tree trunk from the inside out. (The presenter can draw a diagram of the following or simply describe them.)

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

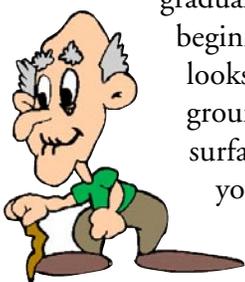
* **Sapwood**, also called xylem (ZYE-luhm), brings water and nutrients up from the roots to the leaves; older xylem cells become part of the heartwood.

* **Cambium** (KAM-bee-uhm), a very thin layer of growing tissue, makes cells that become new xylem, phloem, or cambium.

* **Phloem** (FLOW-uhm), also called the inner bark, carries sap (sugar and nutrients dissolved in water) from the leaves to the rest of the tree; at certain times of the year, phloem may transport stored sugars from the roots up to the rest of the tree (for example, in the springtime, the sap of sugar maples rises from the roots and is tapped by people to make maple syrup.) Ask, “Do any of you like pancakes? Maple syrup is GOOD!”

* **Bark** protects the tree from injury caused by insects and other animals, by other plants, by disease, and by fire. Bark acts like your skin does. It can get scraped or gouged, but it will heal over and will leave a scar on the tree just like a cut will usually leave a scar on your skin. Bark characteristics vary from species to species (for example, it may be thin, thick, rough, smooth, stringy, and so on, depending on the tree). Use the small examples of an aspen, ponderosa, oak, and shaggy bark juniper to show the kids some of these characteristics.

• On a tree, new growth rings form each year and gradually curl over the edges of the damaged area, beginning to cover it. From the outside, the scar looks like a triangular patch arising from the ground (use Class Page 7 to illustrate). On the surface of a tree cookie, a fire scar shows where young wood curls over older wood at one or both edges of a damaged area.



New Mexico Standards

MATH

Strand: Number and Operations

Standard: Students will understand numerical concepts and mathematical operations.

5-8 Benchmark: Understand numbers, ways of representing numbers, relationships among numbers, and number systems.

Grade 6 Performance Standards

1. Compare and order rational numbers.
2. Use equivalent representations for rational numbers (e.g., integers, decimals, fractions, percents, ratios, numbers with whole-number exponents).
3. Use appropriate representations of positive rational numbers in the context of real-life applications.
4. Identify greatest common factor and least common multiples for a set of whole numbers.
5. Identify and represent on a number line decimals, fractions, mixed numbers, and positive and negative integers.

5-8 Benchmark: Understand the meaning of operations and how they relate to one another.

Grade 6 Performance Standards

1. Calculate multiplication and division problems using contextual situations.
5. Explain and perform:
 - whole number division and express remainders as decimals or appropriately in the context of the problem
 - addition, subtraction, multiplication, and division with decimals
 - addition and subtraction with integers
 - addition, subtraction, and multiplication with fractions and mixed numerals

5-8 Benchmark: Compute fluently and make reasonable estimates.

Grade 6 Performance Standards

1. Estimate quantities involving rational numbers using various estimations.

Strand: Data Analysis and Probability

Standard: Students will understand how to formulate questions, analyze data, and determine probabilities.

5-8 Benchmark: Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them

Grade 6 Performance Standards

3. Use mean, median, mode, and range to describe data.

SOCIAL STUDIES

Strand: History

ACTIVITY

Now you are going to get to study some fire scars on your own tree cookies! I am going to break you into teams. I am going to write on the board what each team should report:

Team name

Kind of tree

How old the tree is?

How many scars from surface fires?

Years between any two scars that are next to each other

(Set up a chart on the board that looks like the one below.)

	Team	How old?	How many scars?	Years between 2 scars
Ponderosa Pine				
Lodgepole Pine				

(Explain to the kids that they need to count the number of rings on the cookie to determine how old it was. Then tell them to learn about fire history they have to count the rings between two adjacent fire scars. If a cookie has only two scars, they should count the rings between those two scars. If the cookie has several scars, they should pick one interval between adjacent scars and count the rings in that interval. This will serve as one example from the tree.)

(Next, hand out the fire-scarred cookies, hand lenses and straight pins. Also, hand out the Tree Stories sheet – Class Page 6. The hand lenses are for examining narrow tree rings, and the straight pins are for sticking into the wood at 10-ring intervals to help keep track of their counting. **WATCH OUT:** Be aware that some kids might try to use the hand lenses to light fires. Also, tell them to use caution with the pins. Give the kids

Content Standard I : Students are able to identify important people and events in order to analyze significant patterns, relationships, themes, ideas, beliefs, and turning points in New Mexico, United States, and world history in order to understand the complexity of the human experience.

5-8 Benchmark I-D (Skills): Research historical events and people from a variety of perspectives.

Grade 6 Performance Standards

1. Organize information by sequencing, categorizing, identifying cause-and-effect relationships, comparing and contrasting, finding the main idea, summarizing, making generalizations and predictions, drawing inferences and conclusions.
2. Identify different points of view about an issue or topic.
3. Use a decision-making process to identify a situation that requires a solution; gather information, identify options, predict consequences, and take action to implement that solution.

Strand: Geography

Content Standard II: Students understand how physical, natural, and cultural processes influence where people live, the ways in which people live, and how societies interact with one another and their environments.

5-8 Benchmark II-B: Explain the physical and human characteristics of places and use this knowledge to define regions, their relationships with other regions, and their patterns of change.

Grade 6 Performance Standards

1. Explain how places change due to human activity.
2. Explain how places and regions serve as cultural symbols and explore the influences and effects of regional symbols.
3. Identify a region by its formal, functional, or perceived characteristics.

5-8 Benchmark II-D: Explain how physical processes shape the Earth's surface patterns and biosystems.

Grade 6 Performance Standards

1. Describe how physical processes shape the environmental patterns of air, land, water, plants and animals.

5-8 Benchmark II-F: Understand the effects of interactions between human and natural systems in terms of changes in meaning, use, distribution, and relative importance of resources.

Grade 6 Performance Standards

1. Describe how human modifications to physical environments and use of resources in one place often lead to changes in other places.

about 15 minutes to study their cookies. Tell each team to work together and record their results on the Tree Stories sheet.)

How old was your tree? (Write the answers on the board.) What kind of tree did you have? (Again, write the answers on the board.) (Determine what the oldest tree was and circle it on the board.) How many scars did your tree have? (Write answers on the board.) (Determine the tree with the most number of scars and circle it on the board.) How many years were between your scars? (Write answers on the board. Determine the most and least number of years between scars and circle them on the board.)

What can we learn from what we've just done? (Listen to their responses.) One thing we might learn is whether fire burns more often in a ponderosa pine forest or a lodgepole pine forest. We can also learn if a crown fire burned through the area where your tree lived – if it did, your tree would have likely been killed. We can learn if fires burned more frequently when your tree was younger or older.

Now, let's look at some other things. Wide tree rings show good years for growth, when moisture, sunlight and nutrients were plentiful. (Trees also tend to grow faster when they are younger.) Rings that are very close together show years of drought, disease, injury, shading or crowding by other trees. How do you think the trees in our forest have been doing the last several years? Not very good. We've been in a serious drought. Many parts of the forest have way too many trees, and the bark beetles have killed hundreds of thousands of trees. Do you think the growth rings will be wide or narrow? Right, probably very narrow.



We can learn a lot of things by studying trees. Some things we can learn include the history of fire in an area, the age of a tree, whether or not the tree has lived through droughts or wet periods, and more. Photo courtesy of the Ecological Restoration Institute, Northern Arizona University.

Strand I: Scientific Thinking and Practice

Standard I: Understand the processes of scientific investigations and use inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.

5-8 Benchmark II: Understand the processes of scientific investigation and how scientific inquiry results in scientific knowledge.

Grade 6 Performance Standards

1. Understand that scientific knowledge is continually reviewed, critiqued, and revised as new data become available.
2. Understand that scientific investigations use common processes that include the collection of relevant data and observations, accurate measurements, the identification and control of variables, and logical reasoning to formulate hypotheses and explanations.
3. Understand that not all investigations result in defensible scientific explanations.

Strand I: Scientific Thinking and Practice

Standard I: Understand the processes of scientific investigations and use inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.

5-8 Benchmark III: Use mathematical ideas, tools, and techniques to understand scientific knowledge.

Grade 6 Performance Standards

1. Evaluate the usefulness and relevance of data to an investigation.
2. Use probabilities, patterns, and relationships to explain data and observations.

Strand II: Content of Science

Standard II (Life Science): Understand the properties, structures, and processes of living things and the interdependence of living things and their environments.

5-8 Benchmark I: Explain the diverse structures and functions of living things and the complex relationships between living things and their environments.

Grade 6 Performance Standards

1. Understand how organisms interact with their physical environments to meet their needs (i.e., food, water, air) and how the water cycle is essential to most living systems.
2. Describe how weather and geologic events (e.g., volcanoes, earthquakes) affect the function of living systems.
3. Describe how organisms have adapted to various environmental conditions.

Now, I want you to look at your tree cookies and answer a few questions:

1. What age did your tree grow best?
2. At what age did your tree grow most slowly?
3. Were the years right after fire usually good or poor for growth?
4. How would you explain your tree's response to fire?
5. Do you think your tree could be damaged by lack of fire?

Go over the kids' responses. For questions 1 and 2, the answers might include the age of the tree (remember, young trees tend to grow faster), wet years (wide rings-fast growth), dry years (narrow rings-slow growth).

(For questions 3 and 4, the answers might include the following: If poor growth, it may be that the forest was in a drought, and that's one reason the fire burned in the first place. If good growth occurred, the answers might include decreased competition from other trees for moisture and nutrients or by an increase in nutrients that were released from burned vegetation.)

(For question 5, tell the kids that the answers to this question vary from place to place and from one species to another. For example, when fire is excluded for a long period from ponderosa pine forests, the trees begin to grow too closely together and become very crowded. As mentioned before, when this happens the trees have to fight for moisture, nutrients and sunlight. They are weakened and become much more susceptible to wildfire, insects and disease. So, the answer to question 5 if your tree is a ponderosa pine is yes – your tree

definitely could be damaged by lack of fire. In contrast, if your tree is a lodgepole pine, it is less affected by lack of fire. Lodgepole pine forests have followed the pattern of severe, infrequent burning for thousands of years. However, lack of fire can alter lodgepole pine forests because it causes the mosaic of forest patches across the landscape to become more uniform. Ask the kids if there are any questions.)

I would like to cover one more thing before I go. Who can tell me how you can count the



There is a way to count the rings of a tree without actually cutting the tree down. You can do it using an increment borer. In this photo, a Forest Service employee shows a child how to use the increment borer.

FOREST SERVICE CONSERVATION EDUCATION LEARNER GUIDELINES

Program title: How Trees Tell Time

Target audience: Sixth Grade

Primary topic: Dendrochronology.

Length of program: 1 hour

Setting: indoors

Guidelines addressed are referenced here:

5-8
I. Questioning and Analysis Skills
A2, A3, C1, C3, D3, E1, E3, F1, F3, G2, G3
II. Knowledge of Environmental Processes and Systems
1. A1, A2, A3, B2
2. A3
3.
4. C2, C4
III. Skills for Understanding and Addressing Environmental Issues
1. A3
2. A2
IV. Personal and Civic Responsibility

rings of a tree without actually cutting the tree? The increment borer! (Show them the borer and a core that has already been extracted. If you have time, you might demonstrate how to use the corer and let some of the kids participate.)

CLOSING

I hope that you better understand dendrochronology - the study of tree time. What I really hope you understand is why dendrochronology is important. By studying tree rings we can learn much information about the history of our forest, and thus, know better how to manage our forest for the future. Have a great day!

HANDOUT

“Fire Safety Fun With Smokey Bear” (one per student) (If there is extra time, you can work as a class on this handout. If not, pass out to the class and encourage them to work on it at home.)

SUPPLIES

- “Activity 5-1. For Elementary: Tree Stories” trunk (one)
(From “Fireworks Curriculum: Featuring Ponderosa, Lodgepole, and Whitebark Pine Forests,”
http://www.fs.fed.us/rm/pubs/rmrs_gtr65.pdf)
 - Trunk includes:
 - ⊙ Ancient Tree Poster (one)
 - ⊙ Hand lenses (10)
 - ⊙ Pins in film canister
 - ⊙ Tree cookies, including one labeled “Demonstration cookie”
 - ⊙ Class Page 6, Tree Stories transparency
 - ⊙ Class Page 7, Fire Scars transparency
- Overhead projector (one)
- Increment borer (one)
- Previously-extracted core (one)
- Tree stump to bore into (one)
- “Fire Safety Fun With Smokey Bear” (one per student)
 - Available through Syndistar Publishing, 1-800-841-9532;
http://www.syndistar.com/media/activity_sheets/fire/prevention/pbfp06act.html
 - Just like the “Smokey’s Fire Safety Tips” video, this activity sheet teaches kids to respect the forest and wildlife, and how playing with matches or lighters can destroy their home. Activities include word searches, mazes and secret messages. Kids will have fun learning to prevent forest fires with one of the most enduring and lovable icons of forest fire prevention.

Class Page 6

TREE STORIES

	Team	How old?	How many scars?	Years between 2 scars
Ponderosa Pine				
Lodgepole Pine				

Class Page 7

FIRE SCARS

