



FIRE ECOLOGY CURRICULUM

USDA Forest Service
Southwestern Region



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Objectives:

- Build an educated and involved public
- Create support within the local community
- Reach future leaders with our messages
- Enhance our presence in the community
- Build a foundation of understanding about scientific principles related to fire's role in the ecosystem and Forest Service management
- Enhance classroom instruction while supporting state education standards

Benefits for Southwestern Region, Forest Service:

- Foster public involvement in forest activities and decision making
- Gain community support for forest programs and management techniques
- Educate future leaders about the Forest Service mission
- Enhance Forest Service presence in the community

Benefits for Schools:

- Supports academic standards
- Supports improving math, writing, reading and science skills
- Provides opportunities for exciting, hands-on lessons
- Demonstrates real-world applications of textbook lessons
- Augments regular classroom instruction
- Provides opportunities for students to learn about a range of potential careers



Key Messages:

(Each lesson is correlated not only to Arizona and New Mexico educational standards, but also to the following Key Messages.)



The National Forests of the USDA Forest Service Southwestern Region provide superior stewardship for current and future generations through the practice of ecosystem management.

- A. The Forest Service applies the fundamental principles of science and ecology in order to better understand and manage forest ecosystems.
 - 1. Fire has a natural role in the ecosystems.
 - 2. Southwestern forests are primarily limited by water availability, not light.
 - 3. Leaving nature alone has consequences, risks and trade-offs.
 - 4. All components of the environment function as a dynamic, interdependent and interrelated system.
 - 5. The study of the science of fire and its behavior is important.

- B. People are part of nature, and their actions have effects on the land.
 - 1. People need to be careful with fire.
 - 2. Public lands are unique, valuable resources for which the public has a shared responsibility in their care.
 - 3. Human development near or within forest boundaries has a long-lasting effect and brings risks and obligations.
 - 4. The complexity of managing our public lands is compounded by the numbers of people living near or within our boundaries and the increasing demands from public land users.
 - 5. There are limits to sustainable development.
 - 6. The understanding of fire suppression techniques is important.

- C. The Forest Service seeks to improve overall forest health and lessen the risk of high-intensity, destructive wildland fires by working to bring the forests closer to historic, ecological conditions.
 - 1. Prior to European settlement, Southwestern ponderosa pine forests had far fewer trees than today and had frequent, low-intensity surface fires.
 - 2. Infrequent, high-intensity fires – like those seen in mixed conifer forests of the Pacific Northwest – were not normal in ponderosa and pinyon-juniper forests before 1900.
 - 3. Forest conditions now are not natural or healthy.
 - 4. Because of unnaturally dense conditions, our forests are at risk for destructive wildland fires, insect infestations and diseases.
 - 5. In many places on Southwestern forests, conditions now are such that wildland fires can have devastating, long-lasting effects.
 - 6. The Forest Service cuts trees to accomplish specific objectives within the ecosystem such as reducing the risk of wildland fire, enhancing dwindling aspen stands, restoring grasslands, and improving forest health and wildlife habitat.
 - 7. The Forest Service manages for biodiversity, not single species.
 - 8. Doing nothing is not always the right answer. The Forest Service alone cannot know the right answer, but by collaborating with the public, we can come closer to it.
 - 9. Prescribed fire is one tool the Forest Service uses to meet ecosystem goals.

How To Use This Manual

If this is your first time giving a program to school children, please read the section below on giving an effective program. Then, review the lesson plan for the grade to which you will be presenting. Take your time reviewing the lesson plan, but don't memorize it. Put it into your own words and use your own presentation style. (Nobody likes canned speeches, especially children!) As you practice, pretend you have the kids sitting in front of you. Ask your imaginary children questions and think of ways to get them involved in the program. Remember, these programs aren't lectures. They should be interactive and fun!

Giving an Effective Program

(The following tips were adapted from "Environmental Education," by Ron Russo.)

Getting started

- Before you begin, observe the group, their energy level, their behavior, and their relationship to the teacher. Ask the teacher what the children have already learned about fire. This information can help you adjust your program to your audience.
- Start by introducing yourself and your agency. (Example: "I'm Kelly, and I'm a volunteer with the United States Forest Service.")
- Smile. This is supposed to be fun!
- Make good eye contact. Ask them for their names, their grade level, the name of their school.
- Be outgoing; engage them in conversation, but maintain control of the group!

During the Program

- Ask questions.
- Involve the kids in the program; don't just lecture.
- Give your program a sense of discovery, of learning something amazing.
- Be enthusiastic.
- Use humor.
- Use props and visual aids; make portions of the program hands-on.
- Relate the information in the program to experiences in their own lives.
- Repeat important concepts, and make sure to recap important messages again at the end of the program.
- Slow down. Adults talk at 100-120 words per minute, which makes it hard for children to understand.
- Use drama. When attention starts to wander, change the tone or loudness of your voice. You can also pick on someone, ask a question, or change your facial expression.
- Kids and adults love stories; when possible, present your information as a story.
- Be flexible and ready to adjust your program to the group.
- Observe the children as you speak; if they don't seem to understand, try explaining it again with different words.
- Especially with younger children, do not give them too many ideas at once. Present ideas one at a time, and make sure they understand before going on to the next message.
- Use language appropriate to their grade level.



General Characteristics of Children By Grade Level (Kindergarten Through Sixth Grade)



Preschool-Kindergarten

- Attention span is short; for a sit-down program, about 10 minutes.
- They are extremely experimental.
- They tend to roam and must be constantly monitored.
- They are unencumbered by adult attitudes or self-imposed restrictions.
- They are extremely tactile and sensory.
- Discipline problems minimal, but they need lots of attention.

Grades 1-3

- Attention span about 15 minutes for a sit-down program.
- They are alert, keen observers with good imaginations.
- They are beginning to absorb adult fears, concerns and restraints.
- In between major concepts, pauses to let the children digest new information are helpful.
- Discipline problems begin to emerge: competition for attention, shoving to get closer or in front of you.

Grades 4-6

- Attention span about 20 minutes for a sit-down program.
- They are very physical with lots of energy.
- Major discipline problems emerge: fighting, willful disobedience, wandering, talking.
- They are often reluctant to get involved.
- Rules and expectations must be made clear from the start.
- Avoid militaristic “ordering”; deal with them more as a parent or big brother/big sister.
- They can be testy, more demanding.
- They can assimilate major ecological concepts and discussions.

USDA Forest Service Southwestern Region

Conservation Education Program Presenter Evaluation

1. Name: _____
Title: _____
E-mail: _____
Phone:(____)_____

2. Date of your school presentation _____

3. School at which you presented _____

4. Grade(s) to which you presented (k-12) _____

5. Teacher of the class to which you presented _____

6. Number of students to whom you presented _____

7. How long did your presentation last? (Example: 55 minutes) _____

8. Considering the reaction of the students to the presentation, was the program:

Too long

Just right

Too short

9. How would you describe the reaction of the students to the program?

Positive

Neutral

Negative

(Please note any specific feedback received) _____

10. How would you describe the reaction of the teacher to the program?

Positive

Neutral

Negative

(Please note any specific feedback received) _____

11. Would you be willing to participate again in presenting this program or others to students?

yes no

Why or why not? _____

12. How would you improve this program for future use?

USDA Forest Service Southwestern Region

Conservation Education Program Teacher Evaluation

1. Name: _____
School: _____
E-mail: _____
Phone: (____) _____
2. Grade(s) Taught (k-12) _____
3. Did this program help you meet any of the required statewide curriculum standards?
___yes ___no
4. How close were this program and its associated materials to the appropriate reading and comprehension level for your students?
___Very close
___Somewhat close
___Not close
If the program was "somewhat close" or "not close" to the appropriate reading and comprehension level, is it:
___Too hard
___Too easy
5. Would you use this program again in your classroom?
___yes ___no

Why or why not? _____

6. Please rate the program on a scale of 1 to 5:

	Poor		Average		Excellent
Interactivity	1	2	3	4	5
Visual materials	1	2	3	4	5
Written materials	1	2	3	4	5
Activities	1	2	3	4	5

7. Would you recommend the USDA Forest Service Southwestern Region Conservation Education Program to other teachers? ___yes ___no
Why/why not (please note any changes you would make)? _____

8. Would you be willing to help us periodically with future research efforts to improve our educational offerings? ___yes ___no



Kindergarten Good Fire/Bad Fire



INTRODUCTION

Hi kids! My name is _____, and I work for the _____ National Forest. I hope you are ready for some fun today because I came here to have fun. It is school, though, so hopefully we'll learn something as well! We are going to be talking about fire.

LESSON

First I want to ask you a question – Is fire hot or cold? Right, fire is hot. What happens if you touch a fire? Yes, it will burn you. Have any of you ever been burned by fire? Tell us what happened and what it was like. Okay, now how many of you have seen a fire? Where did you see the fire? What was the fire doing? (Answers might include a campfire, cigarette, burning house, etc.) There sure are a lot of different kinds of fires, aren't there?

Now, I want to tell you a little story. I want you to close your eyes while I'm telling you this story so that you can "see" it in your mind. Do you know what you will be using to see the story in your mind? Your imagination! Are you ready? Close your eyes and listen closely. You and your family are walking through the forest. It's a nice day. The sun is shining, and you can feel the warmth on your skin. Can you feel how warm it is? You stop to look at the wildflowers. Can you see the wildflowers in your mind? Good. Then, all of a sudden, you smell something. (Sniff a few times. Ask the kids to sniff too, and say, "Can you smell it?") It smells like SMOKE! You look at the trees up ahead and you see a bright, orange color. Can you see it? That's where the smoke is coming from. What is that bright, orange color? It's a fire that is burning the trees!



Okay, you can open your eyes now. Boy, that got kind of scary at the end, huh? If that really happened to you, what would you do? (Listen to



FOREST SERVICE MESSAGES

- A-5:** The study of the science of fire and its behavior is important.
- B-1:** People need to be careful with fire.
- B-6:** The understanding of fire suppression techniques is important.



ACADEMIC STANDARDS



Arizona Standards

MATH

- 2M-R1:** Compare and sort objects by their physical attributes
- 6M-R1:** Sort and classify objects according to observable attributes
- 6M-R2:** Justify their answers and reasoning processes

SCIENCE

- 1SC-R1:** Identify and use safe procedures in all science activities
- 1SC-R2:** Ask questions about the natural world (e.g., How do trees grow? Why is the sky blue? Where does rain come from?)
- PO 1:** Formulate questions about objects, organisms, events and relationships in the natural world
- 1SC-R3:** Categorize objects, organisms and events in different ways
- PO 1:** Organize (e.g., sort, classify, sequence) objects, organisms and events by different characteristics
- 1SC-R6:** Communicate observations and comparisons through various means such as pictographs, pictures, models and words
- PO 1:** Describe observations with pictographs, pictures, models and words
- PO 2:** Describe similarities and differences of observations

LANGUAGE ARTS

- LS-R1:** Tell or retell a personal experience or creative story in a logical sequence
- LS-R3:** Share ideas, information, opinions and questions
- LS-R5:** Participate in group discussions

ART

- 1AT-R2:** Develop sensory perception and the ability to describe mental pictures by recalling objects and/or events (e.g., use words, movement, or drawings in a

the kids' answers. Depending on what they say, you should mention telling a Forest Service ranger, calling 911, telling a police officer, etc.)



I'd like everyone to get up out of your chairs. Come over here and form a circle. I am going to show you a bunch of items I brought with me, and I am going to have you tell me whether or not they will burn. (Put items in a "will burn" or a "won't burn" pile.)

These are the items:

Burn

- a pine cone
- a piece of wood
- pine needles
- cardboard
- a t-shirt
- paper
- a leaf
- dried grass

Won't Burn

- a small glass bottle
- a rock
- a wrench
- a coin
- dirt (in a small bottle)

Good job! Look at how many things in the forest burn! (Pick up the cone, needles, leaf, grass and wood.) That's why a forest fire burns so hot – because almost everything in the forest can burn.

(Pick up the t-shirt.) What should you do if your clothes catch on fire? Stop, drop and roll. Then go see a doctor. If you or someone else gets hurt and needs help, you should tell an adult or call "911" on the phone.

ACTIVITY



Good-fire



Bad-fire

Fires can either be bad or good. It depends on what kind of fire it is and what its effects are.

variety of ways to illustrate things seen, heard, felt, tasted, or smelled in class or home experiences or created after listening to stories told or read)

After a discussion about mental imaging on specific sensory stimuli:

PO 1: Describe a recalled sensory experience

HEALTH

1CH-F5: Describe how environmental health and personal health are related

2CH-F7: Identify when and how to seek emergency medical assistance and shelter

PO 1: Demonstrate how to contact parents and/or emergency services in emergency situations

PO 2: Recall emergency numbers

New Mexico Standards

MATH

Strand: Algebra

Standard: Students will understand algebraic concepts and applications.

K-4 Benchmark: Understand patterns, relations, and functions.

Grade K Performance Standards

1. Identify the attributes of objects (e.g., the ability to identify attributes is a foundational skill for sorting and classifying).
2. Sort, classify, and order objects by size, number, and other properties.

Strand: Data Analysis and Probability

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

K-4 Benchmark: Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.

Grade K Performance Standards

1. Collect data about objects and events in the environment to answer simple questions (e.g., brainstorm questions about self and surroundings, collect data, and record the results using objects, pictures, and pictographs).

SCIENCE

Strand I: Scientific Thinking and Practice

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

Now I have another question for you: Is fire “bad” or is fire “good”? Well, fire can actually be both good and bad. Let’s play a game to find out which fires are good and which are bad. (Begin “Meet the Fire Education Team, Good Fire Bad Fire” activity. Depending on how much time you have left, you could just go through the cards quickly or spend more time on them.)



Now that we know about good fires and bad fires, let’s do an activity together. (Pass out “Good Fire, Bad Fire” Activity Sheet.) We are going to draw a line from the happy flame to the good fires. Then, we’ll draw a line from the angry flame to the bad fires. (Go through this activity with the kids. Give each student a sticker for doing the activity.)

HANDOUT

(Pass out the “Coloring Book for Smokey’s Friends.” Quickly go over the Fire Safety Quiz on the first page. Tell the kids to have fun coloring the pictures and to ask their teacher or family members to read it with them.)

CLOSING

I had a great time with you today, and I hope you did too. I also hope you learned a lot about fire. Remember what Smokey says: “Never play with matches,” and “Always be careful with fire.” To help you remember that fires can be bad or good, I’m going to leave your class this poster called “Fire in Nature.” I hope you’ll put it up on your wall so that you will remember what we talked about today.

SUPPLIES

- Pine cone
- Small glass bottle
- Piece of wood
- Rock
- Pine needles
- Wrench
- Piece of cardboard
- A coin
- A t-shirt
- Dirt (in a small, glass bottle)
- Piece of paper
- Leaf
- Dried grass



K-4 Benchmark I: Use scientific methods to observe, collect, record, analyze, predict, interpret, and determine reasonableness of data.

Grade K Performance Standards

2. Ask and answer questions about surroundings and share findings with classmates.

K-4 Benchmark II: Use scientific thinking and knowledge and communicate findings.

Grade K Performance Standards

1. Communicate observations and answer questions about surroundings.

Strand II: Content of Science

Standard I (Physical Science): Understand the structure and properties of matter, the characteristics of energy, and the interactions between matter and energy.

K-4 Benchmark I: Recognize that matter has different forms and properties.

Grade K Performance Standards

1. Observe that objects are made of different types of materials (e.g., metal, plastic, cloth, wood).
2. Observe that different materials have different properties (e.g., color, odor).

LANGUAGE ARTS

Strand: Writing and Speaking for Expression

Content Standard II: Students will communicate effectively through speaking and writing.

K-4 Benchmark II-A: Demonstrate competence in speaking to convey information.

Grade K Performance Standards

1. Retell, reenact, or dramatize stories or parts of stories, including personal events.
2. Use correct words to name objects or tell actions.
3. Use speaking skills to connect experiences by:
 - listening to and retelling stories
 - discussing and dramatizing stories
 - discovering relationships
 - taking turns, expressing ideas, and asking questions
5. Ask questions to resolve confusion about a topic.

ART

Content Standard 2: Use dance, music, theatre/drama, and visual arts to express ideas.

Visual Arts

A. Explore and understand works of art based on self, family, community and the world.

2. Participate in a variety of reflective processes (individual tasks, group discussions, journaling, portfolio and display).

- “Meet the Fire Education Team, Good Fire Bad Fire” Activity Kit
 - Available through National Symbols Catalog
 - A complete educators’ guide for a lesson on the difference between good fires and bad fires, also includes basic fire safety tips. The kit includes presentation instructions, color Fire Education Team poster, flash cards (showing good and bad fires), activity worksheets and award stickers.
- Award stickers from activity kit
 - Comes in the Good Fire Bad Fire Activity Kit
- “Good Fire, Bad Fire” Activity Sheets (one for each student)
 - Comes in the Good Fire Bad Fire Activity Kit
- Coloring Book for Smokey’s Friends (one for each student)
 - Available through National Symbols Catalog
 - Eight-page, black and white coloring book for children; perfect for classrooms and community youth groups as a bright reminder to Smokey Bear’s helpers in fire prevention. Book includes a fire safety quiz helping children learn five rules of fire prevention education.
- Fire in Nature poster (one for each class)
 - Available through National Symbols Catalog
 - An animated poster featuring the “Fire Education Team” and the wildland fire cycle in nature. An intro to the “Fire in Nature” poster series designed for a younger audience.



HEALTH EDUCATION

Standard 1: Students will comprehend concepts related to health promotion and disease prevention.

4. Students will describe how physical, social, and emotional environments influence personal health.

Standard 2: Students will demonstrate the ability to access valid health information and health promoting products and services.

4. Students will demonstrate the ability to locate school and community health helpers.

FOREST SERVICE CONSERVATION EDUCATION LEARNER GUIDELINES

Program title: Good Fire/Bad Fire

Target audience: Kindergarten

Primary topic: Different kinds of fire.

Length of program: 30 minutes

Setting: indoors or outdoors

Guidelines addressed are referenced here:

K-4
I. Questioning and Analysis Skills
A1, A3, E1
II. Knowledge of Environmental Processes and Systems
1.
2.
3. D1
4.
III. Skills for Understanding and Addressing Environmental Issues
1.
2.
IV. Personal and Civic Responsibility
B2, D2



First Grade

Fire and the Animals of the Forest



INTRODUCTION:

Good morning/afternoon! My name is _____, and I work for the _____ National Forest. Today we are going to talk about animals in the forest and what happens to them when there is a fire. What animals have you seen in the forest?

LESSON

First, though, I need to tell you a little bit about fire. Does anyone know how many seasons there are in a year? There are four – summer, fall, winter and spring. Summer is hot and dry, and that is when you get to go swimming, play in the sprinklers and be outside a lot. Fall usually has warm days and cool nights. The leaves turn colors on the aspens and oaks and then fall to the ground. Do any of you help clean up leaves in your yards at home? Winter is cold, and we could get snow. The nights are very cold, and there is usually ice on everything outside in the early morning. That is called frost. When spring comes, the days start getting longer and the trees start leafing out again and it is usually very windy. What season is it now?

Now I have something to tell you that is going to really surprise you. There is a fifth season! Well, sort of. There is a fifth season



There are lots of animals in the Southwestern ponderosa pine forest. These animal species have evolved with fire and have their own techniques to escape during a fire.

Coyote pups
 Photo by Walter and Phyllis Crick



FOREST SERVICE MESSAGES

- A-1:** Fire has a natural role in the ecosystem.
- A-4:** All components of the environment function as a dynamic, interdependent and interrelated system.
- A-5:** The study of the science of fire and its behavior is important.
- C-7:** The Forest Service manages for biodiversity, not single species.



ACADEMIC STANDARDS



Arizona Standards

HEALTH

- 1CH-F5:** Describe how environmental health and personal health are related
- 2CH-F7:** Identify when and how to seek emergency medical assistance and shelter
- PO 1:** Demonstrate how to contact parents and/or emergency services in emergency situations
- PO 2:** Recall emergency numbers

SOCIAL STUDIES

- 3SS-F2:** Identify natural and human characteristics of places and how people interact with and modify their environment, with emphasis on:
- PO 6:** the ways in which people have used and modified resources in the local region, including dam construction, building roads, building cities, and raising crops

LANGUAGE ARTS

- 3LS-F1:** Use effective vocabulary and logical organization to relate or summarize ideas, events and other information
- 4VP-F4:** Interpret visual clues in cartoons, graphs, tables and charts that enhance the comprehension of text

ART

- 1AT-F2:** Imagine and clearly describe (e.g., through variations of movement and gesture, vocal pitch, volume and tempo) characters, their relationships, what they want and why
- PO 1:** Describe the imagined characters and their wants and needs (motivation), and basic relationships with the other characters in the scene

IF you are a fire fighter! Fire season comes in the early spring and summer when the weather starts getting hot and dry. Fire season can be good and bad. The good that comes from forest fires is that they clean up our forest floor just like you help clean up the floor at home. This also helps the plants, trees and animals by bringing back new growth and getting rid of the old pine needles and little trees that take the water and food away from the bigger trees. The animals have fresh food to eat when the new plants start to grow after a fire has gone through the forest. But, fires can be bad too. Can you think of some examples

of bad fires? One example is a fire that burns down someone's house. Some fires in the forest can also be bad. If there are too many trees in the forest, the fire can get hotter and hotter and burn faster

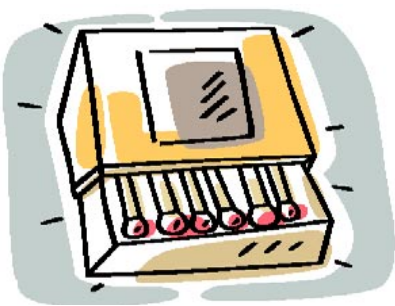


Mexican spotted owls

and faster. Think about it – doesn't a campfire get bigger if you add more wood to it? A forest fire is the same way; the more wood in the forest, the bigger a forest fire can get. When that happens, the fire can burn down everything – even the big, healthy trees that are usually able to survive a fire. As we continue today, I will explain more about fire and how it affects humans, animals, plants and trees.

Let's start by looking at the Fire Education Team Big Book! (There is a picture on one side with a description on the back that explains the picture. This should be presented in an interactive way with the kids using questions and answers.)

First, let's get to know the fire education team. (Go through names of the animals and show their pictures on page 1: Pat Pronghorn, Bert Bison, Karl Quail, Merrie Marmot, Bob Cat, Jack Rabbit, Ernie Eagle, Larry Lizard and Charlie Coyote.)



Now that we've met all the members of the fire education team, let's go on through the rest of the big book and find out what the animals want us to know about fire!

PO 2: Demonstrate the character motivations and relationships through dialogue and movement

Possible links to: Science-social perspectives

1AT-F3: As a character, play out her/his wants by interacting with others, maintaining concentration, and contributing to the action of classroom improvisations (e.g., scenes based on personal experience and heritage, imagination, literature and history)

PO 1: Develop small group improvisations based on characters' wants and needs

PO 2: Interact in role with other characters in the improvisation

PO 3: Use an imaginative range of movement and dialogue that is appropriate to the characters within the improvisation

Possible links to: Language Arts – literature; Social Studies – history

3AT-F5: Explain personal preferences for specific dramatizations

PO 1: Identify a character that one enjoyed and explain one's own reaction

SCIENCE

3SC-F3: Describe and explain the interrelationship of populations, resources and environments

PO 1: Describe populations, resources and environments (e.g., habitat, ecosystem, food chain)

PO 2: Explain interactions and interdependence among specific populations, resources and environments

4SC-F1: Describe and explain cause-and-effect relationships in living systems

PO 1: Identify cause-and-effect relationships in living systems

PO 2: Explain cause-and-effect relationships in living systems

4SC-F4: Identify characteristics of plants and animals (including extinct organisms) that allow them to live in specific environments

PO 1: Identify adaptations of plants that allow them to live in specific environments

PO 2: Identify adaptations of animals that allow them to live in specific environments

4SC-F7: Explain the interaction of living and non-living components within ecosystems

PO 1: Identify living components within ecosystems

PO 2: Identify non-living components within ecosystems

PO 3: Describe the interaction among living and non-living components in an ecosystem

6SC-F3: Identify the seasons and their characteristics

PO 1: Identify the seasons

6SC-F5: Identify major features of natural processes and forces that shape the earth's surface, including

(Focus on the information under the heading “Fire Fact.” Also, touch on some of the fun facts about the animals.)

(Example – Page 2): Ernie Eagle says, “Don’t Play with Fire.” Fires can be dangerous and hard to control. Do you know how most fires across the country are started? Most damaging wildland fires are started by children or adults. Most of these people don’t mean to start the fires. They were accidents. Have you ever done anything on accident? That’s why when you are out in the woods, you have to be really careful with fire. If you have a campfire, you should make sure that a grown-up watches the fire at all times. You should also remember that running or playing near a campfire is unsafe. When it is time to put the campfire out, make sure that the grown-up never leaves the fire until it is out cold! Some other things you can do to help protect the forest are to never play with matches; never use firewood unless an adult is watching; and remind grown-ups to never throw their cigarettes on the ground. Now that we know more about how fire can be dangerous, Ernie Eagle wants us to know a little more about himself. Does anyone know why eagles are known all around the world? That’s right – the bald eagle is the national bird of the United States!



(Go through each page. Make it interactive. Ask questions. Call the animals by their names. Show props that are applicable to each page.)

Props and applicable pages:

- Piece of wood (Slope, Fuels and Weather)
- Dry grass (Slope, Fuels and Weather)
Show the kids the piece of wood and the dry grass and ask them which one they think will burn faster. Which one will burn longer?
- Piece of ponderosa pine bark (By Adapting)
Show the kids how thick the ponderosa pine bark is and explain that it helps protect the tree from fire.

weathering and volcanic activity

- PO 1:** Identify natural forces (e.g., water, ice, wind) that shape the earth’s surface
- PO 3:** Identify natural processes (e.g., earthquake, floods, volcanic eruptions) that rapidly shape the earth’s surface
- 6SC-F6:** Describe natural events and how humans are affected by them
- PO 1:** Identify natural events that affect humans
- PO 2:** Explain how natural events impact human life



New Mexico Standards

HEALTH EDUCATION

- Standard 1:** Students will comprehend concepts related to health promotion and disease prevention.
- 4. Students will describe how physical, social, and emotional environments influence personal health.
- Standard 2:** Students will demonstrate the ability to access valid health information and health promoting products and services.
- 4. Students will demonstrate the ability to locate school and community health helpers.

SOCIAL STUDIES

Strand: Geography

- Content Standard II:** Students understand how physical, natural, and cultural processes influence where people live, the ways in which people live, and how societies interact with one another and their environments.
- K-4 Benchmark II-B:** Distinguish between natural and human characteristics of places and use this knowledge to define regions, their relationships with other regions, and patterns of change.

Grade 1 Performance Standards

1. Identify and classify characteristics of places as human or natural.

- K-4 Benchmark II-C:** Be familiar with aspects of human behavior and man-made and natural environments in order to recognize their impact on the past and present.

Grade 1 Performance Standards

1. Identify examples of and uses for natural resources in the community, state, and nation.
2. Describe the human characteristics of places such as housing types and professions.

- K-4 Benchmark II-F:** Describe how natural and man-made changes affect the meaning, use, distribution, and value of resources.

Grade 1 Performance Standards

1. Describe the role of resources in daily life.

ACTIVITY

(Note: This activity was adapted from “Activity 6-7. Great Escape” from “FireWorks Curriculum: Featuring Ponderosa, Lodgepole, and Whitebark Pine Forests.”



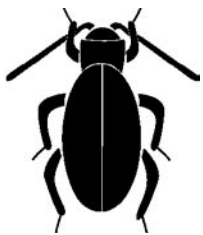
Horned lizard

http://www.fs.fed.us/rm/pubs/rmrs_gtr65.pdf)

Now that we’ve learned a little about fire, let’s play a game that will help us understand even better how fire affects the animals in the forest! We are going to play the Great Escape Game! This is how it works. Someone is going to pretend that they are a certain animal. They will have to act like the animal would act. Then, the person has to act out what the animal would do if there were a fire. Then, we all have to guess which animal we think that person is acting like. So, the animals we have to choose from are the Fire Education Team animals. I’ll put the names of all the animals up here on the board so that we can remember all nine of them. Now, I need nine volunteers. (Pick nine students. Take the students to the side. Pass out the Fire Education Team playing cards. Each student should receive one. The card that the student is holding is the one that they will act out.) Now, you have to really act like the animal would act! Then, I’ll ask you to show us – without using any words or sounds – what the animal would do if a fire started. Then, we’ll give the rest of the class a chance to guess! (Go through each of the nine volunteers and let the class figure out which animal is being acted out. After the class guesses the right animal, explain what that animal does when there is a fire. Information on this is available on the back of each animal card.)

CLOSING

So, you see that there are lots of ways that animals in the forest have adapted to deal with fire. Fire is a normal occurrence in the forest. That’s why animals have developed ways to live through it. What should you do if there is a fire? Also, fires actually help a lot of the animals by providing food. For example, Merrie Marmot likes to eat the tender new plants that grow after a fire.



2. Describe ways that humans depend upon, adapt to, and affect the physical environment.

LANGUAGE ARTS

Strand: Reading and Listening for Comprehension

Content Standard I: Students will apply strategies and skills to comprehend information that is read, heard, and viewed.

K-4 Benchmark I-A: Listen to, read, react to, and retell information.

Grade 1 Performance Standards

1. Listen to and retell short stories.
6. Follow simple written and oral instructions.
7. Increase vocabulary through reading, listening, and interacting.

ART

Content Standard 1: Learn and develop the essential skills and technical demands unique to dance, music, theatre/drama, and visual arts.

Theatre

- A. Use body and voice to portray character that contributes to the action of a dramatization.
 1. Demonstrate the ability to concentrate and stay in character for the duration of short improvised dramatizations.
 2. Participate within the range of all students’ abilities.
- C. Select characters, environments, and situations for dramatizations.
 1. In small or large group discussions, describe in detail what they imagine characters in their dramatizations look like, how they behave, how they feel about other characters, and where they live.

Content Standard 5: Observe, discuss, analyze, and make critical judgments about artistic works.

Theatre

- B. Explain how wants and needs of characters are different from their own.
 1. In class discussions or in writing, describe their emotional reactions to and personal preferences about a performance, relating their reactions to their sensory perceptions, personal experiences and knowledge of the subject or topic of the play.

SCIENCE

Strand II: Content of Science

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

HANDOUT

A few sets of The Fire Education Team playing cards for the classroom. Smokey and Friends “What is a Forest” coloring sheets (one per student). One “Fire in Nature” poster for the classroom.

SUPPLIES

- Fire Education Team Big Book (one)
 - Available through National Symbols Catalog
 - Eighteen large graphical descriptions of basic wildland fire principles. Great for group presentations! It expands on lessons of the “Good Fire/Bad Fire” Fire Activity Kit and introduces the
- Piece of wood
- Dry grass
- Piece of ponderosa pine bark
- Fire Education Team playing cards (5 sets)
 - Available through National Symbols Catalog
 - Sheets of 10 perforated cards of the animals in the Fire Education Team. Card backs describe each animal species and how they respond to wildland fire.
- Smokey and Friends “What is a Forest” coloring sheets (one per student)
 - Available from <http://www.smokeybear.com/resources.asp>
- “Fire in Nature” poster (one per classroom)
 - Available through National Symbols Catalog
 - An animated poster featuring the “Fire Education Team” and the wildland fire cycle in nature. An intro to the “Fire in Nature” poster series designed for a younger audience.



K-4 Benchmark I: Know that living things have diverse forms, structures, functions, and habitats.

Grade 1 Performance Standards

1. Know that living organisms (e.g., plants, animals) have needs (e.g., water, air, food, sunlight).
2. Know that living organisms (e.g., plants, animals) inhabit various environments and have various external features to help them satisfy their needs (e.g., leaves, legs, claws).
3. Describe the differences and similarities among living organisms (e.g., plants, animals).
4. Observe that living organisms (e.g., plants, animals) have predictable but varied life cycles.

Strand II: Content of Science

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

K-4 Benchmark II: Know that living things have similarities and differences and that living things change over time.

Grade 1 Performance Standards

1. Identify differences between living and nonliving things.
2. Recognize the differences between mature and immature plants and animals (e.g., trees/seedlings, dogs/puppies, cats/kittens).

FOREST SERVICE CONSERVATION EDUCATION LEARNER GUIDELINES

Program title: Fire and the Animals of the Forest

Target audience: First Grade

Primary topic: Animals' adaptations to fire in the forest.

Length of program: 45 minutes

Setting: indoors or outdoors

Guidelines addressed are referenced here:

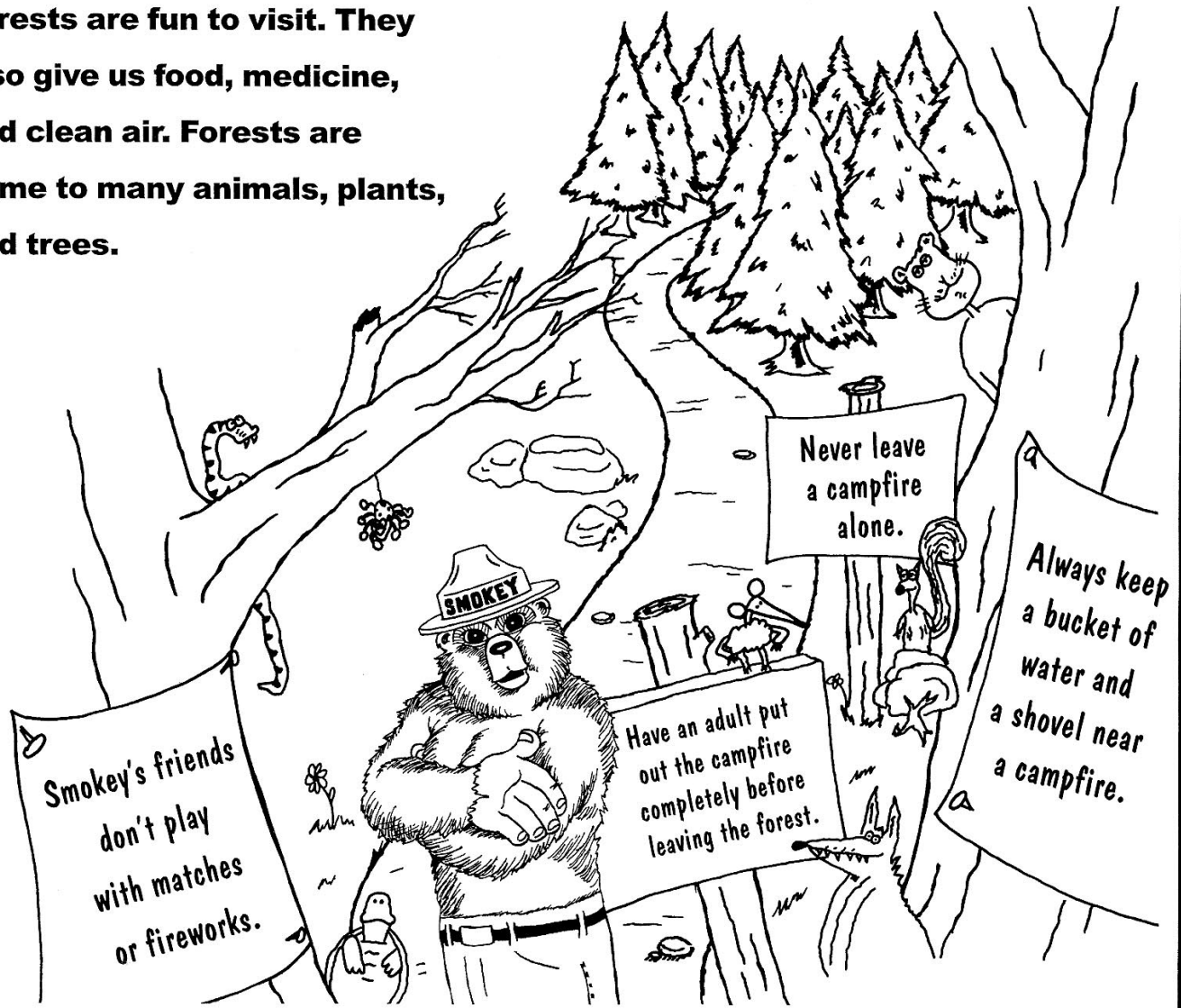
K-4
I. Questioning and Analysis Skills
A1
II. Knowledge of Environmental Processes and Systems
1. A3
2. C1, C2
3.
4.
III. Skills for Understanding and Addressing Environmental Issues
1.
2.
IV. Personal and Civic Responsibility
D2





What is a Forest?

Forests are fun to visit. They also give us food, medicine, and clean air. Forests are home to many animals, plants, and trees.



What do you like best about forests?



Second Grade The Fire Triangle



INTRODUCTION

Hi kids! My name is _____, and I work for the _____ National Forest. We're going to do some neat stuff today, and I want everyone to get involved! We'll be learning about fires, about our forest, and about how people can change the forest.

LESSON

I want to start by asking you a question – how are fires started? (The kids will probably have a lot of answers such as matches, campfires, etc. If they only mention human-caused ways, ask them about how nature can start fires – examples include lightning and volcanoes.) So, people and nature can start fires.



Forest Service employee teaches students about the fire triangle.

Now, who can tell me the three things that are needed for a fire to burn?

First, you need something to burn – we call this fuel. (Have a small limb and a piece of paper to show them.) Can both of these things burn? Yes! So, they are both fuels.

Then, you need something hot to get the fire going. (Have matches and a cardboard cutout of a lightning bolt to show the



FOREST SERVICE MESSAGES

- A:** The Forest Service applies the fundamental principles of science and ecology in order to better understand and manage forest ecosystems.
- B:** People are part of nature, and their actions have effects on the land.
- A-5:** The study of the science of fire and its behavior is important.
- C-3:** Forest conditions now are not natural or healthy.
- C-4:** Because of unnaturally dense conditions, our forests are at risk for destructive wildland fires, insect infestations and diseases.



ACADEMIC STANDARDS



Arizona Standards

HEALTH

- 1CH-F5:** Describe how environmental health and personal health are related
- 2CH-F7:** Identify when and how to seek emergency medical assistance and shelter
- PO 1:** Demonstrate how to contact parents and/or emergency services in emergency situations
- PO 2:** Recall emergency numbers

SOCIAL STUDIES

- 3SS-F2:** Identify natural and human characteristics of places and how people interact with and modify their environment, with emphasis on:
- PO 6:** the ways in which people have used and modified resources in the local region, including dam construction, building roads, building cities, and raising crops

SCIENCE

- 2SC-F3:** Understand that science involves asking and answering questions and comparing the results to what is already known
- PO 1:** Explain how asking and answering questions are part of the process of a scientific investigation
- PO 2:** Compare prior knowledge to the results of a scientific investigation
- 4SC-F1:** Describe and explain cause-and-effect relationships in living systems
- PO 1:** Identify cause-and-effect relationships in living systems

kids. Light the match.) These are both hot, right? So, both of these can be the heat that is needed to start a fire.

Finally, the third thing that you need is oxygen. Oxygen is in the air all around us (wave your arms all around).

So, if you need all of these things for a fire to burn, how do you put a fire out? You only need to take away one of these three things, and the fire will go out. Now, I will show you how this works.

DEMONSTRATION

(Take out the wooden “Fire Triangle” and put it on a table. Get the glass jar with a lid out and place a small, lighted birthday candle in the jar. Mount it in a dab of modeling clay. Seal the jar with the lid to cut off the supply of oxygen. The flame will go out.)



There are three things that have to be present for any fire to burn – heat, fuel and oxygen. If any one of these things is removed, the fire will go out.



Forest Service employee performs some experiments to show students what happens when part of the fire triangle is removed.

What just happened? That’s right! The flame used up all of the oxygen that was available in the jar, so the fire went out. Remember, you only need to take away one of the three parts of the triangle for a fire to no longer be able to burn.

- PO 2:** Explain cause-and-effect relationships in living systems
- 4SC-F7:** Explain the interaction of living and non-living components within ecosystems
- PO 1:** Identify living components within ecosystems
- PO 2:** Identify non-living components within ecosystems
- PO 3:** Describe the interaction among living and non-living components in an ecosystem
- 5SC-F2:** Demonstrate that light, heat, motion, magnetism and sound can cause changes
- PO 2:** Demonstrate that heat can cause change
- 6SC-F5:** Identify major features of natural processes and forces that shape the earth’s surface, including weathering and volcanic activity
- PO 1:** Identify natural forces (e.g., water, ice, wind) that shape the earth’s surface
- PO 3:** Identify natural processes (e.g., earthquake, floods, volcanic eruptions) that rapidly shape the earth’s surface
- 6SC-F6:** Describe natural events and how humans are affected by them
- PO 1:** Identify natural events that affect humans
- PO 2:** Explain how natural events impact human life

New Mexico Standards

HEALTH

- Standard 1:** Students will comprehend concepts related to health promotion and disease prevention.
- 4.** Students will describe how physical, social, and emotional environments influence personal health.
- Standard 2:** Students will demonstrate the ability to access valid health information and health promoting products and services.
- 4.** Students will demonstrate the ability to locate school and community health helpers.

SOCIAL STUDIES

Strand: Geography

- Content Standard II:** Students understand how physical, natural, and cultural processes influence where people live, the ways in which people live, and how societies interact with one another and their environments.
- K-4 Benchmark II-B:** Distinguish between natural and human characteristics of places and use this knowledge to define regions, their relationships with other regions, and patterns of change.
- Grade 2 Performance Standards**
 1. Describe how climate, natural resources, and natural hazards affect activities and settlement patterns.
 2. Explain how people depend on the environment and

(Open the jar, re-light the candle and put the lid back on. As the flame starts to go out, reopen the lid to let more oxygen in. The candle should re-ignite.)



Now what just happened? When air was allowed back in, the fire was able to keep burning because it had access to an oxygen supply again.

(Take the lid completely off and allow the candle to burn until all the fuel – wax – melts and the flame goes out.)

What happened this time? Why did the fire go out? The fire burned all of the fuel. Do you remember that fuel was one of the components of the fire triangle? If there is no fuel, a fire can't burn. Fire fighters use that fact to their advantage. By reducing fuels – not wax, but trees and pine needles – fire fighters can help to stop a fire from burning. There are a lot more trees in the forest than there used to be. That means that there is a lot more fuel that can burn. Have any of you heard of cutting down trees in the forest in order to reduce fire risk? We call that thinning. Because there are too many trees in the forest that can fuel a fire, we need to cut some down to make the forest healthier. What kind of things can we make with the trees that we cut down? We can build houses, make furniture (do any of you have a wood table at home?), make paper, and more. There sure are a lot of things we make from trees!

(Light another candle and put it in the jar with the lid off. Let it burn for a few seconds. Then, extinguish the flame by sprinkling some water on it.)

Now what just happened? The water took the heat away. Do you remember that heat was the third component of the fire triangle? Fire fighters use water to help put fires out. Have you seen them do this?

ACTIVITY

(Note: This activity was adapted from the “Living With Fire” chapter of “Ecosystem Matters, Activity and Resource Guide for Environmental Educators,” Pre K-2 Fire Tag.)



its resources to satisfy their basic needs.

K-4 Benchmark II-C: Be familiar with aspects of human behavior and man-made and natural environments in order to recognize their impact on the past and present.

Grade 2 Performance Standards

1. Identify ways in which people depend on natural and man-made environments including natural resources to meet basic needs.

SCIENCE

Strand I: Scientific Thinking And Practice

Standard 1: Understand the processes of scientific investigations and use inquiry and scientific ways of observing, experimenting, predicting, and validating to think critically.

K-4 Benchmark I: Use scientific methods to observe, collect, record, analyze, predict, interpret, and determine reasonableness of data.

Grade 2 Performance Standards

1. Conduct simple investigations (e.g., measure the sizes of plants of the same kind that are grown in sunlight and in shade).
3. Make predictions based on observed patterns as opposed to random guessing.
4. Follow simple instructions for a scientific investigation.

Strand II: Content of Science

Standard I (Physical Science): Understand the structure and properties of matter, the characteristics of energy, and the interactions between matter and energy.

K-4 Benchmark II: Know that energy is needed to get things done and that energy has different forms.

Grade 2 Performance Standards

1. Describe how heat can be produced (e.g., burning, rubbing, mixing some substances).
3. Describe the usefulness of some forms of energy (e.g., electricity, sunlight, wind, sound) and how energy (e.g., heat, light,) can affect common objects (e.g., sunlight warms dark objects, heat melts candles).

Strand II: Content of Science

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

K-4 Benchmark II: Know that living things have similarities and differences and that living things change over time.

Grade 2 Performance Standards

3. Observe how the environment influences some characteristics of living things (e.g., amount of sunlight required for plant growth).

Alright, I want everyone to get up and stretch now because we're going to play a game called Wildfire Tag! This will show you how fires burn trees, how the trees can be protected from fire, and how the trees grow back. Are you ready?



Wildfire Tag Instructions:

1. Choose one student to become the wildfire that burns the trees. He or she wears a red headband. Give them a long, red rope or long piece of red flagging.
2. Choose four students to be Smokey Bear rangers. They wear green headbands. Give each ranger a long, green rope or long piece of green flagging to hold.
3. The remaining students pretend to be trees. They scatter to different parts of the room and stand still.
4. The Smokey Bear rangers gather around the wildfire in the middle of the room.
5. The game starts when the teacher/presenter yells "Fire!" Then, the wildfire runs to tag the trees. When a tree has been tagged, he/she holds onto the red rope/flagging and becomes part of the wildfire, and the two of them run to tag another tree. Thus, the fire builds and spreads with more and more "trees" holding onto the rope or flagging.
6. At the same time, the Smokey Bear rangers run to protect the trees by tagging them and having them hold onto the green rope/flagging. They can protect only trees that have not yet caught on fire.
7. When a tree is tagged by a Smokey Bear ranger, it joins the other protected trees to make a "fire break" (line of protection that the fire cannot penetrate). In reality, this could be a strip of wet or bare earth. (The protected trees are all holding onto the green rope/flagging.)
8. When the fire runs out of fuel, it burns out. Wildfire students drop the red rope/flagging and fall to the ground.
9. Slowly, the wildfire students rise up from the ground and stretch out their arms. This is to show that new trees will grow in the soil that has been enriched by wildfire. Once again, there is a forest.
10. Before dismissing the group, discuss the meaning of Smokey Bear's slogan "Only you can prevent forest fires."



**FOREST SERVICE CONSERVATION
EDUCATION LEARNER GUIDELINES**

Program title: The Fire Triangle
Target audience: Second Grade
Primary topic: The three things every fire needs to burn.

Length of program: 1 hour

Setting: indoors or outdoors

Guidelines addressed are referenced here:

K-4
I. Questioning and Analysis Skills
A1, A2, B2, F1
II. Knowledge of Environmental Processes and Systems
1.
2. C2, D3
3.
4. A1, A2, C3
III. Skills for Understanding and Addressing Environmental Issues
1.
2.
IV. Personal and Civic Responsibility

LESSON CONTINUED

What did you learn from that game? What did the fire do to the trees? Yes! The fire burned some of the trees but not all of them, right? And, new, healthy trees started to grow because they had more room and because the soil had been enriched with nutrients by the wildfire. How were some of the trees saved from the fire? Right! By the Smokey Bear Rangers. Way to go Rangers, good job! Good job everyone!

CLOSING

I really enjoyed helping you learn how fires burn and how to protect our forest. Now I'm going to give you a really fun handout that you can work on. You can do the coloring and then have someone from your family or your teacher read the words with you!

(For Kaibab National Forest only: I'm also going to pass out the Kaibab National Forest Junior Naturalist quiz. To become a Junior Naturalist, you need to have attended a Forest Service program – which you did today! – and then complete this quiz and help to keep the environment clean by picking up litter you find. It is that easy! If you become a Junior Naturalist, we will give you a certificate and a cool patch to wear. Show them the certificate and the patch. When you have completed your quiz, you can turn it into your teacher. Then, he/she can send them into us, and we'll be sure to get a certificate and patch to you. The only chances you get to become a Junior Naturalist are in the second and the fifth grades, so good luck!)

HANDOUT

“Smokey’s Fire Safety Tips Learning and Coloring Book” (one per student)

(Kaibab National Forest only: Kaibab National Forest Junior Naturalist Quiz, Grades 1-3; one per student)

SUPPLIES

- Small tree limb
- Piece of paper
- Matches
- Cardboard cutout of lightning bolt
- Wooden fire triangle
- Glass jar with lid
- Small, birthday candles
- Model clay
- Water
- Red headband (one)
- Long, red rope or long piece of red flagging
- Green headbands (four)
- Long, green rope or long piece of green flagging (four)
- “Smokey’s Fire Safety Tips Learning and Coloring Book” (one per student)
 - Available through Syndistar Publishing, 1-800-841-9532;
http://www.syndistar.com/media/activity_books/fire/prevention/pbfp06.html
 - Children learn valuable match safety rules from Smokey and his lovable Animal Fire Patrol. This coloring book correlates with the Smokey’s Fire Safety Tips video – carrying the same story and message. Students are able to bring important prevention messages with them so they are sure to remember what they learned.



Kaibab National Forest only:

- Kaibab National Forest Junior Naturalist Quiz, Grades 1-3 (one per student)
- Junior Naturalist patch (one)
- Junior Naturalist certificate (one)



Third Grade

The Story of a Forest



INTRODUCTION

Hello! My name is _____, and I work for the _____ National Forest. Today, we are going to learn about fire and the role it plays in the forest. Let me ask you a question. Do you think fires are bad for the forest? Why or why not? Well, let's find out together while I tell you a story. While I tell this story, I want you to use your imagination to the fullest.

LESSON:

Now remember to use your imagination!

- 1:
- A. Imagine a forest full of big, healthy trees. Between the trees are areas where the sunlight falls on the forest floor. Flowers, grasses and bushes are growing in the sunshine. Deer and elk wander into these clearings, eating the nice, green leaves. How many of you have seen deer and elk foraging in the forest?
 - B. Underneath the big trees are little trees that have sprouted from seeds the big tree has dropped.



A healthy forest in the Southwestern ponderosa pine ecosystem has trees that are well-spaced, allowing sunlight to reach the forest floor. Grasses and flowers abound.

Photo courtesy of the Ecological Restoration Institute, Northern Arizona University.



FOREST SERVICE MESSAGES

- A:** The Forest Service applies the fundamental principles of science and ecology in order to better understand and manage forest ecosystems.
- B:** People are part of nature, and their actions have effects on the land.
- A-1:** Fire has a natural role in the ecosystem.
- A-2:** Southwest forests are primarily limited by water availability, not light.
- B-1:** People need to be careful with fire.
- C-1:** Prior to European settlement, Southwestern ponderosa pine forests had far fewer trees than today and had frequent, low-intensity surface fires.
- C-3:** Forest conditions now are not natural or healthy.
- C-4:** Because of unnaturally dense conditions, our forests are at risk for destructive wildland fires, insect infestations and diseases.



ACADEMIC STANDARDS



Arizona Standards

SCIENCE

- 4SC-F1:** Describe and explain cause-and-effect relationships in living systems
- PO 1:** Identify cause-and-effect relationships in living systems
- PO 2:** Explain cause-and-effect relationships in living systems
- 4SC-F2:** Trace the life cycles of various organisms
- PO 1:** Identify the stages in a life cycle
- 4SC-F4:** Identify characteristics of plants and animals (including extinct organisms) that allow them to live in specific environments
- PO 1:** Identify adaptations of plants that allow them to live in specific environments
- PO 2:** Identify adaptations of animals that allow them to live in specific environments

LANGUAGE ARTS

- 3LS-F1:** Use effective vocabulary and logical organization to relate or summarize ideas, events and other information
- R-F1:** Use phonetic skills to decode words
- PO 1:** Decode words in context using beginning, middle and final letter/sound relationships
- R-F2:** Use word recognition and decoding strategies such as

- C. Over time, these little trees grow, sending their roots down into the soil and their branches up toward the sunlight. The forest is becoming more crowded with trees. In the clearing, some little trees have sprouted among the grasses, flowers and bushes, and these trees are growing too – their tiny branches casting shadows on the ground.
- D. Over time, all the little trees grow bigger and bigger, taking food and water away from the bigger trees. In the clearings, the little trees are growing and making more and more shade. Underneath the trees, the grasses and flowers start to die because they need sunlight to live. Soon, the little clearing is filled in with trees. The grasses, flowers, and bushes are gone, and the deer and elk have no more green leaves to eat.
- E. One day, lightning strikes in the forest, and a fire starts. The fire burns along the forest floor, burning up all the little trees and the sick, weak or old trees that are no longer strong enough to survive a fire. In the clearing where the flowers used to be, the fire removes all the little trees, and once again sunlight spills onto the forest floor.
- F. After the fire, grasses and flowers grow once again. Where the old, sick trees used to be, sunlight bathes the forest floor allowing even more grasses and flowers to grow. Deer and elk again like to come here to nibble the nice, green leaves.
- G. Then the big trees produce their seeds, the seeds fall to the forest floor, and little trees start to grow. Eventually, the little trees grow up, the grasses and bushes die, and it is time for another forest fire.

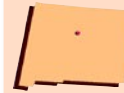


When a fire moves through an area, it recycles nutrients into the soil. Once the burned area receives a little rain, grasses sprout and provide a food source for animals like these elk.

phonetic skills, context clues, picture clues, word order, prefixes and suffixes to comprehend written selections

P0 1: Derive meaning from a written selection using reading/decoding strategies

- phonetic clues
- context clues
- picture clues
- word order
- structural analysis (e.g., prefixes, suffixes)
- word recognition



New Mexico Standards

SCIENCE

Strand I: Scientific Thinking and Practice

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

K-4 Benchmark II: Use scientific thinking and knowledge and communicate findings.

Grade 3 Performance Standards

2. Understand that predictions are based on observations, measurements, and cause-and-effect relationships.

Strand II: Content of Science

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

K-4 Benchmark I: Know that living things have diverse forms, structures, functions, and habitats.

Grade 3 Performance Standards

1. Know that an adaptation in physical structure or behavior can improve an organism's chance for survival (e.g., horned toads, chameleons, cacti, mushrooms).
4. Classify plants according to their characteristics (e.g., tree leaves, flowers, seeds).

K-4 Benchmark II: Know that living things have similarities and differences and that living things change over time.

Grade 3 Performance Standards

1. Identify how living things cause changes to the environments in which they live, and that some of these changes are detrimental to the organism and some are beneficial.

LANGUAGE ARTS

Strand: Reading and Listening for

2. (Pull out the tree cookie and show the children what a fire scar looks like. Make sure they understand that by counting the fire scars, they can see how often the tree survived forest fires.) These fire scars show that in the past, fires were common and perfectly natural in a forest. (If you don't have a tree cookie with fire scars, pass out a drawing of a tree cookie with fire scars. Tell the children that some trees have nice, thick bark to help them survive fires. Show them a piece of ponderosa pine bark so they can see how thick it is.)



Fire is a natural part of the forested ecosystems of the Southwest. Without fire, the forest can become very unhealthy.

3. What would happen if the forest did not burn anymore? The forest would get too crowded.

When a forest has too many trees, the trees get hungry and thirsty. (Show children a big cup with a straw in it.) Imagine that Smokey Bear was drinking from this cup. He would have plenty of water. Right? But, what if all the other animals in the forest – the squirrels, the rabbits, the birds, the deer – came and put their straws in the cup? (Put all the remaining straws in.) Would the water last very long? It is the same way with trees; if there are a lot of trees growing close together, then all the trees will be thirsty and hungry, and they won't be able to grow big and strong.

4. What would happen if someone left a campfire burning in a forest with lots and lots of trees? A fire could start. But, it probably wouldn't be a good fire like we talked about earlier. Good fires in the forest are ones that are hot enough to get rid of some of the little trees and the unhealthy trees but not hot enough to burn up all the bigger, healthier trees. A fire that started in a forest with lots and lots of trees would probably be a big fire. Think about it – doesn't a campfire get bigger if you add more wood to it? A forest fire is the same way; the more wood in the forest, the bigger a forest fire can get. Big fires can kill all the trees in the forest – young or old, sick or healthy. These big fires are bad fires. We call them wildfires.

Comprehension

Content Standard I: Students will apply strategies and skills to comprehend information that is read, heard, and viewed.

K-4 Benchmark I-D: Acquire reading strategies.

Grade 3 Performance Standards

1. Apply phonics and structural analysis to decode words (e.g., less common vowel patterns, syllable breaks).
5. Read aloud with fluency and comprehension grade-level text.
6. Increase vocabulary through reading, listening, and interacting.

SOCIAL STUDIES

Strand: Geography

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

K-4 Benchmark II-B: Distinguish between natural and human characteristics of places and use this knowledge to define regions, their relationships with other regions, and patterns of change.

Grade 3 Performance Standards

1. Describe how human and natural processes can sometimes work together to shape the appearance of places (e.g., post-fire reforestation).
2. Explore examples of environmental and social changes in various regions.

K-4 Benchmark II-C: Be familiar with aspects of human behavior and man-made and natural environments in order to recognize their impact on the past and present.

Grade 3 Performance Standards

2. Identify ways in which people have modified their environments (e.g., building roads, clearing land for development, mining, and constructing towns and cities).
3. Describe the consequences of human modification of the natural environment (e.g., use of irrigation to improve crop yields, highways).

5. Many of our forests are crowded right now because they haven't burned in a long, long time. That means our forests are very dangerous. We have to be careful with fire like never before. If we are careless with fire now, we can start a wildfire that sweeps through the forest and kills all the trees. What are some ways that fires get started in the woods? What can you do to help make sure that fires don't start?

CLOSING

Now, let's review some of the main things we just learned about.

1. Fires are a natural part of the forest's life cycle. When they burn through the forest on a regular basis, they remove young, sick, weak and old trees, leaving the healthy trees to grow big and strong. These fires are "good" fires.
2. If a forest hasn't burned in a long time, it will get crowded and unhealthy. A forest fire in a crowded forest can get very large and dangerous. These "bad" fires are called wildfires.
3. We have to be very careful with fire in the forest. Our forests are very, very crowded, and if we're careless, we will start a wildfire that may destroy the forest.

ACTIVITY

Interactive Zip Game

Is everyone ready to play a game now? This is a very special game because not only is it fun, but it also gives us more information on what we were learning about!



First, let me ask you some questions to get you ready for the game. How many of you think you know everything about fire in the forest now? So, what is a wildfire? Is fire good or bad? How can we all help to prevent the bad kind of wildfires?

This game is going to help us understand how we affect our environment and how our environment affects us. Think about fire. How does fire affect us? How can we affect fire?

(The Interactive Zip Game consists of 30 Fire Education question and answer cards. These cards are keyed in such a way that the question on the front of one card requires an answer that appears as a graphic on another game card. Every card must be used in order to complete the game, so if there are

FOREST SERVICE CONSERVATION EDUCATION LEARNER GUIDELINES

Program title: The Story of a Forest

Target audience: Third Grade

Primary topic: Fire is part of the forest's life cycle.

Length of program: 1 hour

Setting: indoors or outdoors

Guidelines addressed are referenced here:

K-4
I. Questioning and Analysis Skills
A1
II. Knowledge of Environmental Processes and Systems
1.
2. A1, C1, C2, D1, D3
3.
4. A2
III. Skills for Understanding and Addressing Environmental Issues
1. A1
2.
IV. Personal and Civic Responsibility
B2, C1, D2

fewer than 30 students in the class, give some children more than one card until all the cards have been passed out.)

Now, here are the rules. You must speak clearly when you read the question on the front of your card so that everyone will understand what the question is. Then, the rest of the class must listen carefully to see if he or she is holding the card that has the answer to the question.

The teacher and presenter will now pass out the cards to all the students. Some students may get more than one card if there are fewer than 30 students in the class. **Do not hand out the card with the entire answer key on it.** This is on the back of the game instruction card. The speaker should keep this card handy so that he/she will know if the student has the correct answer to the question.

1. The teacher and speaker will then give students time to read their cards. This may take a few minutes to review the educational message on the back of the cards.

2. The game will begin by the student holding card number 1 and he/she will read the question on his/her card. The holder of the card with the correct answer should read the answer to the class. The answer card has the answer on the front at the top of the card and the back of the card explains the answer in more detail including the animal, habitat, history and geography affected by the fire.

3. Next the holder of card number 2 will ask his/her question at the bottom of the card and another student will be able to provide the answer. Then card holder number 3 reads his/her question, and so on through the end of the game. The game ends when all the questions have been asked and answered. (The card numbers are not sequential – 1, 2, 3, etc. but the answer card tells which card number answers which). Also, there are a couple that are similar, so if there's some hesitation or duplication, just use the answer card to check who has which number. You can say, "That's good, but there's a better answer."



CLOSING

Wasn't that fun! Does anyone have any questions about what we've talked about so far? Now I'm going to give you a really fun activity book related to what we have learned today. (If there is extra time, pick an activity to do as a group.)



A class of students listens to a presentation and watches a demonstration related to fire.

HANDOUT

"Discover Fire Education" or "Activity Book for Smokey's Friends"

Options for interpretive program done at a campground:

You can do a safe campfire demonstration. Have the kids sit in a circle 10 feet away from where the fire will be. Start building a campfire and go over safe procedures while you are doing this. You will need a shovel, a bucket and a few pieces of wood.

To start a fire, you should:

1. Help a grown-up pick an open, level spot for the campfire.
2. Help check for overhanging tree branches.
3. Help clear away dry leaves, twigs and grass to make a 10-foot circle of safety around the fire.
4. Make sure the grown-ups have water handy before they start the fire.
5. Have the grown-up start the fire, and make sure the grown-up adds one stick at a time to control the size of the fire.
6. Remember that running or playing near the fire is unsafe.
7. Make sure the grown-up watches the fire at all times.

To put a fire out safely, you should:

1. Have a grown-up sprinkle water over all parts of the fire and gently stir the remains of the fire.
2. Be sure the grown-up stirs the fire and sprinkles water until all the steaming and sizzling has stopped.
3. Remind the grown-up never to leave a fire until the fire is out cold.

Be Smokey's helper. Be careful with fire, and remind grown-ups to be safe with fire too.

1. Never play with matches.
2. Never use firewood unless an adult is watching.
3. Remind grown-ups to never throw cigarettes on the ground.

SUPPLIES

- Tree cookie showing fire scars or picture of a tree cookie with fire scars
- Piece of ponderosa pine bark
- Drinking glass with water
- Straws (several)
- Interactive Zip Game
 - Available through National Symbols Catalog
 - An interactive game for groups of up to thirty. Questions and graphics cover fire ecology, fire behavior, recreational and home fire safety, fire suppression, and wildland/urban fire protection. Includes sample lesson plan and instructions.
- “Discover Fire Education” or “Activity Book for Smokey's Friends” – one per student
 - “Discover Fire Education”: Available through National Symbols Catalog. A 16-page color/activity book featuring the Fire Education Team with numerous puzzles and activities that involve fire ecology, wildland and home fire safety.
 - “Activity Book for Smokey's Friends”: Available through National Symbols Catalog. Eight-page, black and white fire prevention activity and game book for children; perfect for classrooms and community youth groups as a reminder to Smokey Bear's helpers in fire prevention. Book includes: fire hazards exercise, forest crossword, add-a-line activity, forest word find, picture this activity, Smokey rebus, and Smokey's five rules of fire prevention education.



For campfire program only:

- Shovel
- Bucket
- Pieces of wood



Fourth Grade

What Smokey Bear Never Told You



INTRODUCTION

Hi kids! My name is _____, and I work for the _____ National Forest. I am glad to be here with you. Today, I'm going to talk to you about "What Smokey Bear Never Told You."

LESSON

Who has heard of Smokey Bear? That's what I thought – all of you. What are some of the things that Smokey Bear says? Well, there are some things that Smokey hasn't told you. That's what we're going to talk about today.

1. Smokey Bear has been teaching people to be careful with fire in the forest since 1944. By telling people to be careful with fire, Smokey has prevented many forest fires. The U.S. Forest Service and forest rangers from other agencies spread the message about fire prevention. When a fire did break out in the forest, they quickly put it out. Our efforts worked, and we kept a lot of forest fires from burning in our forests. We thought we were doing the right thing, keeping our forests nice and green.

2. But, then scientists learned that fire actually plays an important role in the forest. They looked at cross-sections of trees – what we call tree cookies – and noticed that there were black areas on some of the rings. These were fire scars, left by fires that burned through the forest in the past. These fires were hot enough to leave a fire scar, but not hot enough to kill the tree. By counting the rings and marking where each scar was, they learned how often the tree had been burned. Some trees had burned as often as every 2 to 10 years! Now they realized that in the past, fires were a natural and common occurrence in many types of forests. (As you speak, show the children the tree cookie or pass out tree cookie drawing.)



FOREST SERVICE MESSAGES

- A-1: Fire has a natural role in the ecosystem.
- B-1: People need to be careful with fire.
- B-3: Public lands are unique, valuable resources for which the public has a shared responsibility in their care.
- C-1: Prior to European settlement, Southwestern ponderosa pine forests had far fewer trees than today and had frequent, low-intensity surface fires.
- C-3: Forest conditions now are not natural or healthy.
- C-4: Because of unnaturally dense conditions, our forests are at risk for destructive wildland fires, insect infestations and diseases.
- C-9: Prescribed fire is one tool the Forest Service uses to meet ecosystem goals.



ACADEMIC STANDARDS



Arizona Standards

SCIENCE

- 3SC-E3:** Identify a specific need and propose a solution or product that addresses this need, taking into consideration various factors
- PO 1:** Identify a human or environmental need
- PO 2:** Describe the various factors affecting the need
- PO 3:** Propose a solution or product that addresses the need
- 4SC-E7:** Explain and model the interaction and interdependence of living and non-living components within ecosystems, including the adaptation of plants and animals to their environment
- PO 1:** Describe the components of an ecosystem
- PO 2:** Describe how living and non-living components interact within an ecosystem
- PO 3:** Describe how living and non-living components are interdependent within an ecosystem
- PO 4:** Explain how plant species adapt to their environment
- 6SC-E4:** Provide evidence of how life and environmental conditions have changed
- PO 2:** Describe how environmental conditions have changed over time (geologic and recent)

MATH

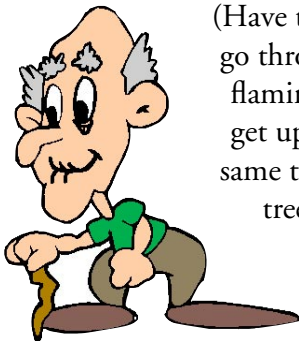
- 1M-E3:** Demonstrate proficiency with the operations of multiplication and division of whole numbers
- PO 1:** Calculate multiplication/division
- A:** three-digit by two-digit to find the product

3. Soon the scientists began to understand what fires do for the forest. Scientists learned that fires can keep the forest healthy.



ACTIVITY

(Have about half of the class – ex. 10 out of a class of 21 – stand up. Everyone should stand at least two arm lengths away from one another. These are the mature, healthy trees. Now, from the students who are still seated, pick half of the remaining kids. These are the young, little trees. Have them crouch down next to a mature tree. Now, have one student from those still seated lie down under the mature trees and be a log. Now, have one or two students who are still seated stick on a few bugs – plastic of course – and stand amongst the mature trees. Have one student who is still seated stand up and put on an old man mask – he/she is an old, dying tree. Make sure all the kids but one have a role.)



(Have the last kid be the fire. He/she should go through and “zap” the little trees with a flaming staff. Once “zapped,” they have to get up and go back to their seats. Do the same to the logs, the insect trees and the old tree. When they have all been “burned up,” have the remaining healthy trees stretch, take a big breath, and say, “I feel a lot better now!”)

LESSON CONTINUED

What we just did was to imitate what fires of the past did!

- A.** Fires killed young trees that sprouted underneath older, larger trees. This prevented the little trees from growing up and competing with the larger trees for water and nutrients in the soil.
- B.** Fires killed trees that were old, sick or infested with insects. That prevented diseases and insects from spreading to healthy trees. By removing the old and sick trees, fires also gave healthy trees more room to grow.
- C.** Also, fires removed trees that were starting to fill in meadows, so that grasses, flowers and shrubs could grow in the sunshine. Meadows provide food and habitat (homes) for wildlife.

4. Scientists realized that by putting out all the fires, we have changed our forests.

- B:** facts through 12
- C:** mental math and estimation with multiples of 10
- D:** one-digit divisor to find quotient with remainder
- PO 2:** Calculate multiplication and division problems using contextual situations
- 1M-E5:** Represent and use numbers in equivalent forms (integers, fractions, percent, decimals, exponents, scientific notation and square roots)
- PO 2:** Demonstrate the relationship and equivalency among
- A:** decimals, fractions and percents (e.g., $1/2 = .5 = 50\%$ with halves, fourths and tenths)
- 2M-E3:** Display and use measures of range and central tendency (i.e., mean, median and mode)
- PO 1:** Find the mean, median, mode and range of data using concrete and illustrative models

LANGUAGE ARTS

- W-E1:** Use correct spelling, punctuation, capitalization, grammar and usage, along with varied sentence structure and paragraph organization, to complete effectively a variety of writing tasks



New Mexico Standards

SCIENCE:

Strand II: Content of Science

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

K-4 Benchmark II: Know that living things have similarities and differences and that living things change over time.

Grade 4 Performance Standards

1. Know that in any particular environment some kinds of plants and animals survive well, some survive less well, and others cannot survive at all.
2. Know that a change in physical structure or behavior can improve an organism's chance of survival (e.g., a chameleon changes color, a turtle pulls its head into its shell, a plant grows toward the light).
3. Describe how some living organisms have developed characteristics from generation to generation to improve chances of survival (e.g., spines on cacti, long beaks on hummingbirds, good eyesight on hawks).

MATH

Strand: Number and Operations

Standard: Students will understand numerical concepts and mathematical operations.

K-4 Benchmark: Understand numbers, ways of

ACTIVITY

(Have about one-third of the kids in class – ex. 7 out of a class of 21 – get up from their seats and stand two arm lengths apart from one another. Again, these are the mature, healthy trees. Have several of the remaining kids become young trees and crouch under the healthy, spaced trees. Have one or two kids become logs and lie down in the forest. Have a couple of kids with the bugs stuck to them crowd in. Have two kids put on old man masks and become old trees.)



Tree thinning and prescribed burning are important management tools used by the Forest Service. Thinning and burning help to prevent high-intensity, destructive wildland fires.

Without fires, this is what happens:

(Have the young trees slowly stand up. Have the old ones fall over and become logs. Have the insect trees take a bug off and stick it onto a nearby tree. Have the mature trees say, “Boy is it crowded! I am hungry and thirsty, but all these other trees are using up my water!” After the kids have looked around at themselves and realized how crowded it is, let them sit down.)

LESSON CONTINUED

A. Our forests have become very, very dangerous. Imagine walking through a forest today. What would you see? Dead trees on the ground? Trees that seem sick? Dozens of little trees growing between the larger trees? With all this wood in the forest, what would happen if someone left a campfire unattended and a spark flew from the fire up into the trees? A fire would start, and it wouldn't be a nice, small fire that kills weak trees and leaves the healthy ones standing. It would be a large fire with large, greedy flames that consume many of the trees, whether young or old, sick or healthy. These destructive, dangerous fires are called wildfires. Have you heard about wildfires in Arizona? A wildfire is a bad



representing numbers, relationships among numbers, and number systems.

Grade 4 Performance Standards

1. Exhibit an understanding of the place-value structure of the base-ten number system by reading, modeling, writing, and interpreting whole numbers up to 100,000; compare and order the numbers:
 - recognize equivalent representations for the same number and generate them by decomposing and combining numbers (e.g., $853 = 8 \times 100 + 5 \times 10 + 3$; $853 = 85 \times 10 + 3$; $853 = 900 - 50 + 3$)
 - identify the numbers less than 0 by extending the number line and using negative numbers through familiar applications (e.g., temperature, money)
2. Identify fractions as parts of unit wholes, as parts of groups, and as locations on number lines:
 - use visual models and other strategies to compare and order commonly used fractions
 - use models to show how whole numbers and decimals (to the hundredths place) relate to simple fractions (e.g., $\frac{1}{2}$, $\frac{5}{10}$, 0.5)
 - identify different interpretations of fractions:
 - ⊙ division of whole numbers by whole numbers
 - ⊙ ratio
 - ⊙ equivalence
 - ⊙ ordering of fractions
 - ⊙ parts of a whole or parts of a set
3. Add and subtract fractions with common and uncommon denominators using a variety of strategies (e.g., manipulatives, numbers, pictures):
 - recognize and generate equivalent decimal forms of commonly used fractions (e.g., halves, quarters, tenths, fifths)
 - identify the numbers less than 0 by extending the number line and using negative numbers through familiar applications (e.g., temperature, money)
4. Recognize classes of numbers (e.g., odd, even, factors, multiples, square numbers) and apply these concepts in problem-solving situations.

Strand: Number and Operations

Standard: Students will understand numerical concepts and mathematical operations.

K-4 Benchmark: Understand the meaning of operations and how they relate to one another.

Grade 4 Performance Standards

1. Demonstrate an understanding of and the ability to use:

fire because it can kill most of the trees in the forest.

B. Our forests are unhealthy. Since there are so many trees, the trees have to compete with one another for water and nutrients. Think about it – if you had a garden, would you plant all the trees close together, or would you space them out? Since the trees are all sharing a limited amount of nutrients and water, many of the trees don't get enough of either. Then, they become weak or even sick.



5. Imagine you are a ranger, and you are taking care of a forest that is full of wood. What would you do to save the forest? Answer: We need to let fires burn through the forest again. But we can't just let all the fires that start in the forest burn. Why? Because there's too much wood in the forest, and the fire could easily turn into a wildfire.

6. So what can you do? We can set fires intentionally on days when we know the fire will stay small. We can set fires in the spring or fall when the air is nice and cool and there isn't too much wind. Why don't we burn on days that are windy? Because the wind will fan the flames and make them bigger. Have you ever blown on hot coals to get them to flame up? Wind does the same thing to a forest fire.

To keep the fires we start small, we also remove some of the trees before we burn. This is called thinning. That way, there won't be too much wood in the forest, and the fire will stay small.

A fire that is set deliberately, or a fire that we allow to burn, is called a prescribed fire. Like a doctor's prescription, prescribed fires help keep the forest healthy. Prescribed fires kill young, weak and sick trees, leaving the other trees more room to grow. Because these fires remove wood from the forest, they also help prevent wildfires. Prescribed fires are done very, very carefully, with a lot of people and a lot of equipment.

7. So, is Smokey Bear wrong? Should we stop being careful with fire because the forest needs to burn? NO! Our forests are more dangerous than they have ever been. On a hot, dry day

- standard algorithms for the addition and subtraction of multi-digit numbers
- standard algorithms for multiplying a multi-digit number by a two-digit number and for dividing a multi-digit number by a one-digit number

2. Select and use appropriate operations (addition, subtraction, multiplication, and division) to solve problems.
3. Extend the uses of whole numbers to the addition and subtraction of simple decimals (positive numbers to two places).
4. Demonstrate commutative, associative, identity, and zero properties of operations on whole numbers (e.g., $37 \times 46 = 46 \times 37$ and $(6 \times 2) \times 5 = 6 \times (2 \times 5)$).
5. Demonstrate the concept of distributivity of multiplication over addition and subtraction (e.g., 7×28 is equivalent to $(7 \times 20) + (7 \times 8)$ or $(7 \times 30) - (7 \times 2)$).

Strand: Data Analysis and Probability

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

K-4 Benchmark: Select and use appropriate statistical methods to analyze data.

Grade 4 Performance Standards

1. Compare and describe related data sets.
2. Use the concepts of median, mode, maximum, minimum, and range and draw conclusions about a data set.
3. Use data analysis to make reasonable inferences/predictions and to develop convincing arguments from data described in a variety of formats (e.g., bar graphs, Venn diagrams, charts, tables, line graphs, and pictographs).

LANGUAGE ARTS

Strand: Writing and Speaking for Expression

Content Standard II: Students will communicate effectively through speaking and writing.

K-4 Benchmarks II-B: Apply grammatical and language conventions to communicate.

Grade 4 Performance Standards

1. Use simple and compound sentences in writing and speaking.
2. Combine short, related sentences with appositives, participial phrases, adjectives, adverbs, and prepositional phrases.
3. Identify and use regular and irregular verbs, adverbs, prepositions, and coordinating conjunctions in



Smokey Bear travels all over the country telling people about the importance of being careful with fire. Smokey Bear's message is as important today as it was 60 years ago when he started his career.

it doesn't take much to start a large, devastating, deadly wildfire. Have you heard about people accidentally starting big fires? We have to be careful with fire like never before. Please remember to always be careful with fire in the forest. Leave the prescribed burning to the professionals!

ACTIVITY

I hope you enjoyed that lesson and learned some things too. Now, I'm going to hand out something I want you to read and then there

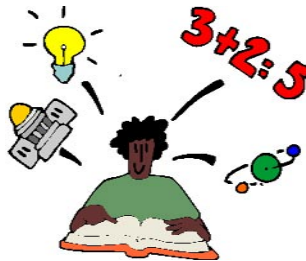
are some math questions on what you read. OOOH! Math questions! I know some of you might be good in math and that's great. But, I've got to admit to you that I had a hard time with math in school. I studied hard, though, and ended up doing pretty well in math. Now I'm glad I did because I can see how important math is in so many ways.

Anyway, I think you will find these questions interesting because they all relate to forests and fire. (Hand out "Fast Forest Facts," "Fast Fire Facts," and "Math in the Forest" student sheets. Let the students have some time to read and work on the problems. Encourage the teacher to go around the room and help the kids. You do the same. After the students have had some time to work on the problems, review the answers to the "Math in the Forest" worksheet with them.) You may want to customize the facts and worksheet for your forest. The following sites have good statistical information:

http://www.fs.fed.us/fire/links/links_firestats.html and
<http://www.nifc.gov/stats/>

CLOSING:

I hope that you had some fun today and also learned some important things about how fire affects our forest.



writing and speaking.

4. Use parentheses, commas in direct quotations, and apostrophes in the possessive case of nouns and in contractions.
5. Use underlining, quotation marks, or italics to identify titles of documents.
6. Capitalize names of magazines, newspapers, works of art, musical compositions, organizations, proper nouns, and the first word in quotations when appropriate.
7. Spell correctly roots, inflections, affixes, and syllable constructions.
8. Compose multiple paragraphs with:
 - topic sentences
 - specific, relevant details
 - logical progression and movement of ideas
 - coherence
 - elaboration
 - concluding statement related to topic
9. Speak in a manner that guides the listener to understand important ideas by using proper phrasing, pitch, and modulation.

SOCIAL STUDIES

Strand: Geography

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

K-4 Benchmark II-C: Be familiar with aspects of human behavior and man-made and natural environments in order to recognize their impact on the past and present.

Grade 4 Performance Standards

1. Explain how geographic factors have influenced people, including settlement patterns and population distribution in New Mexico, past and present.
2. Describe how environments, both natural and man-made, have influenced people and events over time, and describe how places change.
3. Understand how visual data (e.g., maps, graphs, diagrams, tables, charts) organizes and presents geographic information.

OPTIONAL ASSESSMENT:

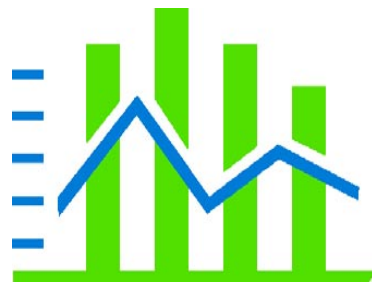
Now after everything we've done today, I would like to ask each of you to write a paragraph with three positive and three negative things about fire in the forest. You can turn these into your teacher later so that he/she can check your paragraph for correct grammar, spelling and structure. Right now, though, I'd like you to tell me some ideas about what you might write. So, what are some of your ideas about positive and negative aspects of fire in the forest? (Depending on time, you may want to make your closing remarks and let the kids discuss their paragraphs with the teacher later.)

HANDOUT

Smokey Bear comic books in Spanish and English (one per student); "Children's Fire Safety Activity Book" (one per student).

SUPPLIES

- Tree cookie or drawing of tree cookie
- Plastic bugs to stick on students during activity
- Old man masks (two)
- Flaming staff
- "Fast Forest Facts" sheet (one per student)
- "Fast Fire Facts" sheet (one per student)
- "Math in the Forest" sheet (one per student)
- Smokey Bear comic books in English and Spanish (one per student)
 - Available through National Symbols Catalog.
 - The comic book of the origin of the living symbol of Smokey Bear. This classic story has endeared generations of children to Smokey and his educational fire prevention messages.
- "Children's Fire Safety Activity Book" (one per student)
 - Available through National Symbols Catalog.
 - Activity book on fire safety, fire education, Smokey prevention messages, and wildland/urban interface home tips plus word games, mazes, and assorted coloring sheets.



FOREST SERVICE CONSERVATION EDUCATION LEARNER GUIDELINES

Program title: What Smokey Bear Never Told You

Target audience: Fourth Grade

Primary topic: Fire is necessary for the forest to be healthy.

Length of program: 1 hour

Setting: indoors

Guidelines addressed are referenced here:

K-4
I. Questioning and Analysis Skills
A1, A2, E4, F1, G1, G3
II. Knowledge of Environmental Processes and Systems
1.
2. A1, C1, C2, C3, D2
3.
4. A2, A3, D2
III. Skills for Understanding and Addressing Environmental Issues
1. A1, A2, A3, A4, B1
2. A4, B1
IV. Personal and Civic Responsibility
C1, D2

Student Page

FAST FOREST FACTS

- According to the U.S. Department of Agriculture, there are 155 national forests covering 192 million acres in the United States. That's about the same size as the state of Texas.
- There are six national forests located in Arizona. The largest one is the Tonto National Forest, which is 2,873,300 acres. The smallest is the Prescott National Forest, which is 1,237,061 acres.
- There are five national forests located in New Mexico. The largest one is the Gila National Forest, which is 3,321,101 acres. The smallest is the Lincoln National Forest, which is 1,103,466 acres.
- The pine bark beetle is a tiny insect that is found naturally in our forests. Because of the conditions mentioned in the lesson (overly thick forest and drought), this insect's population exploded in the summers of 2002 and 2003 and killed hundreds of thousands of trees. Many of the dead, red-needled trees that you can see on the mountains were killed by bark beetles.
- Many areas of our ponderosa pine forest in Arizona/New Mexico have too many trees growing too closely together. When this happens, the trees are weakened and become much more susceptible to wildfire, disease and insects.
- The highest point on the Kaibab National Forest is around 10,000 feet and the lowest point is around 3,000 feet.
- America's largest national forest is the Tongass National Forest in Alaska, which covers more than 17 million acres.
- Our national forests provide habitat for all kinds of wildlife, especially large animals like elk and Rocky Mountain bighorn sheep.

Student Page

FAST FIRE FACTS

- In 2002, the Rodeo-Chediski Fire burned 470,000 acres on the Apache-Sitgreaves National Forests and the White Mountain Apache Reservation, making it the largest fire in Arizona's history. Both fires were started by people.
- Approximately two-thirds of wildfires in the United States are set accidentally by people.
- Some fires in the forest are set on purpose by the Forest Service to burn up some of the smaller trees and debris on the forest floor like pine needles. This helps the trees that are left to grow strong and healthy. These are called "controlled" or "prescribed" fires and are lit only when the winds are not too strong and there is enough moisture so the fires don't burn too hot.
- In 2002, the Kaibab National Forest had 146 fires. Of those fires, 111 were caused by lightning and 36 were human-caused. The forest was closed for several weeks during the summer to help prevent person-caused fires. In 2000, the forest was also closed for awhile during the summer. Out of 248 total wildfires that year, only 19 were caused by people. The rest were started by lightning.

Student Page

MATH IN THE FOREST

Use the facts given to you to answer the following questions.

1. What would the average elevation be for the Kaibab National Forest?
 - a. 5,500 feet
 - b. 6,500 feet
 - c. 7,500 feet
 - d. 8,500 feet
2. About what percentage of wildfires in the United States are set accidentally by people each year?
 - a. About 33%
 - b. About 50%
 - c. About 67%
 - d. About 88%
3. About how many Prescott National Forests would fit in the Tongass National Forest?
 - a. About 10
 - b. About 14
 - c. About 20
 - d. About 24
4. Approximately what percentage of all national forests in the United States are found in Arizona?
 - a. 1%
 - b. 4%
 - c. 7%
 - d. 10%
5. The Rodeo-Chediski Fire burned nearly _____ acres?
 - a. $\frac{1}{4}$ million acres
 - b. $\frac{1}{2}$ million acres
 - c. $\frac{3}{4}$ million acres
 - d. 1 million acres
6. In the year 2000, how many lightning fires were there on the Kaibab National Forest?
 - a. 210
 - b. 219
 - c. 229
 - d. 238



Fifth Grade How To Be a Wildland Firefighter



INTRODUCTION

Good afternoon everyone! I am _____, and I work for the _____ National Forest. Today I'm going to talk to you about how to be a wildland firefighter.

LESSON

How many of you have ever thought about becoming a firefighter? What kind would you want to be? Well today, I am going to give you a crash course in becoming a wildland firefighter. Those are the firefighters who work to control the wildfires that burn in our forests. Today, I'm going to talk with you about the protective gear a firefighter has to wear, show you the tools a firefighter uses, and teach you the basics that all firefighters need to know before they can fight fire.



This wildland firefighter is helping to ignite a prescribed burn. All wildland firefighters have to wear personal protective equipment such as hardhats and gloves to help prevent injury.

Let's start with the protective gear that all firefighters must wear. First, why do you think firefighters have to wear special clothing? The bottom line is firefighter safety. Our goal is to have no firefighters injured or killed in the line of duty. The protective gear I'm about to show you helps ensure that our firefighters remain safe.

Who's going to help me with this demonstration? (Pick a child to come to the front of the class. As you explain the PPE, have the child put on each piece so at the end he/she



FOREST SERVICE MESSAGES

- A-1:** Fire has a natural role in the ecosystem.
- A-3:** Leaving nature alone has consequences, risks and trade-offs.
- A-5:** The study of the science of fire and its behavior is important.
- B-1:** People need to be careful with fire.
- B-4:** The complexity of managing our public lands is compounded by the numbers of people living near or within our boundaries and the increasing demands from public land users.
- C-1:** Prior to European settlement, Southwestern ponderosa pine forests had far fewer trees than today and had frequent, low-intensity surface fires.
- C-3:** Forest conditions now are not natural or healthy.
- C-4:** Because of unnaturally dense conditions, our forests are at risk for destructive wildland fires, insect infestations and diseases.
- C-9:** Prescribed fire is one tool the Forest Service uses to meet ecosystem goals.



ACADEMIC STANDARDS



Arizona Standards

SCIENCE

- 3SC-E1:** Recognize how scientific knowledge, thinking processes and skills are used in a great variety of careers
- 4SC-E7:** Explain and model the interaction and interdependence of living and non-living components within ecosystems, including the adaptation of plants and animals to their environment
- PO 1:** Describe the components of an ecosystem
- PO 2:** Describe how living and non-living components interact within an ecosystem
- PO 3:** Describe how living and non-living components are interdependent within an ecosystem
- PO 4:** Explain how plant species adapt to their environment
- 6SC-E4:** Provide evidence of how life and environmental conditions have changed
- PO 2:** Describe how environmental conditions have changed over time (geologic and recent)
- 1SC-E6:** Analyze scientific reports from magazines, television or other media
- PO 1:** Analyze the reliability of scientific information from a variety of sources
- PO 2:** Use evidence to support or refute a conclusion drawn

will look like a wildland firefighter.) Every firefighter must have Nomex pants and shirts. You've seen these yellow shirts before, right? The shirts and pants are made out of a special, fire-resistant material. While the material is fire-resistant, it is not fire-proof. If you threw this into a campfire, it would burn just like your clothes would. The difference is that if we pulled this Nomex shirt out of the fire, it would stop burning, whereas your clothes would continue to burn. Every firefighter must also have high-topped, laced, leather boots; a hardhat; goggles; ear plugs; and leather gloves.

Now with all that gear, doesn't he/she look ready to go fight a fire? But, he/she isn't ready yet. He/she is missing probably the most important piece of firefighting gear. I'm talking about the fire shelter. Fire shelters have saved many firefighters' lives. The fire shelter is used as a last resort in firefighting. If you are being surrounded by fire and there are no escape routes, you would use your fire shelter. The fire shelter protects primarily by reflecting radiant heat and by trapping breathable air. It is made of aluminum foil bonded to fiberglass cloth. Once you are inside the fire shelter, it is basically like a pup tent that helps protect you from the fire's heat. Who wants to help me demonstrate how to use a fire shelter? (Have a student come forward. Show the class how to open a fire shelter. Have the student get in. Then, shake the tent to show what it would be like if a fire were burning nearby.)

So, how does a firefighter carry all this equipment? Most is carried in or attached to what we call an initial attack pack. Firefighters must have their initial attack pack ready to go at all times. Besides the things we've already talked about, firefighters also carry other items they might need including a first-aid kit, head lamp, and MRE (meal ready to eat). Firefighters often carry about 45 pounds worth of gear with them when they go to a fire. Who wants to see what 45 pounds feels like? (Have a student come forward and try on a 45-pound vest. Have them walk around a little and tell the other students what it feels like.)



These wildland firefighters are part of a helitack crew. Part of their job is to rappel into fires that are in rugged terrain. They also have to wear special equipment to help prevent injury.

from a scientific report

SSC-E3: Show that energy exists in many forms and can be transferred in many ways

P0 1: Identify various types of energy sources

P0 2: Describe how energy is transferred

SSC-E4: Identify and predict what will change and what will remain unchanged when matter experiences an external force or energy change (e.g., boiling a liquid; comparing the force, distance and work involved in simple machines)

P0 3: Describe how a change in energy will affect matter

SOCIAL STUDIES

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

P0 4: how people have depended on the physical environment and its natural resources to satisfy their basic needs, including the consequences of Arizonans' adaptation to, and modification of, the natural environment

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

P0 2: consequences to humans of earthquakes, hurricanes, tornadoes, flash floods, and other natural hazards

P0 3: how and why humans modify ecosystems, including deforestation and desertification

New Mexico Standards

SCIENCE

Strand II: Content of Science

Standard I (Physical Science): Understand the structure and properties of matter, the characteristics of energy, and the interactions between matter and energy.

5-8 Benchmark I: Know the forms and properties of matter and how matter interacts.

Grade 5 Performance Standards

1. Describe properties (e.g., relative volume, ability to flow) of the three states of matter.
2. Describe how matter changes from one phase to another (e.g., condensation, evaporation).
3. Know that matter is made up of particles (atoms) that can combine to form molecules and that these particles are too small to see with the naked eye.
6. Explain the relationship between temperature and

When I first started talking with you, I mentioned that I would also tell you about firefighting tools. Besides all the gear that they carry, firefighters also carry one or more tools with them. These tools are used to fight the fire by digging line. That means that firefighters literally dig lines to halt a fire's advance. Firefighters remove all fuels – things like sticks, leaves and pine needles that can burn – so that the fire can't continue to grow.

The three primary tools firefighters use for this kind of work are right here. Can anyone guess what these are called? The McCloud has a heavy rake on one side and a sharpened scraper on the other. It works well in areas with thick pine needles, duff and dirt but doesn't work so well in rocky areas.

The Pulaski, on the other hand, works very well in rocky areas. It has an axe on one end and a sharpened grub end on the other. You can dig rocks out of your line and dig down to mineral soil with the grub end and cut small trees or branches that hang over your line with the axe.

The shovel allows a firefighter to scrape a line using less upper body strength than the other tools require. That's important because firefighters work very long hours for several days straight and often experience fatigue. The shovel can also be used to scoop up dirt and throw it at flames on trees or bushes nearby. If the flames are small and isolated, this action could help put them out.



There are lots of other resources used to put out a fire – including engines, helicopters, air tankers, and bulldozers – but the three tools I just showed you are the primary ones used by on-the-ground firefighters. Now, I need a few people to help me demonstrate how to dig a fire line. (Show them how firefighters form a line and each help create the line.) How would you like to do that for 12 to 16 hours per day? Now imagine that you have all your gear on, you have your initial attack pack on your back and you are carrying your tool. How many miles of line do you think you could build?

Now, to the most important part of my presentation. I'm going to share with you some of the knowledge that firefighters have to have before they can ever pick up a Pulaski or McCloud. All firefighters must go through what we call Basic Firefighter

the motion of particles in each state of matter.

Strand II: Content of Science

Standard I (Physical Science): Understand the structure and properties of matter, the characteristics of energy, and the interactions between matter and energy.

5-8 Benchmark II: Explain the physical processes involved in the transfer, change, and conservation of energy.

Grade 5 Performance Standards

1. Know that heat is transferred from hotter to cooler materials or regions until both reach the same temperature.
2. Know that heat is often produced as a by-product when one form of energy is converted to another form (e.g., when machines or organisms convert stored energy into motion).
3. Know that there are different forms of energy.
4. Describe how energy can be stored and converted to a different form of energy (e.g., springs, gravity) and know that machines and living things convert stored energy to motion and heat.

Strand II: Content of Science

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

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

Grade 5 Performance Standards

1. Identify the components of habitats and ecosystems (producers, consumers, decomposers, predators).
2. Understand how food webs depict relationships between different organisms.
3. Know that changes in the environment can have different effects on different organisms (e.g., some organisms move, some survive, some reproduce, some die).
4. Describe how human activity impacts the environment.

SOCIAL STUDIES

Strand: History

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

Grade 5 Performance Standards

1. Describe the characteristics of early societies, including the development of tools and

Training. The very first thing they learn there is the Fire Triangle. Three elements must be present and satisfactorily combined before combustion can occur and continue. Can anyone guess what those three elements are? Draw triangle on board. First, there must be fuel to burn. I'm going to talk with you more about fuel in a minute, because the fuel in our forests has changed substantially over time. Second, there must be air to supply oxygen for the flame. Third, there must be heat to start and continue the combustion process. Remove any single one of these elements, and there can be no fire.



In order for combustion to take place, three things must be present – fuel, heat and oxygen. If any one of these is taken away, combustion will cease.

Let's talk a little bit about what every firefighter needs to know about fuel – and I don't mean the kind you put in your car. When we say fuel, we are talking about the things that carry the fire. Can you think of some fuels in the forest? Fuels can be anything from grasses, pine needles and leaves – what we call fine fuels – to limbs, logs and tree trunks – what we call heavy fuels. The quantity of fuels in the forest and how they are arranged make a big difference in how a fire burns.

A big part of the reason we are seeing so many very large, very dangerous, very destructive wildfires these days is that there are simply too many fuels – like trees and brush – in the forest. Firefighters need to understand why that has happened so that they can work to fight fires.

More than 100 years ago, before our European ancestors settled in this area, low-to-medium intensity ground fires moved through our forests every 2-10 years. That means that every few years, a fire would get started – usually by lightning – and be carried by grasses through the forest. The fires actually did good things for our forests, like recycle nutrients back into the soil and prevent the buildup of pine needles and other materials on the forest floor. Most large trees in the forest would survive the fires, but many small trees would be killed. Early settlers in this area described the forest as being like a park, with big, open spaces in between trees.

When people moved into the forests, things began to change. Settlers allowed their animals to eat all of the grasses that once

adaptation to environments.

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

Grade 5 Performance Standards

1. Differentiate between, locate, and use primary and secondary sources (e.g., computer software, interviews, biographies, oral histories, print, visual material, artifacts) to acquire information.
2. Use resources for historical information (e.g., libraries, museums, historical societies, courthouse, world wide web, family records, elders).
3. Gather, organize, and interpret information using a variety of media and technology.
4. Show the relationship between social contexts and events.
5. Use effective communication skills and strategies to share research findings.

Strand: Geography

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

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

Grade 5 Performance Standards

1. Describe human and natural characteristics of places.
2. Describe similarities and differences among regions of the globe, and their patterns of change.

5-8 Benchmark II-C: Understand how human behavior impacts man-made and natural environments, recognizes past and present results, and predicts potential changes.

Grade 5 Performance Standards

1. Describe how man-made and natural environments have influenced conditions in the past.
2. Identify and define geographic issues and problems from accounts of current events.

CAREER READINESS

Standard 1: Students will identify their career interests and aptitudes to develop an educational plan which supports personal career goals.

5-8 Benchmark: 1. Students will explore areas of interest and possible career choices.

Standard 2: Students will utilize and manage resources effectively to produce quality services and products.

5-8 Benchmark: 2. Students will determine the education and training requirements for careers identified as possible areas of interest.

Standard 3: Students will demonstrate the technological

carried fires. The settlers also quickly put out any fires that did get started because they didn't want the fires to threaten their homes or property. Pretty soon, because there were no fires to clean up the forests or to keep small trees from taking over, a



huge crop of young trees started growing. As the years passed, more and more trees started filling up our forests.

You are probably wondering why it makes a difference whether there are more trees or less trees.

Let me show you why. I need 5 of you to stand up. Say that those of

you standing up lived here together. Each day I brought you 5 sack lunches and 5 bottles of water. You would have plenty of water and plenty of food and would be able to continue growing and developing. Now, 5 more people stand up. Now, you first 5 have to share your sack lunch and bottle of water with these other 5. Because you wouldn't have sufficient water or food, your body would become stressed. You wouldn't grow as quickly, and you would be more susceptible to getting sick.

Now everyone stand up. Imagine that you all had to share those 5 lunches and 5 bottles of water. Now, many of you aren't going to be healthy or grow properly because you simply don't have the water or nutrients you need. The same thing happens in our forests when there are too many trees. The trees can't grow as well and many become susceptible to diseases and insect infestation.



This wildland firefighter is using a hose and water to extinguish a snag that is on fire. Water helps to remove heat from the fire triangle, which causes the fire to go out.

The other thing that happens when forests become too crowded is that fires stop moving through the forest on the ground and start being carried from tree to tree. We call these crown fires. Whereas ground fires are good for the forest, crown fires can be very destructive. Instead of helping trees by providing nutrients and removing competition like ground fires do, crown fires can kill acres and

knowledge and skills required for future careers.

5-8 Benchmark: 1. Students will describe ways in which tools, instruments, and equipment are used to solve problems, extend human capabilities and provide for the needs of society.

FOREST SERVICE CONSERVATION EDUCATION LEARNER GUIDELINES

Program title: How To Be a Wildland Firefighter

Target audience: Fifth Grade

Primary topic: How the fire triangle relates to wildland firefighting operations.

Length of program: 1 hour

Setting: indoors or outdoors

Guidelines addressed are referenced here:

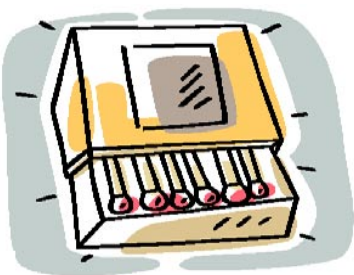
5-8
I. Questioning and Analysis Skills
A2, F2, F3, G2
II. Knowledge of Environmental Processes and Systems
1. A2, B1, C1
2. C3
3. B1, E1
4. A1, C4, D1, D2
III. Skills for Understanding and Addressing Environmental Issues
1. A1, A3, B1, B2, B3
2.
IV. Personal and Civic Responsibility
B2, C1, C2

acres of trees because of how intensely they burn. The more fuels in the forest, the more intensely the fire will burn. The more intensely the fire burns, the fewer trees and other living things that will be able to survive it.

ACTIVITY

(Note: This activity was adapted from “Activity 3-4. The Fire Triangle in Wildlands” from “Fireworks Curriculum: Featuring Ponderosa, Lodgepole, and Whitebark Pine Forests,” http://www.fs.fed.us/rm/pubs/rmrs_gtr65.pdf)

This activity is going to show us how fires behave in an overcrowded forest. This activity is similar to research done by chemists and physicists. Results from research like this are used by foresters, firefighters, range managers, wildlife biologists and ecologists.



(Show students two matchstick forests – one with only a few matches and one with lots of matches. Explain that the forest with only a few matches resembles the presettlement forest that we just talked about. The forest with many matches is like the forest that exists today. It is overcrowded. Don't do anything with slope. Keep the matchstick forests flat. The goal of this activity is to show that a forest with more fuels – in this case, trees – burns more quickly and more intensely than a forest with fewer fuels.)

(Explain to the students that the individual matches represent trees that have flammable crowns, like the ponderosa pines in our local forest. Before lighting the matches, ask the students for their guess – hypothesis – about how the fires will differ in size and intensity. Why?)

(Light the match tips along one edge of the more open forest and observe the fire behavior. Ask the students their opinion about how the fire burns. Explain what a low-intensity surface fire is like in the forest. Then light the match tips along one edge of the more dense forest and observe the fire behavior. Ask for descriptions of what the students observe and interpretations in terms of the fire triangle.)

(Ask the students to compare the model forests used in this experiment to real forests. What are the similarities? What are the differences?)

CLOSING

So what does all that mean? It means that our forests aren't healthy right now because there are simply too many trees. People have changed the forests to meet their needs without an understanding of the consequences of those changes. It also means that even though fires are a natural part of our forests, they are becoming larger, more intense and more dangerous because of the unnatural conditions that people have created.

Because of all these things, we must have well-trained, knowledgeable, and dedicated firefighters willing to do sometimes very demanding and very dangerous work. Not only are firefighters working to protect our forests, they are also working to protect our homes and communities, which are increasingly being built in forested areas where fires happen. I hope that today I have been able to give you a little insight into what it is like to be a wildland firefighter – from the gear you need to wear, to the tools you use, to the kind of knowledge and training you must have. Any questions?



HANDOUT

“Student Page 1: Fire Triangle” from the “Living With Fire” chapter of “Ecosystem Matters, Activity and Resource Guide for Environmental Educators”

(If there is time, do the Fire Triangle worksheet together as a class. Otherwise, leave it with the teacher as an assignment for later.)

“Natural Inquirer: Wildland Fire Edition”

(Point out some of the interesting articles related to fire. Encourage the teacher to make use of the activities in the “Natural Inquirer” for future lessons.)

(Kaibab National Forest only: Besides these handouts, I’m also going to pass out the Kaibab National Forest Junior Naturalist quiz. To become a Junior Naturalist, you need to have attended a Forest Service program – which you did today! – and then complete this quiz and help to keep the environment clean by picking up litter you find. It is that easy! If you become a Junior Naturalist, we will give you a certificate and a cool patch to wear. Show them the certificate and the patch. When you have completed your quiz, you can turn it into your teacher. Then, he/she can send them into us, and we’ll be sure to get a certificate and patch to you. The only chances you get to become a Junior Naturalist are in the second and the fifth grades, so good luck!)

SUPPLIES

- Nomex Pants
- Nomex Shirt
- Boots
- Hardhat
- Goggles
- Ear Plugs
- Leather Gloves
- Fire Shelter
- 45-Pound Pack
- Shovel
- Pulaski
- McCloud
- Matchstick forests (two) (can use clay instead of masonite)
- Trash can lid filled with sand (serves as burning tray)
- Spray bottle with water
- Matches (several boxes)
- Small fire extinguisher
- “Student Page 1: Fire Triangle” (one per student)
- “Natural Inquirer: Wildland Fire Edition” (one per student)
 - www.naturalinquirer.usda.gov



Kaibab National Forest only:

- Kaibab National Forest Junior Naturalist quiz, Grades 4-6 (one per student)
- Junior Naturalist patch (one)
- Junior Naturalist certificate (one)

Student Page 1.

FIRE TRIANGLE

1. Fires need heat, fuel, and oxygen to burn. This is known as the "fire triangle." Draw a triangle below and label each of the three sides with the word and a picture for each of the three parts.

4. Oxygen is available in the air. weather has a great influence on when fires occur and on how they spread. Hot temperatures and dry winds can create severe fire conditions by affecting fuel, moisture, and oxygen. What can dry winds do to fuels to make them more likely to burn?

2. Initially, the heat is provided by an ignition source, which can be human or natural. Name two natural and two human-caused sources of heat for fire ignition.

Natural:

1. _____

2. _____

Human-caused:

1. _____

2. _____

5. If you cut off any one of these elements a fire will not burn. What are some ways firefighters might cut off each of the three parts of the fire triangle?

3. Fires need fuel to burn. In a forest, what sort of fuels might you expect to find?

Name three potential fuels:

1. _____

2. _____

3. _____



Sixth Grade

How Trees Tell Time



INTRODUCTION

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

LESSON

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

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

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

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

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



FOREST SERVICE MESSAGES

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



ACADEMIC STANDARDS



Arizona Standards

MATH

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

GEOGRAPHY

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

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



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

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

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

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

SOCIAL STUDIES

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

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

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

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

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

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

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

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

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

SCIENCE

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

PO 1: Compare and contrast the evidence of a hypothesis

PO 2: Compare and contrast the evidence of a theory

PO 3: Analyze a hypothesis

PO 4: Analyze a theory

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

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

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

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

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

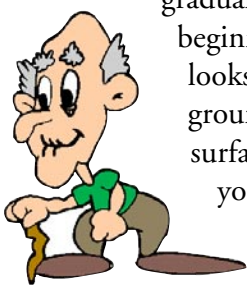
- * **Sapwood**, also called xylem (ZYE-luhm), brings water and nutrients up from the roots to the leaves; older xylem cells become part of the heartwood.

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

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

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

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



New Mexico Standards

MATH

Strand: Number and Operations

Standard: Students will understand numerical concepts and mathematical operations.

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

Grade 6 Performance Standards

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

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

Grade 6 Performance Standards

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

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

Grade 6 Performance Standards

1. Estimate quantities involving rational numbers using various estimations.

Strand: Data Analysis and Probability

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

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

Grade 6 Performance Standards

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

SOCIAL STUDIES

Strand: History

ACTIVITY

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

Team name

Kind of tree

How old the tree is?

How many scars from surface fires?

Years between any two scars that are next to each other

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

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

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

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

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

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

Grade 6 Performance Standards

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

Strand: Geography

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

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

Grade 6 Performance Standards

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

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

Grade 6 Performance Standards

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

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

Grade 6 Performance Standards

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

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

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

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

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



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

Strand I: Scientific Thinking and Practice

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

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

Grade 6 Performance Standards

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

Strand I: Scientific Thinking and Practice

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

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

Grade 6 Performance Standards

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

Strand II: Content of Science

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

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

Grade 6 Performance Standards

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

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

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

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

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

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

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

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



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

FOREST SERVICE CONSERVATION EDUCATION LEARNER GUIDELINES

Program title: How Trees Tell Time

Target audience: Sixth Grade

Primary topic: Dendrochronology.

Length of program: 1 hour

Setting: indoors

Guidelines addressed are referenced here:

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

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

CLOSING

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

HANDOUT

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

SUPPLIES

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

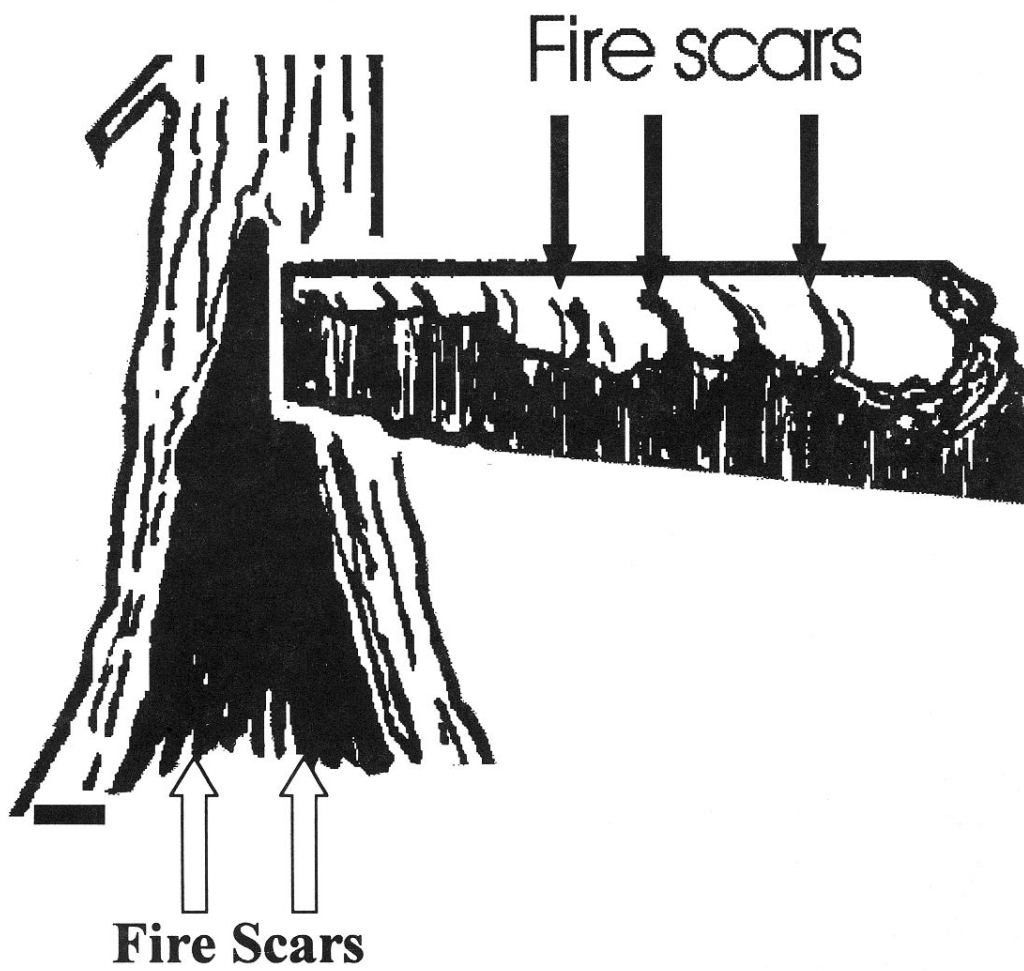
Class Page 6

TREE STORIES

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

Class Page 7

FIRE SCARS





Seventh Grade Effects of Fire on the Diversity of the Forest



INTRODUCTION

Good morning/afternoon. I am _____, and I work for the _____ National Forest. My job is _____.

LESSON

Who thinks they know the worst fire in United States history? (Give students a chance to offer some ideas. Many may say the Rodeo-Chediski Fire. The Rodeo-Chediski Fire was the largest – in terms of acres burned – of any fire ever in Arizona. It was not the “worst” fire ever in the U.S. in terms of acreage or lives lost.) A fire in Peshtigo, Wisconsin, (http://mt.essortment.com/peshtigofire_rixl.htm) in 1871 started in dry timber just outside of town. With terrifying force, the fire swept into town and killed 1,125 people. In terms of people killed, this was the worst fire in U.S. history – even worse than the great Chicago Fire that burned that same day, killing 250 people!

Those and other deadly fires convinced people that we had to do everything in our power to manage this awesome force of nature. And that is exactly what we set out to do – “manage” fire. How do you think we have done “managing” fire? Can we “manage” a force of nature like fire? (Give students a chance to express some of their viewpoints. There really are not right and wrong answers.)



FOREST SERVICE MESSAGES

- A-1:** Fire has a natural role in the ecosystem.
- A-5:** The study of the science of fire and its behavior is important.
- B-1:** People need to be careful with fire.
- B-3:** Human development near or within forest boundaries has a long-lasting effect and brings risks and obligations.
- B-4:** The complexity of managing our public lands is compounded by the numbers of people living near or within our boundaries and the increasing demands from public land users.
- C-1:** Prior to European settlement, Southwestern ponderosa pine forests had far fewer trees than today and had frequent, low-intensity surface fires.
- C-3:** Forest conditions now are not natural or healthy.
- C-4:** Because of unnaturally dense conditions, our forests are at risk for destructive wildland fires, insect infestations and diseases.
- C-5:** In many places on Southwestern forests, conditions now are such that wildland fires can have devastating, long-lasting effects.
- C-6:** The Forest Service cuts trees to accomplish specific objectives within the ecosystem such as reducing the risk of wildland fire, enhancing dwindling aspen stands, restoring grasslands, and improving forest health and wildlife habitat.
- C-7:** The Forest Service manages for biodiversity, not single species.
- C-8:** Doing nothing is not always the right answer. The Forest Service alone cannot know the right answer, but by collaborating with the public, we can come closer to it.
- C-9:** Prescribed fire is one tool the Forest Service uses to meet ecosystem goals.

ACADEMIC STANDARDS



Arizona Standards

SCIENCE

- 3SC-E3:** Identify a specific need and propose a solution or product that addresses this need, taking into consideration various factors
- PO 1:** Design a solution or product that addresses a need and considers the factors of an environmental or human problem



An engine crew is monitoring an underburn, in which fire is used to burn off the natural litter layer that has accumulated on the forest floor.

Now, we are going to view a slideshow on fire in the forest.
(Show slideshow.)

Fire in the Forest PowerPoint Presentation (This slideshow can be adapted to fit any forest in the Southwest Region.)

Slide 1

Fires are a usual occurrence on the Kaibab National Forest – as expected as the sun rising and setting.

Slide 2

It is not uncommon for us to have 200 or more fires each year. The majority of these fires are caused by lightning – usually preceding or during the monsoons. While we do get human-caused starts, they are not as frequent on the Kaibab as they are on our neighboring forests – the Coconino and the Prescott, which are headquartered in more urban areas – Flagstaff and Prescott respectively.

The vast majority of the fires we have remain small – many just a tenth of an acre or less. Here's a typical scenario – it's late July; a storm cell moves through producing precipitation and lightning. A lightning bolt strikes a tree. A small fire begins near the lightning strike and sort of smolders for awhile. By the hottest part of the next day, the fire produces enough smoke for it to be sighted by one of our lookouts. We send out resources, and the fire is quickly contained. That happens on a very regular basis. However, when conditions are extremely dry as they have been in recent years, the situation can become much different.

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

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

PO 2: Create a model of the interaction of living/non-living components within an ecosystem

6SC-E4: Provide evidence of how life and environmental conditions have changed

PO 1: Compare and contrast the life and environmental conditions within geological time periods

3SC-E1: Recognize how scientific knowledge, thinking processes and skills are used in a great variety of careers

PO 1: Explain how scientific knowledge, thinking processes and skills are used to solve problems in a variety of careers

4SC-P6: Describe and explain how the environment can affect the number of species and the diversity of species in an environment

PO 3: Predict how a change in an environmental factor can affect the number of organisms in a population

PO 4: Predict how a change in an environmental factor can affect the biodiversity in an ecosystem

1SC-E3: Organize and present data gathered from their own experiences, using appropriate mathematical analyses and graphical representations

PO 1: Construct a representation of data (e.g., histogram, stem-and-leaf plot, scatter plot, circle graph, flow chart)

PO 2: Interpret patterns in collected data

SOCIAL STUDIES

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

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

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

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

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

PO 4: how changes in the natural environment can increase or diminish its capacity to support human activities



When fires move through an area, they often leave some trees and bushes untouched. Fires often leave a mosaic pattern – with areas that were severely, moderately and lightly burned and some areas that were not burned at all. In this photo, you can see both burned and unburned areas.

Slide 3

I want to emphasize that fire is a very natural part of the Southwestern ponderosa pine ecosystem. Fire has been a part of this forest since long before we were here. In many ways, fire is a healthy, vital part of the forest. It recycles nutrients back into the soil and cleans up the forest by removing accumulations of pine needles, duff and other forest debris. After a fire moves through an area, you will often see how quickly green grasses sprout up, providing nourishment for forest animals.

Slide 4

But we have also all seen – especially in recent years – how dangerous, destructive and devastating wildfires can be. They can literally devour hundreds of thousands of acres of forest. They can destroy communities. They can threaten lives. They can leave people without homes. Arizona experienced its largest wildfire ever in 2002. At more than 400,000 acres, the Rodeo-Chediski Fire seared an image of wildfires into people’s minds that they won’t soon be able to modify.

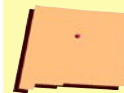
So, why are we seeing such monstrous, devastating wildfires if they are supposed to be a natural, healthy, positive part of our forests? The reason is simply this – fire has changed. What I mean by that is that the kind of wildfires we are seeing now are different than the kind of wildfires that moved through this area more than a century ago. Why? Fires have changed because the forest has changed.

Slide 5

Prior to European settlement in this area, low-to-medium intensity ground fires moved through our forests every 2-10

MATH

- 2M-E1:** Construct, read, analyze and interpret tables, charts, graphs and data plots (e.g., box-and-whisker, stem-and-leaf, and scatter plots)
- PO 3:** Choose an appropriate graphical format to organize and represent data
- 2M-E2:** Make valid inferences, predictions and arguments based on statistical analysis
- PO 1:** Formulate predictions from a given set of data and justify predictions
- PO 2:** Compare a given prediction with the results of an investigation
- 2M-E3:** Display and use measures of range and central tendency (i.e., mean, median and mode)
- PO 2:** Find the mean, median, mode and range of a data set
- PO 3:** Choose appropriate measures of central tendencies to describe given or derived data
- 3M-E4:** Analyze functional relationships to explain how a change in one variable results in a change in another
- PO 2:** Produce the rule (function) that explains the relationship (pattern) between the numbers when a change in the first variable affects the second variable (T-chart, two-row table, or input/output machine)
- PO 4:** Complete a T-chart for a given rule
- 3M-E8:** Develop, analyze and explain methods for solving proportions
- PO 1:** Describe how to solve a problem in context using a proportion
- PO 2:** Compare quantities using ratios
- PO 3:** Solve proportions using formal (e.g., cross product) or informal methods (e.g., diagrams, geometric models)



New Mexico Standards

SCIENCE

Strand I: Scientific Thinking and Practice

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

5-8 Benchmark I: Use scientific methods to develop questions, design and conduct experiments using appropriate technologies, analyze and evaluate results, make predictions, and communicate findings.

Grade 7 Performance Standards

1. Use a variety of print and web resources to collect information, inform investigations, and answer a scientific question or hypothesis.
2. Use models to explain the relationships between variables being investigated.

years, killing many small trees but sparing the larger ones. Ponderosa pines, which are adapted to that kind of fire regime, develop thick bark as they age, which helps protect them from frequent ground fires. The forest, as described by early settlers, was open and parklike with significant spacing between trees.

Around 1870, things began to change. Heavy, unregulated grazing lasting several decades reduced the grass cover that carried ground fires. Those fires that did get started were quickly suppressed. Fire exclusion, livestock grazing and other factors have created forests much more dense than they were a century and more ago.

Slide 6

Natural wildland fires moving through a relatively open landscape with large trees like we see here in 1910 would have, for the most part, remained on the ground. Many smaller trees would have been killed by the flames, but most of the larger ones would have remained.

Slide 7

By the 1930s after settlers had established themselves in the area, you can see a large crop of small trees growing unimpeded in the forest. Because the grasses that carried fires were being eaten by livestock and the fires that did get started were quickly put out, the small trees had no barriers to continued growth. In basic terms, the natural ways – such as frequent low-to-medium intensity ground fires – that Mother Nature had used to regulate tree density had been taken away.

Slide 8

By 1989, the forest is crowded with dense thickets of trees. If a wildland fire were to move through this area, the outcome would be much different than it was in 1910. The small trees



In order to try to prevent high-intensity wildland fires, land managers often intentionally light fires on days when the fires are likely to remain at low-to-moderate levels of intensity. These photos show two different kinds of burns on the Kaibab National Forest in northern Arizona. In one photo, tree slash that was left over from a thinning project has been piled and is being burned.

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

Grade 7 Performance Standards

1. Understand that the number of data (sample size) influences the reliability of a prediction.
2. Use mathematical expressions to represent data and observations collected in scientific investigations.
3. Select and use an appropriate model to examine a phenomenon.

Strand II: Content of Science

Standard I (Physical Science): Understand the structure and properties of matter, the characteristics of energy, and the interactions between matter and energy.

5-8 Benchmark II: Explain the physical processes involved in the transfer, change, and conservation of energy.

Grade 7 Performance Standards

1. Know how various forms of energy are transformed through organisms and ecosystems, including:
 - sunlight and photosynthesis
 - energy transformation in living systems (e.g., cellular processes changing chemical energy to heat and motion)
 - effect of mankind's use of energy and other activities on living systems (e.g., global warming, water quality).

Strand II: Content of Science

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

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

Grade 7 Performance Standards

Populations and Ecosystems

1. Identify the living and nonliving parts of an ecosystem and describe the relationships among these components.
2. Explain biomes (i.e., aquatic, desert, rainforest, grasslands, tundra) and describe the New Mexico biome.
3. Explain how individuals of species that exist together interact with their environment to create an ecosystem (e.g., populations, communities, niches, habitats, food webs).
4. Explain the conditions and resources needed to sustain life in specific ecosystems.
5. Describe how the availability of resources and physical factors limit growth (e.g., quantity of light and water, range of temperature, composition of soil) and how the water, carbon,

would form a ladder, carrying the flames into the tops of trees. The flames would quickly spread across the treetops, probably killing most trees in its path. A fire in this forest could result in destruction of the entire area.

Slide 9

Fire isn't the only thing that has changed over the years. People have also changed. More and more families are choosing – and I emphasize the word choosing – to move into what we call the wildland-urban interface, the areas where our forests and communities meet. Along with the beauty of the trees and wildlife comes the threat of wildland fire.

Slide 10

With the changing dynamics of fire and where people are choosing to live, what is our role – as land management agency employees – in preventing destructive fires in the wildland-urban interface? We actually have many roles.



I can sum it up quickly – prevention, suppression and fuels management. Prevention is truly the cornerstone of any fire management program. We want to work to stop fires before they start. While we can't

prevent lightning strikes, we can work to reduce the number of human-caused fires. With less human-caused fires to fight, we will have more firefighting resources available to attack the inevitable lightning-caused blazes.

Slide 11

The second major role of the Forest Service in today's fires is suppression.

Slide 12

Lookouts are stationed at strategic locations across the forest. Lookouts are often the first people to report a smoke sighting. All smoke reports eventually make their way to our Dispatch office. Dispatch is responsible for assigning resources to the fire and keeping track of all units responding.



and nitrogen cycles contribute to the availability of those resources to support living systems.

Biodiversity

6. Understand how diverse species fill all niches in an ecosystem.
7. Know how to classify organisms: domain, kingdom, phylum, class, order, family, genus, species.

Strand II: Content of Science

Standard III (Earth and Space Science): Understand the structure of Earth, the solar system, and the universe, the interconnections among them, and the processes and interactions of Earth's systems.

5-8 Benchmark II: Describe the structure of Earth and its atmosphere and explain how energy, matter, and forces shape Earth's systems.

Grade 7 Performance Standards

1. Understand how the remains of living things give us information about the history of Earth, including:
 - layers of sedimentary rock, the fossil record, and radioactive dating showing that life has been present on Earth for more than 3.5 billion years.
2. Understand how living organisms have played many roles in changes of Earth's systems through time (e.g., atmospheric composition, creation of soil, impact on Earth's surface).
3. Know that changes to ecosystems sometimes decrease the capacity of the environment to support some life forms and are difficult and/or costly to remediate.

SOCIAL STUDIES

Strand: History

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

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

Grade 7 Performance Standards

1. Analyze and evaluate information by developing and applying criteria for selecting appropriate information and use it to answer critical questions.
2. Demonstrate the ability to examine history from the perspectives of the participants.
3. Use the problem-solving process to identify a problem; gather information, list and consider advantages and disadvantages, choose and implement a solution, and evaluate the

Slide 13

Often, the first resources to be assigned to an incident and arrive on scene are our ground resources, which include engines, patrol units and dozers.



Slide 14

Other tools in the arsenal are aerial resources. Helicopters have various roles in a wildland fire situation. First, they can perform aerial reconnaissance missions to provide information on the location, size and behavior of a wildland fire. Second, they can quickly deliver firefighters to remote locations where they can begin initial attack operations. In terrain too rough for the helicopter to land, firefighters use rappel operations to get from air to ground quickly. The third and probably most well-known function of helicopters is to drop water onto wildland fires. Finally, helicopters also deliver cargo to firefighters and support personnel on the ground.

Slide 15

On to the third and final role of the Forest Service in today's fires – Fuels Management. I'm going to cover what that is, why it's important and the current fuels management initiatives in place on the Kaibab National Forest.

Slide 16

So, what do I mean by Fuels Management? Fuels Management most basically involves evaluating the current conditions of



The forests in the Southwest are unhealthy. There are too many trees and not enough water to sustain them all. The trees are becoming more and more susceptible to insect infestation, disease, and high-intensity wildland fire.

dead and live fuels – for instance, pine needles, trees, snags, debris on the forest floor – and determining the best tools to manage those fuels. Two of our most common Fuels Management tools are tree thinning, in which we remove trees from overstocked stands, and prescribed burning, in which forest managers intentionally start fires. Both tools, when used correctly,

effectiveness of the solution using technology to present findings.

Strand: Geography

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

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

Grade 7 Performance Standards

1. Explain how physical processes influence the formation and location of resources.
2. Use data to interpret changing patterns of air, land, water, plants, and animals.
3. Explain how ecosystems influence settlements and societies.

MATH

Strand: Algebra

Standard: Students will understand algebraic concepts and applications.

5-8 Benchmark: Understand patterns, relations, and functions.

Grade 7 Performance Standards

1. Identify and continue patterns presented in a variety of formats.
2. Represent a variety of relationships using tables, graphs, verbal rules, and possible symbolic notation, and recognize the same general pattern presented in different representations.
3. Simplify numerical expressions by applying properties of rational numbers, and justify the process used.
4. Interpret and evaluate expressions involving integer powers and simple roots.
5. Graph and interpret linear functions.
6. Solve problems involving rate, average speed, distance, and time.

Strand: Data Analysis and Probability

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

5-8 Benchmark: Select and use appropriate statistical methods to analyze data.

Grade 7 Performance Standards

1. Choose and justify appropriate measures of central tendencies (e.g., mean, median, mode, range) to describe given or derived data.
2. Know various ways to display data sets (e.g., stem and leaf plot, box and whisker plot, scatter plots) and use these forms to display a single set of data or to compare two sets of data.

can improve overall forest health. Fuels Management can be much more than just thinning and prescribed burning, though. For the average homeowner, Fuels Management can mean thinning and pruning trees, mowing grass and removing brush, moving wood piles away from homes, and cleaning debris from rain gutters.

Slide 17

So, why do we even need Fuels Management? Shouldn't we just leave the forest and trees the way they are? Think back to my earlier description of how the forests have changed over the last century and the resulting changes in the kind of wildfires we are seeing. Given the history of our forests, there are several reasons why Fuels Management is important. The one that most people are now coming to realize is wildland fire risk reduction. The overarching goal of many Fuels Management projects is to reduce the threat of wildland fire. Thinning and burning treatments help remove the materials that fuel fires.



As part of wildland fire suppression efforts, helicopter crewmembers can rappel into areas that are difficult to access by road and begin firefighting operations. Firefighters must go through extensive training before being allowed to participate in rappel operations.

Slide 18

Through lessening the risk of wildland fire, Fuels Management projects help to protect lives and communities – especially in the areas where communities and forests meet, what we call the wildland-urban interface.

Slide 19

Fuels Management projects improve the overall forest health in the areas treated. For example, thinning improves the rate of growth in the remaining stand and makes the trees that are left healthier. Also important in these drought years is the fact that dense tree stands require more moisture, and drought-stressed

3. Use the analysis of data to make convincing arguments.

Strand: Data Analysis and Probability

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

5-8 Benchmark: Develop and evaluate inferences and predictions that are based on data.

Grade 7 Performance Standards

1. Formulate and justify mathematical conjectures based on data and a general description of the mathematical question or problem posed.
2. Analyze data to make accurate inferences, predictions, and to develop convincing arguments from data displayed in a variety of forms.

trees are more vulnerable to insect infestation and disease. We have seen this clearly over the last few years. Our forests are filled with dead and dying trees – from drought, dwarf mistletoe, and bark beetle infestation.

Slide 20

Finally, Fuels Management projects can help to get our forests closer to historic ecological conditions – open, parklike and with abundant grasses and forbs.

Slide 21

Thank you for your time. I hope that you leave today with a better understanding of fire in our forest. It is really important that we all have some background knowledge about fire’s role in our forest, the fire history of our forest, and the role the Forest Service plays in today’s fires.

(End slideshow.)

ACTIVITY

Now I want to ask you a question based on everything you have learned about fire in our forest. Do you think fire increases or decreases diversity within a forest? (Let the students have time to comment.) As our activity for today, we are going to study some research that will prove the answer to that question – one way or the other.

I am going to ask you to graph information collected before and after treatment with thinning and prescribed burning on two different research plots. This is real research that was shared with us by Mark Daniels at Northern Arizona University in Flagstaff, Arizona. The data come from two plots at a study site near Mount Trumbull on the Arizona Strip. The plots were measured before treatments in 1996 and then again in 1999 after treatments of thinning and prescribed burning.

Spreadsheet #1 “Species Lists” shows the number of species both pre- and post-treatment with thinning and prescribed burning for Plots A and B.

Spreadsheet #2 “Frequencies” shows the actual frequency measurements of individual plant species both pre- and post-treatment with thinning and prescribed burning for Plots A and B.



**FOREST SERVICE CONSERVATION
EDUCATION LEARNER GUIDELINES**

Program title: The Effects of Fire on the Diversity of the Forest

Target audience: Seventh Grade

Primary topic: Fuels management helps increase diversity in the forest.

Length of program: 1 to 1.25 hours

Setting: indoors

Guidelines addressed are referenced here:

5-8
I. Questioning and Analysis Skills
A1, A2, B2, C2, C3, E1, E3, G2, G3
II. Knowledge of Environmental Processes and Systems
1. A1, A2, C2
2. A1, C2, C3, C4, D1
3. B2, C1, C3
4. A1, A2, A3, C4, D1, D2
III. Skills for Understanding and Addressing Environmental Issues
1. A1, A3, B1, B2, B3, C2, D1
2. A1, A2, B1, D1
IV. Personal and Civic Responsibility
A3, B2, B3, C1, C2

Do you think there will be a greater number of species present in each plot before or after thinning and burning?

Do you think there will be higher or lower numbers of plants within each species after thinning and burning?

Let's find out!

(Break students into five groups.)

(All groups are to use line graphs or bar charts.)

Group 1: Graph number of species pre- and post-treatments for Plots A and B.

(Presenter/Teacher Tip: Use a line graph or bar chart. Prior to treatment, Plot A has 8 species present. Post-treatment, Plot A has 34 species present. Prior to treatment, Plot B has 11 species present. Post-treatment, Plot B has 33 species present.)

Groups 2 and 4: Graph percentage of each species pre- and post-treatment for Plot A. Please notice that there are more species post-treatment in Plot A. You only need to graph the changes for those species that were present pre-treatment. (If there is extra time for graphing, students can use zero as the pre-treatment frequency for all those species that manifested post-treatment in Plot A.)

Groups 3 and 5: Graph percentage of each species pre- and post- for Plot B. Please notice that there are more species post-treatment in Plot B. You only need to graph the changes for those species that were present pre-treatment. (If there is extra time for graphing, students can use zero as the pre-treatment frequency for all those species that manifested post-treatment in Plot B.)

(Have a representative from each group share their findings with the class. If there is time, you may want to re-create some of their graphs/charts on the board.)

So, was there a greater number of species present in each plot before or after thinning and burning? (After!)

So, were there higher or lower numbers of plants within each species after thinning and burning? (Higher!)

CLOSING

I hope that from the presentation and activity, you learned that keeping fire out of the forest is not a good idea and really is not possible. Fire plays a natural role in our forest. In fact, it is essential to forest health.

HANDOUT

Forest Service brochures on fire (any or all of the following):

- ⊙ "Fire and the Changing Land"
- ⊙ "Rx Fire!"
- ⊙ "Living With Fire"

Set of Smokey Posters on Diversity for the classroom

SUPPLIES

- Laptop
- Projector
- Screen
- "Fire In Our Forest" PowerPoint (see companion PowerPoint presentation.)
- Pencils (one per student)
- Graph paper (a few sheets per group – five groups)
- Hard copies of “Seventh Grade Data” spreadsheet (one copy per group – five groups)
- Forest Service brochures on fire
- Set of Smokey Posters on Diversity (one per classroom)
 - Available through National Symbols Catalog.
 - Collated sets of 15 posters (6 complete sets of 15). Reserve a special place on the wall for these colorful posters as a bright reminder to Smokey Bear’s partners in fire prevention. Set includes: trees, birds, mammals, invertebrates, nests, tracks, butterflies, wildflowers, insects, fish, snakes, mushrooms, herbs, and leaf types along with “Don’t Light Up the Night”.



Student Page

Seventh Grade Data Spreadsheets

Species lists from two plots, both pre-treatment and 3 years after thinning & burning:

Plot#	Trt Status	Common Name	Date
	APRE	beardlip penstemon	4/10/1996
	APRE	big sagebrush	4/10/1996
	APRE	Carruth's sagewort	4/10/1996
	APRE	common dandelion	4/10/1996
	APRE	New Mexico locust	4/10/1996
	APRE	silver lupine	4/10/1996
	APRE	thick-leaf beardtongue	4/10/1996
	APRE	western bottle-brush grass	4/10/1996
	APOST	American dragonhead	5/31/1999
	APOST	beardlip penstemon	5/31/1999
	APOST	big sagebrush	5/31/1999
	APOST	birdsfoot trefoil	5/31/1999
	APOST	blue grama	5/31/1999
	APOST	Canadian horseweed	5/31/1999
	APOST	cheatgrass	5/31/1999
	APOST	common mullein	5/31/1999
	APOST	coyote tobacco	5/31/1999
	APOST	desert ragwort	5/31/1999
	APOST	Douglas' knotweed	5/31/1999
	APOST	Fendler's rockcress	5/31/1999
	APOST	Gambel oak	5/31/1999
	APOST	hoary aster	5/31/1999
	APOST	horned spurge	5/31/1999
	APOST	lambquarters	5/31/1999
	APOST	lobeleaf groundsel	5/31/1999
	APOST	longleaf phlox	5/31/1999
	APOST	New Mexico bird's-foot trefoil	5/31/1999
	APOST	New Mexico locust	5/31/1999
	APOST	nodding buckwheat	5/31/1999
	APOST	pale agoseris	5/31/1999
	APOST	ponderosa pine	5/31/1999
	APOST	red monkeyflower	5/31/1999
	APOST	silver lupine	5/31/1999
	APOST	slender phlox	5/31/1999
	APOST	smallflower blue eyed Mary	5/31/1999
	APOST	spreading groundsmoke	5/31/1999
	APOST	stickywilly	5/31/1999
	APOST	tall annual willowherb	5/31/1999
	APOST	thick-leaf beardtongue	5/31/1999
	APOST	wax currant	5/31/1999
	APOST	western bottle-brush grass	5/31/1999
	APOST	wheatgrass	5/31/1999

B PRE	big sagebrush	4/10/1996	
B PRE	cheatgrass	4/10/1996	
B PRE	common mullein	4/10/1996	
B PRE	desert ragwort	4/10/1996	
B PRE	hoary aster	4/10/1996	
B PRE	horned spurge	4/10/1996	
B PRE	lobeleaf groundsel	4/10/1996	
B PRE	pale agoseris	4/10/1996	
B PRE	silver lupine	4/10/1996	
B PRE	wax currant	4/10/1996	
B PRE	western bottle-brush grass	4/10/1996	
B POST	beardlip penstemon	5/31/1999	
B POST	big sagebrush	5/31/1999	
B POST	Canadian horseweed	5/31/1999	
B POST	Carruth's sagewort	5/31/1999	
B POST	cheatgrass	5/31/1999	
B POST	common mullein	5/31/1999	
B POST	common pepperweed	5/31/1999	
B POST	cryptantha	5/31/1999	
B POST	desert ragwort	5/31/1999	
B POST	Douglas' knotweed	5/31/1999	
B POST	Fendler's rockcress	5/31/1999	
B POST	Gambel oak	5/31/1999	
B POST	hoary aster	5/31/1999	
B POST	horned spurge	5/31/1999	
B POST	lambquarters	5/31/1999	
B POST	lobeleaf groundsel	5/31/1999	
B POST	New Mexico locust	5/31/1999	
B POST	nodding buckwheat	5/31/1999	
B POST	prickly lettuce	5/31/1999	
B POST	red monkeyflower	5/31/1999	
B POST	showy goldeneye	5/31/1999	
B POST	silver lupine	5/31/1999	
B POST	slender phlox	5/31/1999	
B POST	smallflower blue eyed Mary	5/31/1999	
B POST	spotted missionbells	5/31/1999	
B POST	spreading fleabane	5/31/1999	
B POST	spreading groundsmoke	5/31/1999	
B POST	spreading sandwort	5/31/1999	
B POST	tall annual willowherb	5/31/1999	
B POST	toadflax penstemon	5/31/1999	
B POST	western bottle-brush grass	5/31/1999	
B POST	Wright's deervetch	5/31/1999	
B POST	yellow salsify	5/31/1999	

Student Page

Plant species' frequencies from two plots, both pre-treatment and 3 years after thinning & burning:

Plot#	Trt Status	Species/Substrate	Frequency (%)	Date
	APRE	big sagebrush	1.81	4/10/1996
	APRE	western bottle-brush grass	1.51	4/10/1996
	APRE	silvery lupine	1.20	4/10/1996
	APRE	thick-leaf beardtongue	0.60	4/10/1996
	APRE	New Mexico locust	0.30	4/10/1996
	APRE	common dandelion	0.30	4/10/1996
	APOST	silvery lupine	9.94	5/31/1999
	APOST	New Mexico locust	3.31	5/31/1999
	APOST	cheatgrass	3.01	5/31/1999
	APOST	smallflower blue eyed Mary	2.71	5/31/1999
	APOST	western bottle-brush grass	2.71	5/31/1999
	APOST	big sagebrush	2.11	5/31/1999
	APOST	lobeleaf groundsel	1.20	5/31/1999
	APOST	thick-leaf beardtongue	1.20	5/31/1999
	APOST	Gambel oak	0.90	5/31/1999
	APOST	slender phlox	0.60	5/31/1999
	APOST	common mullein	0.60	5/31/1999
	APOST	spreading groundsmoke	0.60	5/31/1999
	APOST	New Mexico bird's-foot trefoil	0.30	5/31/1999
	APOST	wheatgrass	0.30	5/31/1999
	APOST	blue grama	0.30	5/31/1999
	BPRE	big sagebrush	2.41	4/10/1996
	BPRE	western bottle-brush grass	1.81	4/10/1996
	BPRE	cheatgrass	1.20	4/10/1996
	BPRE	common mullein	0.30	4/10/1996
	BPOST	big sagebrush	4.22	5/31/1999
	BPOST	smallflower blue eyed Mary	4.22	5/31/1999
	BPOST	silvery lupine	3.61	5/31/1999
	BPOST	western bottle-brush grass	3.01	5/31/1999
	BPOST	cheatgrass	2.71	5/31/1999
	BPOST	New Mexico locust	2.41	5/31/1999
	BPOST	lobeleaf groundsel	2.11	5/31/1999
	BPOST	Canadian horseweed	1.81	5/31/1999
	BPOST	common mullein	1.81	5/31/1999
	BPOST	tall annual willowherb	0.90	5/31/1999
	BPOST	desert ragwort	0.60	5/31/1999
	BPOST	slender phlox	0.60	5/31/1999
	BPOST	Gambel oak	0.30	5/31/1999
	BPOST	red monkeyflower	0.30	5/31/1999
	BPOST	horned spurge	0.30	5/31/1999
	BPOST	lambsquarters	0.30	5/31/1999
	BPOST	prickly lettuce	0.30	5/31/1999



Eighth Grade Fire in the Wildland- Urban Interface



INTRODUCTION

Good morning/afternoon. My name is _____
 _____, and I work for the _____ National
 Forest. Today we are going to be talking about wildland fire.
 More specifically, we are going to be talking about fires in the
 wildland-urban interface.

LESSON

Every year many families lose their homes and possessions to
 the ravages of fire. Have any of you known people who lost
 their homes to fire? (Allow students to give some examples.)
 How about a wildfire? (Allow students to respond.)

Much of the Southwest is considered a high-hazard fire
 environment. Based on recent history, we know that our
 area has all the things necessary to support large, intense and
 dangerous wildland fires. As the number of people living in
 and adjacent to wildlands grows, the likelihood of homes being
 threatened by wildfire also grows.

Have any of you heard the term wildland-urban interface?
 What does that mean? (Give students the opportunity to
 answer.) The WUI, as we call it, is the area where human
 development meets the undeveloped wildlands. We are
 especially concerned about fires in these areas because they
 threaten lives, homes and property.

This is what we call the Fire in the WUI Equation (write this
 on the board and draw little, fun graphics to go along): A (Fire)
 + B (People) + C (Increasing fire starts) + D (Larger, more
 intense fires) = E (Greater loss of life, homes and property)



FOREST SERVICE MESSAGES

- B-2:** Public lands are unique, valuable resources for which the public has a shared responsibility in their care.
- B-3:** Human development near or within forest boundaries has a long-lasting effect and brings risks and obligations.
- B-4:** The complexity of managing our public lands is compounded by the numbers of people living near or within our boundaries and the increasing demands from public land users.
- B-5:** There are limits to sustainable development.

ACADEMIC STANDARDS



Arizona Standards

SCIENCE

- 3SC-E2:** Develop and use a systematic approach to analyze the risks associated with natural and biological hazards
- PO 1:** Analyze the risk factors associated with natural and biological hazards
- 3SC-E3:** Identify a specific need and propose a solution or product that addresses this need, taking into consideration various factors
- PO 1:** Design a solution or product that addresses a need and considers the factors of an environmental or human problem
- 3SC-E4:** Implement a proposed solution or design and evaluate its merit
- PO 1:** Apply a proposed solution to a problem
- 3SC-P2:** Propose and test, using computer software or common materials a solution to an existing problem; or design a product to meet a need, using a model or simulation
- PO 2:** Propose a solution to the problem or design a product to meet the need

SOCIAL STUDIES

- 3SS-E2:** Describe the impact of interactions between people and the natural environment on the development of places and regions in Arizona, including how people have adapted to and modified the environment, with emphasis on:
 - PO 4:** how people have depended on the physical environment and its natural resources to satisfy their basic needs, including the consequences of Arizonans'

(Then, read the following and involve the students as you go.)

A = Fire is a natural part of our environment. (Fire was here long before we were. In fact, in the Southwestern ponderosa pine ecosystem, researchers have shown that fires burned through areas every 2 to 12 years.)

B = More and more people are living in this environment. (People like to live near the forest, so they build homes here. Many homes are built and maintained without regard to wildfire.)

C = There is a greater chance of fires starting. (With more people using our wildlands, more fire ignitions are likely. What are some ways people may start fires? Examples: campfires, cigarettes, matches, etc.)

D = Today's wildfires can burn intensely and be difficult to control. (Fires in the Southwest are bigger and more dangerous than they used to be. That's because when people moved into the forests, they decided to put out all those natural fires that were occurring. The problem was that without those fires, the fuels in the forest – such as pine needles, brush and trees – started to build up. So now when a fire starts, it has so much fuel that it burns more intensely and grows more rapidly.)

E = Greater loss of life; increased property losses; damage to natural resources; more money spent on firefighting. (Instead of doing positive things for the forest like fires used to do, some fires today are causing a lot of damage because of their high intensities. Can you think of some negative things that high-intensity wildfires can do? Examples: destroy all the trees; destroy wildlife habitat; kill animals and people; burn down homes, etc. Can you think of some positive things that lower-intensity wildfires can do? Examples: release nutrients into the soil; clean up accumulated fuels in the forest; stimulate new grasses to grow, which will attract wildlife, etc.)



This photo was taken on the Kaibab National Forest during a prescribed burn in the wildland-urban interface. In the background, there is a school. Prescribed burns are conducted in the wildland-urban interface in order to reduce the risk of high-intensity, destructive wildland fires.

adaptation to, and modification of, the natural environment

LANGUAGE ARTS

W-E1: Use correct spelling, punctuation, capitalization, grammar and usage, along with varied sentence structure and paragraph organization, to complete effectively a variety of writing tasks

PO 1: Spell correctly

PO 2: Punctuate correctly (e.g., sentence endings, commas in a series, commas in compound sentences, abbreviations, quotation marks, colon in a business letter greeting, apostrophes)

PO 3: Apply rules of capitalization (e.g., sentence beginnings, titles, abbreviations, proper nouns, direct quotations)

PO 4: Apply standard grammar and usage (e.g., subject-verb agreement; simple, compound and complex sentences; appropriate verb tense; plurals; prepositions)

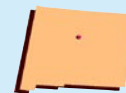
PO 5: Organize paragraphs with a variety of sentence structures (e.g., simple, compound, complex)

W-E6: Write formal communications, such as personal or business letters, messages, directions and applications, in an appropriate format and for a specific audience and purpose

PO 1: Write a formal communication in an appropriate format for a specific audience and purpose

PO 2: Organize ideas in a meaningful sequence using smooth transitions

PO 3: Express ideas that are clear and directly related to the topic



New Mexico Standards

SCIENCE

Strand I: Scientific Thinking and Practice

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

5-8 Benchmark I: Use scientific methods to develop questions, design and conduct experiments using appropriate technologies, analyze and evaluate results, make predictions, and communicate findings.

Grade 8 Performance Standards

2. Use a variety of technologies to gather, analyze and interpret scientific data.

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

Grade 8 Performance Standards

Now that we know more about why wildfires in the WUI can be scary, let's talk about things that can be done to reduce fire risk. Any ideas?

Let's start by assessing the safety of homes in the WUI.

(This part of the lesson is derived from "Where Growth Meets Growth" of Nova Activity Fire Wars,

http://www.pbs.org/wgbh/nova/teachers/activities/pdf/2908_fire_01.pdf.)

- Organize students into teams. Give each team copies of the "Where Growth Meets Growth" activity sheets and colored pencils.
- Have students identify, number and provide reasons for areas of increased risk they think should be changed.
- Have students consider changes that may mean adding or taking something away from the property that is not currently featured in the illustration.
- When teams are finished, compile everyone's results on the chalkboard and review them.
- Discuss the changes and why they should be made. Which changes would the students make first and why?
- Use the "Where Growth Meets Growth" answer sheet to identify changes that should be made that students might have missed. Print this page for answers:

http://www.pbs.org/wgbh/nova/teachers/activities/2908_fire.html

(As an extension that the class could do now or later, have students survey and identify areas of their towns that may be most at risk for fire.)



ACTIVITY #1

(There are two activities offered in the Eighth Grade program. You can select one or the other or both depending on time and resources. This first activity requires use of the "Burning Issues" CD-ROMS. Computer requirements: Adobe Acrobat 3.0 or higher, QuickTime 3.0 or higher, 4X CD-ROM player. If these aren't on the computer, they need to be loaded from the CD. Be sure that you have sound on the computer. Use one computer, a projector and a screen so the class can all work together.)

Now, we are going to use everything we have learned to decide where and how we want to build a home in the WUI. We are going to do this using a program called "Burning Issues."

1. Examine alternative explanations for observations.
2. Describe ways in which science differs from other ways of knowing and from other bodies of knowledge (e.g., experimentation, logical arguments, skepticism).
3. Know that scientific knowledge is built on questions posed as testable hypotheses, which are tested until the results are accepted by peers.

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

Grade 8 Performance Standards

2. Create models to describe phenomena.

Strand II: Content of Science

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

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

Grade 8 Performance Standards

2. Describe how energy flows through ecosystems (e.g. sunlight, green plants, food for animals).
3. Explain how a change in the flow of energy can impact an ecosystem (e.g. the amount of sunlight available for plant growth, global climate change).

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

Grade 8 Performance Standards

1. Understand and apply the problem-solving skills for historical research, to include:
 - use of primary and secondary sources sequencing posing questions to be answered by historical inquiry
 - collecting, interpreting, and applying information gathering and validating materials that present a variety of perspectives.

Strand: Geography

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

5-8 Benchmark II-C: Understand how human behavior impacts man-made and natural environments, recognizes past and present results, and predicts potential changes.

(These instructions are from “Burning Issues” Teachers’ Workbook.)

- You will be accessing the Chaparral I-Zone for this particular activity.
- Start with My Computer.
- Then open Burn CD and double-click on Start.exe (Be patient. It may take a little time.)
- Play the Introduction.
- You are in the virtual Fire Center now, trapped in the hallway with three doors. Your only option is to enter the briefing room to get further instructions. (To scan, hold down left mouse button and move mouse. To zoom in, hold down Shift. To zoom out, hold down Ctrl.)
- Go through the Briefing Room door. Listen to the welcome.
- Click on a chair. Listen to the introduction and instructions.
- Exit the room to the hallway.
- Go through the door to the airfield. (E-R-I-F in order to get through.)
- Click on the Small Plane to get to the Chaparral I-Zone.

As we have already learned, the area where wildlands and human activities merge is often called the wildland-urban interface or, on this CD, the I-Zone. In this EcoVenture you will learn about the chaparral ecosystem and how people are moving into areas that were maintained by a natural fire regime. The activities involve the challenges of building and sustaining homes in areas where wildland fires occur. Some of the things you do are:

- select a FIREWISE building site,
- construct a FIREWISE home, and
- design FIREWISE landscaping around the home.

Most homeowners don’t understand the natural cycle of wildfire and don’t realize they are living in an area “designed” by nature to burn. Agency fire services are not always able to protect homes during wildland fires. Homeowners, community planners, fire agencies and others must work together to reduce these risks to homeowners and firefighters, and to prevent the loss of homes and structures. Before building a home and selecting a site, ask yourself, “Before the fire comes, have I done everything I could to protect my home and family?”.

Grade 8 Performance Standards

1. Explain and evaluate how changing perceptions of place and the natural environment have affected human behavior

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

Grade 8 Performance Standards

1. Explain how human activities and physical processes influence change in ecosystems.

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

Grade 8 Performance Standards

1. Describe the differing viewpoints that individuals and groups have with respect to the use of resources.

LANGUAGE ARTS

Strand: Reading and Listening for Comprehension

Content Standard I: Students will apply strategies and skills to comprehend information that is read, heard, and viewed.

5-8 Benchmark I-A: Listen to, read, react to, and interpret information

Grade 8 Performance Standards

1. Narrate a personal account that:
 - establishes a point of view and sharpens focus
 - uses remembered feelings
 - selects details that best illuminate the topic
 - connects events to self and society
2. Interact in group activities and/or seminars to:
 - share personal reactions to questions raised
 - give reasons and cite examples from texts to support opinions
 - clarify, illustrate, or expand on a response
 - ask classmates for similar expansion
3. Compare, contrast, and evaluate for details, main ideas, themes, actions, and main character from oral selections.

Strand: Reading and Listening for Comprehension

Content Standard I: Students will apply strategies and skills to comprehend information that is read, heard, and viewed.

5-8 Benchmark I-B: Gather and use information for research and other purposes

Grade 8 Performance Standards

1. Use information for specific tasks by:
 - analyzing and evaluating information to extend ideas



An area burned by fire on the Prescott National Forest. More and more people are choosing to live in areas that historically burned at regular intervals.

- Divide students into three groups. Explain that they are all going to have a part in building “their” house. Hopefully it will be a FIREWISE house.
- Group 1 is going to select a building lot in the chaparral “neighborhood”.
- Group 2 is going to decide what building materials to use to construct your house.
- Group 3 is going to landscape your house.
- Group 1:
 - As you and the rest of the class look at the picture on the screen, I’m going to tell you a little about the neighborhood. This site is located in California’s chaparral ecosystem. People have modified this area’s vegetation by planting trees and other plants. Keep in mind trees are not always good indicators of the most dangerous fuels. Small diameter fuels, such as brush and grass, burn fiercely. Look at the potential building sites extending from the edge of town into the surrounding countryside. These sites extend along the street, out into the valley and up the side of the mountain.
 - Use the overlays to see the city water supply, electrical grid, existing streets and the topography. Spend a little time switching between overlays.
 - Tell Groups 2 and 3 that even though this isn’t “their” activity, they should be thinking about where they would select a building lot.
 - After Group 1 has become familiar with the neighborhood, have them select a building lot to begin constructing their new home. The most FIREWISE sites are assigned a Survivability Factor of 30 points. Now that they have picked a possible building site, have them review the overlays again and tell them it’s not too late to choose another site!

- analyzing and evaluating themes and central ideas in relation to personal and societal issues
 - creating a research product in both written and presentation form
2. Use images, videos, and visual representations as informational research tools.

5-8 Benchmark I-C: Apply critical thinking skills to analyze information

Grade 8 Performance Standards

1. Create a research product in both written and presentation form by:
 - determining purpose, audience, and context
 - choosing a relevant topic
 - selecting a presentation format (e.g., video, essay, interactive technology)
 - evaluating information for extraneous detail, inconsistencies, relevant facts, and organization
 - researching and organizing information to achieve purpose using notes and memory aides to structure information
 - supporting ideas with examples, definitions, analogies, and direct references to primary and secondary sources
 - citing sources used
 - employing graphics, charts, diagrams, and graphs to enhance communication
2. Analyze the inferences and conclusions from fictional and non-fictional contexts, events, characters, settings, and themes.

Strand: Writing and Speaking for Expression

Content Standard II: Students will communicate effectively through speaking and writing.

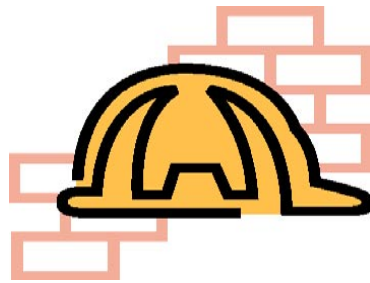
5-8 Benchmark II-A: Use speaking as an interpersonal communication tool.

Grade 8 Performance Standards

1. Present similar content for various purposes and to different audiences showing appropriate changes in delivery.
2. Create and present arguments that persuade by:
 - engaging the audience by establishing a context, creating a persona, and developing interest
 - developing an idea that makes a clear and informed conclusion
 - arranging details, reasons, and examples persuasively
 - anticipating and addressing reader/listener concerns and counter-arguments

– Have them explain why they chose the lot they did. Listen to their reasons. As the presenter, you have a list of possible reasons for not choosing a building lot. Some of these are:

- ⊙ away from the city water supply (relying on electric pumps to supply water during a fire is risky due to the possibility of the electrical supply being interrupted during this emergency),
- ⊙ outside the boundaries of the local fire department and having reduced fire protection services,
- ⊙ on a steep slope (fire traveling up a slope will move faster and have longer flames. A fire on a 30 percent slope will have flames up to twice the length and travel as much as one and a half times as fast as a fire on flat ground),
- ⊙ on a road too narrow or steep for fire equipment or evacuation,
- ⊙ in an area where alternate escape routes are not available,
- ⊙ in a ravine or canyon which serves as a natural chimney, and
- ⊙ near highly flammable landscape or wildland vegetation (flame lengths can exceed 30 meters; radiated heat can ignite combustible materials from distances 30 meters or more).



– Discuss as class: Why did some lots have a lower Survivability Factor than others?

• **Group 2:**

- Hand out the “Table 1. House Survivability” sheet to each group. Explain to them that they are to record points as they make building decisions. Points will be added when they make a FIREWISE decision and subtracted when they make a risky decision.
- Click on “Build House” to begin construction.
- Select materials for the house from the options provided.
- Keep a careful record of choices in Table 1.
- Have Group 2 discuss their choices with the rest of the class.

• **Group 3:**

- Select materials for landscaping from the options provided.

CAREER READINESS

Standard 5: Students will develop effective leadership, interpersonal, and team skills.

5-8 Benchmark: 1. Students will explore the positive and negative implications of team work.

**FOREST SERVICE CONSERVATION
EDUCATION LEARNER GUIDELINES**

Program title: Fire in the Wildland-Urban Interface

Target audience: Eighth Grade

Primary topic: Living in the wildland-urban interface brings responsibilities.

Length of program: 1 to 1.25 hours

Setting: indoors

Guidelines addressed are referenced here:

5-8
I. Questioning and Analysis Skills
A1, A3, B2, C1, C3, E3, F2, G2, G3, G4
II. Knowledge of Environmental Processes and Systems
1. A2, C1
2. A1
3. A1, B2, E2
4. B2, C4, D1, D2
III. Skills for Understanding and Addressing Environmental Issues
1. A1, A3, B1, B2, B3, C2, C3
2. A1, A2, A3, B1, D1
IV. Personal and Civic Responsibility
A3, C1, C3, C4

- Keep a careful record of choices in Table 1.
- Have Group 3 discuss their choices with the rest of the class.
- Ask the class if they can think of reasons why people might build homes with a low Survivability Factor. (Examples: Not aware of risks; Cost; Etc.)

ACTIVITY #2

(This activity can be done instead of Activity #1. This activity borrowed from “Activity 8-2. Houses in the Woods” from “FireWorks Curriculum: Featuring Ponderosa, Lodgepole, and Whitebark Pine Forests,”

http://www.fs.fed.us/rm/pubs/rmrs_gtr65.pdf.)

- Explain that students will use what they know about fire in evaluating the safety of homes that have been built in wildland areas.
- Break the students into groups. Have the groups use the photo prints in the “People in Fire’s Homeland” kit.
- With the students, review “Safety in Fire’s Homeland” (Student Page 24). Give each group a copy. Ask the students to identify and discuss what they have learned about fire that supports the points mentioned in the checklist.
- Explain to the students that they may not be able to answer every question for every picture, because each photo shows only some of the features of the checklist. It’s all right to check “Can’t Tell” on the safety checklist.
- Have groups begin their work. Use Tables 12 and 13 to help guide discussions within the groups.
- Ask the groups to report their findings to the rest of the class.
- Ask the whole class: Do you think any homes in your neighborhoods need some work to improve their safety?

CLOSING

I really enjoyed being here with you today. I hope you learned a lot about Fire in the Wildland-Urban Interface.

HANDOUT

“Burning Issues” CD-ROM (one per class)

SUPPLIES

- “Where Growth Meets Growth” activity sheets (one per team)
http://www.pbs.org/wgbh/nova/teachers/activities/pdf/2908_fire_01.pdf
- Colored pencils (one set per team)
- **Activity #1:**
 - ⊙ Computer
 - ⊙ Projector
 - ⊙ Screen
 - ⊙ “Burning Issues” CD-ROM (two – one for activity and one to leave for class)
 - ⊙ “Table 1. House Survivability” sheets (one per group)
This worksheet is found in Section IV Chaparral I-Zone of the Teacher and Student Guides to the “Burning Issues” CD-ROM (these guides are on the CD-ROM)
- **Activity #2:**
 - ⊙ “Safety in Fire’s Homeland” (Student Page 24) sheets (one per group)
 - ⊙ “People in Fire’s Homeland” Kit (one per group)
This kit is from “Activity 8-2. Houses in the Woods” from “FireWorks Curriculum: Featuring Ponderosa, Lodgepole, and Whitebark Pine Forests,”
http://www.fs.fed.us/rm/pubs/rmrs_gtr65.pdf.)
 - ⊙ Copy of Tables 12 (Relationship of safety checklist to concepts covered by FireWorks) and 13 (Assessment of fire hazards around wildland homes) from “Activity 8-2. Houses in the Woods” from FireWorks Curriculum



Student Page 24



Safety in Fire's Homeland

Name _____

Photo Number: _____

Put a check in the "yes," "no," or "can't tell" column.

		Yes!	No!	Can't tell
About the House:				
1	Is the roof covered with metal or asphalt shingles (<u>not</u> wood shakes)?			
2	Are firewood and other wood stored away from the house, not touching walls or deck?			
3	Are weeds cleared away from the sides of the house?			
4	Are tree limbs cleared away from roof and chimney?			
5	Are dead leaves and needles cleaned from roof and rain gutters?			
Around the House (safety zone, within 10 m):				
6	Are trees and shrubs 5 m apart or more?			
7	Are ladder fuels and low branches cleared from underneath big trees?			
8	Is the lawn kept green, even in late summer?			
9	If the house is at the top of a slope, is the safety zone 30 m or more?			
About the Location:				
10	Is the house on a flat place, set back from the top of a slope?			
11	Is the road wide enough for a car going out to pass a fire engine coming in?			
Count the checks in each column:				

Table 12—Relationship of safety checklist (Student Page 24) to concepts covered by *FireWorks*.

No.	Safety Checklist Point	<i>FireWorks</i> concepts
1	Is the roof metal or shingle? NOTE that home photo 2 shows shakes, 4 shows shingles, and 9 shows metal roofing.	Fires need fuel. Wood shakes, especially untreated ones, are great fuel.
2	Is firewood and other wood stored away from the house, not touching walls or deck?	Although big logs would be hard to ignite, they would burn long and hot.
3	Are weeds cleared away from the sides of the house?	Weeds dry out in late summer. Dead, dry, "fluffy" material burns easily.
4	Are tree limbs cleared from the roof and around the chimney?	A single match can start a fire. So can a spark from a chimney.
5	Are dead leaves and needles cleaned from the roof and rain gutters?	Fire needs fuel. Dead leaves and needles burn well.
6	Are trees and shrubs 5 m apart or more?	For fire to spread, heat must reach new fuels.
7	Are "ladder fuels" and low branches cleared from underneath big trees?	Heat rises. Saplings and low branches increase chance of crown fire.
8	Is the lawn watered and green, even in late summer?	Green fuels burn less readily than dead, dry fuels.
9	If the house is at the top of a slope, is the "safety zone" 30 m or more?	Heat rises....
10	Is the house on a flat place, or set back from the top of a slope?	Heat rises....
11	Is the road wide enough for a car going out to pass a fire engine going in?	

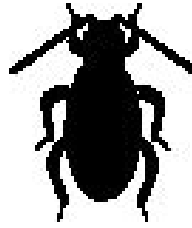
Table 13—Assessment of fire hazards around wildland homes in *People in Fire's Homeland* Kit. Numbers in the table refer to numbered safety criteria in table 12. Question marks indicate that the criterion was difficult or impossible to assess from the photo.

Home No.	"Yes!"—Looks safe because...	"No"—Needs improvement because...	Can't tell or doesn't apply
1	2, 3, 5, 6(?), 8, 10	1, 4(?), 7	9, 11
2	2(?), 5, 8(?), 10	1, 3, 4, 6, 7	9, 11
3	8, 10	1(?), 2, 3(?), 4, 5, 6, 7	9, 11
4	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	none	none
5	10(?)	3, 4, 6, 7, 8	1, 2, 5, 9, 11
6	3, 4(?), 7, 10	1, 2, 5, 6, 8	9, 11
7	1, 2(?), 4, 5, 6, 7, 10	3, 8	9, 11
8	1(?), 2, 10	3, 4, 5, 6, 7, 8	9, 11
9	1, 3, 5, 10	2, 6, 7, 8	4, 9, 11
10	2(?), 4, 8	3(?), 7, 9, 10	1, 5, 6, 11
11	1, 2, 3, 4, 5, 6, 7, 8, 11(?)	none	9, 10



High School Biology

Saga of the Bark Beetle



INTRODUCTION

Good morning/afternoon. My name is _____, and I work for the _____ National Forest. Today we are going to be talking about a biological topic that has gotten a lot of attention in recent years – the bark beetle. How many of you have heard of the bark beetle?

LESSON

Pine bark beetles are among the most important tree killing agents in Southwestern pine forests. In some years, these insects kill thousands of pinyon pines and ponderosa pines. In fact, in recent years, hundreds of thousands of trees have been killed in the local area by bark beetles. On the _____ National Forest, we are now counting the number of dead trees due to the beetles in the millions!

These insects are native to the Southwest, and they normally play a beneficial role in pine ecosystems by acting as a natural thinning agent on trees weakened by factors such as fires, high winds, storms or heavy snow. These insects begin the lengthy decomposition process that returns the tree material back to the soil. Also, a variety of wildlife feeds on these beetles, and beetle-killed trees serve as nesting sites. Even though the beetles are natural to this area and have beneficial roles, they are considered pests when they kill trees people want to preserve. That is what has been happening here locally in recent years. Because our forests are overly crowded with trees and are drought-stricken, we've seen an explosion in the beetle population. Does anyone know why an over-crowded and drought-stricken forest would be more susceptible to



FOREST SERVICE MESSAGES

- A-3:** Leaving nature alone has consequences, risks and trade-offs.
- A-4:** All components of the environment function as a dynamic, interdependent and interrelated system.
- C-3:** Forest conditions now are not natural or healthy.
- C-4:** Because of unnaturally dense conditions, our forests are at risk for destructive wildland fires, insect infestations and diseases.
- C-6:** The Forest Service cuts trees to accomplish specific objectives within the ecosystem such as reducing the risk of wildland fire, enhancing dwindling aspen stands, restoring grasslands, and improving forest health and wildlife habitat.
- C-7:** The Forest Service manages for biodiversity, not single species.
- C-8:** Doing nothing is not always the right answer. The Forest Service alone cannot know the right answer, but by collaborating with the public, we can come closer to it.
- C-9:** Prescribed fire is one tool the Forest Service uses to meet ecosystem goals.

ACADEMIC STANDARDS



Arizona Standards

SCIENCE

- 1SC-P1:** Propose solutions to practical and theoretical problems by synthesizing and evaluating information gained from scientific investigations
- P0 2:** Propose solutions to a problem, based on information gained from scientific investigations
- 1SC-P3:** Analyze and evaluate reports of scientific studies
- P0 1:** Analyze reports of scientific studies for elements of experimental design
- P0 2:** Compare conclusions to original hypotheses
- P0 3:** Evaluate validity of conclusions
- 2SC-P6:** Analyze evidence that supports past and current scientific theories about a specific topic
- P0 1:** Distinguish between evidence which supports a given scientific theory (e.g., model of the atom, plate tectonics, natural selection) and evidence which does not support the theory
- 3SC-P1:** Apply scientific thought processes and procedures to personal and social issues
- P0 1:** Apply scientific thought processes of skepticism, empiricism, objectivity and logic to seek a solution to

beetle infestation? Well, it has to do with how trees defend themselves against bark beetle attack. The only defense a tree has is to “pitch” the beetles out as they try to bore into the tree’s bark. Has anyone seen pitch on trees? The only way a tree can produce pitch is by taking in a sufficient amount of water. When there are too many trees in the forest, the trees are all competing for a limited amount of water and nutrients. Eventually, the trees become stressed because they aren’t getting enough water. Stressed trees aren’t able to produce sufficient pitch and are thus unable to defend themselves against attack. Drought conditions just exacerbate this situation.

So, how do you know if a tree has been attacked by bark beetles? Fading foliage on a tree is often the first sign of a beetle attack. The needles change from green to a light straw color within a few weeks to a year after an



These photos were taken at a public meeting on bark beetles that was held in Tusayan, Arizona. Attendees learned about bark beetles and were able to look at beetles and their galleries.

attack and eventually become yellowish-brown or orange-red in color. You may also see a fine boring dust in the bark crevices and at the base of the tree. It looks kind of like sawdust. Also, small pitch tubes or globules of pitch may appear on the trunk of live trees that have been attacked. This doesn’t mean that the tree is definitely going to die, though. The pitch could be evidence that the tree successfully defended itself against beetle attack. Remember that pitch is the way the tree defends itself against beetle attack. The real key to knowing if a tree is infested with beetles is to remove a section of bark. If the tree is infested, you will see the characteristic beetle galleries. I’ll explain more about what these galleries are a little later. But, for now, let’s take a look at them!

personal and social issues

- PO 2:** Apply a scientific method to the solution of personal and social issues
- 3SC-P4:** Identify and describe the basic processes of the natural ecosystems and how these processes affect, and are affected by, humans
- PO 1:** Describe the basic processes of the natural ecosystems (e.g., water cycle, nutrient cycles)
- PO 2:** Explain how these processes affect, and are affected by, humans
- 3SC-P5:** Describe and explain factors that affect population size and growth (e.g., birth and death rates, quality of environment, disease, education)
- PO 1:** Describe biotic and abiotic factors that affect populations
- PO 2:** Predict the effect of a change in a specific factor on a population
- 4SC-P6:** Describe and explain how the environment can affect the number of species and the diversity of species in an environment
- PO 1:** Explain how the adaptations of various species are related to their success in an ecosystem
- PO 3:** Predict how a change in an environmental factor can affect the number of organisms in a population

LANGUAGE ARTS

- R-P1:** Apply reading strategies such as extracting, summarizing, clarifying, and interpreting information; predicting events and extending the ideas presented; relating new information to prior knowledge; supporting assertions with evidence; and making useful connections to other topics to comprehend works of literature and documents
- PO 1:** Extract critical details or elements of literature
- PO 2:** Summarize the main points
- PO 3:** Make predictions based on evidence presented
- PO 4:** Extend ideas presented in the text
- PO 5:** Connect prior knowledge to information available
- W-P2:** Write a persuasive essay (e.g., an editorial, a review, an essay, a critique) that contains effective introductory and summary statements; arranges the arguments effectively; and fully develops the ideas with convincing proof, details, facts, examples and descriptions
- PO 1:** Write a thesis statement to convey a point of view about a subject
- PO 2:** Develop the point of view with ample and convincing support (e.g., details, facts, reasons, examples and descriptions) appropriate to audience and purpose
- PO 3:** Create an organizational structure that includes an effective beginning, middle and ending
- PO 4:** Use persuasive word choice and sentence structure (e.g., connotation, strong verbs, repetition and



ACTIVITY

(Pull out a couple of pieces of bark with galleries. Let the students come up and look at them.)

LESSON

Now that you've seen a beetle gallery, what do you think they are used for? Well, it all has to do with the bark beetle's life

cycle. Beetles generally produce two to four generations per year, depending on the climate and elevation of the area being attacked. In the spring, adult beetles emerge from material infested the previous fall and fly to attack new host trees. Beetles prefer fresh debris from logging, construction activity or natural events like drought. During these outbreaks, live trees may be attacked, especially those located adjacent to fresh slash. Also, trees weakened by drought, disease, overcrowding or damage are extremely vulnerable to attack, as we discussed earlier.

Males initiate attacks by boring through the outer bark and then tunneling into the soft, inner bark of the tree. The males then release chemical messengers – called pheromones – to attract females.

So, the male beetles find a weak tree and attack it. Then they basically call all their beetle buddies and say, "Hey, here's an easy tree to attack. Come help." Then, the adult beetles create tunnels under the bark

called "egg galleries" and lay eggs alongside their galleries. Eggs hatch in about a week. White, worm-like larva hatch and feed on the inner bark for six to eight weeks before they pupate. Adults develop from pupae and then emerge by boring out through the bark. The cycle then starts again. The new, adult beetles fly to another, usually nearby, tree and call for their



Learning about bark beetles

parallelism)

LS-P2: Deliver an impromptu speech that is organized, addresses a particular subject and is tailored to the audience



New Mexico Standards

SCIENCE

Strand I: Scientific Thinking and Practice

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

9-12 Benchmark I: Use accepted scientific methods to collect, analyze, and interpret data and observations and to design and conduct scientific investigations and communicate results.

Grade 9-12 Performance Standards

4. Convey results of investigations using scientific concepts, methodologies, and expressions, including:
 - clear, logical, and concise communication
 - reasoned arguments.
5. Understand how scientific theories are used to explain and predict natural phenomena (e.g., plate tectonics, ocean currents, structure of atom).

9-12 Benchmark II: Understand that scientific processes produce scientific knowledge that is continually evaluated, validated, revised, or rejected.

Grade 9-12 Performance Standards

6. Examine the scientific processes and logic used in investigations of past events (e.g., using data from crime scenes, fossils), investigations that can be planned in advance but are only done once (e.g., expensive or time-consuming experiments such as medical clinical trials), and investigations of phenomena that can be repeated easily and frequently.

Strand II: The Content of Science

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

9-12 Benchmark I: Understand how the survival of species depends on biodiversity and on complex interactions, including the cycling of matter and the flow of energy.

Grade 9-12 Performance Standards

Ecosystems

1. Know that an ecosystem is complex and may exhibit

These photos show the bark beetles that are causing damage to ponderosa pine trees in the Southwest. Here is shown an adult Ips and an adult western pine beetle.

These photos were taken by the Forest Service Health Protection staff.



friends. Several overlapping generations may occur through the summer and fall until colder temperatures arrive. When temperatures drop, the beetles overwinter under the tree's bark.

So now we know how the beetles attack, but can anyone tell me how the beetles actually kill the tree? Well, it is a combination of factors. First, the boring activity of the adult beetles and the feeding of the larva on the inner bark helps to kill the tree by girdling it. When a tree is "girdled," it basically means that the tree is no longer able to carry water and nutrients through its system. Also, beetles carry a fungi on their bodies. This fungi is



Here we see a larva, pupa, and adult stage of Ips.

often called blue-stain fungi. Once the beetles attack a tree, this fungi begins to grow in the wood, which clogs the tree's water conducting system. So, in simple terms, the tree eventually dies because it is no longer able to provide itself with water and nutrients.

Let's take a look at these tree-killing machines!

fluctuations around a steady state or may evolve over time.

2. Describe how organisms cooperate and compete in ecosystems (e.g., producers, decomposers, herbivores, carnivores, omnivores, predator-prey, symbiosis, mutualism).
3. Understand and describe how available resources limit the amount of life an ecosystem can support (e.g., energy, water, oxygen, nutrients).
4. Critically analyze how humans modify and change ecosystems (e.g., harvesting, pollution, population growth, technology).

Biodiversity

8. Understand and explain the hierarchical classification scheme (i.e., domain, kingdom, phylum, class, order, family, genus, species), including:
 - classification of an organism into a category
 - similarity inferred from molecular structure (DNA) closely matching classification based on anatomical similarities
 - similarities of organisms reflecting evolutionary relationships.
9. Understand variation within and among species, including:
 - mutations and genetic drift
 - factors affecting the survival of an organism
 - natural selection.

Strand II: The Content of Science

Standard III (Earth and Space Science): Understand the structure of Earth, the solar system, and the universe, the interconnections among them, and the processes and interactions of Earth's systems.

9-12 Benchmark II: Examine the scientific theories of the origin, structure, energy, and evolution of Earth and its atmosphere, and their interconnections.

Grade 9-12 Performance Standards

Geochemical Cycles

9. Know that Earth's system contains a fixed amount of natural resources that cycle among land, water, the atmosphere, and living things (e.g., carbon and nitrogen cycles, rock cycle, water cycle, ground water, aquifers).

Strand III: Science and Society

Standard I: Understand how scientific discoveries, inventions, practices, and knowledge influence, and are influenced by, individuals and societies.

9-12 Benchmark I: Examine and analyze how scientific discoveries and their applications affect the world, and explain how societies influence scientific investigations and applications.

ACTIVITY

(Set up microscope or magnifying glass. Set out dead bark beetles for the students to look at. Explain that the pine bark beetles in Arizona/New Mexico are generally of the genus *Ips* or *Dendroctonus*. You can tell the difference between the two genus by the shape of the beetles' rear ends. Point out the difference to the students. See if they can see the difference using the microscope/magnifying glass. Also, tell them that different species of beetles can attack the same tree. So, you might have *Ips* and *Dendroctonus* beetles in the same tree!)

ACTIVITY

(Note: This activity was adapted from "Saga of the Gypsy Moth" that appeared in "Project Learning Tree, The Changing Forest: Forest Ecology,"

http://www.plt.org/cms/pages/21_21_11.html.)

Now that we are all bark beetle experts, we are going to have some fun. First, I should ask you a question. Should bark beetles be controlled? (In other words, should people do something about them?) Why? How?

Those are good thoughts. We are going to explore this more in our next activity.

(Randomly divide students into five groups called "bark beetle management teams." The five teams will be:

1. No Control
2. Cultural Control
3. Mechanical or Manual Control
4. Biological Control
5. Chemical Control

Give each group a copy of their "bark beetle control team card" so they understand their management strategy better.)

You will be using a technique called the "Power of Persuasion" to convince the other teams and your teacher that your management strategy is the best. (Pass out a copy of the "Power of Persuasion" student page to each group.) Before your team gets started, you should each take a look at this student page to get some hints on persuading people and organizing your arguments.



Each team will get five minutes or less to present their argument. The other

Grade 9-12 Performance Standards

Science and Technology

12. Explain how societies can change ecosystems and how these changes can be reversible or irreversible.

LANGUAGE ARTS

Strand: Reading and Listening for Comprehension

Content Standard I: Students will apply strategies and skills to comprehend information that is read, heard, and viewed.

9-12 Benchmark I-B: Synthesize and evaluate information to solve problems across the curriculum.

Grade 9 Performance Standards

1. Use a variety of techniques for researching topics including:
 - cross-referencing while gathering information
 - summarizing dialogue
 - using news sources (e.g., newspapers, magazines, TV, radio, videotapes, Internet, email, government publications, microfiche, other library resources)

Grade 10 Performance Standards

3. Use multiple resources to gather information to evaluate problems, examine cause and effect relationships, and answer research questions to inform an audience.

Grade 12 Performance Standards

1. Identify and defend research questions and topics that will be important in the future.
2. Use a variety of resources to gather information to critically analyze texts to gain meaning, develop thematic connections, and synthesize ideas.
3. Demonstrate increasing sophistication in the selection and use of resources to define issues and use argument effectively.

9-12 Benchmark I-C: Demonstrate critical thinking skills to evaluate information and solve problems.

Grade 9 Performance Standards

1. Examine texts for arguments and develop informed opinions by:
 - examining relevant reason and evidence
 - noting the progression of ideas that substantiate the proposal
 - analyzing the style, tone, and use of language for a particular effect
 - identifying and analyzing personal, social, historical, or cultural influences, contexts, or biases
 - identifying and analyzing rhetorical strategies that support proposals

teams will not interrupt the presenting team. After your five minutes, your team will sit down and listen to the other teams' arguments. At the end of your presentations, your teacher will be the one to decide which control method he/she thinks would work the best. So, the teacher is like our district ranger. All the specialists present their points of view and then the district ranger decides which one to go with. (Put the ranger hat on the teacher.)

Now, we'll take 10 minutes so each team can talk about their management strategy, plan their argument and arrange their presentation. During the 10 minutes, I will be available to answer any questions that your team might have.

(Call each group up to present. Time them. Stop them after five minutes if they are still talking. At the end, have the teacher pick which management strategy to go with and have him/her explain why he/she picked that one.)

Now that we know what your teacher would do, let's find out what real bark experts recommend.

Prevention is the best way to reduce losses due to bark beetles. Healthy trees are usually not attacked. Those trees that are stressed by disease and overcrowding are more prone to attack. Knowing that, one way to improve the chances for a tree to survive is to make it healthier. If natural precipitation is below normal during the fall and winter, trees benefit from being irrigated. You remember that we talked about how important water is in supporting the tree's natural defense mechanism – pitch. So, in simple terms, you can water the tree. Watering the tree would fall under which management strategy? Cultural. Applications of fertilizers will not help protect trees from the effects of drought and will not protect them against bark beetle attacks.

But, you can't water all the trees in the forest. There is not enough water anywhere to do that! So, what can you do to help the forest as a whole. The answer is to find a way to relieve overcrowding so that the trees that remain have greater access to water and nutrients. The best way we know to reduce overcrowding is through thinning – where we cut down trees – and prescribed burning – where we use management-ignited fire to kill off some of the trees. Which management strategy would thinning and prescribed burning fall under? Mechanical.

Another way to protect your favorite trees from bark beetles is through the use of insecticides. Before I go into details, I

2. Support informed opinions by providing relevant and convincing reasons, using various types of evidence, language, and organizational structure, and demonstrating an awareness of possible questions, concerns, or counter-arguments.

Grade 10 Performance Standards

1. Examine controversial issues by:
 - sharing and evaluating personal response
 - researching and summarizing data
 - developing a framework in which to discuss the issue (creating the context)
 - compiling personal responses and researched data to organize the argument
 - presenting data in various forms (e.g., graph, essay, speech, video)

Grade 11 Performance Standards

1. Use language persuasively in addressing a particular issue by:
 - finding and interpreting information effectively
 - establishing and defending a particular perspective
 - responding respectfully to viewpoints and biases

Grade 12 Performance Standards

1. Research, define, and present issues of public concern by:
 - specifying the nature of an issue, including claims made and the reasoning that supports those claims
 - organizing and delivering a presentation that specifies reasons for the claim and makes a clear stance on the issue.

9-12 Benchmark I-D: Apply knowledge of reading process to evaluate print, non-print, and technology-based information.

Grade 9 Performance Standards

1. Explain meaning, describe processes, and answer research questions to inform others by:
 - demonstrating the ability to read and listen to explanatory texts using appropriate preparation, engagement, and reflection
 - demonstrating comprehension of major ideas
 - summarizing major steps
 - determining accuracy and clarity of the selection

Grade 10 Performance Standards

1. Pose questions prompted by text and research answers by:
 - prioritizing and organizing information to construct a complete and reasonable explanation
3. Demonstrate increasing comprehension and ability

should tell you that there is no way to save a tree once it has been attacked by bark beetles. Even if it is still green, if there are beetles in it, it will eventually die. There is nothing that can be done about that. However, insecticides can be used as a protective measure before the tree is attacked. Preventive spraying involves the application of pesticides and is usually performed by commercial applicators. Because of the associated environmental considerations and the expense of getting this work done, it is neither practical nor advisable to spray every tree on a tract of land. It truly is for only your high-value trees – the ones you really don't want to lose. There is no way we could spray it across the forest for two reasons. First, the cost would be astronomical. Second, it would be terrible for the environment! Which management strategy would preventive spraying fall under? Chemical.

Some other things people can do to try to prevent bark beetle attack:

- Only cut down trees at certain times of year. Remember that bark beetles are attracted to tree slash. If you cut down trees in late summer and fall, that allows the debris to dry out and become less suitable for beetles. (Management Strategy – Cultural)
- Destroying debris by chipping it or burning it can also prevent problems. (Management Strategy – Mechanical)
- Avoid collecting firewood from an area with a beetle infestation. (Management Strategy – Cultural)

Even though experts have largely focused on cultural, mechanical and chemical controls, that does not mean that the other management strategies do not have value. In fact, the management strategies of “no control” and “biological control” are really the ones that will play a big role in the long-term. Much of the current explosion in beetle populations that we are seeing now is due to the drought in our area. When precipitation levels return to normal, beetle populations will naturally decline. That doesn't mean that we shouldn't continue thinning and burning though! Our forests truly are overcrowded, and we have to take action now so that our trees won't be decimated by beetles, disease and wildfire.

CLOSING

I really enjoyed being here with you today. I hope you learned a lot about the bark beetle. I encourage you to give us a call at the _____ National Forest if you are interested in learning more.

to respond personally to texts by selecting and exploring a wide range of works that relate to an issue, author, or theme.

Grade 11 Performance Standards

3. Recognize how new information changes one's personal knowledge base.

Strand: Speaking and Writing for Expression

Content Standard II: Students will communicate effectively through speaking and writing.

9-12 Benchmark II-A: Communicate information in a coherent and persuasive manner using verbal and non-verbal language.

Grade 9 Performance Standards

1. Evaluate personal effectiveness in group discussions and make corrections as necessary.
2. Ask questions to broaden and enrich discussions.
3. Express an informed opinion that clearly states a personal view, is logical and coherent, and engages the reader's interest.
4. Support an informed opinion by using appropriate language, reason, and organizational structure for the audience and purpose.

Grade 10 Performance Standards

2. Make well-informed and well-organized formal presentations with a clear main point, adjusting the message, wording, and delivery to the particular audience and context.

Grade 11 Performance Standards

1. Use language persuasively in addressing a particular issue by:
 - finding and interpreting information effectively
 - recognizing propaganda as a purposeful technique
 - establishing and defending a point of view
 - responding respectfully to viewpoints and biases

Grade 12 Performance Standards

1. Develop oral formal presentations using clear enunciation, gestures, tone, vocabulary, and organization appropriate for a particular audience.
2. Make explicit use of various techniques for effective presentations (e.g., voice, inflection, tempo, gestures).

9-12 Benchmarks II-C: Demonstrate competence in the skills and strategies of the writing process to inform and persuade

Grade 9 Performance Standards

3. Compose written arguments that develop and support informed opinions by:
 - stating a progression of ideas

HANDOUT

No handout.

SUPPLIES

- Pieces of bark with beetle galleries
- Dead bark beetles
- Beetle larva or pupa, if available
- Magnifying glass or microscope
- Bark beetle control team cards (one per group)
- “Power of Persuasion” student page (one per group)
- Ranger hat (one)
- Stopwatch

- selecting appropriate style, tone, and use of language for a particular effect
- describing and analyzing personal, social, historical, or cultural influences
- presenting rhetorical strategies to support the proposal

Grade 10 Performance Standards

2. Clearly articulate a position through the use of a thesis statement, anticipate and deal with counter-arguments, and develop arguments using a variety of methods such as:
 - examples and details
 - commonly accepted beliefs
 - expert opinions
 - quotations and citations
 - cause and effect
 - comparison and contrast reasoning
3. Differentiate among literal, figurative, and connotative meanings.

Grade 11 Performance Standards

1. Use argument to:
 - interpret researched information
 - establish and defend a point of view
 - address concerns of the opposition
2. Synthesize and organize information from a variety of sources in order to inform and persuade an audience.

Grade 12 Performance Standards

3. Analyze own work for:
 - consistency of facts, ideas, tone, voice
 - development of argument or plot
 - clarity and conciseness

SOCIAL STUDIES

Strand: Geography

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

9-12 Benchmark II-A: Analyze and evaluate the characteristics and purposes of geographic tools, knowledge, skills, and perspectives, and apply them to explain the past, present, and future in terms of patterns, events, and issues.

Grade 9-12 Performance Standards

1. Evaluate and select appropriate geographic representations to analyze and explain natural and man-made issues and problems.
2. Understand the vocabulary and concepts of spatial interaction, including an analysis of population distributions and settlements patterns.

9-12 Benchmark II-B: Analyze natural and man-made

characteristics of worldwide locales; describe regions, their interrelationships, and patterns of change.

Grade 9-12 Performance Standards

1. Analyze the interrelationships among natural and human processes that shape the geographic connections and characteristics of regions, including connections among economic development, urbanization, population growth, and environmental change.
2. Analyze how the character and meaning of a place is related to its economic, social, and cultural characteristics, and why diverse groups in society view places and regions differently.
3. Analyze and evaluate changes in regions and recognize the patterns and causes of those changes (e.g., mining, tourism).

9-12 Benchmark II-C: Analyze the impact of people, places, and natural environments upon the past and present in terms of our ability to plan for the future.

Grade 9-12 Performance Standards

2. Compare and contrast how different viewpoints influence policy regarding the use and management of natural resources.
3. Analyze the role that spatial relationships have played in effecting historic events.
4. Analyze the use of and effectiveness of technology in the study of geography.

9-12 Benchmark II-D: Analyze how physical processes shape the Earth’s surface patterns and biosystems.

Grade 9-12 Performance Standards

1. Analyze how the Earth’s physical processes are dynamic and interactive.
2. Analyze the importance of ecosystems in understanding environments.
3. Explain and analyze how water is a scarce resource in New Mexico, both in quantity and quality.

9-12 Benchmark II-E: Analyze and evaluate how economic, political, cultural, and social processes interact to shape patterns of human populations, and their interdependence, cooperation, and conflict.

Grade 9-12 Performance Standards

6. Analyze how differing points of view and self-interest play a role in conflict over territory and resources (e.g., impact of culture, politics, strategic locations, resources).

9-12 Benchmark II-F: Analyze and evaluate the effects of human and natural interactions in terms of changes in the meaning, use, distribution, and importance of resources in order to predict our global capacity to support human activity.

Grade 9-12 Performance Standards

1. Compare the ways man-made and natural processes modify the environment and how these modifications impact resource allocations.
2. Analyze how environmental changes bring about and impact resources.

**FOREST SERVICE CONSERVATION
EDUCATION LEARNER GUIDELINES**

Program title: Saga of the Bark Beetle

Target audience: High School Biology

Primary topic: There are costs and benefits to different land management strategies.

Length of program: 1 to 1.25 hours

Setting: indoors

Guidelines addressed are referenced here:

9-adult
I. Questioning and Analysis Skills
A1, A2, A3, G1
II. Knowledge of Environmental Processes and Systems
1. A3, B1, B2
2. A1, B1, C2, C4, D3
3. A1, C2, E1
4. A1, A2, A3, A4, B1, B3, C3, C4, E1
III. Skills for Understanding and Addressing Environmental Issues
1. A1, A2, A3, B1, B2, B3, B4, C1, C2, C4, D1
2. A1, A4, B1, D1
IV. Personal and Civic Responsibility
C1, C2, D1, D2, D4

Power of Persuasion

Here are a few tips to help persuade others to see your point of view:

- ▶ **Organize your thoughts and concepts logically.**
You may want to jot on a notecard your major points in order of priority so you don't forget them.
- ▶ **Start with an attention-getter.**
Open with a powerful statement to grab the attention of your audience.
- ▶ **Clearly explain your point of view.**
Give specific examples, if you can, to illustrate your position.
- ▶ **Be Concise.**
Keep it short and simple! Short speeches are usually more powerful and memorable than longer ones.
- ▶ **Make eye contact.**
Eye contact shows that you are sincere about your topic and that you acknowledge your audience.
- ▶ **Speak slowly.**
Most people tend to rush when they talk before a group. Speak slowly and loudly enough so everyone can easily hear you.
- ▶ **Use visuals.**
You may want to highlight major points by writing them on a chalkboard, easel pad, or handout; showing slides, a poster, or other pictures will help people remember important points.
- ▶ **Reinforce your position and your argument.**
After you introduce your position and your argument, you should articulate your position, then conclude by reiterating the major points of your argument.



Student Page

Bark Beetle Control Team Cards

NO CONTROL: Your team advocates doing nothing, which allows natural biological controls to function in the forest. Your team hopes that outbreak populations will be brought back to nondamaging levels by those natural controls before causing significant social or economic damage.

If your team has any questions about the bark beetle, please ask the facilitator.

CULTURAL CONTROL: Your team focuses on cultural practices, such as planting trees that pine bark beetles do not use. Cultural practices could also include improving the health of trees through various means so that the trees can better withstand a bark beetle attack.

If your team has any questions about the bark beetle, please ask the facilitator.

MECHANICAL OR MANUAL CONTROL: Your team focuses on mechanical practices that change the bark beetles' access to food and their ability to reproduce. Your team might advocate various ways to treat slash to try to prevent bark beetle infestation. Your team might also advocate various ways of treating the forest so that it is better able to withstand a bark beetle infestation.

If your team has any questions about the bark beetle, please ask the facilitator.

BIOLOGICAL CONTROL: Your team focuses on biological controls, such as introducing natural enemies (parasites, predators, and disease organisms) to maintain bark beetle populations at nondamaging levels.

If your team has any questions about the bark beetle, please ask the facilitator.

CHEMICAL CONTROL: Your team advocates using chemicals to eradicate or manage the bark beetle. Your team may advocate using broad-spectrum synthetic chemicals that are poisonous to many insects and other organisms. Your team may also advocate using sprays derived from natural products that are generally restricted to killing invertebrates.

If your team has any questions about the bark beetle, please ask the facilitator.



High School Chemistry

The Role of Chemistry in Fire Management



INTRODUCTION

Good morning/afternoon. I am _____, and I work for the _____ National Forest. My job is _____.

LESSON

How many of you have ever played ping-pong? How much more exciting would that ping-pong game be if you got to use this ping pong ball?

ACTIVITY

(Light ping-pong ball.)

LESSON CONTINUED

That's just one example of the many chemical reactions that we as wildland firefighters study and use in our jobs.

But, before we get to the specifics of advanced fire management techniques, like flaming ping-pong balls and the chemistry behind them, let's start with the basic chemistry of fire.

In order for there to be fire – or, in other words, in order for the chemical reactions that we simply call fire to take place – there need to be three components. Each one is equally important, and if one is missing, fire will not occur.

The first component is oxygen. Nothing can burn without the presence of oxygen. The second component is fuel. Fuel can be any substance that burns. The final component is heat. Heat is what keeps the chemical reactions of fire going. Together, these



FOREST SERVICE MESSAGES

- A: The Forest Service applies the fundamental principles of science and ecology in order to better understand and manage forest ecosystems.
- A-5: The study of the science of fire and its behavior is important.
- B-1: People need to be careful with fire.
- B-6: The understanding of fire suppression techniques is important.
- C-5: In many places on the National Forest, conditions now are such that wildland fires can have devastating, long-lasting effects.
- C-6: The Forest Service cuts trees to accomplish specific objectives within the ecosystem such as reducing the risk of wildland fire, enhancing dwindling aspen stands, restoring grasslands, and improving forest health and wildlife habitat.
- C-9: Prescribed fire is one tool the Forest Service uses to meet ecosystem goals.

ACADEMIC STANDARDS



Arizona Standards

SCIENCE

- 1SC-P1:** Propose solutions to practical and theoretical problems by synthesizing and evaluating information gained from scientific investigations
- P0 1:** Evaluate scientific information for relevance to a given problem
- P0 2:** Propose solutions to a problem, based on information gained from scientific investigations
- 3SC-P1:** Apply scientific thought processes and procedures to personal and social issues
- P0 1:** Apply scientific thought processes of skepticism, empiricism, objectivity and logic to seek a solution to personal and social issues
- P0 2:** Apply a scientific method to the solution of personal and social issues
- 5SC-P1:** Predict chemical and physical properties of substances (e.g., color, solubility, chemical reactivity, melting point, boiling point)
- P0 1:** Describe physical and chemical properties that are used to characterize substances
- P0 2:** Determine physical and chemical properties of a substance through observation, measurement and

three components are known as the fire triangle. (Show picture of fire triangle or draw it on the board.)

Chemically speaking:

- Fire is simply another word for combustion.
- Combustion is a rapid oxidation that is accompanied by high temperature and usually light.
- Oxidation put simply means a chemical reaction that involves combining substances with oxygen. This chemical reaction releases a lot of energy.



In order for there to be fire – or, in other words, in order for the chemical reactions that we simply call fire to take place – there need to be three components. Each one is equally important, and if one is missing, fire will not occur. These three components make up the fire triangle.

So, those are the basics of fire chemistry in general terms, but now I'd like to talk about the chemistry involved in the natural process of wildland fire.

Let's look at our fire triangle again. The first component I mentioned was oxygen. As you know, oxygen exists in the air we breathe. Oxygen is the second most common substance in the earth's atmosphere. The atmosphere contains approximately 21 percent oxygen and 78 percent nitrogen. As you can tell by your campfire, there is obviously just enough oxygen in our atmosphere to sustain a fire. If there were any less oxygen in our atmosphere, there wouldn't be enough to keep a fire going. And, we wouldn't need firefighters because most fires would immediately go out. If there was too much oxygen in our atmosphere, when you struck a match to light your campfire,



The smoke you see coming off of a fire is made up of tar along with water, which is escaping as steam.

the fire would spread uncontrollably and eventually burn everything in sight. It is because the atmosphere has just the right mixture of oxygen,

experimentation

5SC-P5: Describe and predict chemical reactions (including combustion and simple chemical reactions) and physical interaction of matter (including velocity, force, work and power), using words or symbolic equations

PO 2: Predict the products of a chemical reaction using types of reactions (e.g., synthesis, decomposition, replacement, combustion)

PO 3: Describe physical interactions through use of word equations or formulae

5SC-D3: Apply knowledge and understanding of chemical and physical interactions (e.g., rates of reactions, stoichiometry, electromagnetic phenomena, statics and dynamics, electrochemistry)



New Mexico Standards

SCIENCE

Strand I: Scientific Thinking and Practice

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

9-12 Benchmark I: Use accepted scientific methods to collect, analyze, and interpret data and observations and to design and conduct scientific investigations and communicate results.

Grade 9-12 Performance Standards

1. Describe the essential components of an investigation, including appropriate methodologies, proper equipment, and safety precautions.
2. Design and conduct scientific investigations that include:
 - testable hypotheses
 - controls and variables
 - methods to collect, analyze, and interpret data
 - results that address hypotheses being investigated
 - predictions based on results
 - re-evaluation of hypotheses and additional experimentation as necessary
 - error analysis.
3. Use appropriate technologies to collect, analyze, and communicate scientific data (e.g., computers, calculators, balances, microscopes).
4. Convey results of investigations using scientific concepts, methodologies, and expressions, including:

which allows combustion, and nitrogen, which hampers combustion, that fires on this planet burn as they do. So, the oxygen portion of our fire triangle for wildland fires comes from the oxygen in our atmosphere.



Fire Triangle

The second component of the fire triangle is fuel. Generally speaking, fuel is any material that can burn. The materials that fuel wildland fire are simply those materials that are found naturally in the forest. Specifically, in a ponderosa pine forest such as around here, these fuels are the natural duff and litter on the forest floor, the grasses and brush that grow amongst the trees, and the trees themselves. Because people have made the decision to move into the woods, homes can also be fuel for fire.

The final component of the fire triangle is heat. A wildland fire can't start without a source of heat, which we call an ignition source. A natural ignition source is lightning. On the _____ National Forest where I work, the majority of our fires are started by lightning. Unfortunately, we also have to deal with human-made ignition sources such as campfires, cigarettes, vehicle exhaust systems, and fireworks. Our major goal during fire season is to prevent fires from human-made ignition sources. If we can prevent those kind of fires, then we will have more resources available to fight the inevitable lightning-caused fires.

Once one of these initial heat sources starts a wildland fire, the heat from the combustion reaction is what keeps the fire going and allows it to spread. This type of reaction is called exothermic, which means that the chemical reaction is accompanied by a release of heat. So, the heat component of a wildland fire is always initiated by an external heat source, either natural or human-made, but once the fire starts, it supplies its own heat to keep going.

The fire triangle explains combustion in non-chemical terms. But, I'd like to talk a little about the chemistry of combustion as it relates to wildland fire. In this discussion, we know that the oxygen comes from the atmosphere, and let's assume that the fuel we are talking about is wood. So just what exactly is wood? Who (in the class) knows what wood is really made

- scientific language and symbols
 - diagrams, charts, and other data displays
 - mathematical expressions and processes (e.g., mean, median, slope, proportionality)
 - clear, logical, and concise communication
5. Understand how scientific theories are used to explain and predict natural phenomena (e.g., plate tectonics, ocean currents, structure of atom).

Strand II: The Content of Science

Standard I (Physical Science): Understand the structure and properties of matter, the characteristics of energy, and the interactions between matter and energy.

9-12 Benchmark I: Understand the properties, underlying structure, and reactions of matter.

Grade 9-12 Performance Standards

Structure of Matter

5. Understand that matter is made of atoms and that atoms are made of subatomic particles.
9. Understand how the type and arrangement of atoms and their bonds determine macroscopic properties (e.g., boiling point, electrical conductivity, hardness of minerals).
10. Know that states of matter (i.e., solid, liquid, gas) depend on the arrangement of atoms and molecules and on their freedom of motion.

Chemical Reactions

12. Know that chemical reactions involve the rearrangement of atoms, and that they occur on many timescales (e.g., picoseconds to millennia).
13. Understand types of chemical reactions (e.g., synthesis, decomposition, combustion, redox, neutralization) and identify them as exothermic or endothermic.

Strand II: The Content of Science

Standard I (Physical Science): Understand the structure and properties of matter, the characteristics of energy, and the interactions between matter and energy.

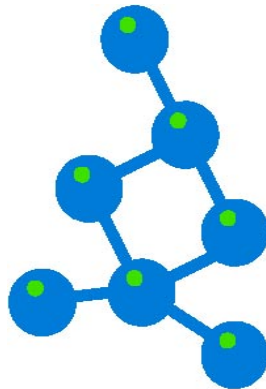
9-12 Benchmark II: Understand the transformation and transmission of energy and how energy and matter interact.

Grade 9-12 Performance Standards

Energy Transformation and Transfer

1. Identify different forms of energy, including kinetic, gravitational (potential), chemical, thermal, nuclear, and electromagnetic.
2. Explain how thermal energy (heat) consists of the random motion and vibrations of atoms and molecules and is measured by temperature.
3. Understand that energy can change from one form to another (e.g., changes in kinetic and potential energy in a gravitational field, heats of reaction,

of? (Take class answers.) The major structural components of wood are cellulose, hemicellulose, and lignin. Cellulose is a carbohydrate, which is an organic compound made up of only carbon, hydrogen and oxygen, and is produced in green plants by photosynthesis. The cellulose forms most of the walls of plant cells. Hemicellulose is a gummy carbohydrate that is less complex than cellulose. Lignin is an organic substance. Together, cellulose, hemicellulose and lignin form most of the woody tissues of trees. These substances also make up most of the weight of dry wood and comprise about 93 percent of wood. On an even more fundamental level, trees are approximately 50 percent carbon, 42 percent oxygen and 6 percent hydrogen.



Here is a question for you – Does wood burn? (Take responses from class.) Actually, wood never burns directly. Wood is considered a solid biomass fuel, which means that it is made up of living matter. The thermal degradation of wood is called pyrolysis. Wood fuel breaks down chemically when it is heated into a mixture of flammable gases and char. These two substances then combust under completely different chemical processes. Cellulose and hemicellulose mostly form flammable gases when they are heated. The lignin is what mostly forms the char. During pyrolysis (i.e. the burning of wood), the exact proportion of flammable gases to char is impossible to determine and is based on all kinds of variables such as temperature, fuel particle size, and the chemical makeup of the wood. Generally, however, the hotter the fire and the smaller the pieces of wood, the more flammable gases are produced. Whereas, the lower the temperature and the larger the pieces of wood, the more char is produced. That is why in a very hot fire, there will be less charred trees left standing because more of the original tree matter will have combusted and turned into gases.



As I said earlier, the organic compounds in wood when heated break down into flammable gases and char. The

hydroelectric dams) and know that energy is conserved in these changes.

4. Understand how heat can be transferred by conduction, convection, and radiation, and how heat conduction differs in conductors and insulators.
5. Explain how heat flows in terms of the transfer of vibrational motion of atoms and molecules from hotter to colder regions.

Strand II: The Content of Science

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

9-12 Benchmark I: Understand how the survival of species depends on biodiversity and on complex interactions, including the cycling of matter and the flow of energy.

Grade 9-12 Performance Standards

Energy Flow in the Environment

5. Explain how matter and energy flow through biological systems (e.g., organisms, communities, ecosystems), and how the total amount of matter and energy is conserved but some energy is always released as heat to the environment.
6. Describe how energy flows from the sun through plants to herbivores to carnivores and decomposers.
7. Understand and explain the principles of photosynthesis (i.e., chloroplasts in plants convert light energy, carbon dioxide, and water into chemical energy).

Strand II: The Content of Science

Standard III (Earth and Space Science): Understand the structure of Earth, the solar system, and the universe, the interconnections among them, and the processes and interactions of Earth's systems.

9-12 Benchmark II: Examine the scientific theories of the origin, structure, energy, and evolution of Earth and its atmosphere, and their interconnections.

Grade 9-12 Performance Standards

Geochemical Cycles

9. Know that Earth's system contains a fixed amount of natural resources that cycle among land, water, the atmosphere, and living things (e.g., carbon and nitrogen cycles, rock cycle, water cycle, ground water, aquifers).
10. Describe the composition and structure of Earth's materials, including:
 - the major rock types (i.e., sedimentary, igneous, metamorphic) and their formation
 - natural resources (e.g., minerals, petroleum) and their formation.

flammable gases that are produced contain mostly carbon monoxide (CO), carbon dioxide (CO²), some hydrocarbons and hydrogen (H²). The flames you see in a fire are these flammable gases combusting. Also released with these gases are water and tar. (Tar contains organic compounds and airborne particles of tar and charred material.) The smoke you see coming off of a fire is this tar and the water, which is escaping as steam.

The properties of the char that is produced are highly dependent on the properties of the wood. When temperatures are high and there is enough oxygen, the carbon in the char burns to form carbon dioxide. When temperatures are low or there is insufficient oxygen, smoldering occurs, which causes a lot of smoke.

As this shows, the burning of the flammable gases, which is called flaming combustion, creates the flames of a fire, while the smoke you see comes from the tar and steam released in flaming combustion and also from the smoldering that occurs at lower temperatures.

What I have been explaining is in general terms. The process of wood combustion is extremely complicated, mostly because wood has a complex physical and chemical composition and is burned in an uncontrolled environment. Every fire is unique and even on one fire, the type of combustion that occurs will change from minute to minute and even from tree to tree.

Now, let's do a demonstration that shows some of the unique characteristics of pyrolysis, which is the burning of wood.



ACTIVITY

(Light a piece of dry wood that will burn with a flame and also leave a smoldering piece of char. Once the wood is burning on its own, remove the flame source. Observe the wood burning.)

Look closely at the surface of the wood where it is combusting. You will notice that the actual flame does not come in contact with the wood. That is because the wood itself is not burning. Instead, when the wood next to the flame is heated by the flame, it goes through pyrolysis, where the wood separates chemically into flammable gases and char. The flames you

SOCIAL STUDIES

Strand: Geography

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

9-12 Benchmark II-C: Analyze the impact of people, places, and natural environments upon the past and present in terms of our ability to plan for the future.

Grade 9-12 Performance Standards

2. Compare and contrast how different viewpoints influence policy regarding the use and management of natural resources.

9-12 Benchmark II-E: Analyze and evaluate how economic, political, cultural, and social processes interact to shape patterns of human populations, and their interdependence, cooperation, and conflict.

Grade 9-12 Performance Standards

6. Analyze how differing points of view and self-interest play a role in conflict over territory and resources (e.g., impact of culture, politics, strategic locations, resources).

LANGUAGE ARTS

Strand: Speaking and Writing for Expression

Content Standard II: Students will communicate effectively through speaking and writing.

9-12 Benchmarks II-C: Demonstrate competence in the skills and strategies of the writing process to inform and persuade

Grade 10 Performance Standards

2. Clearly articulate a position through the use of a thesis statement, anticipate and deal with counter-arguments, and develop arguments using a variety of methods such as:

- examples and details
- commonly accepted beliefs
- expert opinions
- quotations and citations
- cause and effect
- comparison and contrast reasoning

3. Differentiate among literal, figurative, and connotative meanings

Grade 11 Performance Standards

1. Use argument to:

- interpret researched information
- establish and defend a point of view
- address concerns of the opposition

2. Synthesize and organize information from a variety

see above the wood are the flammable gases combusting in the process of flame combustion. This combustion gives off the light that we see as flame. The black, solid substance beneath the flame is the char. Also, above the flame you will see the smoke, which you now know is actually steam, tar and particulates. Now look at the char that no longer has a flame near it (i.e. the wood that has already been burned). Notice that this char is still hot and may even still be glowing red. By blowing on it, you can make it glow even brighter. This char is smoldering, which is combustion at a lower temperature. Smoldering causes a lot of smoke.

ACTIVITY

(Light piece of bark or something else that will smolder but not flame combust. Hold the flame source to the bark until the bark starts burning. Then, remove the flame source.)

Notice that when I remove the ignition source from this piece of bark that the flames immediately go out, but the part that was burned remains hot, glowing red and smoking. What you are seeing, like the wood earlier, is the bark combusting by smoldering. But, because there is no flame, there is no flame combustion. This bark is burning by smoldering. Remember that smoldering occurs at a lower temperature. Without the flame combustion, less of the actual wood is burned in the same amount of time. You may also notice that this smoldering stops rather quickly and the bark cools down a lot more quickly than the piece of dry wood we burned earlier. This is why ponderosa pines are considered fire resistant – because their bark is less conducive to burning. As long as a wildfire is of low enough intensity, or in other words is not too hot, the bark of the ponderosa pines will only smolder and not flame combust. Also, once the flames of the fire have passed, the combustion of the bark will usually stop before the living part of the tree is burned.



LESSON CONTINUED

Okay, that's the chemistry of wood combustion in a wildland fire. As fire managers, it's important for us to understand how

of sources in order to inform and persuade an audience.

FOREST SERVICE CONSERVATION EDUCATION LEARNER GUIDELINES

Program title: The Role of Chemistry in Fire Management

Target audience: High School Chemistry

Primary topic: Chemistry is fundamental to firefighting.

Length of program: 1 to 1.25 hours

Setting: indoors

Guidelines addressed are referenced here:

9-adult
I. Questioning and Analysis Skills
A1, A3
II. Knowledge of Environmental Processes and Systems
1. A1, B1, B2, C1
2. C5, D1, D2
3. C2
4. A1, A3, B1, B3, B4, C1, C2, C3, C4, D1
III. Skills for Understanding and Addressing Environmental Issues
1. A3, A4, C2, C3
2. D1
IV. Personal and Civic Responsibility
C1, D2, D3, D4

the chemistry works. We also go beyond that by applying this chemistry into techniques and science that we use on a daily basis to help us understand, manage, fight, and even predict wildland fire.

Note: Use this section as time and attention span allows. If not using it, read the paragraph in brackets [] only and then skip to next section titled “Lesson Continued.” If using this section, skip the paragraph in brackets [] and continue with the next paragraph, which begins, “Certain people in the Forest Service”

[We use a system called the National Fire Danger Rating System to help us predict where wildland fires might occur and how intense these fires might be. You’ve all seen the little Smokey Bear signs that tell you the fire danger for the day, right? How do we come up with that fire danger rating? Does Smokey go out and sniff the air? No. It’s based on science and chemistry. Every single day across the country, scientists and government workers are monitoring things like the weather, the winds and how dry the vegetation in our forests is for every section of wildland across the country. So, you can see – we don’t just use science in the laboratory to study how different kinds of wood burn just for the fun of it, we actually use the information that we’ve learned every single day to help us predict and fight wildland fires.]

Certain people in the Forest Service and in other government agencies continually study how different types of trees and vegetation burn. They do this to better understand wildfire and to help us predict what a wildfire might do once it starts. But, beyond simply studying fire itself, many government agencies are now dedicated to studying the three components of the fire triangle to help us predict when and where wildfires might occur before they even start. This is what I’m going to talk about now – how we look at the weather, the climate, the terrain and the ecology of an area to help us predict wildfires so that we can have the people and resources in the right place at the right time ready to fight them.

You’ve all seen the little Smokey Bear signs that tell you the fire danger for the day, right? How do we come up with that fire danger rating? Does Smokey go out and sniff the air? No. It’s based on science and chemistry, and here is how we do it. We use a system called the National Fire Danger Rating System. This system is run by the National Weather Service and is operational from Maine to California and from Florida to Alaska. It is a set of computer programs and mathematical equations that allow land management agencies to estimate the fire danger for today or tomorrow in a given area. For each day, the National Fire Danger Rating System characterizes the fire danger in an area by evaluating how bad a wildfire would be if one were to start that day in that area. These calculations are based on fuels, topography, and weather. You should recognize these three things as relating to our fire triangle. In this case, the oxygen and heat sides of our fire triangle are taken into consideration by looking at the topography of the area and the weather that day.



The fire danger rating for each day is based on science and chemistry.

The National Fire Danger Rating System gives us relative ratings on the potential growth and behavior of any wildfire. We use these ratings not only to tell us what rating to put on the Smokey Bear signs, but also to guide us in planning where to put our fire crews and how many firefighters to send to a fire once it starts. The system uses what are called indexes to calculate the fire danger ratings. These indexes are derived from three fire behavior components. The spread component or SC, the energy release component or ERC, and the ignition component or IC.

The ignition component is a number that relates to the probability that a fire will start if an ignition source is put into the forest. The IC can range from 0 when conditions are cool and damp to 100 on days when the weather is

dry and windy. For example, on a day when the IC registers a 60, that means that about 60 percent of all ignition sources that come into contact with fuels in the forest will start a wildland fire. Ignition usually takes place in small, dead fuel, such as pine needles. Three things must happen for a fire to start. They are: 1. An ignition source must come into contact with the dead fuel. 2. The fuel particle must be dry. And, 3. The temperature of the fuel particle must be raised to the kindling point – the point at which wood will combust – which is about 380 degrees Celsius. Living material in the forest reduces the chances of ignition. So, the more dead trees that are in the forest, the better the chances that a fire will start. What do you think that means for our forest right now with all the trees that are brown? Moisture in dead wood will also hamper ignition. The NFDRS looks at the weather, temperature and relative humidity to help determine the moisture content of dead wood. Also, the warmer the dead wood is, the closer it is to its kindling point, which means the more likely a fire is to start. So, on hotter days, the fire danger will go up. It is the chemistry of wood combustion that we talked about earlier that is the basis for all of these calculations. All these considerations are put into a complex equation to determine the numerical IC rating.

The spread component is a number that looks at the effects of wind, slope and fuel properties in determining how fast a wildfire will spread. This rating is given in feet per minute. The SC uses wind speed, slope, fuel moisture and the amount of living vs. dead vegetation in an area to compute how much oxygen, heat and fuel are available to a fire. If a fire is moving uphill through a forest on a windy day, the fire can spread incredibly quickly. It is the chemistry of the fire triangle that forms the basis for these calculations.

The energy release component is the potential available energy per square foot of flaming fire at the head of the fire. In other words, the ERC looks at the amount and types of fuels available to a wildfire to determine how much fuel there is for the fire to burn. The more fuel to burn, the more intense the fire will be and the more energy it will release. The ERC varies widely depending on the type of fuel (i.e. the type of vegetation – grasses, trees, shrubs, etc.). Scientists who have studied the chemistry of how different types of wood burn have determined how to calculate the amount of energy that each type of fuel releases. It is this energy release that the ERC is measuring. The ERC is expressed in units of BTUs per square foot. (BTU = British Thermal Unit, which measures the amount of energy release necessary to raise the temperature of a pound of water by one degree Fahrenheit.)

The National Fire Danger Rating System has maps of the entire country that show both the topography (the terrain) as well as the type and amount of fuels (vegetation) on the land. Every day during fire season, the NFDRS uses these maps combined with up-to-the-minute weather observations to calculate the ratings of the SC, IC and ERC. Using these ratings, the NFDRS then computes an overall fire danger rating for every section of wildland across the country.

(Get NFDRS maps from their Web site – Show maps to the students)

The bottom line of this rating system is to help land management agencies prevent and put out wildland fire by helping them determine where and how to staff their firefighters. It is extremely important to try to catch wildland fires when they are still small. Once a fire has grown to a certain size, it becomes much more difficult to stop it. We use the NFDRS to try to anticipate fires so that a small fire doesn't become a catastrophic wildland fire.

LESSON CONTINUED

So now that we understand some of the chemistry involved in burning, how do we actually go about putting out a fire? Well, that's all based on chemistry too. If you'll remember when I first talked about the fire triangle, I said that if one of the three components were missing, fire could not occur. Obviously, if there is no fuel (i.e. something to burn), there will be no fire. But also, if there is no oxygen, then the chemical process of burning cannot occur. Lastly, if there is not enough heat to either start or support a fire, then there will not be enough energy for the

chemical process of burning to occur. So, to put out a fire, all we have to do is take away one of the three components of the fire triangle. We use a combination of techniques to try to take away these components from a fire. Once a fire is started, we can try to put water on the fuel to cool it down, thereby taking away the fire's heat. Or, we can cut down trees and remove vegetation in the fire's path to take away its source of fuel. Or, on some small fires, you can even beat the fire with a burlap sack or step on it to take away the air, thereby taking away the oxygen.

Let's talk about one of the interesting techniques we use to manage a wildland fire. Maybe you can help me out – How can we get water to stick to the side of a house so that it will be protected when a wildland fire approaches? Any ideas? Well, years ago, as a wildfire was approaching a home, firefighters were faced with the problem of trying to keep the house wet while at the same time ensuring that they could get out of the way of the fire. Unfortunately, in the heat of a fire, water dries very quickly, and it is also hard to get water to stick to the walls of a house! Now, we use a relatively recent invention called fire foam. Fire foam is a sticky, puffy looking substance that we spray on structures that are in the path of a wildfire. The foam sticks to the walls and roof of a structure long after the firefighters leave. Also, it is designed to be extremely fire resistant so that in the best scenario, as the flames burn around the structure, the foam keeps the structure itself from catching on fire. A lot of chemical research and study into the chemistry of fire went into the design of fire foam. In fact, the chemistry behind fire foam is so complex and so important that the companies that make fire foam keep their ingredients and exactly how they make the foam a secret! Generally, though, fire foam does three things. First, it does something called “wetting” the water, which means that it reduces the surface tension of water. This allows the water to better penetrate surfaces. Second, it changes the properties of water so that it is better able to stick to surfaces. Finally, it makes the water foamy, which results in a thicker barrier between the fuel and the fire.

Let's watch a brief video clip to see some of these properties of foam.

VIDEO

(Show NFES 2073 Introduction to Class A Foam, time 4:28 through 6:45.)

LESSON CONTINUED

When it is not fire season, firefighters are still actively working to prevent wildland fires. One of the ways we do that is through prescribed burning. Prescribed burning removes fuels from the forest that could carry a wildland fire. So, it is like getting rid of one component of the fire triangle – fuel – long before a wildland fire has the chance to start. We can light prescribed burns from the ground or from the air. This is where that crazy ping-pong ball that I showed you earlier comes into play. Just like the fire foam, these aerial ignition ping-pong balls are based on chemistry. The plastic sphere of the ball is filled with a precise amount of potassium permanganate, which is an inorganic chemical oxidizer. Inorganic simply means that it does not contain carbon. And, oxidizer means that it easily gives up its oxygen atoms in a chemical reaction, which makes it great for use in combustion. The stuff that I injected into the ping-pong ball was ethylene glycol. When these two chemicals are combined, a chemical reaction takes place that produces a lot of heat. This heat quickly builds up to the point where a combustion reaction (i.e. burning) takes place. That is the fire that you saw.



These aerial ignition ping-pong balls are based on chemistry. The plastic sphere of the ball is filled with a precise amount of potassium permanganate. The sphere then gets injected with ethylene glycol. When these two chemicals are combined, a chemical reaction takes place that produces a lot of heat. This heat quickly builds up to the point where a combustion reaction (i.e. burning) takes place.

To light a prescribed fire, we use a helicopter to drop these ping-pong balls onto the exact location that we want to burn. The ping-pong balls ignite just after hitting the ground. They easily burn hot enough to light the fuels on the forest floor on fire right where fire managers want the burn to take place.

CLOSING

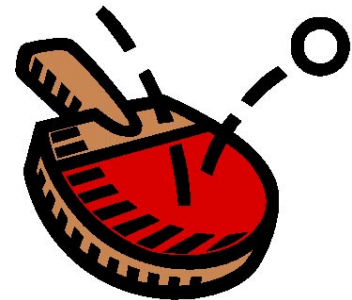
I hope that you have learned a lot today about the importance of chemistry to wildland fire managers. Not only is it important for us to understand the chemistry of burning, but it is also important for us to use that knowledge of chemistry in predicting and fighting wildland fire.

HANDOUT

No handout.

SUPPLIES

- 2 aerial ignition ping-pong balls and materials necessary to ignite them
- Graphic rendering of fire triangle (or ability to draw it on a board)
- Piece of dry wood
- Piece of bark
- Lighter or other ignition source
- NFDRS maps of the country (only if this section is being used)
- NFES 2073 Introduction to Class A Foam, time 4:28 through 6:45





High School Physical Science People in Fire's Homeland



INTRODUCTION

Good morning/afternoon. My name is _____
 _____, and I work for the _____ National
 Forest.

LESSON

(Note: This lesson was adapted from “Chapter 8. People in Fire’s Homeland” from “FireWorks Curriculum: Featuring Ponderosa, Lodgepole, and Whitebark Pine Forests,” http://www.fs.fed.us/rm/pubs/rmrs_gtr65.pdf.)

Fire is quite at home in the forests of the West. And, the plants and animals of these forests are quite at home with fire. The people who lived in these forests prior to 1800 were also at home with fire, but things have changed. People have built permanent homes in the midst of forests and along their edges. Thousands of people live in valleys that fill with smoke during wildland fires. People need to be informed about fire for their own safety and to help make wise choices about managing wildlands.

Today, we are going to be doing some real-world activities related to wildland fire. First, we are going to watch a short video (12 minutes) and go over an informational booklet that fire managers have developed. Your assignment while watching the video and reading the booklet will be to describe the organization of the video and to think about scientific information and viewpoints being presented. Specifically, I want each of you to pull out a piece of paper and make a brief outline of the organization of the video while you watch it. Any questions?



FOREST SERVICE MESSAGES

- A-1:** Fire has a natural role in the ecosystem.
- A-3:** Leaving nature alone has consequences, risks and trade-offs.
- A-5:** The study of the science of fire and its behavior is important.
- B:** People are part of nature, and their actions have effects on the land.
- C:** The Forest Service seeks to improve overall forest health and lessen the risk of high intensity, destructive wildland fires by working to bring the forests closer to historic, ecological conditions.
- C-1:** Prior to European settlement, Southwestern ponderosa pine forests had far fewer trees than today and had frequent, low-intensity surface fires.
- C-4:** Because of unnaturally dense conditions, our forests are at risk for destructive wildland fires, insect infestations and diseases.

ACADEMIC STANDARDS



Arizona Standards

LANGUAGE ARTS

- LS-P2:** Deliver an impromptu speech that is organized, addresses a particular subject and is tailored to the audience
- R-P1:** Apply reading strategies such as extracting, summarizing, clarifying, and interpreting information; predicting events and extending the ideas presented; relating new information to prior knowledge; supporting assertions with evidence; and making useful connections to other topics to comprehend works of literature and documents
- P0 1:** Extract critical details or elements of literature
- P0 2:** Summarize the main points
- P0 3:** Make predictions based on evidence presented
- P0 4:** Extend ideas presented in the text
- P0 5:** Connect prior knowledge to information available

SOCIAL STUDIES

- 3SS-P4:** Analyze the interactions between human activities and the natural world in different regions, including changes in the meaning, use, distribution, and importance of natural resources, with emphasis on:
- P0 2:** How humans perceive, react to, and prepare for natural



Fires are a natural part of Southwestern forest ecosystems. More and more people are choosing to build their homes in areas where fires have burned naturally for hundreds of years. With the decision to move to these areas comes risks and obligations.

(View the videotape “Managing Wildland Fire – a Matter of Choice,” which will take about 12 minutes.)

After viewing, ask the class to describe the organization of the video. Ask a few of the students to share their outlines of the video’s organization with the class. Then, put the following outline on the board:

I. Ask questions

- A. Can forests thrive with fire?
- B. Can people and property be protected?
- C. How much smoke is too much?

II. Suggest answers or solutions, at least in part

- A. Forests can thrive with fire.
- B. People and property can be protected
- C. Living with Smoke

(Note that each question is paired with an answer.)

Pick a question-and-answer pair. Ask the class to discuss the video’s treatment of that question and answer. (This part of the lesson can be done with the whole class, in small groups, or as a writing assignment.)

- Does the information presented seem to be based on valid science? If you can’t tell, how might you find out? (Some answers might include asking an expert that you trust, looking up more information in books and scientific articles, and doing experiments that test some of the ideas presented in the videotape. Also, the Internet might provide interesting information – how might they judge its validity?)
- What viewpoint is presented, and what techniques are used to present it?
- Do you agree or disagree with the viewpoint? Can you explain why? Can you suggest information or ideas to add to a discussion of the issue?

hazards

- PO 3:** How changes in the natural environment can increase or diminish its capacity to support human activity
- PO 6:** Policies and programs for resource use and management, including the trade-off between environmental quality and economic growth in the twentieth century

SCIENCE

- 1SC-P1:** Propose solutions to practical and theoretical problems by synthesizing and evaluating information gained from scientific investigations
- PO 1:** Evaluate scientific information for relevance to a given problem
- PO 2:** Propose solutions to a problem, based on information gained from scientific investigations
- 1SC-P2:** Compare observations of the real world to observations of a constructed model (e.g., an aquarium, a terrarium, a volcano)
- PO 1:** Assess the capability of a model to represent a “real world” scenario
- 1SC-P6:** Identify and refine a researchable question, conduct the experiment, collect and analyze data, share and discuss findings
- PO 1:** Construct a researchable question
- PO 2:** Employ a research design that incorporates a scientific method to carry out an experiment
- PO 3:** Analyze experimental data
- PO 4:** Communicate experimental findings to others
- 2SC-P6:** Analyze evidence that supports past and current scientific theories about a specific topic
- PO 1:** Distinguish between evidence which supports a given scientific theory (e.g., model of the atom, plate tectonics, natural selection) and evidence which does not support the theory
- 3SC-P1:** Apply scientific thought processes and procedures to personal and social issues
- PO 1:** Apply scientific thought processes of skepticism, empiricism, objectivity and logic to seek a solution to personal and social issues
- PO 2:** Apply a scientific method to the solution of personal and social issues
- 3SC-P4:** Identify and describe the basic processes of the natural ecosystems and how these processes affect, and are affected by, humans
- PO 1:** Describe the basic processes of the natural ecosystems (e.g., water cycle, nutrient cycles)
- PO 2:** Explain how these processes affect, and are affected by, humans
- 5SC-P3:** Identify, measure, calculate, and analyze qualitative and quantitative relationships associated with energy forms and energy transfer or transformation (e.g.,

(Additional exercise if there is extra time: If you could add one more thought to the videotape, what would it be? Write a script for your 2-minute addition to the video. Explain what part of the video you would use it in, and describe the video footage you would like to include with it.)

Ask the students if they think the issues in the videotape are important for their geographic area, and have them explain why or why not. Ask them if they think students in larger, metropolitan areas such as Phoenix would answer differently.

ACTIVITY

(This activity is taken from “Activity 3-4. The Fire Triangle in Wildlands” of “FireWorks Curriculum: Featuring Ponderosa, Lodgepole, and Whitebark Pine Forests,” http://www.fs.fed.us/rm/pubs/rmrs_gtr65.pdf.)

Now that you’ve learned some of the issues associated with fire management, we are going to do an activity to demonstrate some principles of fire behavior.

I think we are fortunate to live in an area that has a varied landscape. There are mountains, valleys, canyons, steep land, flat land, and more. You name it, and we’ve got it. However, when a wildland fire starts, this same diversity of landscapes and topography can lead to some very interesting fire behavior. That is what we are about to witness, albeit in a controlled environment.

1. Break up the class into four student teams. Explain to them that what they are about to do is similar to research done by chemists and physicists, and that results from research like this are used by foresters, firefighters, range managers, wildlife biologists, and ecologists.
2. Explain that each team will set up different experiments, but the whole class will observe every fire. Yes, I did say “fire,” so let’s go over some safety issues.
3. Review safety procedures in the laboratory; ask teacher to provide guidelines.
4. Give each student team a matchstick forest model (drilled square of masonite, 2 bolts, 1 nut-and-washer set, 1 nail) and 50-100 matches.



changes in temperature, velocity, potential energy, kinetic energy, conduction, convection, radiation)

PO 1: Identify qualitative and quantitative relationships associated with energy (e.g., heat, mechanical, electrical)

PO 2: Measure quantitative (e.g., heat, mechanical, electrical) relationships associated with energy

SSC-P4: Observe, measure and calculate quantities to demonstrate conservation of matter and energy in chemical changes (e.g., acid base, precipitation, heat)

PO 4: Quantify the energy changes in chemical reactions

SSC-P5: Describe and predict chemical reactions (including combustion and simple chemical reactions) and physical interaction of matter (including velocity, force, work and power), using words or symbolic equations

PO 2: Predict the products of a chemical reaction using types of reactions (e.g., synthesis, decomposition, replacement, combustion)

PO 3: Describe physical interactions through use of word equations or formulae

New Mexico Standards

LANGUAGE ARTS

Strand: Reading and Listening for Comprehension

Content Standard I: Students will apply strategies and skills to comprehend information that is read, heard, and viewed.

9-12 Benchmark I-B: Synthesize and evaluate information to solve problems across the curriculum

Grade 9 Performance Standards

1. Use a variety of techniques for researching topics including:
 - cross-referencing while gathering information
 - summarizing dialogue
 - using news sources (e.g., newspapers, magazines, TV, radio, videotapes, Internet, email, government publications, microfiche, other library resources)

Grade 10 Performance Standards

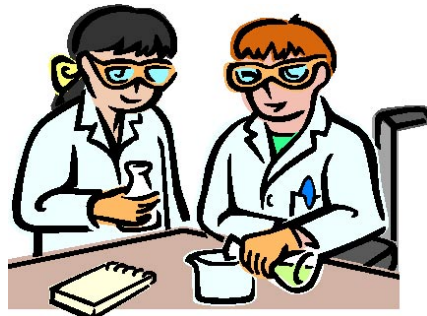
3. Use multiple resources to gather information to evaluate problems, examine cause and effect relationships, and answer research questions to inform an audience.

Grade 11 Performance Standards

1. Conduct research using data from in-depth field studies.
2. Synthesize information from multiple research studies to draw conclusions that go beyond those found in any of the individual studies.

Have students insert a match in every hole of the matchstick forest model, tips pointing up.

- Set these “matchstick forests” in burning trays on a heat-resistant surface. If you don’t have laboratory facilities, you might use a trash-can lid filled with sand. Have the first “forest” be level; to the second and third, attach a short bolt so the slope is about 20 degrees. To the fourth, attach the long bolt so the slope is about 40 degrees. Have a spray bottle and fire extinguisher nearby.
- Explain to the students that the individual matches represent trees that have flammable crowns, like the conifers (ponderosas, Douglas firs, pinyons) found in local forests. Tell them that in this demonstration they will observe how slope and tree density affect fire spread through tree crowns. Before lighting the matches, ask students for their guess (hypothesis) about how the fires will differ.
- Have one team light the match tips along one edge of the flat “forest” and observe fire behavior (everyone observe). Then have another team light the match tips along the edge of a medium-slope forest and observe. Then have another team light the bottom row of matches on the other medium-slope forest and observe. Finally, have another team light the bottom row of matches on the steep-slope 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. The fire pre-heats the trees above – you might want to draw a simple drawing on the chalkboard showing this.) Ask students to answer Questions 1-3 on Student Page 5.



- Have the students 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.



Grade 12 Performance Standards

- Identify and defend research questions and topics that will be important in the future.
- Use a variety of resources to gather information to critically analyze texts to gain meaning, develop thematic connections, and synthesize ideas.
- Demonstrate increasing sophistication in the selection and use of resources to define issues and use argument effectively.

9-12 Benchmark I-C: Demonstrate critical thinking skills to evaluate information and solve problems.

Grade 9 Performance Standards

- Support informed opinions by providing relevant and convincing reasons, using various types of evidence, language, and organizational structure, and demonstrating an awareness of possible questions, concerns, or counter-arguments.

Grade 10 Performance Standards

- Examine controversial issues by:
 - sharing and evaluating personal response
 - researching and summarizing data
 - developing a framework in which to discuss the issue (creating the context)
 - compiling personal responses and researched data to organize the argument
 - presenting data in various forms (e.g., graph, essay, speech, video)

Grade 11 Performance Standards

- Use language persuasively in addressing a particular issue by:
 - finding and interpreting information effectively
 - establishing and defending a particular perspective
 - responding respectfully to viewpoints and biases

Grade 12 Performance Standards

- Research, define, and present issues of public concern by:
 - specifying the nature of an issue, including claims made and the reasoning that supports those claims
 - organizing and delivering a presentation that specifies reasons for the claim and makes a clear stance on the issue.

Strand: Writing and Speaking for Expression

Content Standard II: Students will communicate effectively through speaking and writing.

9-12 Benchmark II-A: Communicate information in a coherent and persuasive manner using verbal and non-verbal language.

9. Now, explain that the arrangement of “trees” in the matchstick forests studied so far resembles the arrangement in lodgepole pine/subalpine fir forests



and in the Southwestern ponderosa pine forests we see today that are much more dense than they used to be. Show Class Page 2 on the overhead projector (or just hand out a copy to each team). This table describes the number and arrangement of trees in ponderosa pine/Douglas-fir forests and whitebark pine/subalpine fir forests. (Note: This shows a healthy number and arrangement. Today’s Southwestern ponderosa pine forests have many more trees and are not in a healthy condition.) Ask students to set up matchstick forests resembling these two forest types – using the long bolts to make “steep” forests. Ask how they expect fire behavior to differ.

10. Light these matchstick forests, one at a time, and discuss observations while having students record them on Student Page 5, lines 4 and 5. Also have them complete line 6.
11. Now, ask the students to compare the model forests used in this experiment to real forests. What are the similarities? What are the differences? How would they expect wildland fires to differ from matchstick forest fires? Explain that real wildland fires are much more complicated than model fires. With the models we have been using, we are dealing only with how slope, tree density and arrangement can affect fire behavior. In a real wildland fire, many other factors come into play. Wind has a tremendous effect on fire. Other things that affect fire behavior include the amount of fuels on the ground, fuel moisture, humidity, local terrain features (canyons, draws, etc.), time of day, fire’s ability to create its own weather, aspect (mention that south-facing slopes are usually warmer and drier and thus burn hotter), and the list goes on and on.

(Note to presenter: If while doing this program you notice that time is getting short, you may have to skip some subjects. If you do, cover the topics that you feel are the most important to your objective.)

Grade 9 Performance Standards

1. Evaluate personal effectiveness in group discussions and make corrections as necessary.
2. Ask questions to broaden and enrich discussions.
3. Express an informed opinion that clearly states a personal view, is logical and coherent, and engages the reader’s interest.
4. Support an informed opinion by using appropriate language, reason, and organizational structure for the audience and purpose.

Grade 10 Performance Standards

2. Make well-informed and well-organized formal presentations with a clear main point, adjusting the message, wording, and delivery to the particular audience and context.

Grade 11 Performance Standards

1. Use language persuasively in addressing a particular issue by:
 - finding and interpreting information effectively
 - recognizing propaganda as a purposeful technique
 - establishing and defending a point of view
 - responding respectfully to viewpoints and biases

Grade 12 Performance Standards

1. Develop oral formal presentations using clear enunciation, gestures, tone, vocabulary, and organization appropriate for a particular audience.
2. Make explicit use of various techniques for effective presentations (e.g., voice, inflection, tempo, gestures).

9-12 Benchmarks II-C: Demonstrate competence in the skills and strategies of the writing process to inform and persuade.

Grade 9 Performance Standards

3. Compose written arguments that develop and support informed opinions by:
 - stating a progression of ideas
 - selecting appropriate style, tone, and use of language for a particular effect
 - describing and analyzing personal, social, historical, or cultural influences
 - presenting rhetorical strategies to support the proposal
4. Analyze the origins and meanings of common, learned, and foreign words used frequently in written English.

Grade 10 Performance Standards

1. Write to stimulate the emotions of the reader.
2. Clearly articulate a position through the use of a thesis statement, anticipate and deal with counter-arguments, and develop arguments using

CLOSING

I hope that you have learned about some of the complexities of fire today – both in terms of fire management and fire behavior.

HANDOUT

- Student Page 5
- Class Page 2

SUPPLIES

- “Activity 8-1. A Matter of Choice” trunk from FireWorks Curriculum
 - ⊙ Trunk is from “Activity 8-1. A Matter of Choice” from “FireWorks Curriculum: Featuring Ponderosa, Lodgepole, and Whitebark Pine Forests,” http://www.fs.fed.us/rm/pubs/rmrs_gtr65.pdf.)
- Trunk includes:
 - ⊙ “Managing Wildland Fire – a Matter of Choice” videotape (12 minutes)
 - ⊙ “Managing Wildland Fire booklets (one per student)
- Television
- VCR
- Wooden matches (lots)
- “Activity 3-4. The Fire Triangle in Wildlands” trunk from FireWorks Curriculum
 - ⊙ Trunk is from “Activity 3-4. The Fire Triangle in Wildlands” from “FireWorks Curriculum: Featuring Ponderosa, Lodgepole, and Whitebark Pine Forests,” http://www.fs.fed.us/rm/pubs/rmrs_gtr65.pdf.)
- Trunk includes:
 - ⊙ Matchstick forest kits (4) (could use clay instead of masonite)
 - ⊙ Fire extinguisher
 - ⊙ Burning trays
 - ⊙ Spray bottles with water (2)
- Copies of Student Page 5 (one per team)
- Copies of Class Page 2 (one per team)
- Trash can lids (4)
- Sand
- Long-handled lighter

a variety of methods such as:

- examples and details
- commonly accepted beliefs
- expert opinions
- quotations and citations
- cause and effect
- comparison and contrast reasoning

Grade 11 Performance Standards

1. Use argument to:
 - interpret researched information
 - establish and defend a point of view
 - address concerns of the opposition
 - use techniques (e.g., rhetorical devices, parallelism, hypothetical situation, irony, concrete images)
 - develop a sense of completion
2. Synthesize and organize information from a variety of sources in order to inform and persuade an audience.

Grade 12 Performance Standards

3. Analyze own work for:
 - consistency of facts, ideas, tone, voice
 - development of argument or plot
 - clarity and conciseness

SOCIAL STUDIES

Strand: History

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

9-12 Benchmark I-A—New Mexico: Analyze how people and events of New Mexico have influenced United States and world history since statehood.

Grade 9-12 Performance Standards

5. Explain how New Mexico history represents a framework of knowledge and skills within which to understand the complexity of the human experience, to include:
 - explain connections made between the past and the present and their impact.

Strand: Geography

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

9-12 Benchmark II-A: Analyze and evaluate the characteristics and purposes of geographic tools, knowledge, skills, and perspectives, and apply them to

explain the past, present, and future in terms of patterns, events, and issues.

Grade 9-12 Performance Standards

1. Evaluate and select appropriate geographic representations to analyze and explain natural and man-made issues and problems.
2. Understand the vocabulary and concepts of spatial interaction, including an analysis of population distributions and settlements patterns.

9-12 Benchmark II-B: Analyze natural and man-made characteristics of worldwide locales; describe regions, their interrelationships, and patterns of change.

Grade 9-12 Performance Standards

1. Analyze the interrelationships among natural and human processes that shape the geographic connections and characteristics of regions, including connections among economic development, urbanization, population growth, and environmental change.
2. Analyze how the character and meaning of a place is related to its economic, social, and cultural characteristics, and why diverse groups in society view places and regions differently.
3. Analyze and evaluate changes in regions and recognize the patterns and causes of those changes (e.g., mining, tourism).

9-12 Benchmark II-C: Analyze the impact of people, places, and natural environments upon the past and present in terms of our ability to plan for the future.

Grade 9-12 Performance Standards

1. Compare and contrast how different viewpoints influence policy regarding the use and management of natural resources.

9-12 Benchmark II-D: Analyze how physical processes shape the Earth's surface patterns and biosystems.

Grade 9-12 Performance Standards

1. Analyze how the Earth's physical processes are dynamic and interactive.
2. Analyze the importance of ecosystems in understanding environments.
3. Explain and analyze how water is a scarce resource in New Mexico, both in quantity and quality.

9-12 Benchmark II-E: Analyze and evaluate how economic, political, cultural, and social processes interact to shape patterns of human populations, and their interdependence, cooperation, and conflict.

Grade 9-12 Performance Standards

1. Analyze the factors influencing economic activities (e.g., mining, ranching, agriculture, tribal gaming, tourism, high tech) that have resulted in New Mexico's population growth.
3. Analyze the interrelationships among settlement,

migration, population-distribution patterns, landforms, and climates in developing and developed countries.

4. Analyze how cooperation and conflict are involved in shaping the distribution of political, social and economic factors in New Mexico, United States, and throughout the world (e.g., land grants, border issues, United States territories, Israel and the Middle East, the former Soviet Union, and Sub-Saharan Africa).
5. Analyze how cultures shape characteristics of a region.
6. Analyze how differing points of view and self-interest play a role in conflict over territory and resources (e.g., impact of culture, politics, strategic locations, resources).

9-12 Benchmark II-F: Analyze and evaluate the effects of human and natural interactions in terms of changes in the meaning, use, distribution, and importance of resources in order to predict our global capacity to support human activity.

Grade 9-12 Performance Standards

1. Compare the ways man-made and natural processes modify the environment and how these modifications impact resource allocations.
2. Analyze how environmental changes bring about and impact resources.

SCIENCE

Strand I: Scientific Thinking and Practice

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

9-12 Benchmark I: Use accepted scientific methods to collect, analyze, and interpret data and observations and to design and conduct scientific investigations and communicate results.

Grade 9-12 Performance Standards

1. Describe the essential components of an investigation, including appropriate methodologies, proper equipment, and safety precautions.
2. Design and conduct scientific investigations that include:
 - testable hypotheses
 - controls and variables
 - methods to collect, analyze, and interpret data
 - results that address hypotheses being investigated
 - predictions based on results
 - re-evaluation of hypotheses and additional experimentation as necessary

- error analysis.
4. Convey results of investigations using scientific concepts, methodologies, and expressions, including:
 - clear, logical, and concise communication
 - reasoned arguments.
 5. Understand how scientific theories are used to explain and predict natural phenomena (e.g., plate tectonics, ocean currents, structure of atom).

9-12 Benchmark II: Understand that scientific processes produce scientific knowledge that is continually evaluated, validated, revised, or rejected.

Grade 9-12 Performance Standards

1. Understand how scientific processes produce valid, reliable results, including:
 - consistency of explanations with data and observations
 - openness to peer review
 - full disclosure and examination of assumptions
 - testability of hypotheses
 - repeatability of experiments and reproducibility of results.
3. Understand how new data and observations can result in new scientific knowledge.
6. Examine the scientific processes and logic used in investigations of past events (e.g., using data from crime scenes, fossils), investigations that can be planned in advance but are only done once (e.g., expensive or time-consuming experiments such as medical clinical trials), and investigations of phenomena that can be repeated easily and frequently.

9-12 Benchmark III: Use mathematical concepts, principles, and expressions to analyze data, develop models, understand patterns and relationships, evaluate findings, and draw conclusions.

Grade 9-12 Performance Standards

1. Create multiple displays of data to analyze and explain the relationships in scientific investigations.
2. Use mathematical models to describe, explain, and predict natural phenomena.
3. Use technologies to quantify relationships in scientific hypotheses (e.g., calculators, computer spreadsheets and databases, graphing software, simulations, modeling).
4. Identify and apply measurement techniques and consider possible effects of measurement errors.

Strand II: The Content of Science

Standard I (Physical Science): Understand the structure and properties of matter, the characteristics of energy, and the interactions between matter and energy.

9-12 Benchmark I: Understand the properties, underlying

structure, and reactions of matter.

Grade 9-12 Performance Standards

Properties of Matter

1. Classify matter in a variety of ways (e.g., element, compound, mixture; solid, liquid, gas; acidic, basic, neutral).
2. Identify, measure, and use a variety of physical and chemical properties (e.g., electrical conductivity, density, viscosity, chemical reactivity, pH, melting point).

Chemical Reactions

12. Know that chemical reactions involve the rearrangement of atoms, and that they occur on many timescales (e.g., picoseconds to millennia).
13. Understand types of chemical reactions (e.g., synthesis, decomposition, combustion, redox, neutralization) and identify them as exothermic or endothermic.
15. Describe how the rate of chemical reactions depends on many factors that include temperature, concentration, and the presence of catalysts.

9-12 Benchmark II: Understand the transformation and transmission of energy and how energy and matter interact.

Grade 9-12 Performance Standards

Energy Transformation and Transfer

1. Identify different forms of energy, including kinetic, gravitational (potential), chemical, thermal, nuclear, and electromagnetic.
2. Explain how thermal energy (heat) consists of the random motion and vibrations of atoms and molecules and is measured by temperature.
4. Understand how heat can be transferred by conduction, convection, and radiation, and how heat conduction differs in conductors and insulators.
5. Explain how heat flows in terms of the transfer of vibrational motion of atoms and molecules from hotter to colder regions.
6. Understand that the ability of energy to do something useful (work) tends to decrease (and never increases) as energy is converted from one form to another.

Strand II: The Content of Science

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

9-12 Benchmark I: Understand how the survival of species depends on biodiversity and on complex interactions, including the cycling of matter and the flow of energy.

Grade 9-12 Performance Standards

Ecosystems

1. Know that an ecosystem is complex and may exhibit

fluctuations around a steady state or may evolve over time.

3. Understand and describe how available resources limit the amount of life an ecosystem can support (e.g., energy, water, oxygen, nutrients).
4. Critically analyze how humans modify and change ecosystems (e.g., harvesting, pollution, population growth, technology).

Energy Flow in the Environment

5. Explain how matter and energy flow through biological systems (e.g., organisms, communities, ecosystems), and how the total amount of matter and energy is conserved but some energy is always released as heat to the environment.

Strand II: The Content of Science

Standard III (Earth and Space Science): Understand the structure of Earth, the solar system, and the universe, the interconnections among them, and the processes and interactions of Earth’s systems.

9-12 Benchmark II: Examine the scientific theories of the origin, structure, energy, and evolution of Earth and its atmosphere, and their interconnections.

Grade 9-12 Performance Standards

Characteristics and Evolution of Earth

4. Understand the changes in Earth’s past and the investigative methods used to determine geologic time, including:
 - rock sequences, relative dating, fossil correlation, and radiometric dating
 - geologic time scales, historic changes in life forms, and the evidence for absolute ages (e.g., radiometric methods, tree rings, paleomagnetism).
5. Explain plate tectonic theory and understand the evidence that supports it.

Strand III: Science and Society

Standard I: Understand how scientific discoveries, inventions, practices, and knowledge influence, and are influenced by, individuals and societies.

9-12 Benchmark I: Examine and analyze how scientific discoveries and their applications affect the world, and explain how societies influence scientific investigations and applications

Grade 9-12 Performance Standards

Science and Society

9. Describe how scientific knowledge helps decision makers with local, national, and global challenges (e.g., Waste Isolation Pilot Project [WIPP], mining, drought, population growth, alternative energy, climate change).
10. Describe major historical changes in scientific

- perspectives (e.g., atomic theory, germs, cosmology, relativity, plate tectonics, evolution) and the experimental observations that triggered them.
12. Explain how societies can change ecosystems and how these changes can be reversible or irreversible.

**FOREST SERVICE CONSERVATION
EDUCATION LEARNER GUIDELINES**

Program title: People in Fire’s Homeland
Target audience: High School Physical Science
Primary topic: Many factors affect how a fire burns.

Length of program: 1 hour

Setting: indoors

Guidelines addressed are referenced here:

9-adult
I. Questioning and Analysis Skills
A1, A2, A3, B1, C1, D2, D3, E3, F1, F2, F3, G1, G2, G3, G4
II. Knowledge of Environmental Processes and Systems
1. A1, B1
2. C2, D2, D3
3.
4. A1, A3, B3, B4, C4, E1
III. Skills for Understanding and Addressing Environmental Issues
1. A1, A4, B3, B4, C1, D1
2. A1, A4, B1
IV. Personal and Civic Responsibility
C2, D3, D4

Student Page 5

Names: _____

The Fire Triangle in Wildlands

In this demonstration, you watch fires on three slopes--flat, medium, and steep. Answer questions 1-3 using the demonstration fires as examples.		
1	How does the steepness of a hillside affect a fire's spread?	
2	How well do fires burn downhill?	
3	How does slope affect fire spread? Use the Fire Triangle to explain.	
Now you will burn two more "matchstick forests" to explore how the arrangement of trees affects fire spread. Answer the questions below.		
	Description of matchstick forest	How well did this arrangement resist crown fire?
4	Ponderosa pine/Douglas-fir forest 100 years ago (5 large trees in area where lodgepole pine might have 50 trees)	
5	Whitebark pine/subalpine fir forest (13 trees, growing in clusters of 2-5 trees, in area where lodgepole pine might have 50 trees)	
6	Use the Fire Triangle to explain.	

Class Page 2

Arranging Trees in the Forest 100 Years Ago

Three kinds of forest, three arrangements of trees

What kind of forest?	How many trees in a matchstick model?	How are the trees arranged?
Lodgepole pine/subalpine fir	49	Trees are dense and quite evenly spaced.
Ponderosa pine/Douglas-fir	5	Trees occur singly, occasionally in pairs.
Whitebark pine/subalpine fir	13	Trees occur in clusters of 2 to 5.