

Investigating Fire Ecology

Pre-Field Trip Lessons

1. Fire History of Ponderosa Pine Ecosystems.....	49-71
* Student newspaper	5-62
* Student vocabulary.....	63-71
2. Why Do Forests Burn? Exploring Fire Behavior.....	73-82
3. Wildfire and Native Plants: Using a Key to Identify Trees.....	83-96
4. Measuring the Earth from the Ground Up.....	97-103
5. Preparing for the Field Trip: Field Journals and Photo Collages.....	105-124



FIRE HISTORY OF PONDEROSA PINE ECOSYSTEMS



FOCUS QUESTIONS:

Why do foresters and ecologists think many ponderosa pine forests are unhealthy?
What role does fire play in the ponderosa pine ecosystem?

OVERVIEW OF LESSON: This lesson provides students with the basic knowledge and vocabulary they need to begin their study of fire ecology in ponderosa pine forests. Students can use a variety of source materials to learn about how forests, and the fires that burn through them, have changed over the last century. Students will read background material in a fire ecology newspaper, and can watch a presentation about fire from the internet. An evaluation will allow teachers determine if students have the background knowledge to continue with the lesson sequence.

SUGGESTED TIME ALLOWANCE: Class Time: 2 hours

LOCATION: Classroom

SUBJECT AREAS: Science, Math, Technology

STUDENT OBJECTIVES

Students will:

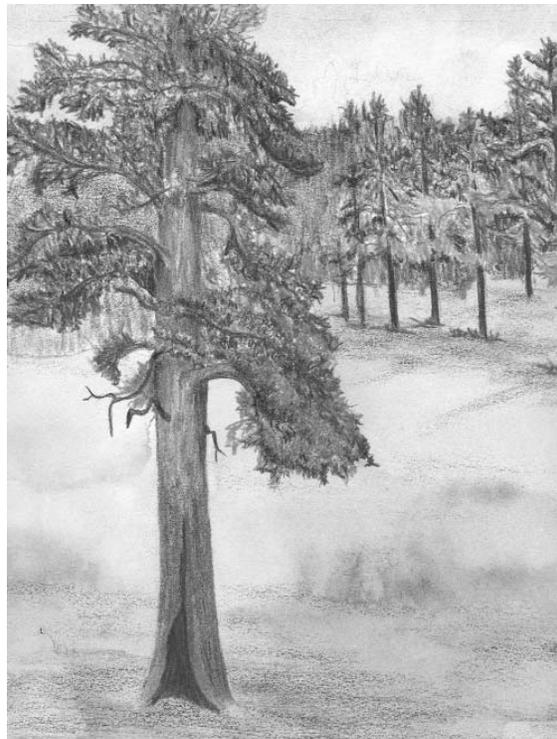
- Identify the basic components of the ponderosa pine ecosystem
- Understand how current forests differ from forests of 100 years ago
- Learn the importance of fire to the balance within the ecosystem

VOCABULARY

- Crown fire
- Cambium
- Fire behavior
- Tree rings
- Surface fire
- Fire suppression

MATERIALS

- Field journals
- Pencils
- Flip chart paper/blackboard
- Pre- and Post evaluation activity sheets
- Investigating Fire Ecology newspaper





PROCEDURES

Pre- Visit LESSON PLAN

Pre- and Post-evaluation

Distribute the pre- and post-evaluation activity sheets. Remind students that this is not a graded test, but rather a measure of success for the lesson. Each student will retake the test at the end of the lesson.

1. As a class, have students brainstorm a list of what makes a healthy forest and what makes an unhealthy forest.
2. Divide students in groups of three or four, assigning each group the following questions:
 - a. When wildfire strikes, why do some trees live and others die?
 - b. What happened in the late 1800 s that contributed to crowded forest conditions?
 - c. How has the local ponderosa pine forest ecosystem changed over the past century?
 - d. What differences do you think you will observe in a thinned plot and an unthinned plot?
3. Hand-out copies of the enclosed newspaper and vocabulary lists to each student. Have each student read the newspaper and answer their question as a group.
4. Resume whole class discussion. Have each group do a presentation on their answers to their question.
5. Invite a local ecologist to the classroom to discuss ponderosa pine fire ecology or view the presentation on fire ecology at: www.volunteertaskforce.org/lessons



Name _____



Fire History of Ponderosa Pine Ecosystems
Assessment Questions

STUDENT SHEET

1. What information can be determined about tree growth from analyzing tree rings?
2. The only part of a tree that is actually alive is a very thin layer directly under the bark called the _____.
3. During good growing conditions, annual growth tree rings will be _____.
4. In years of less favorable growing conditions, annual growth tree rings will be _____.
5. Ponderosa pine forests have evolved over thousands of years. What are some of the adaptations this tree has developed which have helped its survival rate?
6. Before European settlement, widespread fires occurred every 2-15 years. If you were an early explorer how would you describe the condition of the forests in the early 1800 s?
7. What is fire suppression and how has it contributed to the fuel buildup on the forest floor?





8. Today's forests are often characterized by dense "dog-hair" thickets of young pine. Explain what this term means.

9. The three things that affect fire behavior are:

1. _____
2. _____
3. _____

10. Many ponderosa pine forests today have become dense, unhealthy thickets of young trees and needle litter mats. What triggered this change in the forest structure? When did this happen? How has this change contributed to destructive forest fires?

11. New Mexico has the second highest incidence of lightning strikes. What state is the highest?

12. What are some ways we can restore the ponderosa pine forests of the region to a more natural state?

FIRE HISTORY OF PONDEROSA PINE ECOSYSTEMS
ASSESSMENT TEACHER MASTER SHEET



1. What information can be determined about tree growth from analyzing tree rings?

Tree rings can tell how old a tree is and the story of its growth. Widely spaced rings indicate favorable climate conditions when the tree grew much in a year. Closely packed rings indicate drought conditions or increased competition with other vegetation.

2. The only part of a tree that is actually alive is a very thin layer directly under the bark called the cambium.
3. During good growing conditions, annual growth tree rings will be wide apart.
4. In years of less favorable growing conditions, annual growth tree rings will be close together.
5. Ponderosa pine forests have evolved over thousands of years. What are some of the adaptations this tree has developed which have helped its survival rate?

Thick bark protects the cambium from low intensity fires. Lower branches of ponderosa pine are shed to prevent small fires from reaching the needles. This is called self-pruning.

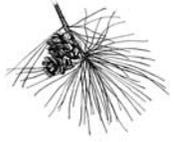
6. Before European settlement, widespread fires occurred every 2-15 years in this area. If you were an early explorer how would you describe the condition of the forests in the early 1800 s?

Forests were open and park-like. Ponderosa pines were widely spaced at a density of between 50 and 150 trees per acre. The ground was covered with tall grasses and many species of wildflowers.

7. What is fire suppression and how has it contributed to the fuel buildup on the forest floor?

Fire suppression is the attempt to extinguish all fires as quickly as possible before they have a chance to spread. Because downed and dead trees, needles and leaves, and other forest litter was not periodically burned, the elimination of fire from ecosystems has resulted in a huge increase in the fuel available to fires on the forest floor.





8. Today's forests are often characterized by dense dog-hair thickets of young pine. Explain what this term means.

Dog hair thickets are stands of small-diameter pines with densities of hundreds or even thousands of trees per acre.

9. The three things that affect fire behavior are:

1. fuel
2. weather
3. topography

10. Many ponderosa pine forests today have become dense, unhealthy thickets of young trees and needle litter mats. What triggered this change in the forest structure? When did this happen? How has this change contributed to destructive forest fires?

Fire suppression played a role in the fuel buildup. Also, grazing patterns in the late 19th and early 20th centuries contributed through large numbers of grazing livestock eating the grassy fuels that once carried low-intensity wildfires through the forest. Livestock grazing patterns changed around 1880 and fire suppression became a factor in about 1910.

11. New Mexico has the second highest incidence of lightning strikes. What state is the highest?

Florida

12. What are some ways we can restore the ponderosa pine forests of the region to a more natural state?

Forests can be mechanically thinned. Once the forest is in a condition that reduces the threat of crown fire, prescribed fires can be introduced.



Fire Ecology

In Ponderosa Pine Forests of the Jemez Mountains

Fire's Place in Ponderosa Pine Forests

Hills covered with ponderosa pine forest are the reason many of us choose to live in the mountains of the Southwest. For millennia, these forests have been maintained by frequent, low-intensity surface fires. But many of the forests that we love are unhealthy, overgrown, and ripe for a devastating crown fire. Between 1996 and 2003, 40,704 wildfires burned 3,152,770 acres of forest in New Mexico and Arizona, enough burned forest to cover the entire state of Connecticut.

By living through the Cerro Grande fire, its aftermath, and the long process of recovery of the forest ecosystem, those of us who live in Los Alamos have a vast pool of knowledge that should be shared with other fire-affected communities around the West. Hundreds of towns and cities within ponderosa pine forests experience the same pre-fire conditions that existed here and, unfortunately, some of these communities will experience wildfire.

Everyone who lives in or near ponderosa pine forests needs to know the role that fire plays in the ecosystem. Studying fire ecology will help you understand how ponderosa pine forests are managed and why it is important to maintain healthy forests. It will give you the knowledge that when used properly, prescribed fire is an essential management tool to keep forests in good condition.

Understanding fire ecology can help you make your home so that it can be defended against a wildfire. To live in ponderosa pine forests, we must accept fire as part of our environment and manage our lands and build our homes accordingly.
Written by the Volunteer Task Force

What's Inside

- Ponderosa Pine Basics 2
- Factors of Fire Behavior 3
- Is This Forest Healthy? 4
- Why are the Trees Dead? 4
- Plant Identification & Succession 5
- Using GPS 5
- Crown Fires Strike the Nation 6
- Forest Recovery after a Crown Fire 7
- Creating Defensible Space 8



Craig Neelin

Fire in the Pines

Cerro Grande. Rodeo-Chediski. Missionary Ridge. Aspen. Since May 2000 raging wildfires have burned through immense expanses of forests in New Mexico, Arizona, and Colorado. Along with dozens of smaller fires, these well-known examples burned mostly through ponderosa pine forest. Each burned as a crown fire, which is a devastating wave of flame that can reach 200-feet or more in height.

The ponderosa pine ecosystem—a unique collection of plants and animals centered on this stately pine species—is widespread throughout western North America, and particularly in the Southwest. Fire has always been a part of the ponderosa pine ecosystem, but the fires of the first years of the 21st century were radically different than fires of the past. Small, low-intensity fires that stayed low to the ground have been replaced by huge crown fires.

The forest itself is very much changed. Historic photographs from the late 1800s show

Fire climbs from the forest floor into the tree canopy creating a raging crown fire.



Forests of the late 1800s (left) were much more open and grassy than the densely crowded forests found in many places today (right).

very different ponderosa pine forests than that found in the Southwest today. Photos show these forests as extensive grasslands dotted with small clusters of ponderosa pines. In some scenes the grasses are two or even three-feet high; the orange-barked trees reach 200 feet into the sky. These forests had an open forest structure with individual trees or small clumps of trees spaced widely apart. The forest held between 50 and 150 trees per acre. Today the forests have far many more trees.

We came to a glorious forest of lofty pines, through which we have traveled ten miles. The country was beautifully undulating; and although we usually associate the idea of barrenness with pine regions that was not so in this sense: every foot being covered with finest grass and beautifully grassy glades extending in every direction. The forest was perfectly open and unencumbered with brush wood so that traveling was excellent.

Edward Beale, Railroad surveyor
Describing the forest when he passed through Arizona in 1858

Ponderosa Pine Basics

Ponderosa pine (*Pinus ponderosa*) is the most common and widespread pine in North America. It grows from the dry mountains of central Mexico north to the Rocky Mountains of Canada, and from Nebraska to the Pacific Ocean. The largest ponderosa forests are found in northern New Mexico and along the Mogollon Rim in central Arizona. In the Southwest, ponderosa pines grow from



Distribution of ponderosa pines in the West

and is found in locations that receive as little as 7 inches of rain per year.

The variety of ponderosa pine in the Southwest usually has needles in bundles of 3. The needles are 4-8 inches long, the longest of any conifer (cone-bearing tree) in the region. On young trees, the bark is grey or black. Once a ponderosa pine reaches about 75 years old, the bark turns orange and cracks into ovals that look like giant lizard scales. When warmed in the sunlight, the orange bark smells like vanilla! The cones are round and heavy, with all the scales tipped with a sharp point. The seeds in the cones are an important food source for all seed-eating animals in the forest, particularly squirrels. Depending on local conditions, a ponderosa pine can grow to be 150 feet tall and up to 4 feet in diameter. The tree can live 400 to 500 years.



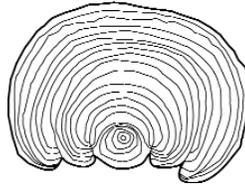
Ponderosa pine is a fire-adapted species. These trees have bark up to 4 inches thick to protect the tender growing tissue beneath. Ponderosas have long needles that help protect the growing branch tips against heat from a fire. As they grow tall, these trees lose their lower branches in a process called self-pruning. This increases the chance of a tree to survive a surface fire by taking away the fuel a fire could burn so that the flames can't reach into the crown of the tree. The root system is deep under the ground, offering the roots protection from fire.

Ponderosa Pine Fire Ecology

Fire is a keystone ecological process in ponderosa pine forests of the Southwest. Fire was a major factor in shaping the appearance and characteristics of these forests. Fire also serves to maintain the forests and keep them functioning as a healthy ecosystem.

Ecologists can learn much about the history of an individual tree or an entire forest by studying tree rings.

As a tree grows, it adds rings of cells to the outside of the trunk. Each year, a light ring of spring cells is added before a darker ring of fall cells. By counting either the light or dark rings, anyone can estimate the age of a tree.



A low intensity surface fire that burns mostly grasses can damage a ponderosa pine without killing the tree. During a small fire, flames can wrap around the base of a tree trunk, eat away the bark, and damage the cambium, the growing layer of cells of the tree. Just like with an injury to human skin, scar tissue forms over the wound. That section of the tree trunk may never grow again. The shape of the tree at the base changes from a circle to a C. The result is called a cat-face scar. In the tree rings, the scar tissue remains as a dark line that interrupts the normal pattern.

By studying tree rings and fire scars, ecologists have found that prior to 1890, ponderosa pine forests had the highest fire frequency of all forest types found in the Jemez Mountains. Frequent, low-intensity surface fires burned through the grassy understory of these forests about every 7-10 years. These fires, mostly caused by lightning, kept the forest open by thinning out some of the seedlings. These fires also recycled important nutrients. Tree rings tell a similar story in other parts of the Southwest such as along the Mogollon Rim in Arizona, near Flagstaff, and in the pine forests of southern Colorado.

Then around 1890, throughout the Southwest the fires just stopped. This was due to the combined effects of overgrazing by livestock, fire suppression, logging, and the highly variable southwestern climate. Grazing animals, especially sheep, ate the grass that once carried small fires through the forest.

Starting around 1910, an effort was made to put out all fires that started in the forest. Lumber companies took many of the old ponderosa pines from the forests, allowing more seedlings to sprout in the sunlight. Also, periods with large amounts of rain and snow allowed more trees to grow. Without the low-intensity surface fires, forests became much denser. Some of our ponderosa pine forests now have several thousand trees per acre! These stands are called dog-hair thickets.

Dense stands of ponderosa pines are very different places than the wide open forests of one hundred years ago. Because the tree canopy - the upper layers of branches on the trees - is so dense, little sunlight reaches the forest floor. Few grasses or wildflowers can grow in deep shade. Also, many pine needles fall from the trees each year. In the past, fire periodically cleaned up the layer of needles and released nutrients into the soil. Without fire, needles can accumulate to depths over one foot. This makes it difficult for seeds to germinate and disrupts some nutrient cycles in the forest. The result is a forest with very few types of plants growing there. Species diversity is low in a dog-hair thicket.

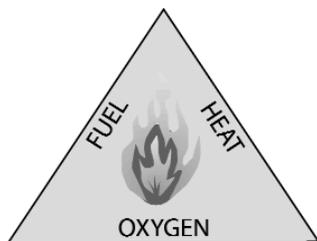
Trees such as Douglas fir grow well in the shade. Inside some dense stands of pines, Douglas firs grow as small and mid-sized trees. During a small fire, young Douglas firs can provide a path for fire to carry from surface fuels into the crowns of ponderosa pines. Plants that allow fire to move into the crowns of the tallest trees are called ladder fuels.

Dense stands of trees, a thick pile of needles on the forest floor, an accumulation of logs and branches from dead trees, and ladder fuels are the recipe for destructive crown fires. When a hot fire reaches toward the needles of ponderosa pines, the heat releases flammable chemicals from the needles. Trees can literally explode, and the sudden increase in heat and flame pushes the wildfire into nearby trees. Crown fires are carried rapidly through ponderosa pine forests.

The important role that fire plays in the ponderosa pine ecosystem is not unique, but ecosystems dominated by other species of conifer respond to fire in different ways. In some ecosystems, such as high elevation forests in the Southwest, crown fires are the natural way they burn. Small, patchy crown fires may burn sections of this forest every 150 to 200 years. Each forest type should be managed according to the specific role fire plays there.

Factors of Fire Behavior

The Fire Triangle and Forests
Fire is a simple chemical reaction that requires three components: heat, oxygen, and fuel. Remove any of the components and you no longer have fire. Each component supports the others in the fire triangle. This is true for something as small as a burning candle or as large as a raging wildfire.



Heat in a Wildfire: Why Fires Start
When enough heat is applied to fuel with oxygen present, fire can start. Before people came to ponderosa pine forests the heat that started wildfires came mainly from lightning. The number of lightning strikes in the Southwest, particularly in the Jemez Mountains, is higher than in any other part of the United States except southern Florida.

When people arrived in the ponderosa pine forest, they used fire on the landscapes. As a result, even more fires occurred in the forest. Campfires sometimes burned into the forest, and sometimes people lit fires to chase game animals out of the forest so that it was easier to hunt. Later, fires were lit to improve grass conditions for grazing cattle or sheep. Today, unintentional sources of wildfire include sparks from vehicles and trash burning.

The temperature of the air and the ground can affect how easy it is to start a fire. High summer temperatures increase the chance of a wildfire start.

Fuel for Thought: What in the Forest Can Burn?
Many parts of the forest can serve as fuel for a fire. Forest fuels include logs, dried grasses, pine needles, and if the fire has enough heat, the crowns of living trees. Fuels are divided into two groups that are based on the way they burn during a fire.

Light fuels ignite fast because they are surrounded by oxygen in the air. They have a small diameter, so it takes less heat to start them burning. Examples of

light fuels are dried grasses, dead leaves, dead pine needles, brush, and small trees. Fires in light fuels spread faster and burn cooler than fires in heavy fuels. Heavy fuels require more heat to ignite. However, after they start burning, heavy fuels give off much heat and burn longer than light fuels. This is due to the fact that heavy fuels burn more slowly than light fuels. The outside layers take longer to burn off before oxygen can reach the inner material. Examples of heavy fuels are logs, stumps, tree branches, deep duff or decayed leaves, and other organic materials.

Oxygen on the Wind
Oxygen is always present in the forest, but certain conditions can add more oxygen to a fire. The harder the wind blows, the faster a fire spreads. Wind not only provides oxygen for the fire, but it also blows the heat and flames toward unburned fuel. As the unburned fuel becomes preheated, it ignites quickly and helps to spread the fire farther. Wind extends fire rapidly into unburned areas. As the wind carries embers over long distances, new fires may ignite.

Other Considerations
In the forest, the supply of the three components can determine the severity of a wildfire. A dense forest offers more fuel; a windy day provides a constant supply of oxygen. How fuels ignite, flames develop, and fire spreads is called fire behavior. Fire behavior is determined by three major factors:

- n The amount and type of fuels present
- n The existing weather conditions
- n The elevation and slope of the area (topography)

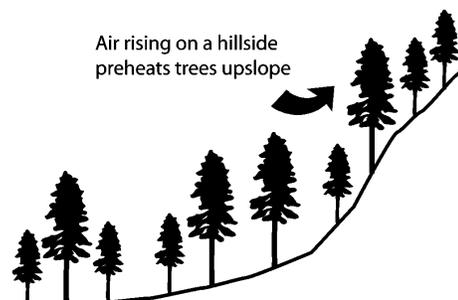
Fuel composition, including moisture level, chemical makeup, and density, determines its degree of flammability. Moisture level is most important. Live trees usually contain a great deal of moisture while dead logs contain very little. The moisture content and distribution of these fuels define how quickly a fire can spread and how intense or hot a fire may become. High moisture content will slow the burning process since heat from the fire must first eliminate moisture. In addition to moisture, a fuel's chemical makeup determines how readily it will burn. Some plants, such as ponderosa pines, have high concentrations of volatile compounds in their needles. Once exposed to flame,

these compounds, called terpenes, can burst into flame with explosive force. Finally, density of fuel beds influence its flammability. If fuel particles are close together, they will burn readily. But, if fuel particles are so close that air cannot circulate easily, the fuel will not burn freely. Weather conditions such as wind, temperature, and humidity contribute to fire behavior. Wind, a most important factor, brings a fresh supply of oxygen to the fire as well as pushes the fire toward new fuel sources.

Temperature of fuels is determined by the surrounding air temperature since fuels initially attain their heat from the sun. As fire burns, high heat from nearby fires preheats fuels around the perimeter of the fire, sometimes to the point that they burst into flames without being touched by advancing flames.

Humidity, the amount of water vapor in the air, affects the moisture level of a fuel. At low humidity levels, fuels become dry, catch fire more easily, and burn more quickly than when humidity levels are high.

The shape of the land, which is called its topography, plays a critical role in how a wildfire burns. On flat land, fires usually burn more slowly than on slopes. This is because on slopes, heat rises from trees burning at the base of the mountain and preheats the trees that grow above. This transmits heat quickly to overhanging branches and other elevated fuels. At the same time, radiant heat is transferred from the fire to other objects on the ground. Convection plays a critical role in spreading fires rapidly upslope. A steep slope draws fire upward by convection, and fire spreads rapidly as convective heat preheats fuels upslope. In contrast, fire travels slowly on flat terrain because ground-level fuels are only preheated by radiant heat.



Newspaper written by: Craig Martin
Designed by: Lynne Dominy

Is This Forest Healthy?

Sampling the Forest

A trained forester can make observations about a forest and determine if it is healthy or fire prone. However, even professionals can make better decisions when they make quantitative rather than qualitative observations. But how do we measure the forest?

One measure of forest health is the density of trees within an area. Before 1880, a typical acre of ponderosa pine forest held 50 to 100 trees. Using that number as a guide, researchers today can use the number of trees per acre as an important indicator of forest conditions.

We can't travel into the past to study forest conditions in the 1800s. But throughout the Southwest, forest managers have used modern techniques to backtrack through time and change forest conditions to something more like those in the past.

We can use thinned and unthinned stands of ponderosa pine to make a comparison between pre-settlement and modern forests and to evaluate the health of the present forest. One such stand is located just outside of Los Alamos in Rendija Canyon. The stand was thinned in 1996 and presents a picture of an open forest much like those of the last centuries.

Ecologists can't count the number of trees in an entire forest, and even an acre of forest can be too large to study. To make measurements easier while keeping them accurate, ecologists use a study plot to sample the forest. A plot is a small area you measure to estimate conditions in a large area that is too big to study. For example, to find the percent of surviving

pine seedlings planted after a fire, you couldn't count all the dead and surviving seedlings on 600 acres. But it would be possible to set up several one-tenth-acre plots and from what you learn to estimate the survival rate of the whole planted area.

Researchers can use a plot sample to calculate tree density. They simply count all the trees in the plot and multiply the count by the size of the plot. For example, in a quarter-acre plot, multiply the number of trees by four. If the plot is one-quarter of one-quarter acre, then multiply the count by 16.

The size and age of the trees in forests can also indicate something about forest health. (To standardize the diameter measurements in the field, foresters measure trees about four feet above the ground or at chest height. The number is called the DBH.) In a dog hair thicket, trees grow close together. Closely spaced trees must compete with each other for water, nutrients in the soil, and for sunlight. Not many trees get all they need to grow. The result is slow growth. This can create a forest of old trees that have small diameters. By drastically reducing competition among the crowded trees, a thinning project releases a burst of growth in the remaining trees. The result is a rapid increase in the size of the trees.

When ecologists measure tree diameters, they can calculate the tree basal area of a stand. Tree basal area is the area of the plot covered by tree trunks. In unthinned plots, there are lots of small diameter trees; in a thinned plot, there are fewer but bigger trees. The total basal area of

two plots such plots can be surprisingly similar.

The two pieces of information about the understory show the effects of the thick accumulation of pine needles when fire is removed from the system, and the effects of a closed canopy that reduces the amount of sunlight on the forest floor. Both the percent cover and the biodiversity are increased when a forest is thinned and the canopy opened up. Biodiversity is a strong indicator of forest health.

WHY ARE SO MANY TREES DEAD?

Drought hit the Bandelier area with a vengeance in 2002.

Ponderosa and piñon pines are showing signs of significant mortality brought on by the lack of rain and the corresponding invasion of pine beetles that attacked the weakened trees. 95% of the trees across some parts of the Pajarito Plateau died by the summer of 2003. Because of the increased fire danger posed specifically by the ponderosas, Bandelier Fire Crews have been working to build fire breaks and to remove bug-killed trees in critical areas. Many of the trees were piled and burned to destroy the beetle larvae and diminish the number that will become adults



Safety in a Burned Area



Many dangers are found in a burned area for years after a wildfire passes through. Visitors to burned areas should always remember to be watchful for hazards: Always look up, look down, look all around.

Hazard Trees: Hazard trees are trees that could fall over and injure someone in the area. Hazard trees can be ones that are leaning, have fallen part way down and are resting on another tree. They can be trees obviously weakened by the fire at the base of the trunk, have vertical splits or cracks, broken or loose limbs, or a loosened and damaged root system. As you walk through a burned area, always try to identify hazard trees and to avoid walking near them. Stay out of burned areas on windy days.

Root Holes: A wildfire can burn the roots of trees and stumps—even though they are underground. When the wood is burned, it leaves a hole in the ground. These holes are often covered with soil and not visible on the surface. If you step on a root hole, the ground above can collapse. Always watch for root holes when traveling in a burned area.

Rolling Objects: After a wildfire there is little vegetation to protect soil from erosion. As soil is washed from around the base of objects on steep slopes, rocks and logs can roll downhill. When walking on slopes,

always watch above for rolling objects

Flash Floods: Because there is no vegetation left to absorb or slow it down, water flowing down hillsides increases after wildfire. When a storm threatens, stay out of canyon bottoms. Remember that a storm that is miles away can send a wall of water downstream where it is not raining.

Plant Identification & Succession

To survive a wildland fire, most plants have adaptive traits or abilities that allow them to reproduce or regenerate after the fire. Such plants are called *pyrophytes*, literally meaning fire-treated plants

To survive a fire, a plant must be able to insulate itself from the heat of the flames. Bark thickness is one of the most important factors determining fire resistance of trees. Ponderosa pine, long leaf pine, slash pine, burr oak and giant sequoia are examples of trees with thick bark that act as insulation. Small woody plants and shrubs, which normally have thin bark, tend to use the soil as an insulating layer to protect their roots. Individual plants resist being killed in fires by producing new growth (shoots) from underground organs or roots. Some plants protect their buds as an adaptive strategy to survive a fire. Buds can be protected by layers of succulent foliage. The buds of the longleaf pine are protected by a thick cluster of needles. Some plants even protect their buds by locating them within the main stem and roots

Retention of seeds by plants until a fire does occur and stimulation of seed dispersal by fire are other examples of fire adaptation. A number of pine species around the world, said to be serotinous, have cones that open only as the result of heat from a fire. Their cones are held closed by a resin that is sensitive to and opens in high temperatures generated by wildland fires. Serotinous cones will not open to release the seeds until the critical temperature is reached. Some cones, such as those on giant sequoia trees, will

not open unless burned by fire. Today, people are beginning to recognize that fire is not always destructive. Fire is merely a means of change in ecosystems.

A hot wildfire burns all the seeds available on the ground and kills most or all the seeds that lie buried in the forest soil. Wildfire also takes away the sources of new seeds that could regrow both the canopy and understory vegetation.

Yet, a burned forest doesn't stay totally barren for very long. The first plants to appear in a burned area are the plants that easily sprout from roots. The roots of some plants that grow beneath four to eight inches of soil are insulated from the heat of a wildfire. When a fire removes the leaves of these plants, a chemical signal stimulates the growth of shoots from the roots. These shoots can reach the surface only a few weeks after a fire. In ponderosa pine forests, Gambel and



other oaks sprout in this way. Aspens, too, grow from the roots of fire-killed trees.

Within a few weeks of a fire, seeds from nearby, unburned stands of forest can blow into the burned area on the wind, or can hitchhike in the fur of mammals. Grasses and some kinds of wildflowers that were found in the forest before the fire start to grow. Other species that thrive on bare soil can go wild.

A year after a fire in ponderosa pine forests, red-stemmed goosefoot plants can grow by the millions.



Aspen shoots grow in the Cerro Grande burn area the year after the fire. These fast growing trees need fires to open the canopy so that their seeds receive enough light to grow.

Global Positioning System

Locating a sampling plot on a map was once a difficult process. Since the invention of the Global Positioning System (GPS), finding exact locations is no more difficult than using the remote control for a television. The system consists of the satellite component and the receiver component. Under the right conditions, handheld GPS receivers are accurate within 10 feet.

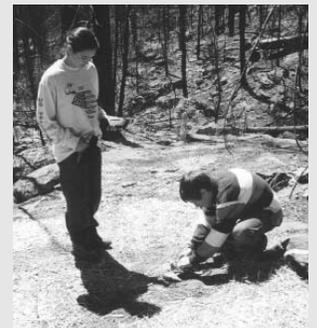
The GPS is a system of 24 satellites. The satellites:

- orbit at 11,000 miles above the earth's surface
- take about 12 hours to complete one orbit
- are spaced so that at least 4 are always in view of an observer at any point on Earth
- contain a controlling computer and communicate with the Earth via radio
- are powered by solar cells
- use atomic clocks to generate and transmit time signals

A GPS receiver locks onto the timing signals to determine the receiver's latitude, longitude, and elevation. Scientists use the GPS in a wide variety of studies. The data can be used to mark the location of a study area on a map, or to re-locate a plot on the ground.

GPS readings need to be precise. This requires recording latitude and longitude in degrees, minutes, seconds, and tenths of seconds.

- Each degree of latitude is about 70 miles.
- Dividing a degree into 60 minutes makes each minute about 1.1 miles.
- Dividing a minute into 60 seconds makes each second about 90 feet.
- Dividing a second into tenths permits the user to be accurate within 9 feet.



Crown Fires Strike the Nation



On May 10, 2000, the Cerro Grande Fire, pushed by high winds up to 54 mph, swept through Los Alamos, New Mexico. In its path, the wildfire burned 235 structures and left 400 families homeless. Before the fire was out more than two months later, it had charred more than 42,000 acres of forest in the Jemez Mountains.

The Cerro Grande Fire
May-July 2000
Location: Bandelier National Monument
& Santa Fe National Forest

On May 7, 2000, what had started as a prescribed fire jumped the fire lines near the summit of Cerro Grande peak and roared into the ponderosa pine forest below. Winds up to 40 miles per hour pushed the fire toward the city of Los Alamos. When the fire front moved one mile in a matter of minutes, the part of Los Alamos closest to the flames was evacuated.



Before the fire, scientists studied tree rings and fire scars from trees in the ponderosa pine forests near Los Alamos. They discovered that before 1880 fires in the forest had burned through the area every five to ten years. By 1910 the fires stopped. Looking for a cause of this sudden end to fires, researchers found that between 1880 and 1910 huge flocks of sheep came to graze in the forests. Starting around 1910 all fires in the area were put out as quickly as possible. Sheep removed the grassy fuels that spread small fires through the ponderosa pine forest and any fire that did start was put out. With no fire to keep the forest fuels - pine needles, dead trees, and crowds of small live trees - in check, fuels in the forest built up to dangerous levels.

After its initial run, the fire grew slowly through ponderosa pine woods choked with small trees over the next two days.

Just after noon on May 10, wind gusts up to 60 miles per hour pushed the fire into the crowns of the trees on the edge of Los Alamos Canyon. As the flames raced from tree to tree, the wind carried burning fire brands across the canyon and into the city. Within minutes, an evacuation order was given to the 12,000 people living in Los Alamos. The residents hurriedly packed a few belongings and drove slowly out of town. By 4 PM, the streets of Los Alamos were empty.

In the forest, wind gusts fed oxygen to the fire and the crown fire raced two miles in one hour. In the town, some of the homes nearest the forest caught fire. Firemen from all over New Mexico fought the flames in the city. The high winds continued into the night, helping spread the flames from house to house.

In the forest, the fire spread to two directions. One branch of the fire reached toward White Rock, a nearby town where many Los Alamos residents had found shelter. At 1 AM on May 11, the order was given to evacuate White Rock. Many Los Alamos residents were evacuated a second time.

The next morning, parts of Los Alamos still burned. The homes of 400 families were lost. The fire in the forest had moved four miles during the night. Another day of strong winds moved the fire through the Santa Fe National Forest to Santa Clara Pueblo lands.

Dry conditions and plenty of fuel kept the fire burning on a smaller scale until July. By then the fire had burned 42,000 acres.

An Early Crown Fire
in the Jemez Mountains
La Mesa Fire June 1977
Location: Santa Fe National Forest
and Bandelier National Monument

A few minutes before 4 PM on June 17, 1977 the St. Peters Dome lookout ranger reported a thin column of smoke on Mesa del Rito. By 4:30 PM, flames and heavy smoke covered the countryside. The human-caused fire started in a slash pile near a dirt road.

In less than two hours, the fire grew to 50 acres. Hot, dry, and windy conditions led to a rapid spread. The fire burned in heavy ponderosa pine forest on the mesas, and cinders fell on the town of White Rock eight miles downwind. For seven days, the fire burned through pine forest. On the night of June 23, a heavy thunderstorm doused most of the fire and it was declared controlled. The fire burned about 15,300 acres.

An Arizona Example

Rodeo-Chediski Fire
Location: Fort Apache Indian
Reservation and Apache-Sitgreaves
National Forest,
June-July 2002

On June 18, 2002 a human-caused fire spread north from near the rodeo grounds on the White Mountain Apache Reservation. Wind pushed the fire north into the world's largest stand of ponderosa pine along the 50-mile Mogollon Rim in central Arizona. Two days later, a lost hiker tried to signal a helicopter by lighting a fire. Winds quickly pushed the fire up Chediski Peak, which was 15 miles from the growing Rodeo Fire.

Both fires found abundant fuel in the overgrown stands of ponderosa pine, and plenty of oxygen in the strong, dry summer winds. Towns to the north were evacuated. By June 22, the fire reached the top of the rim and raced into the towns of Heber and Overgaard, destroying more than 400 homes.

On June 23, the two fires combined into one huge fire called by many The Monster, the largest recorded fire in the history of the Southwest. About 30,000 people were evacuated from nearby towns. By the time the fire was contained in July, it had burned almost 500,000 acres.

The mark of a true community is when disaster strikes and everyone from school students to senior citizens pull together to make recovery happen. From tree planting to seeding & mulching, rebuilding trails to learning in classrooms about fire effects, the citizens of Los Alamos worked together to begin the restoration of their mountain.
Craig Martin, Los Alamos County Open Space Specialist



Forest Recovery After a Crown Fire



(left to right) A burned section of Rendija Canyon shows that few trees survived the heat of the Cerro Grande fire in this part of the canyon; Following reseeding efforts by volunteers, the same section in the canyon has many grasses growing the following year; Heavy flooding affected a burned area in Valle Canyon during the summer rains following the Cerro Grande fire; Volunteers reconstruct a trail damaged by the Cerro Grande fire.

THE FLAMES AND HEAT ARE JUST THE BEGINNING OF THE DAMAGE TO AN ECOSYSTEM CAUSED BY A CROWN FIRE.

Often all vegetation is killed and no tree leaves, conifer needles, or ground cover remain to absorb the impact of falling raindrops or to slow the flow of water across the hillsides. Beginning with the first rainstorm, forest soil begins to erode and is often washed away. In mountain ranges in the Southwest, soil can take 10,000 years to develop. Rainstorms can dump millions of gallons in a watershed in less than an hour. Such storms produce flash floods. Compared to the flow of the streams before the fire, the post-fire flows can be 1,000 times greater.

Intense heat can kill most of the seeds lying in the forest soil. But some plants, such as aspen and oaks, have underground roots deep enough to survive the fire. Within weeks, the surviving roots send up shoots. Aspen sprouts can grow three feet high in the weeks following a wildfire. Oak roots can send up dozens of sprouts. Also, the wind and birds carry seeds from areas outside the burn and drop them on the ash-covered soil. Depending on the climate conditions, many grass and wildflower species come back to a burned area in the first two years.

After a wildfire, it is often a race to get living plants growing before the first rains of the summer to help hold the soil in place. Land managers often operate emergency seeding projects. Because grass plants are quick-growing and have an extensive system of fibrous roots, they are ideal for holding soil. Grass seeds can be scattered by hand or from the air with helicopters or airplanes. Because they are adapted to the conditions in the ecosystem, native grass species are used. The seeds grow best when a layer of straw mulch covers them. After the Cerro Grande fire, much of the seeding and mulching was done by volunteers.

Wildfire can destroy ponderosa pine seeds in the soil. In areas of extensive crown fire, live trees that could provide new seeds may be miles away. It is important to plant ponderosa pine seedlings to regenerate the forest and to provide a source of seeds for the future. Seedlings—usually no more than six-inches tall—are planted in many burned areas. More than 200,000 seedlings have been planted on the Cerro Grande fire.

Both the ecological and human recovery from wildfires is very slow. The community of Los Alamos, with the help of thousands of people in New Mexico, survived the Cerro Grande Fire. In their own words:

We will rebuild and rise out of the ashes. Senator Steve Stoddard,
retired resident of Los Alamos

A disaster survivor is anyone affected by the Cerro Grande Fire. Losing your home, living in a damaged home, as well as having your sense of safety and well-being compromised by the evacuation makes you a survivor. Project Recovery

Quemazon Trail by Caryn Kohlrust
(Mountain Elementary School
6th Grader)

Quiet is this deserted place,
Unique in its own way as,
Erosion comes far and near when
Mammals have left
As many people come and go,
Zillions of lizards and insects remain,
On and under rocks, with,
Nothing left of their home.

Though we know the
Reason the fire has come, the
Amphibians and
Insects might not, some of us are
Looking for what's left of our homes.

Reactions to Burned Forests

The sight of a severely burned forest touches everyone, even the most hardened firefighter. The forest, both before a fire and after, evokes difference sensory experiences and emotions in each of us. How does a burned forest make you feel? You may be surprised to find beauty even in the blackness.

On way of expressing feelings about a burned forest is to create a work of art or poem. David Hockney, an artist best known for paintings, also worked with photographs he called joiners. Joiners is a method of taking many photographs, or the individual parts, of a subject and piecing the prints together to recreate the scene in a photo collage. Hockney combined multiple views of a single scene in order to explore the way people shift their gaze in many directions as they observe something.

Creating Defensible Space



Living on the Edge: Defensible Space

People who live in high risk wildfire areas are faced with the growing concern that a wildfire could damage or destroy their home and property. Every year many families lose their homes and possessions to wildfire. These losses can be minimized if homeowners take a pro-active approach to home safety. When homeowners take the time to become aware of appropriate safety measures and put forth the effort to implement those measures, they often greatly improve the ability of fire fighters to protect their homes, and will reduce their vulnerability to the destructive forces of fire.

Defensible space is one of the primary determinants of a building's ability to survive a wildfire. The goal of creating defensible space is to develop a landscape around a building that provides an opportunity for fire-fighters to defend it against fire. When grasses, brush, trees, and other common forest fuels are removed, reduced, or modified in a yard, a fire's intensity or nearness to a structure decrease. That situation provides a space for firefighters to battle the blaze. Defensible space is not a guarantee that a structure will survive, but it often increases

the chances of protection from wildfire.

Creating a defensible space starts with landscaping. You should remove all burnable vegetation from a distance of at least 30 feet from your house. You may have to cut down trees or remove brush. Pine needles should be no more than two inches deep. All other dead vegetation should be removed. If there are many pine trees around the house, you should thin the forest by removing many of the trees. Any smaller trees or low branches that could act as ladder fuels should be taken out.

You can replace some of the vegetation around your house with fire-resistant plants. These plants usually have a high moisture content in the leaves that makes them more difficult to burn. Trees like maples, walnuts, and willows are good choices. Wildflowers and grasses

can help create a more defensible space.

Houses near the edge of the forest should be built with safe, resistant materials. A metal roof and walls of stucco or adobe offer good fire protection. Wooden decks are highly flammable and should be protected with special materials.

Other actions can make a big difference. Keep the yard clean of debris. Clean the roof and gutters at least twice a year. Move piles of firewood at least 30 feet from the house. Propane tanks should be used or stored away from the house.

Every family who lives in the ponderosa pine ecosystem should make a defensible space plan.

Create a FireWise Home

by Cameron Ott, Collin Delano, and Sarah Wyman

Sixth graders at Mountain Elementary School in Los Alamos have suggested the following ways to help prevent a wildfire from destroying your home:

1. Clean your roof and keep gutters free of debris like pine needles.
2. Move woodpiles away from your house.
3. Clear brush around your home to create at least a thirty foot defensible space.
4. Landscape with fire resistant vegetation.
5. Keep flammables, like propane tanks, 50 feet away from your house.
6. Create fuel breaks by strategically placing sidewalks, graveled paths, fish ponds, and walls.
7. Whenever possible, use fire resistant building materials such as metal roofing.

Visit www.firewise.org for more information.

Extension activities

Visit a nearby ponderosa pine forest. Try to find the following features and answer the questions.

Find a tree with a cat-face scar near the base. From which direction do you think the wind was blowing during the fire?

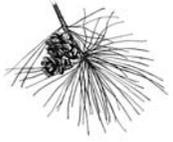
Find a tree that has been cut with a saw. How old was the tree when it was cut? Are there any fire scars interrupting the rings?

Locate a dog-hair thicket. How deep is the layer of pine needles on the forest floor? How many kinds of wildflowers do you see growing there?

Find a tall, orange-barked ponderosa pine. How far above the ground are the first branches? What does the bark smell like?

Locate a small ponderosa pine with needles you can reach. If you break a needle in two, does it release a pleasant smell?

VOCABULARY OF FIRE ECOLOGY



VOCABULARY

Acre: a unit of area equal to 43,560 square feet.

Acquisition time: the time it takes a GPS receiver to acquire satellite signals and determine the initial position.

Adaptation: an alteration in structure or function of a plant or animal that helps it change over the course of successive generations in order to be better suited to live in its environment.

Background: all objects that come from behind the subject away from the camera.

Basal area per hectare: the area of the cross-section of tree stems near their base, generally at breast height and including bark, measured over 1 ha of land.

Biodiversity: the diversity of plants, animals, and other living organisms in all their forms and levels of organization, including genes, species, ecosystems, and the evolutionary and functional processes that link them.

Bole: trunk of a tree

Breast height: the standard height, 1.3m above ground level, at which the diameter of a standing tree is measured.

Camera angles: the area seen by a lens or viewfinder; or the positioning of the subject in relation to the camera shot.

Cambium: the single layer of cells between the woody part of the tree and the bark. Division of these cells results in diameter growth of the tree through formation of wood cells (xylem) and inner bark (phloem).

Canopy: the forest cover of branches and foliage formed by tree crowns.

Centimeter (cm): in the metric system, a unit of length defined as 1/100 of a meter, equal to 10 millimeters or 1/10 of a decimeter.

Circumference: the distance around a circle or sphere.

Clinometer: a simple instrument for measuring vertical angles or slopes. In forestry, used to measure distance and tree heights

Coordinate: a number used to locate a point on a number line, or either of two numbers used to locate a point on a coordinate grid.

Combustible debris: items that catch fire and burn easily; flammable.

Commercial thinning: a silviculture treatment that thins out a thick stand of trees by removing trees that are large enough to be sold as products such as poles or fence posts. It is carried out to improve the health and growth rate of the remaining trees.





Competing vegetation: vegetation that seeks and uses the limited common resources (space, light, water, and nutrients) of a forest site needed by preferred trees for survival and growth.

VOCABULARY

Competition: the struggle among individual organisms for food, water, space, etc. when the available supply is limited.

Composition: the proportion of each tree species in a stand expressed as a percentage of the total number, basal area or volume of all tree species in the stand.

Crown fire: a fire that burns primarily in the leaves and needles of trees, spreading from tree to tree above the ground.

Damaged timber: timber that has been affected by injurious agents such as wind (as in the case of blowdown), fire, insects, or disease.

Debris flow: mixture of soil, rock, wood debris and water which flows rapidly down steep gullies; commonly initiate on slopes greater than 30.

Deciduous: perennial plants which are normally leafless for some time during the year.

Defensible space: an area around a structure where fuels and vegetation are treated, cleared, or reduced to slow the spread of wildfire towards the structure, giving firefighters a chance to defend the structure.

Data: information usually gathered by observation, questioning, or measurement.

Density: In plant ecology, $DENSITY = (\text{Total number of individuals}) / (\text{total area})$.

Diameter: a line segment that passes through the center of a circle (or sphere) and has endpoints on the circle (or sphere); also, the length of such a line segment. In forestry, a line passing through the center of a tree.

Diameter tape: a graduated tape based on the relationship of circumference to diameter which provides direct measure of tree diameter when stretched around the outside of the tree, usually at breast height.

Dichotomous key: a tool used by scientists to find the identity of a butterfly, a plant, a rock, or anything else. Dichotomous means divided in two parts. A key is used by answering a series of yes or no questions.

DBH: Diameter breast height; the bole diameter of a tree measured outside the bark at a height of 1.3 meters.

Disturbance: a discrete event, either natural or human-induced, that causes a change in the existing condition of an ecological system.



Dominance (Dominant): the extent to which a given species predominates in a community because of its size, abundance, or coverage.



Drought: a time when there is little or no precipitation such as rain or snow.

Duff: the layer of partially and fully decomposed organic materials lying below the litter and immediately above the mineral soil.

Ecological balance: a state of dynamic equilibrium within a community of organisms in which genetic, species and ecosystem diversity remain relatively stable, subject to gradual changes through natural succession.

Ecology: the science that studies the ways in which plants and animals live together in the natural environment of our planet.

Ecosystem: a functional unit consisting of all the living organisms (plants, animals, and microbes) in a given area, and all the non-living physical and chemical factors of their environment, linked together through nutrient, cycling and energy flow. An ecosystem can be of any size- a log, pond, field, forest, or the earth's biosphere but it always functions as a whole unit. Ecosystems are commonly described according to the major type of vegetation, for example, forest ecosystem, old-growth ecosystem, or range ecosystem.

Ecotone: a transition area between two adjacent ecological communities usually exhibiting competition between organisms.

Elevation: the height above sea level.

Endangered species: a species in danger of extinction.

Estimate: a ballpark answer, a number close to another number, a calculation of a close, rather than exact, answer.

Evergreen: never entirely without green foliage, leaves persisting until a new set has appeared.

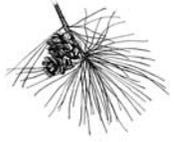
Fire: a self-sustaining chemical reaction that can release energy in the form of light and heat.

Fire behavior: the manner in which a fire reacts to fuel, weather and topography; common terms used to describe fire behavior include smoldering, creeping, running, spotting, torching and crowning.

Fire danger: an assessment of both fixed and variable factors of the fire environment, which determine the ease of ignition, rate of spread, difficulty of control, and fire impact.

Fire hazard: the potential fire behavior for a fuel type, regardless of the fuel type's weather-influenced fuel moisture content or its resistance to fireguard construction. Assessment is based on physical fuel characteristics, such as fuel





arrangement, fuel load, condition of herbaceous vegetation, and presence of elevated fuels.

Fire impact(s): the immediately evident effect of fire on the ecosystem in terms of biophysical alterations (e.g., crown scorch, mineral soil erosion, depth of burn, fuel consumption).

Fire history: the chronological record of the occurrence of fire in an ecosystem.

Fire intensity: a general term relating to the heat energy released in a fire.

Fire-resistant species: species with morphological characteristics that give it a lower probability of being injured or killed by fire than a fire-sensitive species, which has a relatively high probability of being injured or killed by fire.

Fire scars: scar tissue that develops if a tree or shrub is burned by a fire but is not killed. The fire leaves a record of that particular burn on the plant. Scientists can examine fire scars and determine when and how many fires occurred during the plant's lifetime.

Fire suppression: all activities concerned with controlling and extinguishing a fire following its detection. Synonymous with fire control.

Fire triangle: the three components that are necessary for a fire to take place and for the fire to keep burning; the ingredients are heat, fuel, and oxygen.

Firewise landscaping: management of vegetation that removes flammable fuels from around a structure to reduce exposure to radiant heat. The flammable fuels may be replaced with green lawn, gardens, certain-individually spaced green, ornamental shrubs, individually spaced and pruned trees, decorative stone or other non-flammable or flame-resistant materials.

Food chain: a chain of organisms, linked together because each is food for the next in line. Energy passes from one level to next. All the food chains in an ecosystem are connected together in a complex food web.

Forest fire: an uncontained and freely spreading combustion that consumes the natural fuels of a forest, such as duff, litter, grass, dead branch wood, snags, logs, stumps, weeds, brush, foliage, and, to a limited degree, green trees.

Forest management plan: a general plan for the management of a forest area, usually for a full rotation cycle, including the objectives, prescribed management, activities and standards to be employed to achieve specified goals. Commonly supported with more detailed development plans.

Forest health: a forest condition that is naturally resilient to damage; characterized by biodiversity, it contains sustained habitat for timber, fish, wildlife, and humans, and meets present and future resource management objectives.



Formula: a general rule for finding the value of something. A formula is usually written as an equation with variables representing unknown quantities.



Fuel: all the dead and living material that will burn. This includes grasses, dead branches and pine needles on the ground, as well as standing live and dead trees. Also included are minerals near the surface, such as coal that will burn during a fire, and human-built structures.

Fuel load: the amount of combustible material (living and dead plants and trees) that is found in an area.

Global Positioning System (GPS): a global navigation system based on 24 or more satellites orbiting the earth at an altitude of 12,000 miles and providing very precise, worldwide positioning and navigation information 24 hours a day, in any weather.

GPS coordinates: a set of numbers that describes your location on or above the earth. Coordinates are typically based on latitude/longitude lines of reference or a global/regional grid projection.

GPS distance: the length (in feet, meters, miles, etc.) between two waypoints or from your current position to a destination waypoint. This length can be measured in straight-line (rhumb line) or great-circle (over the earth) terms.

GPS receiver: consists of the circuitry necessary to receive the signal from GPS satellites and uses the information to calculate the user's position on the earth.

Ground fire: fire that burns in the organic material in the litter layer, mostly by smoldering combustion. Fires in duff, peat, dead moss and lichens, and downed wood are typically ground fires.

Habitat: the place where an organism lives and/or the conditions of that environment including the soil, vegetation, water, and food.

Hazard tree: a live or dead tree whose trunk, root system or branches have deteriorated or been damaged to such an extent as to be a potential danger to human safety.

Heat: necessary ingredient for fire to start; can be supplied by lightning or human sources.

Hectare: an area of 10,000 square meters, or 100 x 100 meters. There are 100 hectares in a square kilometer.

Human impact or influence: a disturbance or change in ecosystem composition, structure or function caused by humans.

Increment borer: a tool used to extract a core of wood from a living tree for the purpose of studying the annual growth rings of the tree.



Invasive species: species that can move into an area and become dominant numerically or in terms of cover, resource use, or other ecological impacts.

Joiner photographs: multiple frame images shot from different angles and later joined together to recreate the scene or person.

Juvenile spacing: a silvicultural treatment to reduce the number of trees in young stands, often carried out before the stems removed are large enough to be used or sold as a forest product. Prevents stagnation and improves growing conditions for the remaining crop trees so that at final harvest the end-product quality and value is increased. Also called pre-commercial thinning.

Keystone species: a species that plays an important ecological role in determining the overall structure and dynamic relationships within a biotic community. A keystone species presence is essential to the integrity and stability of a particular ecosystem.

Ladder fuels: fuels that provide vertical continuity between the surface fuels and crown fuels in a forest stand, thus contributing to the ease of torching and crowning.

Latitude: the degree measure of an angle whose vertex is the center of the Earth and one side is a radius to the equator. Used to indicate the location of a place with reference (north or south) to the equator.

Litter: the top layer of the forest floor that includes freshly fallen leaves, needles, fine twigs, bark flakes, fruits, matted dead grass and other vegetative parts that are altered little by decomposition. Litter also accumulates beneath rangeland shrubs. Some surface feather moss and lichens are considered to be litter because their moisture response is similar to that of dead fine fuel.

Longitude: the degree measure of how far east or west of the prime meridian a location is on Earth: determined by the angle formed by semicircles of longitude connecting the North Pole and South Pole and the prime meridian.

Maximum density: the maximum allowable stand density above which stands must be spaced to a target density of well-spaced acceptable stems to achieve free-growing status.

Meter (m): the basic unit of length in the metric system, equal to 100 centimeters, and 1000 millimeters.

Monitoring: the periodic measurement or observation of selected physical and biological parameters for establishing base lines and for detecting and quantifying changes over time.

Monitoring plot: a plot installed for measuring or calibrating actual growth of treated stands. The objective is similar to that of research plots but usually limited to one or two treatments; for example, thinned versus unthinned areas. These are usually permanent plots administered by the National Forest system, sometimes in cooperation with Forest Management Research.



Mixed stand: a stand composed of two or more tree species.

Mortality: death or destruction of forest trees as a result of competition, disease, insect damage, drought, wind, fire and other factors (excluding harvesting).

Noxious weeds: any weed so designated by the Weed Control Regulations and identified on a regional district noxious weed control list.

Old growth forest: forest which has not had significant unnatural disturbances altering its content or structure since European settlement.

Organizing data: arranging and presenting data in a way that makes the data easier to understand.

Overgrazing: the practice of grazing too many ruminants on land unable to recover its vegetation or of grazing ruminants on land not suitable for grazing because of slope. Overgrazing exceeds the carrying capacity of a pasture.

Percent (%): per hundred, or out of a hundred. 1% means 1/100 or 0.01.

Phloem: a layer of tree tissue just inside the bark that conducts food from the leaves to the stem and roots. See Cambium

Photo collage: an artistic composition made of various materials (such as paper, cloth, or wood) glued on a picture surface.

Pioneer plants: a succession term for plants capable of invading bare sites, such as a newly exposed soil surface, and persisting there, i.e., colonizing until supplanted by invader or other succession species.

Plant community: an assemblage of plants occurring together at any point in time, thus designating no particular ecological status.

Plant harvesting: the collection of plant life including, but not limited to, bark, berries, boughs, branches, burls, cones, conks, fems, flowers, grasses, herbs, fungi, lichens, mosses, mushrooms, roots, sedges, shrubs, sprays and twigs.

Plot: a carefully measured area laid out for experimentation or measurement.

Prescribed fire: any fire ignited by management actions to meet specific objectives. Prior to ignition, a written, approved prescribed fire plan must exist, and National Environmental Protection Act requirements must be met.

Pre-settlement fire regime: the time from about 1500 to the mid to late 1800 s, a period when Native American populations had already been heavily impacted by European presence and before extensive settlement by European Americans in most parts of North America, before extensive conversion of wildlands for agricultural and other purposes, and before fires were effectively suppressed in many areas.





Prime meridian: an imaginary semicircle on the Earth, connecting the North Pole and South Pole through Greenwich, England.

Random sample: a sample taken from a population in a way that gives all members of the population the same chance of being selected.

Recreation: any physical or psychological revitalization through the voluntary pursuit of leisure time. Forest recreation includes the use and enjoyment of a forest or wild-land setting, including heritage landmarks, developed facilities, and other biophysical features.

Reduction: the removal of plant parts, such as branches or leaves, constitutes reduction. Examples of reduction are pruning dead wood from a shrub, removing low tree branches, and mowing dead grass.

Reforestation: the natural or artificial restocking (i.e., planting, seeding) of an area with forest trees. Also called forest regeneration.

Removal: this technique involves the elimination of entire plants, particularly trees and shrubs, from the site. Examples of removal would be the cutting down of a dead tree or the cutting out of a flammable shrub.

Replacement: Replacement is the substitution of less flammable plants for more hazardous vegetation. For example, removal of a dense stand of flammable shrubs and planting an irrigated, well maintained flower bed would be a type of replacement.

Restoration: the return of an ecosystem or habitat to its original community structure, with its natural complement of species and natural functions.

Sample: a subset of a population used to represent the whole population.

Separation distance: Separation distances are measured between tree canopies (outermost branches) and not between trunks.

Spreadsheet: a table displayed by a computer program, which is used to perform mathematical operations, evaluate formulas, and relate data quickly. The name comes from ledger worksheets for financial records. Such sheets were of ten taped together and then spread out for examination.

Serotinous: a pine cone or other seed case that requires heat from a fire to open and release the seed.

Snag: a standing dead tree or part of a dead tree from which at least the smaller branches have fallen.

Soil erosion: the wearing away of the earth's surface by water, gravity, wind, and ice.



Solar cell: a device made of semiconductor materials which produce a voltage when exposed to light.

Species: a singular or plural term for a population or series of populations of organisms that are capable of interbreeding freely with each other but not with members of other species.

Stand: a group of plants of the same species, same size, and same age.

Stand density: a relative measure of the amount of stocking on a forest area. Often described in terms of stems per hectare.

Stewardship: caring for land and associated resources and passing healthy ecosystems to future generations.

Succession: the gradual replacement of one plant and animal community by another, as in the change from an open field to a mature forest.

Surface fire: a fire that burns leaf litter, fallen branches and other fuels located on the forest floor.

Thinning: a cutting of specific trees made in a forest stand primarily to promote tree growth and to improve the average form of the trees that remain.

Thumbnail sketch: very quick, loose drawing.

Understory: any plants growing under the canopy formed by other plants, particularly herbaceous and shrub vegetation.

Vegetation: plant life in general

Watershed: an area of land that collects and discharges water into a single main stream through a series of smaller tributaries.

Wildfire: an unplanned or unwanted natural or human-caused fire or a prescribed fire that has escaped its bounds.

Wildland/Urban Interface: a popular term used to describe an area where various structures (most notably private homes) and other human developments meet or are intermingled with forest and other vegetative fuel types.

Xeric: having very little moisture; tolerating or adapted to dry conditions.





WHY DO FORESTS BURN? EXPLORING FIRE BEHAVIOR

FOCUS QUESTIONS

Why do some wildfires burn entire forests and others do not?
How do firefighters break the fire triangle to control a wildfire?

OVERVIEW OF LESSON PLAN

Students will arrive at a basic knowledge of the fire triangle through four activities. They will extend this knowledge into the realm of wildland fire, identifying the key components of the fire triangle in the natural world. Simple demonstrations will show students how forest density, slope, and weather conditions affect the nature of wildland fire. For a fun way to study fire behavior, students can play a game of fire tag.

SUGGESTED TIME ALLOWANCE: Class Time: 3 hours

LOCATION: Classroom, school yard

SUBJECT AREAS: Science, Math, Technology

STUDENT OBJECTIVES

Students will:

- Correctly identify the three parts of the fire triangle
- Relate parts of the fire triangle to the forest environment
- Evaluate the effects of slope, forest density, and wind on fire behavior
- Explain how firefighters attack the fire triangle to put out a wildfire

VOCABULARY

- Fire triangle
- Crown fire
- Fire behavior
- Slope
- Forest density

MATERIALS

Three Parts of the Fire Triangle

- Candle
- Pie pan
- Modeling clay
- Matches
- Tall, wide-mouth jar
- Scissors
- Field journals
- Pencils

The Fire Triangle in the Real World

- Investigating Fire Ecology newspaper
- Field journals
- Pencils





Materials (cont.)

Fire Behavior:

How, Where, And When A Fire Burns Can Affect The Fire Triangle

Pre-
Visit
LESSON PLAN

Kitchen matches

Non-toxic modeling clay (potters clay to prevent melting)

Metal trays

Recycled spray bottles for water

Stopwatch

Thermometer

Heat resistant mittens or oven hot pads

Fire extinguishers

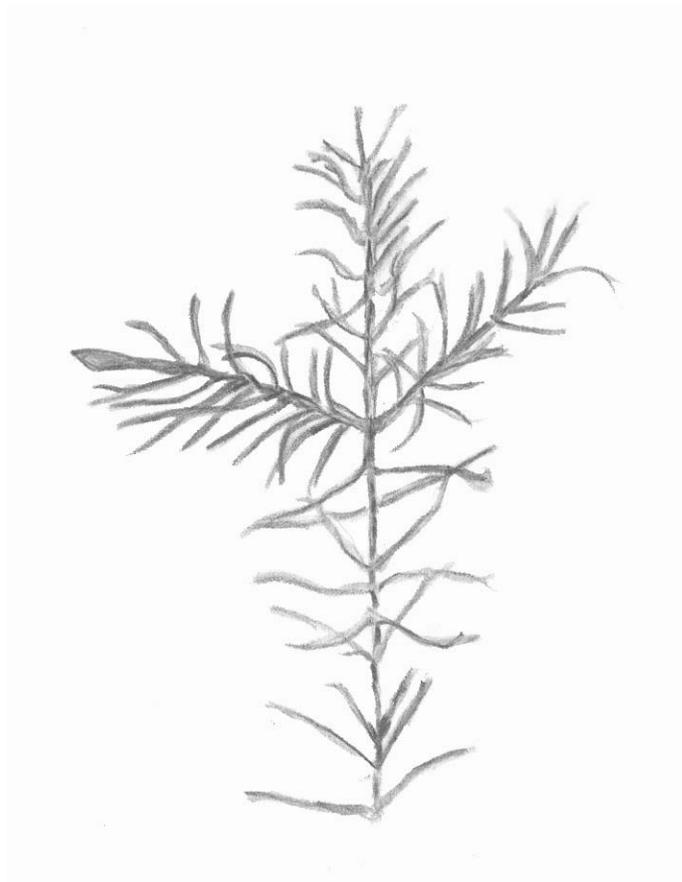
Safety glasses

Data sheets

Fire Tag

Yellow arm bands for one quarter of the students

Blue Nerf balls for one quarter of the students



PROCEDURES



Three Parts of the Fire Triangle

1. Before class, use the modeling clay to hold the candle securely in the pie pan.
2. Draw a triangle on the board or overhead. Ask students what is needed for a fire. Write answers on the board. Then use the answers to organize the three parts of the Fire Triangle: heat, fuel, and oxygen. Include in the discussion the following questions: Burnable things surround us every day. Why aren't they on fire? What is the fuel in fires we are familiar with?
3. With a candle, demonstrate that if any of the three sides of the fire triangle is broken, there is no fire.
4. Stare at the candle for a moment. Ask why it is not burning? What is missing from the fire triangle? (Heat)
5. Light the candle. Place the jar over the candle. Wait until the candle goes out. Ask why the candle is no longer burning. What is missing from the fire triangle? (Oxygen)
6. Light the candle again. Use scissors to cut the wick. What is missing from the fire triangle? (Fuel)

The Fire Triangle in the Real World

Have students read about the fire triangle in the real world in their newspaper.

Students should record in their field journal:

Three sources of heat for wildfires

Four types of fuel for wildfires and classify each as light fuel or heavy fuel

Two ways that wind increases the oxygen for a wildfire



FIRE BEHAVIOR:

HOW, WHERE & WHEN A FIRE BURNS CAN AFFECT THE FIRE TRIANGLE

Pre-
Visit
LESSON PLAN

1. Prepare at least four matchstick forests. Build a forest in each tray. Create a 5 x 8 base for trees (matches) from a thin layer of modeling clay by packing firmly to the pan and flattening. In the first three trays, space matches vertically approximately one-half inch apart. In the last tray, place about 20 matches total in well-spaced clumps to mimic historic ponderosa pine forests.
2. Do the demonstrations on a non-flammable surface in the school yard. Place one tray on a flat surface. Elevate one end of a second tray about 20 degrees to represent a moderate slope in the land's topography. Elevate one end of the third tray about 40 degrees to represent a steep slope in the land's topography. For the historic ponderosa forest tray, keep the tray flat or put it on a 20 degree slope.
3. Set the matchstick forests on a heat-resistant surface. If you don't have laboratory facilities, one really good surface to use is a trash-can lid filled with sand. Have a spray bottle and fire extinguisher nearby.
4. Explain to students that the individual matches represent trees that have flammable crowns, like the conifers in local forests. In this demonstration, students will observe how slope and tree density affect fire spread through tree crowns.
5. Discuss the type of observations students should make and record on the data sheet. Make sure students understand the topography of the forest, number of matches (forest density), the time to burn all the matches in seconds, the ambient temperature, and number of unburned trees.
6. Before lighting the matches, ask students for their hypothesis about how the fires will differ.
7. Light the match tips along one edge of the flat forest and observe fire behavior. Then light the match tips along the top edge of a medium-slope forest and observe. Then light the bottom row of matches on the other medium-slope forest and observe. Finally, light the bottom row of matches on the steep forest and observe. Ask for descriptions of what the students observe and interpretations in terms of the fire triangle. (Heat travels upward, so the matches and trees uphill from a fire receive more heat than those below and are easier to ignite.)
8. Ask students to remove whatever remains of the matches from each board. They can use the nail in the kit to poke the burned matches out, if necessary.

FIREFIGHTERS AND THE FIRE TRIANGLE

1. Review the fire triangle.
2. Have students discuss ways that firefighters could use knowledge of the fire triangle to stop a wildfire.
 - a. Eliminate fuel
Cut down and remove trees in the path of the fire (create a firebreak)
Scrape away a wide band of material lying on the ground (create a fire line)
 - b. Eliminate oxygen
Throw water on the fire
Throw dirt on the fire
 - c. Eliminate heat
Throw water or fire retardant on the fire
3. Play Fire Tag

FIRE TAG

To start, designate one child as the spark (that starts the fire). One quarter of the group will be fire fighters, identified by their yellow arm bands and each equipped with a blue Nerf ball. The remaining students will be trees (or fuel, which allow the fire to grow). At the beginning, explain to the players what each of their roles will be (see below). Have the spark go to one end of the playing area, and align the fire fighters at the other end. Now tell the trees to take root and grow anywhere they wish on the playing field. They should stand with their arms held up to mimic tree branches.

The spark, or lightning, starts the game by tagging a tree. Trees may not run from the fire! Tagged trees become part of the fire and must join hands with the spark. The fire must now continue its pursuit of trees as a unit, attempting to capture trees with their free hands. Captured trees must join the chain of fire.

Fire can either move as a long chain, or may break into several smaller groups and travel as spot fires. They may not travel as individuals (pairs or more only!). This distinguishes them from unburned trees.

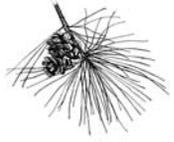
Fire fighters should be held on the sidelines until the fire has had a chance to grow to 3-4 players. At this point, ask the fire fighters, Do you smell smoke? They'll be raring to go, so when they yell Yes!, allow them to go put out the fire.

Firefighters must avoid fire (they, too, can become fuel for the fire and must join the fire if caught) while attempting to slow the fire's growth. They can do this in three ways:

1. Removal of fuels Firefighters may tag trees and escort them out of the game to the sidelines. Fire fighters and trees may not be captured by fire en route!

(Adapted from A Teachers Guide to Fire Ecology in New Mexico and the Southwest, New Mexico South Central Mountains RD and D)





2. Direct attack - Firefighters may tag fire with their blue bandanas (water). Fire units that get hit with water must walk from that point on.
3. Containment Fire fighters may join hands to encircle or contain a spot fire (wet fires are the easiest to contain because they walk slowly). Contained spot fires must go to the sidelines.

Summary of goals of players:

TREES: Stand still: you may be captured by either fire or removed to the sidelines by firefighters.

FIRE: Tag trees and fire fighters and grow! Avoid water-wielding firefighters.

FIRE FIGHTERS: Remove trees to sidelines before they are captured by fire. Tag fire with water to slow its advance. Join hands with other fire fighters to encircle spot fires and remove them to the sidelines.

The game is over when no trees remain. Compare the number of fire players left at the end of the game with the number of tree players on the sidelines. Who won, the fire fighters or the fire? Point out the similarities and differences to real life.

EVALUATION

Direct students to design a matchstick forest to observe a different slope, weather, or fuel condition, or to solve a specific problem. For example, make a matchstick forest on a steep slope and then remove 12 trees from it. Find the best arrangement of 12 fewer trees to reduce the risk of fire spread.

Students should be able to explain why their experiment is important, make a prediction of the results, and support their ideas with their knowledge of fire behavior.

Name _____



Why Do Forests Burn? Exploring the Fire Triangle Assessment Questions

Comprehensive Paragraph: What are the elements of a fire triangle and what occurs when one of these components is removed from the triangle?

Matching:

Fire Triangle

a. a fire that burns primarily in the leaves and needles of trees, spreading from tree to tree above the ground.

Crown Fire

b. manner in which a fire reacts to fuel, weather, and topography; common terms used to describe this activity include: smoldering, creeping, running, spotting and crowning.

Fire Behavior.

c. the three components that are necessary for a fire to take place and for the fire to keep burning

True or False:

1. Trees, flame and weather are the three components of the fire triangle when referring to wildland fires..

True or False

2. Throwing water or dirt on a fire eliminates the fuels, thus stopping the growth of a fire.

True or False

Multiple Choice:

The three sources of heat for a wildland fire are _____, _____ and _____.

Name two ways that wind can add to the intensity of a wild fire.

_____ and _____.

Name at least two types of light fuels _____, and _____.



WHY DO FORESTS BURN? EXPLORING THE FIRE TRIANGLE
ASSESSMENT TEACHER MASTER SHEET

Comprehensive Paragraph:

What are the elements of the fire triangle and what occurs when one of these components is removed from the triangle? How do firefighters take advantage of the fire triangle to stop a fire?

The three elements of the fire triangle are heat, oxygen, and fuel. If any one of the elements is removed, fires will no longer burn. Student should provide an example, such as, cutting a fire break to halt the approach of a fire.

Matching:

Fire Triangle c

Crown Fire a

Fire Behavior b

True or False:

1. Trees, flame and weather are the three components of the fire triangle when referring to wildland fires.. False

2. Throwing water or dirt on a fire eliminates the fuels, thus stopping the growth of a fire. False

Multiple Choice:

1. The three sources of heat for a wildland fire are lightning, fires (campfires), and sparks or power lines .

2. Name two ways that wind can add to the intensity of a wild fire. Provides more oxygen and blows heat/fire to unburned fuel .

3. Name at least two types of light fuels . grasses and brush or small trees .



WHY DO FORESTS BURN? EXPLORING THE FIRE TRIANGLE



Name _____ Date _____

DATA SHEET FOR MATCHSTICK FOREST EXPERIMENTS

Experiment 1: _____

Forest density (number of matches) _____

Topography (slope angle) _____

Temperature _____

Other factors _____

Hypothesis _____

Observations:

Time to burn _____

Number of unburned trees _____

Other observations _____

Experiment 2: _____

Forest density (number of matches) _____

Topography (slope angle) _____

Temperature _____

Other factors _____

Hypothesis _____

Observations:

Time to burn _____

Number of unburned trees _____

Other observations _____

STUDENT SHEET





Experiment 3: _____

Forest density (number of matches) _____

Topography (slope angle) _____

Temperature _____

Other factors _____

Hypothesis _____

Observations:

Time to burn _____

Number of unburned trees _____

Other observations _____

Experiment 4: _____

Forest density (number of matches) _____

Topography (slope angle) _____

Temperature _____

Other factors _____

Hypothesis _____

Observations:

Time to burn _____

Number of unburned trees _____

Other observations _____

STUDENT SHEET





WILDFIRE AND NATIVE PLANTS



FOCUS QUESTIONS

What effect does wildfire have on plants?

What are the common types of plant species that inhabit your area after a forest fire?

How can we use a dichotomous key to classify living things?

OVERVIEW OF THE LESSON PLAN

This lesson will introduce students to common plant species found in the region following a forest fire. It will prepare them for a visit to a recently burned forest, where they will interpret, document, and inventory common plants. Back in the classroom, they will compile their information into a field guide. In order to ensure that this lesson is successful, the students will need to identify common plants via available resources in the classroom before going out in the field. Students will identify common species using a set of plant identification cards and a dichotomous key.

SUGGESTED TIME ALLOWANCE: 2 hours

LOCATION: Classroom

SUBJECTS: Science, Language Arts, Math, Art, Technology

STUDENT OBJECTIVES

Students will:

Respond to the quote *Nobody Sees a Flower*, by Georgia O'Keefe.

Develop a working definition with the word *adaptation*.

Understand the concept of forest succession.

Classify objects with a dichotomous key.

Identify common trees with a dichotomous key.

Use plant identification cards to develop their own dichotomous key.

Develop a working knowledge of common plants and an awareness of plant diversity in a fire disturbed area.

VOCABULARY

Forest succession

Adaptation

Serotinous

Phytophytes

Endangered species

Dichotomous key

MATERIALS

Websites, books, newspaper articles, encyclopedias

Overhead pictures of common plants in region (optional)

Field journals

Field guides of regional plant life

Computer with internet and data base access

Handout: Key to Some Common Trees

Samples of ponderosa pine, limber pine, juniper, piñon pine, Douglas fir

Plant identification cards



PROCEDURES

1. Warm up

Write this quotation on the board: Nobody sees a flower, really it is so small we haven't time, and to see takes time, like to have a friend takes time. Georgia O'Keefe. Students respond to this quote in their science journals.

DISCUSSION QUESTIONS:

- Do you agree or disagree?
- What is the author saying?

WRITING: Create your own saying about flowers and friendships

Write questions you would like to ask Georgia O'Keefe.

ILLUSTRATING: Express the meaning in visual form with a sketch.

Use color, pattern, shapes or shading to interpret the meaning.

Think of five ways people are like flowers. Share your answers with the class.

2. Develop a working definition of the word adaptation with students.

Discuss the fact that plant and animal adaptations don't occur over a generation or two but may take thousands of years to evolve. Plants have a distinct disadvantage, compared to animals, in the face of fires. They are unable to run, fly, creep or crawl out of a fire's path and have adapted other methods to survive fires.

Individual plants have adaptations to ensure their survival through a fire.

To survive a fire, a plant must be able to insulate itself from the heat of the flames. Bark thickness is the most important factor determining fire resistance of trees.

Ponderosa pine, longleaf pine, slash pine, loblolly pine and giant sequoia are examples of trees with thick bark that acts as insulation from forest fires.

Small woody plants and shrubs normally have thin bark. These plants use the soil as an insulating layer to protect themselves. Individual plants resist being killed in fires by producing new growth (shoots) from underground organs or roots. Some plants protect their buds as an adaptive strategy to survive a fire. Buds can be protected by layers of succulent, nonflammable foliage. Longleaf pine exemplifies this adaptive strategy. The buds of the longleaf pine are protected by a thick cluster of needles. Some plants even protect their buds by locating them within the main stem and roots. A few poplar tree species possess this trait.

Retention of seeds by plants and stimulation of seed dispersal by fire are other examples of fire-adaptive strategies. A number of pine species have cones that open only after a fire. These cones are said to be serotinous (pronounced sir-OT-in-cus). Jack pines have cones that are held closed by a resin that is sensitive to high temperatures. These cones will not open to release their seeds until the critical temperature is reached. Cones of Lodgepole pines (a western U.S. variety of tree) vary from serotinous to free-opening.





When these trees grow in areas subject to frequent fires, many of the cones are serotinous. However, if lodgepole pines grow in areas where fire is less frequent, the pine cones open and release their seeds more often without fire.

(Adapted from the Department of Interior, Fire Ecology: Resource Management Education Unit).

Encourage students to give examples of plant and animal adaptations that make it possible for each to live in a particular area. List these in their journals and on the board. Examples for animals might include a box turtle shell that protects it from predators, a great horned owl talons that enable it to catch and hold its prey, the white tailed deer s coloring that blends with forest vegetation and helps it evade predators.

3. Introduce the concept of forest succession.

Forest ecosystems are always changing. Plants grow using soil nutrients and eventually die, returning nutrients to the soil. Animals feed on plants and leave waste. Bacteria, fungi and insects thrive on decaying plants, animals and animal waste, breaking down these materials and replacing soil nutrients. These interactions of plants, animals, bacteria, fungi, and insects constantly occur in ecosystems.

Succession is a change in plants and animals which occurs periodically in all communities. An open space or meadow will eventually be overgrown by a forest which in turn will grow to a climax forest. The length of time and kinds of plants involved in each successional change depend on many factors. The successional progression can be changed at any state by many different factors and disturbances. These factors and disturbances have negative and positive effects on succession. Disturbances in the forest can be human made or natural.

Much of what we know of the effects of wildfire on plant community succession comes from plots established prior to low intensity prescribed fires or from plots sampled immediately after high intensity crown fires. There is obvious change in the plant community following fire. Some of the species may be practically eliminated, perhaps as many as 50%. Some species increase for a short time probably from the stimulation of burning, increased sunlight, lack of competition, water availability and a slight nutrient increase. They then decline, perhaps as a result of increased competition from plants that tolerate the increased sunlight. Some species decline for a few years then begin to increase to their pre-burn status. Some species that were absent or rare before the fire increase in cover; unfortunately some are non-natives.

(Don G. Despain USGS, Northern Rocky Mountain Science Center)

Ask students what they can expect to find in a forest that has been severely burned.

4. Classifying Objects with a Dichotomous Key

(Adapted from the University of North Dakota Volcano World Curriculum)

Explain to students that a dichotomous key is a tool used by scientists to find the identity of a butterfly, a plant, a rock, or anything else.





Dichotomous means divided in two parts. At each step of the process of using the key, the user is given two choices; each alternative leads to another question until the item is identified. It is just like playing the game Twenty Questions.

Classification is the process of organizing things into groups. The ability to classify can be a valuable life skill for students. The concept of classification can be used in everyday life. One can use a classification system to organize term papers, books on a shelf, and clothes in a drawer. Classification systems are used in many different ways in the business world.

Biologists organize and store data about organisms in a KEY. A key is a chart that groups organisms by their characteristics.

Shoe Classification

This activity will give students an idea of how a key works.

Imagine walking into a classroom and finding a pile of shoes and a group of shoeless students. Your task is to match the shoes to the correct student.

To use the key, you start at number one and work to the right. As you come to each fork in the road, you make a choice based on the feature of the shoe. Eventually, by a process of deduction, you come to the owner.

For example, you pick up a shoe. It has laces. That places you at 1A. The shoe is not brown. This is 2B. The shoe is white. That is 10B. The shoe has a high top. That is 14A and the owner is Marty. By doing this to every shoe, you can return each shoe to its owner. You can make a key of shoes for your class, as well.

1. Divide the class into groups of 10 or 12 students.
Have each student take off one shoe and put it into a center pile.
2. Divide the shoes into two piles. Every shoe in one group must have a feature that no shoe in the other group has. Write this distinguishing feature down as 1A on a chart similar to the handout. Its opposite, then, will be 1B.
3. Ignore one pile of shoes for the time being. Pick another feature that allows you to divide the remaining pile of shoes into two smaller groups. Write this feature and its opposite after 1A as 2A and 2B.
4. Repeat steps until each pile is reduced to one shoe, and the owner's name is filled-in on the chart.
5. Go back to the pile that was left behind and repeat the steps. If you are confused, study the key.
6. To test the accuracy and clarity of your key, ask someone from another group to match one shoe to its owner. (Everyone should cover or remove and hide his/her remaining shoe.)





5. Identifying Common Trees with a Key

Before class, collect sample of the common trees listed in the key or use the samples in the Fire Box.

Divide students into groups of three. Give each group a copy of the Key to Some Common Trees and a sample of each tree.

Explain that all the trees in the key are conifers. These are trees that are ever-green. Their leaves are needles, which are hard, narrow leaves.

Let the students work through the key to identify their samples.

6. Student Generated Dichotomous Key using Plant Identification Cards

Using the knowledge gained in the last two exercises, students can make their own dichotomous key. Sorting can be done by color, family, or other student-generated methods.

Students should familiarize themselves with at least 10 plants they will most likely observe in the field. (Copies of these pages should be available in their science journals for easy reference. Students can identify and color each specific plant before the field trip.)

EVALUATION

Students will be evaluated on their knowledge of using a dichotomous key, and recognizing common plants

After the field trip, students will produce a field guide to the common plants in the burned area.





Keying Out Trees

Using a dichotomous key is similar to going down the road and coming to a fork or Y in the road. You must decide which direction to go by observing the plant. There are two choices. Each choice will lead to a different plant. The observations are hints to tell you which way to go. So you must first ask some questions!

ASK THE QUESTION: What kind of leaves does the plant have?

Evergreen or Deciduous?

A. Are the trees deciduous
(lose their leaves in the fall?)

(GO TO PAGE 2 and continue)

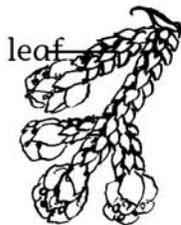


A. Are the trees evergreen
(keep their leaves in the fall?)

At this fork ask the question:
What is the shape of the leaf?

b. Is the leaf small and triangular?

b. Is the leaf needle-like?



You will have to
use a magnifying glass
to see each leaf.



GO TO PAGE 3 and continue

GO TO PAGE 4 and continue

*Reference: Foxx, Teralene and Dorothy Hoard "Flowering Plants of the Southwestern Woodlands." Otowi Press, Los Alamos, 1995; drawings by Dorothy Hoard and Teralene Foxx.





DECIDUOUS TREES

- A. **Trees generally growing along streams,** near springs or other water.
- b. **Trees with leaves that have more than one leaflet (a compound leaf).** Generally growing along streams. Bark pale gray to brown, divided into narrow ridges. Leaves opposite.



BOXELDER MAPLE
Acer negundo

- b. **Trees with leaves with a single leaf blade.**
- c. **Leaves roughly triangular, wider than long.** Leaves yellow green. Bark gray. A dominant tree is a forest along a river called a bosque.



RIO GRANDE COTTONWOOD
Populus fremontii

- c. **Leaves narrow, four times longer than wide.** Upper leaf surfaces light-green lower leaf surface lighter and hairy. Bark gray with narrow fissures. Most often found near streams such as Frijoles.



NARROWLEAF COTTONWOOD
Populus angustifolia

- A. **Trees generally not growing near water.** Trees found in dense groves at high elevations. Bark whitish. Leaves oval with flattened leaf stem. Often found where there has been a fire and is sometimes called a "fire species."



ASPEN

Populus tremuloides



flattened leaf stem
(petiole)



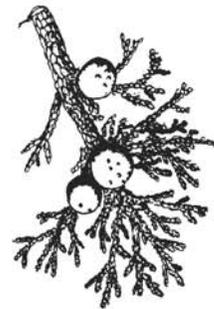
PLANTS WITH SMALL TRIANGULAR LEAVES

Trees are often without one main trunk but multiple branches. Bark is shreddy.

A. Color of the leaves and branches olive green. Male and female trees. Only the female trees have berries. Bark shreddy, gray, fibrous.

ONE-SEED JUNIPER
Juniperus monosperma

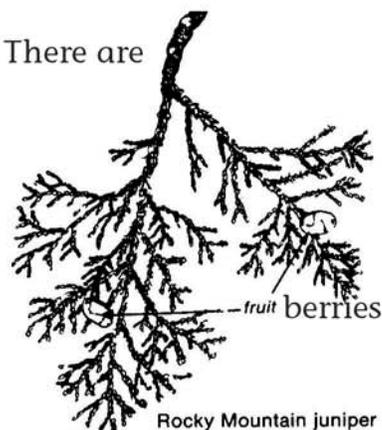
This tree is a common at elevations of 5000-6500 ft. It is one of the main trees in the pinon-juniper woodland and the main tree in a juniper savannah. This is a very hardy tree.



A. **Color of the leaves silver green, drooping, flattened.** Male and female flowers on one tree. Bark reddish brown to gray. Shreddy.

ROCKY MOUNTAIN JUNIPER
Juniperus scopulorum

This tree is found primarily in canyons where there is water or more moisture. There are generally one or two trees in an area, not large groves.



Rocky Mountain juniper





PLANTS WITH NEEDLE-LIKE LEAVES

Needles attached to the twig in bundles of 2 to 5.

- b. Needles in bundles of 5. **LIMBER PINE**
Pinus flexilis

These trees are found scattered throughout the forest at 7500-8000 feet. They often grow in rocky places.



- b. Needles in bundles of 2-3.

- c. Needles in bundles of 3. **PONDEROSA PINE**
Pinus ponderosa

These trees are found in large expanses of forest from 7000-7500 feet and scattered at higher elevations. Bark black to yellow broken into puzzle-like pieces. Smells like vanilla.



- c. Needles in bundles of 2. **PINON PINE**
Pinus edulis

These trees are found in large expanses of forest from 6500-7000 ft.



See "A" on page 5: Needles attached to twig singly.



A. Needles attached to the twig singly.

- b. **Needles flat** (HINT: Leaves will not twirl between your fingers. Needles are soft, not sharp.)
- c. Branches drooping. Leaves blue-green. Cones with three-pointed bracts. Bark reddish to gray brown.

DOUGLAS FIR

Pseudotsuga menziesii

These trees are found most often in canyons or at elevations above 8000 ft. They are in mixed-conifer forests.

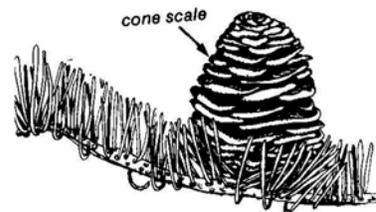


- c. Branches with needles pointing upward. Leaves pale blue. Cones disintegrate on tree so none will be found under the tree. Bark gray and deeply furrowed.

WHITE FIR

Abies concolor

These trees are found most often in canyons or at elevations above 8000 ft. They are in mixed-conifer forest



- b. **Needles four-angled, sharp pointed.** (HINT: The needles will twirl in your fingers and when you grasp the tree the needles are sharp). Bark cinnamon-red.

SPRUCE

Picea engelmannii

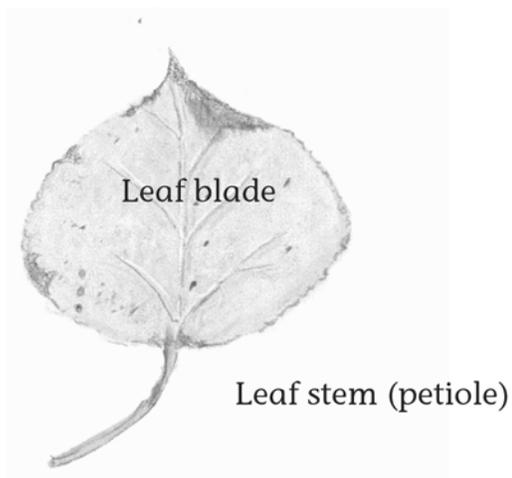
Spruce are generally found at elevations from 8000-10,000 ft.



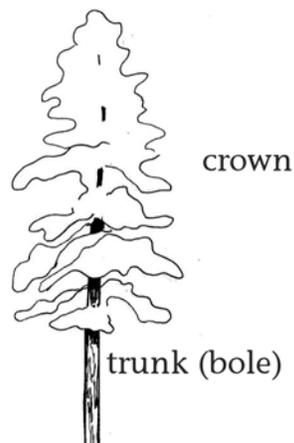


ABOUT LEAVES

PARTS OF A LEAF



PARTS OF A TREE



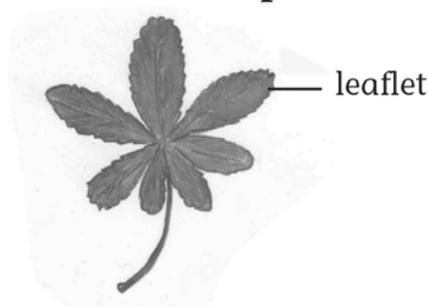
TYPES OF LEAVES

Simple leaves



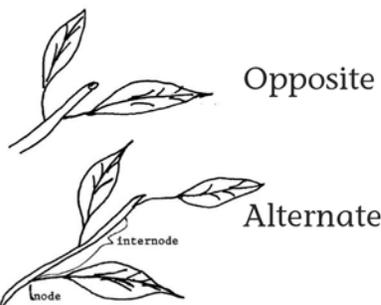
One single blade and leaf stem. Sometimes the small leaflets leaf is deeply incised.

Compound leaves



The leaf is made up of many arranged on the leaf stalk.

HOW LEAVES ARE ON THE STEM



Name _____



Wildfire and Native Plants
Assessment Questions

Comprehensive Paragraph: How do some trees, shrubs and plants protect themselves from the heat and flames of wildland fire and make it possible to grow again on their own?

Vocabulary:

- | | |
|--------------------|--|
| Forest succession | a. necessary ingredient for fire to start. |
| Adaptation | b. function of plant or animal that helps it change over successive generations. |
| Serotinous | c. the gradual replacement of a plant or animal community by another. |
| Phytophytes | d. a pine cone or seed case that requires heat from a fire to open and release the seed. |
| Endangered Species | e. means fire-treated plant. |
| Heat | f. plants or animals that need protection in order to survive. |

True or False:

1. Ponderosa pine and longleaf pine have thick bark to insulate them from fire, therefore, they are the only trees capable of surviving a wildland fire.
a. True b. False
2. When plant collecting, it doesn't matter how much of the plant is collected, because, as long as it is cut properly with sharp shears the plant will always grow back.
a. True b. False

Multiple Choice:

3. Which of the following have the slowest reproductive rate and grow more slowly than other types of plants and therefore should only be collected sparingly?
a. grasses b. wildflowers c. vegetables d. mushrooms
4. Which type of pine cone is actually opened by the heat of a wildfire allowing the cone to drop its seed for new growth?
a. phytophyte cones b. serotinous cones
c. endangered cones d. adaptive cones
5. Forest ecosystems are always changing. Which of the following has direct interaction within the management of a forest ecosystem?
a. bacteria, fungi, animal waste b. insects, dying plants, animals
c. insects, animals, plants d. all of the above





WILDFIRE AND NATIVE PLANTS
ASSESSMENT TEACHER MASTER SHEET

TEACHER MASTER

Comprehensive Paragraph: How do some trees, shrubs and plants protect themselves from the heat and flames of wildland fire and make it possible to grow again on their own?

Insulation, adaptive traits, reproduction, regeneration, bark thickness, heat opening pine cones, self-protecting

Matching:

Forest succession c

Adaptation b

Serotinous d

Phytophytes e

Endangered Species f

Heat a

True or False:

3. Ponderosa pine and longleaf pine have thick bark to insulate them from fire, therefore, they are the only trees capable of surviving a wildland fire. False
4. When plant collecting, it doesn't matter how much of the plant is collected, because, as long as it is cut properly with sharp shears the plant will always grow back. False

Multiple Choice:

5. Which of the following have the slowest reproductive rate and grow more slowly than other types of plants and therefore should only be collected sparingly?
b wildflowers
6. Which type of pine cone is actually opened by the heat of a wildfire allowing the cone to drop its seed for new growth? b serotinous cones
7. Forest ecosystems are always changing. Which of the following has direct interaction within the management of an forest ecosystem? d all of the above



MEASURING THE EARTH FROM THE GROUND UP



FOCUS QUESTIONS

When doing a science study, how can we make estimates of distance & how can we make precise measurements of distance?

OVERVIEW OF LESSON PLAN

Students will practice measuring techniques from estimating distance with the length of their pace to using the Global Positioning System and its satellites to precisely map locations around their school. They can determine the length of their pace, use measuring tapes and simple trigonometry to lay out a rectangle on the ground, and use a GPS to collect data about their school. Each of the activities will prepare students for tasks to which they will be assigned during the field study.

SUGGESTED TIME ALLOWANCE: 2 hours

LOCATION: Classroom, school, school yard

SUBJECT AREAS: Social Studies, Science, Math, Technology

STUDENT OBJECTIVES

Students will:

Determine their pace and apply the knowledge to measuring a part of their school

Use simple mathematics to lay out a rectangle on the ground

Know how to turn a GPS receiver on and off, and to page between the screens

Know how to find their position with a GPS receiver

VOCABULARY

Latitude

Longitude

Coordinate

Satellite

Global Positioning System (GPS)

GPS Receiver

MATERIALS

Field journals

Pencils

Estimating distance and area by pacing

Measuring tapes

String

Pin flags

GPS receivers





Using Measuring Tapes To Lay Out A Rectangle

- Measuring tapes, either 10, 30, or 50 meters
- String
- Sets of four pin flags marked A through D
- Marking pens

THREE SCHOOLYARD ACTIVITIES FOR GPS RECEIVERS

Flag Finder

- Pin flags marked A through M
- GPS receivers
- Datasheets

Testing GPS Accuracy

- 30-meter measuring tapes
- GPS receivers
- Datasheets

Where in the World is My School? Using Mapping Software

- GPS receivers
- Datasheets
- Mapping software, such as Terrain Navigator
- LCD projector

PROCEDURES

The exercises below can be run one at a time or as stations in a Measuring Marathon activity.

Estimating distance and area by pacing

1. In the school yard or in a hallway, use a measuring tape to lay out one or several lines or strings that are 10 meters long.
2. Practice walking in a normal manner, using a comfortable length of step.
3. Start at the beginning of the line. Walk along the string, count the number of steps it takes to reach the end.
4. Divide the number of steps by 10 to find the length of your pace in meters.
5. Repeat three times and estimate your average pace from the three trials.
6. Put out a 25 meter string. Have students estimate the length of the string.
7. In a wide-open part of the school yard, mark off an area of one acre with pin flags. An acre is a square with 640-foot sides.

Using Measuring Tapes To Lay Out A Rectangle

1. Locate a place in the school yard where groups of students can lay out 8 by 10 meter rectangles. Make up student kits that include a measuring tape, string, four coded pin flags, and a marking pen. Divide students into groups of 3 or 4. Push the A pin flag into the ground as a corner of your rectangle.
2. Using the measuring tape, start at the A corner and measure a line that is 10 meters long. Push in the B pin flag to mark a second corner. Run a string between the two corners. Use the measuring tape to mark a spot on the string that is 3 meters from the B corner.





3. Starting at the B corner, use the measuring tape to measure a second side of your rectangle that is 8 meters long. Estimate the right angle for now. Put the C pin flag in the ground to mark the third corner.
4. Put another string between corners B and C. Make a mark on the new string that is 4 meters from corner B.
5. Have one group member take one end of the measuring tape and hold it on the mark on the string that is 3 meters from corner B. Another group member should walk to the other string and the mark that is 4 meters away from corner B.
6. Measure the distance between the two marks on the strings. If it is not 5 meters, have one group member go to flag C. Keeping the string tight, move the C flag from side to side until the distance between the two marks on the strings is 5 meters.
7. Use the same technique to lay out the two remaining sides of the rectangle.

THREE SCHOOLYARD ACTIVITIES FOR GPS RECEIVERS

Flag Finder

1. Before class, scatter between 6 and 12 coded pin flags around the school yard. Write down the coordinates and letter code for each flag.
2. Students should have a data sheet and GPS. Have the students walk around the school yard and record the locations of as many pin flags as they can. Post the correct coordinates in the classroom and have students check their accuracy. Remember that tenths of seconds are important!

Testing GPS Accuracy

1. In the school yard, lay out several 30 meter measuring tapes running north-south, east-west, or both.
2. Stand at one end of a measuring tape and record your location with the GPS.
3. Walk to the 10-meter mark on the tape and record your location again.
4. Walk to the 30-meter mark and record your location again.
5. Use the data sheet to figure out how far the GPS said you were from the starting point at each location. Remember that each one-tenth of a degree is about 9 feet.

Where in the World is My School? Using Mapping Software

Assign groups of students a location in the school or on the school grounds. Have each group record the coordinates for places like the front door, a corner of the building, the library, the corner of the playground, or the principal's desk.

When students return, either download the data from the GPS receivers into the computer using a cable connection, or enter the coordinates of each location by hand.

Project the results on a screen. How accurate is the GPS?





EVALUATION:

Evaluate each student as they go through the activities. Students should be able to set up a density plot on the field trip and to locate one of the corners with a GPS receiver.

Students should be able to use their pace to find a distance with no more than 20 percent error.

Students will be able to lay out a rectangle with square corners.

Students should be able to accurately locate points with a GPS receiver and record the coordinates.

POTENTIAL RESOURCES:

<http://www.state.de.us/planning/coord/dgdc/lessonplan1.htm>

<http://www.mercat.com/QUEST/Intro.htm>

<http://www.volunteertaskforce.org/lessonplans> (PowerPoint presentation on GPS)



Name _____



Measuring the Earth from the Ground Up
Assessment Questions

Comprehensive Paragraph: Explain how latitude and longitude were calculated by 16th Century explorers and how they are determined in today's world.

Matching:

- | | |
|--------------|---|
| Latitude | a. a set of numbers that describes your location on or above the earth |
| Longitude | b. a global navigation system based on 24 or more satellites orbiting the earth at an altitude of 12,000 statute miles and providing very precise, worldwide positioning and navigation information 24 hours a day. |
| Coordinate | c. the degrees measure of how far east or west of the prime meridian a location is on Earth. |
| GPS Receiver | d. consists of the circuitry necessary to receive the signal from a single GPS satellite. |
| GPS | e. the degree measure of an angle whose vertex is the center of the Earth and one side is a radius to the equator. Used to indicate the location of a place with reference (north or south) to the equator. |

True or False:

- GPS can only be used on land and not on water (like an ocean) since water cannot be magnetized.
a. True b. False
- Since Global Positioning Systems (GPS) are a relatively new invention they are only accurate to within 100-500 feet.
a. True b. False

Fill in:

- GPS receivers are used in conjunction with _____ to determine latitude and longitude.
- Latitude refers to distances north and south of the _____.
- Greenwich Meridian refers to the 0-degree of longitude. In which country is meridian located? _____.



MEASURING THE EARTH FROM THE GROUND UP
ASSESSMENT TEACHER MASTER SHEET



TEACHER MASTER

Comprehensive Paragraph: Explain how latitude and longitude were calculated by 16th Century explorers and how they are determined in today's world.

Early explorers charted the skies: moon, stars, planets, in conjunction with horizon and season. Today location is measured with computer technology.

Matching:

Latitude e

Longitude c

Coordinate a

GPS Receiver d

GPS b

True or False:

1. GPS can only be used on land and not on water (like an ocean) since water cannot be magnetized. False
2. Since Global Positioning Systems (GPS) are a relatively new invention they are only accurate to within 100-500 feet. False

Fill in:

GPS receivers are used in conjunction with satellites to determine latitude and longitude.

Latitude refers to distances north and south of the equator.

Greenwich Meridian refers to the 0-degree of longitude. In which country is the meridian located? England



Flag Finder

Record the longitude and latitude of the pin flags:

A) N _____ W _____ E) N _____ W _____

B) N _____ W _____ F) N _____ W _____

C) N _____ W _____ G) N _____ W _____

D) N _____ W _____ H) N _____ W _____

Testing GPS Accuracy

Coordinates of N _____

Coordinates at 10 meters: N _____

the starting point: W _____

W _____

Each 1/10 degree equals 9 feet:

Distance you traveled north from start _____

Distance you traveled west from start _____

Coordinates at 30 meters: N _____

W _____

Distance you traveled north from start _____

Distance you traveled west from start _____

Where in the World is My School?

Where I took coordinates: _____

Coordinates: N _____

W _____



PREPARING FOR THE FIELD TRIP: FIELD JOURNALS AND PHOTO COLLAGES



FOCUS QUESTIONS

How can we best organize the data collected on a field trip? What are the basics of taking a photograph that we can use to make a photo collage?

OVERVIEW OF LESSON PLAN

This lesson will prepare students for organizing their observations and data collected on the field trip. Students will prepare and organize a field journal they will include data sheets needed on the field trip. Students will learn how to organize observations made in burned and unburned forests by using a Venn diagram. Using basic photography skills, they will prepare for taking a series of photos in the field to use in creating a photo collage.

SUGGESTED TIME ALLOWANCE: 2 hours

LOCATION: Classroom

SUBJECT AREAS: Social Studies, Science, Language Arts, Technology

STUDENT OBJECTIVES

Students will:

- Create a field journal and understand the importance of keeping a well-organized record
- Understand how a Venn diagram can organize thoughts, observations, and feelings
- Learn basic photography techniques to use in a series of photographs for a photo collage

VOCABULARY

Observations
Venn diagram
Joiners

MATERIALS

- Pencils
- Photocopied field journal sheets (provided at the end of this lesson) for each student, teacher, and chaperone
- One package blank paper and one package lined paper
- Colored paper, card stock or cardboard for journal covers
- Magic markers or colored pencils for decorating covers
- 3-hole punch
- String, binding tape, or twigs and rubber bands for binding
- Pencil on a string for each student
- Two plastic pencils sharpeners and extra pencils for field trip
- One box of large ziplock bags to rainproof journals





PROCEDURES

Creating Field Journals

1. Explain to students that field journals are an effective way to record and organize the many aspects of the information presented in this unit. Student journals can include writing, art work, data sheets, and general observations about their experiences in the field. Journals also provide a valuable assessment of student progress for teachers.
2. Distribute photocopies of all of the unit handouts and provide each student with double-sided copies. Use recycled paper if it is available. Provide five additional blank sheets of paper and five lined sheets of paper to each student.
3. Have students create front and back covers for their journals using blank sheets of paper.
4. Have students bind their journals using binding tape, hole punches and string, cardboard, or twigs bound by rubber bands threaded through holes. If they do not bind their journals, it is essential that students use a clipboard on the field trip.
5. Once journals are bound, have them decorate the covers. Have each student attach a sharpened pencil on a long string through a hole in the journal binding.
6. Have students use magic markers to write their names on the front covers of their journals.
7. Students will need a sturdy writing surface behind their field journals. Incorporate cardboard as the last page or have clipboards available for each student.

EXTENSION IDEAS

Create a journal that is used throughout the year.

Share student journals with parents at open houses and/or to educate others.

Students may choose to use their journals to create a class newsletter, resource newspaper, or a class website

Using a Venn Diagram to Organize Observations

1. Introduce students to the Venn diagram as a way to graphically organize their thoughts. Explain that the diagram is used to compare two objects, concepts, or even people.
2. After drawing a sample on the board, ask the students to draw two overlapping circles on a blank page in their field journals.
3. Ask students to identify the three areas defined in the drawing (two areas do not overlap and one area is the overlap between the two circles).



4. Explain that when comparing two things, some properties of each will be unique to that object, and that the two objects will share some characteristics. Relate this to the areas on the diagram.
5. Practice comparing two objects: friends, fruits, teachers, characters in a book, plants and animals, historic and modern forests, or surface and crown fires.

Basic Photography for a Photo Collage :

1. Write the following quote on the board: It takes time to see these pictures you can look at them for a long time, they invite that sort of looking. But more importantly, I realize that this sort of picture came closer to how we actually see, which is to say, not all-at-once but rather in discrete, separated glimpses which we then build up into our continuous experience of the world. David Hockney.
2. Share several of Hockney's photo collages (from internet resources or library books) with the class. Display a pre-made collage, not just prints and internet pictures. The ideas of a collage are more clearly seen when students can actually see and touch a collage.
3. Discuss with students why they think Hockney combined hundreds of photos for his compositions instead of just taking a single snapshot. What is unique about these compositions? What techniques of his can you use to develop your own collages?
4. Discuss what makes a good photograph. Some helpful tips are:
 - Shoot tight (close to your subject).
 - Be aware of what is in your background.
 - Watch that your fingers don't block the lens.
 - Hold the camera steady: squeeze the shutter button gently.
 - Surprise is an important ingredient in a good photograph. Photograph your subject from unexpected angles. Low angles can exaggerate the height of tall subjects or reveal unseen aspects. A shift in lateral position or any extreme viewpoint can also produce angles.

POTENTIAL RESOURCES :

<http://www.ibiblio.org/wm/paint/auth/hockney>

<http://www.getty.edu/art/sednet/resources/Look/Landscape/hockney.html>.

<http://www.mcs.csu Hayward.edu/~malek/Hockney.html>

<http://www.atandculture.com/cgi-bin/WebObjects/ACLive.woa/wa/artist?id=262>



Name _____



Preparing for the Field Trip: Photo Collages
Assessment Questions

Comprehensive Paragraph: It has been written that photography is a means of visual communication, just like a word processor, telephone, or pen and paper can be used for correspondence. What is meant by visual communication?

Matching:

- | | |
|---------------|---|
| Joiners | a. The area seen by a lens or viewfinder; or the positioning of the subject in relation to the camera shot. |
| Background | b. All objects that come from behind the subject toward the camera. |
| Camera Angles | c. An artistic composition made of various materials (such as, paper, cloth or wood) glued on a surface. |
| Photo Collage | d. Arranging something into proper proportions, especially into artistic form. |
| Composition | e. To take many photographs, and piece the prints together to recreate the scene or person. |

True or False:

Surprising the subject of a photo is never a good idea. The photographer should always allow the subject to get ready for the photo to eliminate blurriness and movement.

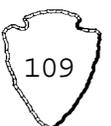
- a. True b. False

Never stand close to your subject. You always want to make sure you stand far enough away so you get the entire subject in the exact center of the frame.

- a. True b. False

Multiple Choice:

1. Photographing your subject from a low angle will make your subject seem
a. taller than normal b. shorter than normal
c. closer to the bottom of the frame d. further away than they appear
2. When taking a photo of an outdoor scene, one needs to design a plan before they actually start taking pictures; which of the following is the most important?
a. unusual shape of the objects: (ie: trees) b. color contrast
c. shadow patterns/ landscape details d. all of the above
3. When taking a photo outdoors during the daytime, where should the sun be positioned so your subject does not become silhouetted (darkened so badly you only see the outline of the subject)?
a. behind the subject b. to the left of the subject
c. to the left of the photographer d. behind the photographer



PREPARING FOR THE FIELD TRIP: PHOTO COLLAGES
ASSESSMENT TEACHER MASTER SHEET



TEACHER MASTER

Comprehensive Paragraph: It has been written that photography is a means of visual communication, just like a word processor, telephone, or pen and paper can be used for correspondence. What is meant by visual communication?

Any answer that the student develops some connection with visual responses, and how to apply these responses in a real-life situation. Students should realize that photography can be a teaching and learning tool.

Matching:

- Joiners c
- Background b
- Camera Angles a
- Photo Collage e
- Composition d

True or False:

Surprising the subject of a photo is never a good idea. The photographer should always allow the subject to get ready for the photo to eliminate blurriness and movement. False

Never stand close to your subject. You always want to make sure you stand far enough away so you get the entire subject in the exact center of the frame. False

Multiple Choice:

1. Photographing your subject from a low angle will make your subject seem?
a. taller than normal
2. When taking a photo of an outdoor scene, you need to design a plan before you actually start taking pictures; which of the following is the most important? d. all of the above
3. When taking a photo outdoors during the daytime, where should the sun be positioned so your subject does not become silhouetted (darkened so badly you only see the outline of the subject)? a. behind the photographer



KEEPING A RECORD OF YOUR WORK
EXPECTATIONS FOR FIELD JOURNALS



Reasons for keeping a journal:

- To teach you about documentation
- To help you be organized
- To have a place for your comments, observations, thoughts, questions, and reflections

Items that will be recorded in your journal:

- Data collection sheets
- Brief notes on activities done in class
- Observations and reflections
- Notes on class discussions and reading done on your own
- Assignments you are asked to do
- Anything else you choose to write that is relevant to the topic being studied

Requirements and Expectations:

- All journal pages should be numbered and both sides of the page should be used.
- All journal entries should be dated (day, month, year).
- All entries should be in pencil unless instructed otherwise.
- Pages should never be torn out.
- Journal entries should contain an interesting variety of writing styles, methods, and products including illustrations, pictures, and graphs.
- Main ideas should be clearly presented.
- Consistent use of appropriate science language and terminology should be present.
- Effective use of models, diagrams, charts, and graphs should be utilized.
- Journals should contain information on experiments (procedures used, actual data, analysis of data, and conclusions).
- Entries should be well-organized, legible, and neat.
- All notes and assignments should be completed on time.
- Organization is important a reader should be able to follow what you have written.
- All entries should be accompanied with a heading to indicate to the reader what the entry is about.

Evaluation of your journal:

Journals will be collected and graded in two week intervals.

You will be evaluated on:

1. Whether you have completed all of the assigned journaling prompts and if you have followed the above guidelines.
2. If your journal reflects a variety of thoughtful responses to the subject matter.





FIELD JOURNAL RATING SCALE

Rate as follows: 4 = Extends/Exceeds 3 = Practitioner 2 = Apprentice
1 = Novice NA = Not Applicable

JOURNAL SHEET

- | | | | | | |
|--|---|---|---|---|----|
| 1. Journal pages are numbered. | 4 | 3 | 2 | 1 | NA |
| 2. Both sides of the page are used. | 4 | 3 | 2 | 1 | NA |
| 3. Journal entries are dated (day, month, year). | 4 | 3 | 2 | 1 | NA |
| 4. All entries are in pencil unless instructed otherwise. | 4 | 3 | 2 | 1 | NA |
| 5. Pages are not torn out. | 4 | 3 | 2 | 1 | NA |
| 6. Journal entries contain an interesting variety
of writing styles, methods, and products including illustrations, pictures
and graphs. | 4 | 3 | 2 | 1 | NA |
| 7. Main ideas are clearly presented. | 4 | 3 | 2 | 1 | NA |
| 8. Consistent use of appropriate science language
and terminology is present. | 4 | 3 | 2 | 1 | NA |
| 9. Effective use of models, diagrams, charts, and
terminology is present. | 4 | 3 | 2 | 1 | NA |
| 10. Journal contains information on experiments (procedures used, actual data, analysis of data, and conclusions). | 4 | 3 | 2 | 1 | NA |
| 11. Entries are well-organized, legible, and reasonably neat. | 4 | 3 | 2 | 1 | NA |
| 12. All notes and assignments are completed on time. | 4 | 3 | 2 | 1 | NA |
| 13. Journal is organized. | 4 | 3 | 2 | 1 | NA |
| 14. All entries are accompanied with a heading. | 4 | 3 | 2 | 1 | NA |

Comments





4 = Extends/Exceeds

The student consistently meets and at times exceeds (more depth/extension with grade level work and/or performing at a higher grade level) the standard as it is described the grade level key indicators. The student, with relative ease, grasps, applies and extends the key concepts, processes, and skills of the grade level. The work is the student's best effort.

3 = Practitioner

Student's work demonstrates solid academic performance. The student regularly meets the standard as it is described in the grade level key indicators. The student, with limited errors, grasps and applies the key concepts, processes, and skills for the grade level.

2 = Apprentice

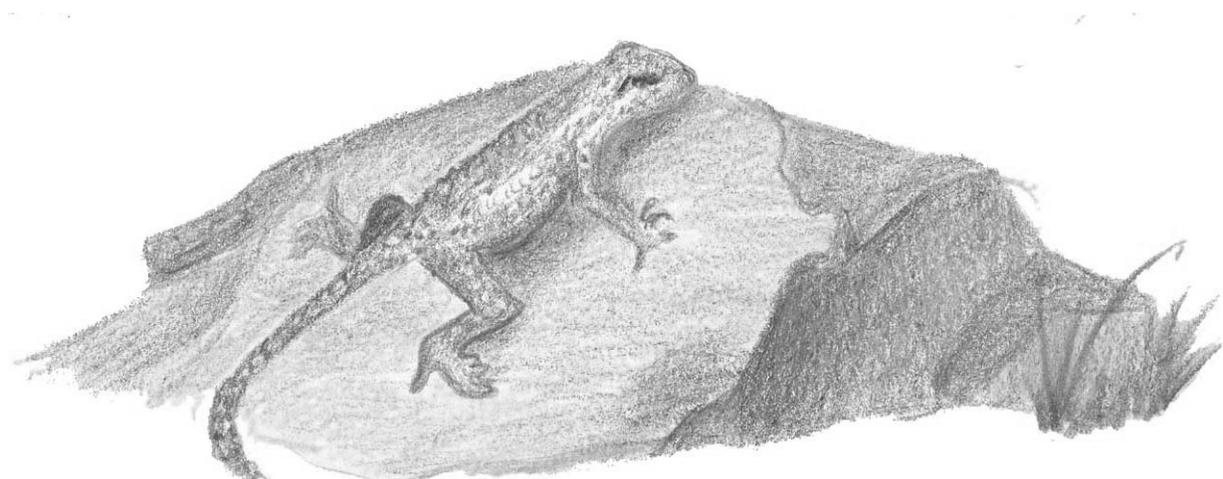
Student's work demonstrates partial mastery of prerequisite knowledge and skills that are fundamental for proficient work at the grade level. The student is beginning to, and occasionally does, meet the standard as it is described by the grade level key indicators. The student is beginning to grasp and apply the key concepts, processes and skills at the grade level but produces work that contains many errors.

1 = Novice

Student's work is yet to demonstrate partial mastery of the knowledge and skills that are fundamental for proficient work at the grade level. The student is not meeting the standard as it is described by the key indicators for this grade level. The student is working on key indicators that are one or more years below grade level.

NA = Not Applicable

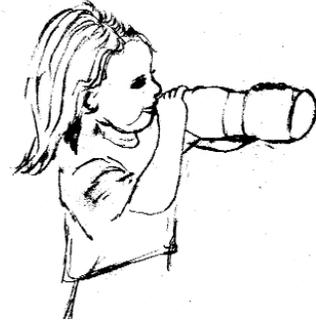
This particular concept has not yet been taught or is not yet ready for evaluation.



Safety is first and foremost. Safety concerns change as forest succession proceeds. In the early stages of succession, root burn-out and falling rocks are issues to be dealt with. As the trees begin to fall, hazard trees and ground litter become important. Other hazards are present regardless of the stage of succession: lack of water, poisonous plants and animals, rolling rocks, and tripping hazards. Below are outlined some hazards that should be discussed with the students before going into the field.

Safety Issues:

- 1) Sufficient Water: In this dry climate sufficient water is essential. Each student should bring approximately one quart of water, or water should be supplied by the field trip leader.

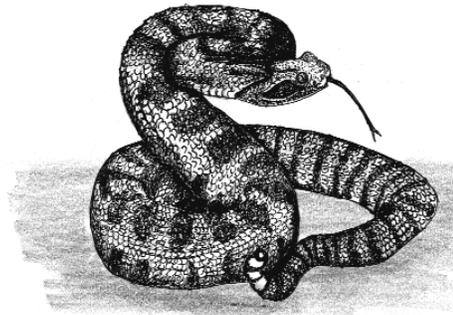


- 2) Sunburn: At high elevations the sun is intense. Sunscreen on exposed skin surfaces should be encouraged.

- 3) Poisonous Plants: Poison ivy causes rashes and sprouts after a fire. Leaves of three, let it be is a good motto.



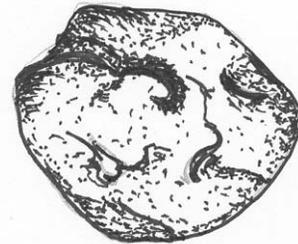
- 4) Poisonous Snakes: Most snakes are not poisonous; however, the Prairie Rattlesnake can be present in forests. The best defense is moving the group away from any snake that is found. Do not kill any snakes.



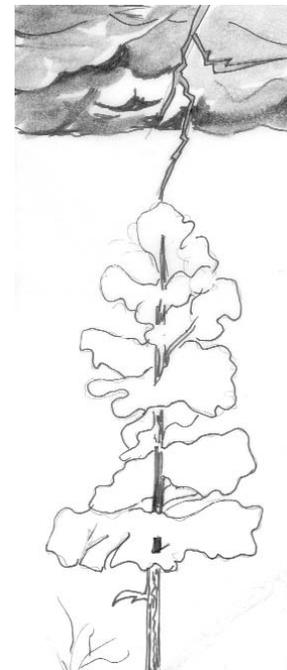
- 5) Hazard Trees: Trees that are leaning or have snapped off are considered hazard trees. Activities should not be done in a burned area when there are winds.



- 6) Rolling Rocks: Immediately after a fire there is not much vegetation to hold rocks on slopes. When a rock is loosened the student should yell Rock, warning anyone below them of the rock hazard.



- 7) Lightning: It is not safe to be on mesa tops or under trees during lightning storms. Lightning can strike you directly or indirectly through nearby objects. Take shelter in a building if a lightning storm arrives during your field trip.





PLANT SCAVENGER HUNT CHECK LIST

JOURNAL SHEET

Shrubs

- Gambel Oak *Quercus gambelii*
- Mountain Mahogany *Cercocarpus montanus*
- Gooseberry *Ribes cereum*
- Wild Rose *Rosa woodsii*
- Raspberry *Rubus strigosus*
- New Mexico Locust *Robinia neomexicana*
- Chokecherry *Prunus virginiana*

Subshrubs

- Kinnikinnik *Arctostaphylos uva-ursi*
- Mountain Lover *Pachystima myrsinites*
- Poison Ivy *Rhus radicans*

Invasive Plants

- Cheatgrass *Bromus tectorum*

Non-native Plants

- California Poppy
- Blue Flax *Linum lewisii*

Native Plants

RED FLOWERS:

- Indian Paintbrush *Castilleja integra*
- Scarlet Bugler *Penstemon barbatus*
- Scarlet Trumpet *Ipomopsis aggregata*

PURPLE FLOWERS:

- Gayfeather *Liatris punctata*
- Wild Onion *Allium cernuum*
- Townsend's Aster *Townsendia incana*
- Aster *Aster* spp
- Daisy *Erigeron* spp
- James geranium *Geranium caespitosum*
- Beardtongue *Penstemon* *Geranium caespitosum*





YELLOW FLOWERS:

- Goldenrod *Solidago* app
- Wild Chrysanthemum *Bahia dissecta*
- Snakeweed *Gutierrezia sarothrae*
- Pinque *Hymenoxys richardsonii*
- Mullein *Verbascum thapsus*
- Mustard *Sisymbrium altissimum*
- Rocky Mountain Bee-Plant *Cleome serrulata*

WEEDY OR GREEN TO BLUEGREEN:

- False tarragon *Dracunculus*
- Chenopods *Cheapodiaim* app
- Sage *Artemisia ludriciana*

WHITE FLOWERS:

- Pussytoes *Antennaria parvifolia*
- Fleabane Daisy *Erigeron divergens*

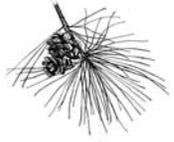
Grasses

- Mountain Muhly *Muhlenbergia montana*
- Little Bluestem *Andropogon scoparius*
- Slender Wheatgrass *Trachycaulum*
- Bromus

Trees

- Limber Pine *Pinus flexilis*
- Ponderosa Pine *Pinus ponderosa*
- Aspen *Populus Tremuloides*





PLANT SCAVENGER HUNT OBSERVATIONS

Use this sheet to draw and label two native plants of your choice.

JOURNAL SHEET





JOURNAL SHEET



Common name refers to the name people in a region call the plant. Often these names express characteristics of the plant. Common names present a problem because the same name is often applied to more than one plant.

Scientific name refers to the name the scientific community has given to the plant.

Location refers to the specifics of where the plant was found.

Habitat refers to specific details of micro-habitat. Important points are type of soil or other substrate (sand, clay, granite, dead wood, other vegetation), associated species, moisture, and aspect (fully exposed on a south facing bank; in a damp hollow under dense scrub, etc.).

Description of plant includes everything about the plant that is not obvious on the identification sheet. Essential items are the height, type of bark, whether the stem is upright, sprawling or drooping, obvious smells, whether the plant is clumped, single or growing in patches, and the presence of creeping or underground stems. Flower and fruit color should also be noted as these often fade on dried specimens.

Surrounding vegetation also helps describe the site. For example Surrounded by scrub oak with an abundance of asters nearby.

Date refers to the day the plant is observed or collected.



PLANT DATA SHEET



JOURNAL SHEET

Name of student: _____ Date: _____

Common name of plant: _____

Scientific name of plant: _____

Location: _____

Habitat: _____

Surrounding vegetation: _____

Description of plant:

PLANT DATA SHEET

Name of student: _____ Date: _____

Common name of plant: _____

Scientific name of plant: _____

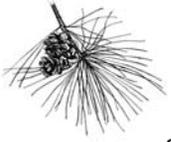
Location collected: _____

Habitat: _____

Surrounding vegetation: _____

Description of plant:





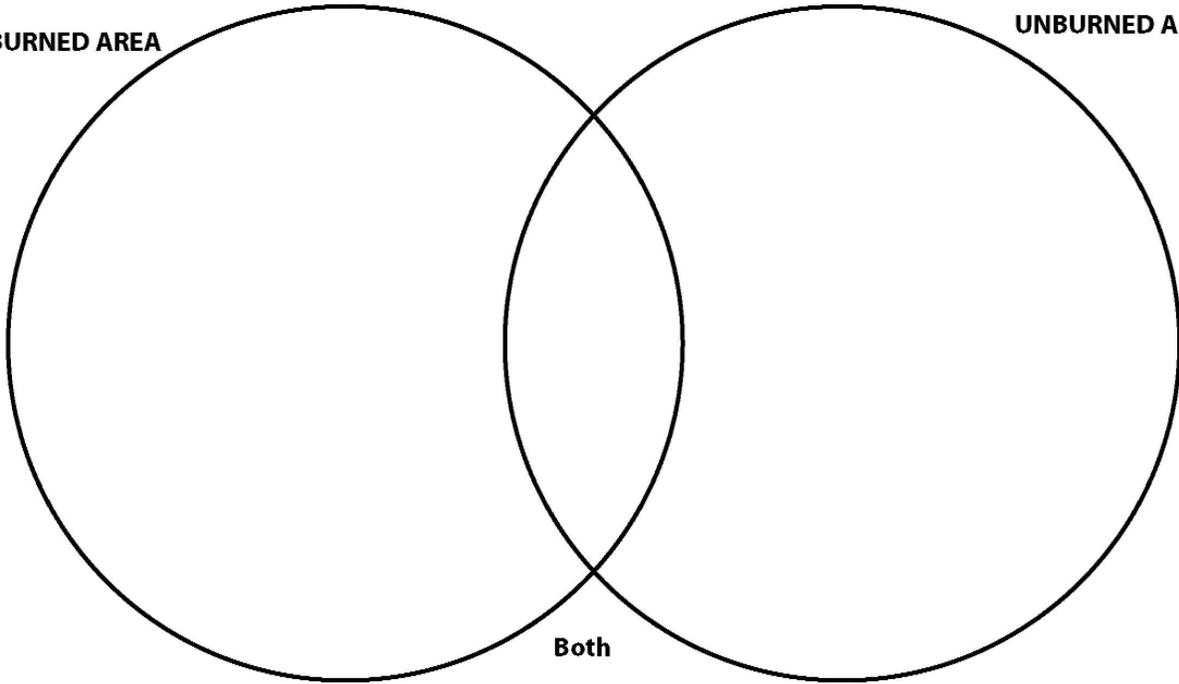
JOURNAL SHEET

OBSERVATIONS IN BURNED AREA

Name: _____ Date: _____

BURNED AREA

UNBURNED AREA



Horizontal lines for writing observations.