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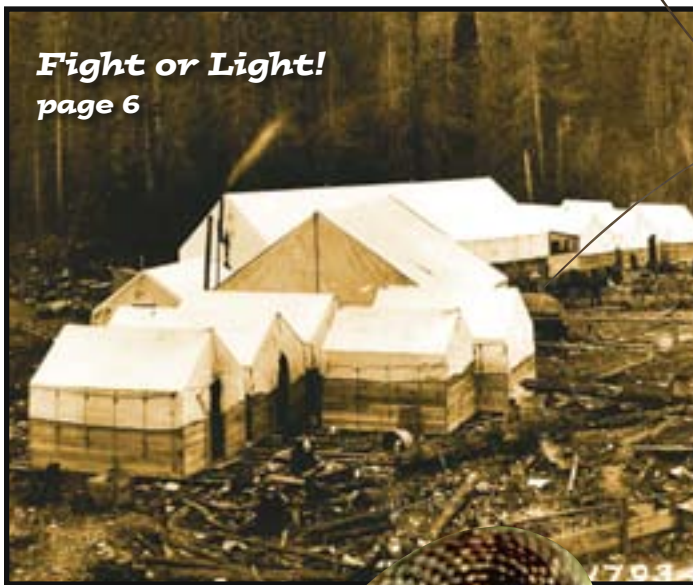
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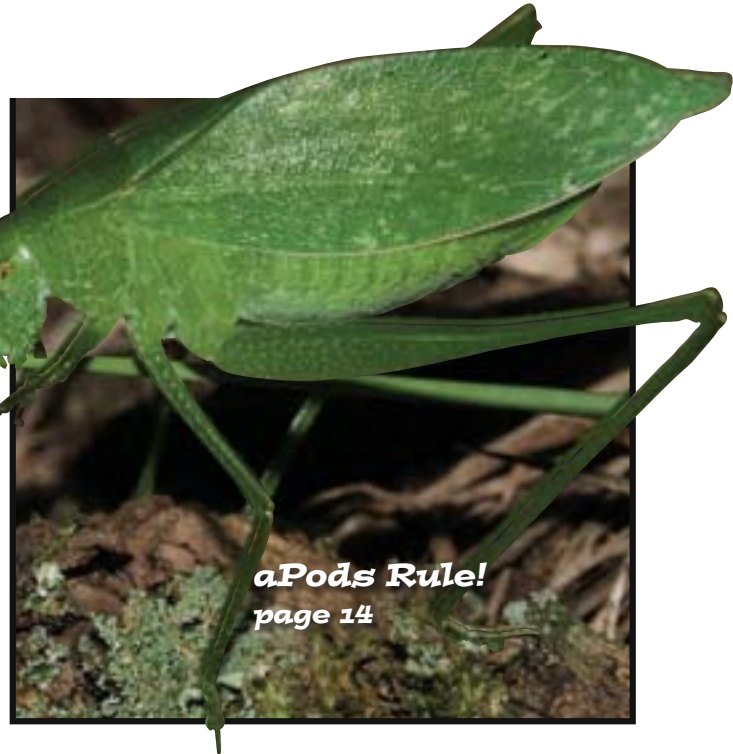
**Wildland Fire
Edition**

Number 13

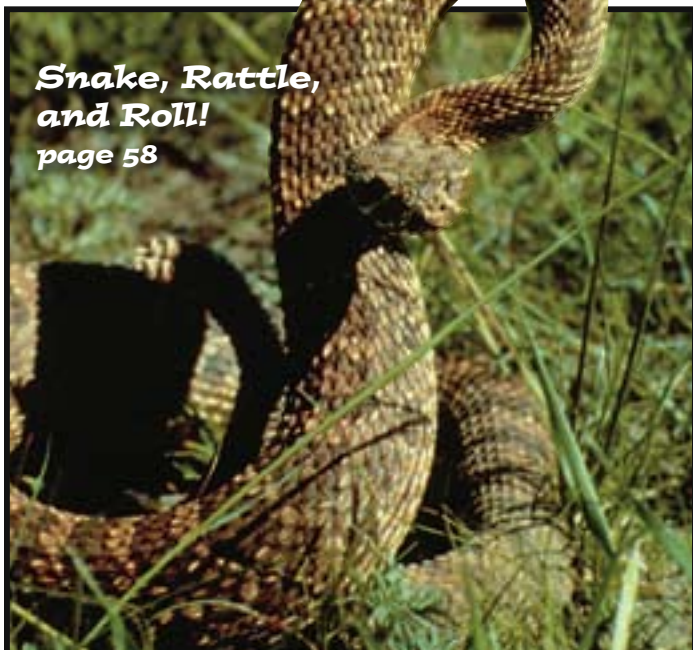
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and Roll!***
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Order***
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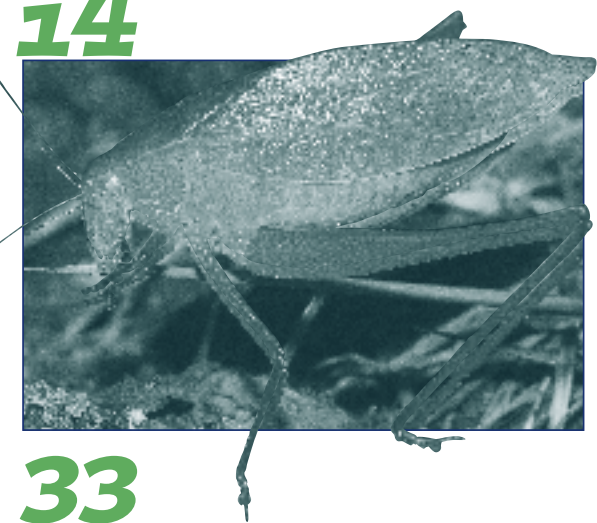
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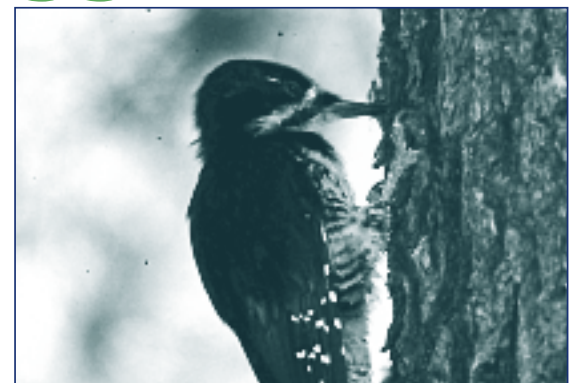
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Editorial Review Board



Natural Inquirer editorial review board hard at work.

Comments from the *Natural Inquirer* editorial review board:

"You might want to explain what the Forest Service is."

"Vocabulary should be all highlighted and referenced in the back, or all explained in the passage."

*"Good writing. History is fun.
Really explains what's going on."*

"Maybe use clearer pictures when published."

"Good question. I don't know the answer though."

"All of the explanations seem to be toward the end of the article (not really good or bad thing just noticing)."

*"[Title] not catchy enough...more curiosity.
Have the title grab your attention."*

"Use a bigger picture, so they know what you are talking about."

"You are a great writer. This was an awesome article to read!"

"Wow! That lizard is really weird looking...But really cool. Great Job!! Loved the pictures!"

"Sentence was repeated earlier. Maybe format differently."

"Maybe tell them what vegetation is..."



**Natural Inquirer review board: C. S. Porter Middle School,
Missoula County Public Schools, Missoula, Montana, Mr. Blake Love, Teacher**

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<http://www.naturalinquirer.org>

About the Natural Inquirer

Scientists report their research in journals, which are special booklets that enable scientists to share information with one another. This journal, the *Natural Inquirer*, was created so that scientists can share their research with you and with other middle school students. Each article tells you about scientific research conducted by scientists in the Forest Service, U.S. Department of Agriculture. If you want to know more about the Forest Service, you can read about it on page 92 of this journal, or you can visit the *Natural Inquirer* Web site at <http://www.naturalinquirer.org>.

All of the research in the *Natural Inquirer* is concerned with nature, such as trees, forests, animals, insects, outdoor activities, and

water. First, you will meet the scientists who conducted the research. Then you will read something special about science and about the natural environment. You will also read about a specific research project. This is written in the format that scientists use when they publish their research in journals. Then, YOU will become the scientist when you conduct the FACTivity associated with each article. Don't forget to look at the glossary and the special sections highlighted in each article.

At the end of each section of the article, you will find a few questions to help you think about what you have read. Your teacher may use these questions in a class discussion.

Who Are Scientists?



Scientists are people who collect and evaluate information about a wide range of topics. Some scientists study the natural environment. To be a successful environmental scientist, you must:

- ✦ **Be curious**—You must be interested in learning.
- ✦ **Be enthusiastic**—You must be interested in an environmental topic.

- ✦ **Be careful**—You must be accurate in everything that you do.
- ✦ **Be open minded**—You must be willing to listen to new ideas.
- ✦ **Question everything**—You must think about what you read and observe.

Welcome

to the Wildland Fire Edition of the *Natural Inquirer*!

One hundred years ago, forest fires roared across the Northern United States. Although fires burned in New England and upper Midwestern States, the fires of Montana, Idaho, and Washington State were by far the worst of that year. On 2 days in August 1910, much of northern Idaho and western Montana were ablaze. The fires of those 2 days are called “the Big Blowup” by foresters. The Big Blowup changed the way Americans viewed wildland fire. These fires also profoundly affected the Forest Service. Following the Big Blowup, fighting wildland fire became its chief mission for almost 75 years.

This edition of the *Natural Inquirer* focuses on wildland fire. Wildland fire has been defined as any fire occurring in vegetation areas regardless of how it was started. In this edition, you will learn about different types of wildland fires, including uncontrolled wildfires and fires purposely set and controlled by foresters to provide benefits to a natural area.



The fires of 1910 destroyed large areas of forest land.

Photo courtesy of Forest Service Northern Region Archives.

Every spring and summer, wildland fires are in the news. These news reports are usually about wildfires. Wildfires are large uncontrolled fires that could have been started by lightning or by careless people. Contrary to what you might think when you hear those reports, wildfires are not always a bad thing for a natural ecosystem. When wildland fires burn close to homes or businesses, or burn out of control, they become news because of the damage they might do to people, farms, livestock, or buildings. Some trees and animals, however, need occasional fire to survive. Wildland fires are a necessary part of some ecosystems. They have been the reason those ecosystems have survived.

In this edition of the *Natural Inquirer*, you will learn about the history of wildland fire in America. You will learn about the Big Blowup. You will learn that wildland fire is not simply bad or good. You will learn how foresters work to enhance the benefits and reduce the dangers of wildland fires. In this edition, you will read about some plants and animals that must experience occasional fire to survive.

In 2010, a century has passed since the Big Blowup. This *Natural Inquirer* was created so that you can learn about wildland fire and what scientists are discovering about it. Hopefully, the next time you hear about a wildland fire in the news, you will pay close attention to the story. You will remember how foresters work to protect people and buildings from wildfires, how they reduce the chance and impact of wildfires, and how they work to increase the benefits that society gains from occasional wildland fire.

Fire Research in the Forest Service

Almost 50 years after the Big Blowup, the Forest Service took action to better understand wildland fire's benefits, its dangers, and how fire should be managed. In 1959, the first laboratory devoted to forest fire research was opened in Macon, Georgia. The following year, the Forest Service established the Missoula, Montana, Fire Laboratory. In 1963, the agency opened the Pacific Southwest Forest Fire Laboratory in Riverside, California. The newest wildland fire research laboratory was opened in Seattle, Washington, in 2003. This lab, however, had been the home of fire research since 1973. In Madison, Wisconsin, scientists working at the Forest Products Laboratory search for better ways to protect wood products from fire damage.

The scientists who work at these laboratories have contributed much to our understanding of wildland fire. They are helping Americans to understand that fire is a necessary and beneficial part of many ecosystems. They are developing better ways to protect people, homes, and businesses



An experiment at the Missoula, Montana, Fire Sciences Laboratory investigates how fire spreads. This fuel bed was composed of shredded wood hanging on wire stands. Fire could spread from one row of stands to the next only if flames contacted the shredded wood in the next row.

Where the gaps between rows were too wide, the fire could not spread. Results like these provide clues about the importance of heat in how fires spread.

from wildland fire. They are improving the way we manage natural areas that may experience wildland fire. The research you will read about in this edition of the *Natural Inquirer* is just a small example of the many topics Forest Service scientists study to improve our understanding of wildland fire.

Fight or Light?



Photo courtesy of Forest Service Northern Region Archives.

The History and Impact of the Big Fires of 1910

Meet the Scientist

Dr. Stephen Pyne, Historian: My favorite science experience was the time I spent a season in Antarctica with groups of people studying ice.



Dr. Pyne as a young smoke chaser
(wildland firefighter).



Thinking About Science

There are many different ways to discover new information. A historian is an individual who does research and writes about human events that happened in the past. The research and writings of historians provide important benefits to society. They tell stories from the past that help society to understand how people, groups of people, or organizations came to be as they are. History also helps society to learn from the mistakes and successes of the past. Often, historians collect information from many different places to tell a story. If possible, they interview people who were involved in the historic events.

Human history can be told at many levels. You, as an individual, have your own history. You have a family history, and your community has a history. Your race has a history, and your country has a history. The history of just about anything can be studied. What is your favorite type of music? It has a history as well. The research you will read about in this article was conducted by a historian who was interested in the history of wildland fire in America.



Thinking About the Environment



In the early years of the 20th century, the Western United States was still being settled by Europeans. Forests were cleared for railroads, mining, agriculture, and the towns where people lived. Much more land, however, remained as wild forests. As more people moved near or into these wild forests, the question of how to manage wildfires became more important. Wildfires are large uncontrolled wildland fires that are started by lightning or by people's careless actions.

In the early 1900s, some people thought that purposefully setting and controlling small fires every few years was the best way to keep any wildfires from getting out of control. Other people felt that the best way to manage wildfires was to prevent them from starting. These people also felt that any fire that started should be put out as quickly as possible. In this article, you will learn about wildfires that burned over 2 days in 1910. You will learn about the effect these wildfires had on how society viewed wildfires throughout the 20th century. One hundred years later, the wildfires of 1910 still affect American society.

Introduction

In the early 1900s, U.S. citizens became more aware of the materials that could be provided by forest lands in the West. These materials included timber for building homes, metals from mining, and water for irrigation of crops. Citizens also became aware of the importance of saving some of these lands for everyone's use. Around this time, national parks and forest **reserves** were created.

In 1905, the Forest Service was established to **manage** the forest reserves, which then became the national forests. As the manager of these large areas of forests, the Forest Service realized it had a big job to do. In particular, it had to figure out how best to manage wildfires. When fires burned the forests, there was less wood available for building homes and businesses. In addition, a growing human population became more concerned for its own safety.

As more people settled the West, therefore, the potential harm to people from wildfires became more important. As with most things, everyone did not agree on the best approach to manage wildfires. The people in the Forest Service believed that fires should be prevented. They also believed that any fire should be put out as soon as possible. Other people believed that fire itself could be used as a tool to manage wildfires. These people pointed to the American Indians' practice of starting and controlling small fires as a way of preventing large uncontrolled wildfires.

On August 20 and 21, 1910, a combination of dry weather, high winds, sparks from lightning, locomotives, and human carelessness caused a large number of wildfires to **ignite** in Idaho and Montana (**figures 1 and 2**). Eighty-five people died, and 78 of them were firefighters. Following these fires, the Forest Service became even more determined to prevent or **extinguish** all wildland fires. This is a policy called fire **suppression**.



Figure 1. Idaho, 1910. Large areas of forest land were burned in the 1910 fires. This photograph was taken during one of the 1910 fires. Photo by H. English. Photo courtesy of Forest Service Northern Region Archives.

The fire suppression policy remained in effect for decades. In the late 1960s, research began to show the beneficial effects of wildland fire. The public's attitudes toward public lands were also changing. People began to favor parks and wilderness over using the forests for timber and other products. At the same time, the harmful effects and high costs of fire suppression became more apparent. Slowly, the Forest Service began to change the way it managed wildland fires.

The historian in this study was interested in understanding the impact of the 1910 fires on fire policy and American society. He wanted to know why the wildfires that burned over those 2 days were so powerful. They influenced public opinion and fire policy for most of the next century. Their influence was felt even after it became clear that fire suppression was not the best policy. The fires of 1910 continue to influence Americans today, even if people are not aware of it. The historian in this study wanted to better understand the story and impact of the 1910 fires.

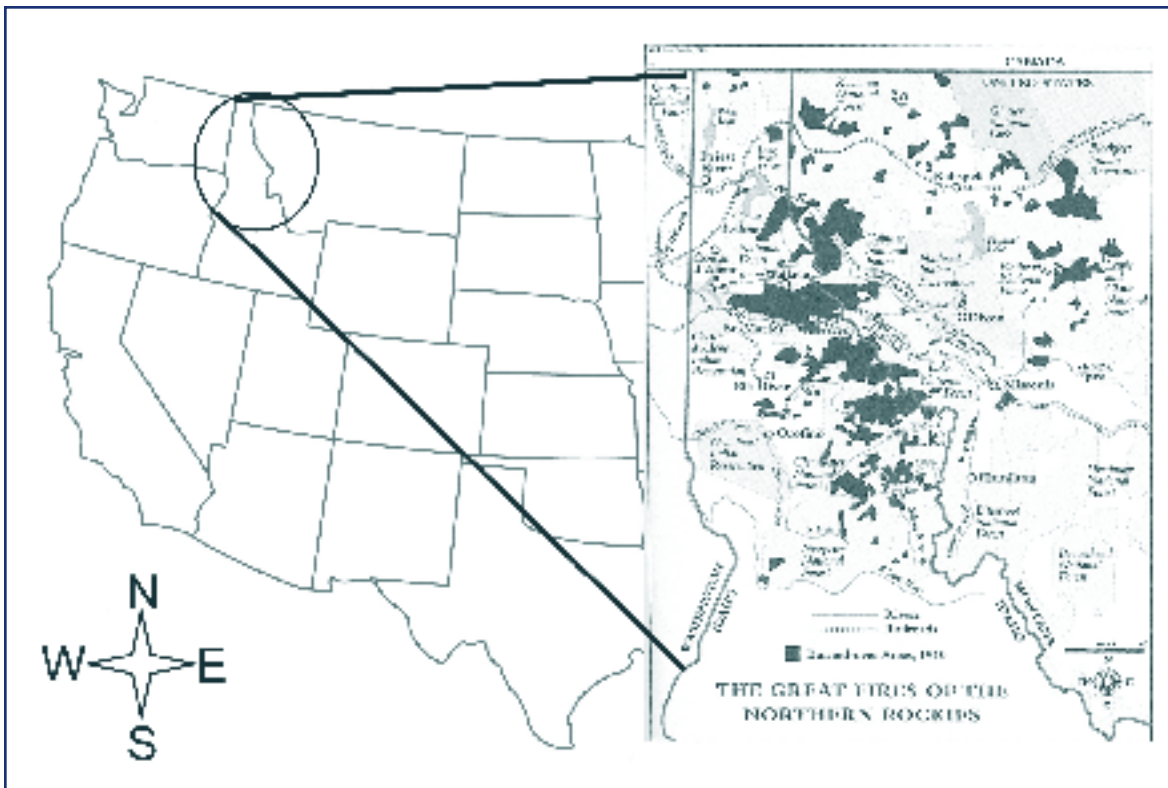


Figure 2. The area of Idaho and Montana where the fires burned.

Using Fire as a Tool

Different forests burn in different ways. In some forests, fires burn along the surface of the ground. In other forests, fires tend to burn in the tree canopy. The tree canopy is the leafy area at the tops of trees. Fires that burn along the surface of the ground are more easily controlled. Foresters can purposely set this kind of fire and use it as a tool.

Small controlled fires burn away much of the **understory**, but leave large trees standing. This is because large trees are **resistant** to

small fires. The burned vegetation provides nutrients to the soil. It also prevents small trees from growing up and competing with larger trees. These smaller trees, once they are burned, are no longer fuel for a larger wildfire. If a wildfire begins to burn, there will be little fuel left to burn near the ground, and the wildfire will burn out, or can be put out, much more quickly.

Number Crunches

🍁 How many years has it been since the wildfires burned in 1910?

Reflection Section

🍁 What were the questions the historian wanted to explore?

🍁 How do you think the historian explored his questions?



Methods

The historian did this research in two ways. Both ways involved traveling to the areas of Idaho and Montana where the wildfires occurred. The historian visited places of importance to the wildfires, such as the tunnel where firefighters sought shelter from one of the fires (**figure 3**). Had survivors still been alive, he could have talked to people who had lived through the fires. Instead, he also visited the libraries, offices, and museums that keep newspaper articles, letters, documents, photographs, and other written or photographic material about the wildfires. This even included a trip to Washington, DC, to read Government documents about the fires and Forest Service fire policy, and to examine old photographs (**figure 4**).

The historian made copies of as much information about the fires as possible. He took notes and recorded his notes on a computer. He then sorted his notes by categories, such as date, individual, and event. Then, he placed related events in the order that they happened to create a timeline. He included information about events that happened before and after the big fires of 1910.

Then, the historian began to write the story of what happened in the years before 1910, during each month of the year of 1910, during the 2 days of the biggest fires, and after 1910.

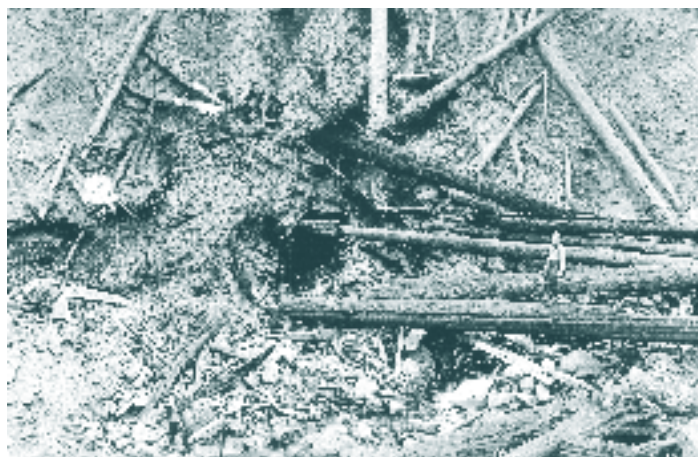


Figure 3. The Nickolson mine shaft. This mine shaft is also called the Pulaski Tunnel, named after the man who saved most of his fire crew on August 20, 1910. Ed Pulaski had led his men into the mine, then forced them to stay by threatening to shoot anyone who tried to leave. Most of the men survived the fire, which had burned to the entrance of the mine. Photo courtesy of Forest Service Northern Region Archives.



Figure 4. Lolo National Forest, Montana, 1910. View from the Northern Pacific Railway grade between Borax and Lookout, taken after the 1910 fires. Photo taken by R.H. McKay. Photo courtesy of Forest Service Northern Region Archives.

Reflection Section

- Look at the photographs in figures 3 and 4. What are some of the advantages of having photographs if you are a historian?
- Historians must write history as accurately as possible. A story of historical **fiction** must be clearly identified. Why should stories of historical fiction be clearly identified as such?



Findings

The foresters who managed the national forests in the early 1900s believed that all fire was bad. They believed that the best thing to do was to keep fires from burning and put out any fires as quickly as possible. The historian discovered, however, that many things in 1910 were beyond the control of the foresters.

The historian found that there were many reasons the fires were so large and numerous on August 20 and 21, 1910. The weather had been dry all spring and summer. On those 2 days, strong winds began to blow. Locomotives with faulty brakes sent sparks out along the railroad tracks. Trees had been cut down to make room for the tracks. The areas beside the tracks contained dry brush that readily ignited and flames were spread by the winds. Lightning and human carelessness with campfires also contributed to the many fires ignited.

On August 24, the winds stopped and it began to rain and snow in the area. Some towns had been burned to the ground, and large areas of Idaho and Montana forests were destroyed. Eighty five people died on August 20 and 21. Once the crisis had passed, the foresters became even more determined not to let fires burn. The public, who witnessed the destruction or heard about it in newspapers, agreed.

In the middle of the 20th century, Forest Service scientists began to learn new things about the role of fire. They began to discover that fire can be used as a tool to prevent large wildfires. They also learned that fire can have benefits in some **ecosystems**.

Slowly, the Forest Service began to change its mind about how best to manage fires. The agency adopted a mixture of approaches. Some fires needed to be controlled, and some needed to be set. Near the end of the 20th century, fire suppression was no longer seen as the best way to prevent large fires. Forest managers now realize that the use of small controlled fires, called **prescribed fire**, is a way to restore the fires we want and that nature needs. It is also a way to prevent the fires we do not want and that do damage.

Reflection Section



- What one thing is still out of the control of people in regard to wildfires?
- How has research helped foresters to do a better job of managing fire?

Discussion

The historian put some thought into what his work means for today. He noted that weather is still important to the start and spread of wildfires, just as it was in 1910. As humans burn

more **fossil fuels**, they may be causing a change in long-term weather patterns. As the **climate** changes, humans may be creating better conditions for large wildfires. People should carefully consider and learn from the past.

Reflection Section



- Before reading this article, did you think all wildfires should be put out? How do you think your opinions about wildfires have been influenced by hearing about wildfires in the news? How is the shaping of your opinion similar to the reaction to the wildfires of 1910? How is it different?
- Describe another instance where learning about the past can help make decisions about the future.

Glossary

Climate ('klī-mət): The average condition of the weather over large areas, over a long time, or both.

Ecosystem (ē-kō-sis-təm): Community of plant and animal species interacting with one another and with the nonliving environment.

Extinguish (ik-'stiŋ-(g)wish): To bring to an end.

Fiction ('fik-shən): An invented story.

Fossil fuel ('fä-səl 'fyü(-ə)l): Fuel, such as coal, petroleum, or natural gas, formed from the fossilized remains of plants and animals.

Ignite (ig-'nīt): To cause to burn.

Prescribed fire (pri-'skribd 'fi(-ə)r): The controlled application of fire to wildland fuels under certain weather conditions as a forest management tool.

Resistant (ri-'zist-tənt): The condition of being able to withstand the force or effect of.

Suppression (sə-'pre-shən): To inhibit the growth or development of.

Understory ('ən-dər-'stôr-ē): The vegetation between the forest canopy (the area with leaves) and the ground cover.

Accented syllables are in **bold**. Marks taken from Merriam-Webster Pronunciation Guide.

Adapted from: Pyne, S.J. 2008. *Year of the fires: The story of the great fires of 1910*. Missoula, MT: Mountain Press Publishing Company.

FACTivity



Time Needed:

One class period or homework

The question to be answered in this FACTivity is: What was the impact of a recent natural disturbance on a community, a region, or the world? Natural disturbances are events such as fires, floods, earthquakes, tsunamis, and volcanoes.

The procedure to use to answer this question is:

Discuss the story of the 1910 fires with the rest of the class after you have all read the article. In particular, discuss the impact the fires had on Forest Service fire policy and on public attitudes toward wildland fires.

As a class, identify a natural disturbance that has been in the news in the past year. Collect information about the event and its impact using the library and Internet. You should also record your own recollection of the event. How did you learn of the event? How did you feel about it? Were you or someone you know directly affected by the event? Collect photographs as well.

Write a story about the event and its impact, including photographs. Your teacher will have you share your stories with the class or in small groups.



After you and your classmates have shared your stories, your teacher will hold a class discussion comparing and contrasting your stories with the story of the 1910 fires. How are the natural disturbances similar and different? How do the impacts compare? Do you think the impact of the recent event will last as long as the impact of the 1910 fires? Why or why not?



Teachers: If you are a PLT-trained teacher, you may use Activity #86, "Our Changing World," #89 "Trees for Many Reasons," and #81, "Living with Fire," as additional resources.

National Science Education Standards

Science as Inquiry:

- Abilities Necessary To Do Scientific Inquiry;
- Understanding About Scientific Inquiry

Life Science:

- Structure and Function in Living Systems;
- Populations and Ecosystems

Science in Personal and Social Perspectives:

- Populations, Resources, and Environments;
- Natural Hazards;
- Risk and Benefits;
- Science and Technology in Society

Science and Technology:

- Understanding About Science and Technology

History and Nature of Science:

- Science as a Human Endeavor;
- Nature of Science

Additional Web Resources

1910 Fire Commemoration Information Site
(includes good photographs and eyewitness accounts)

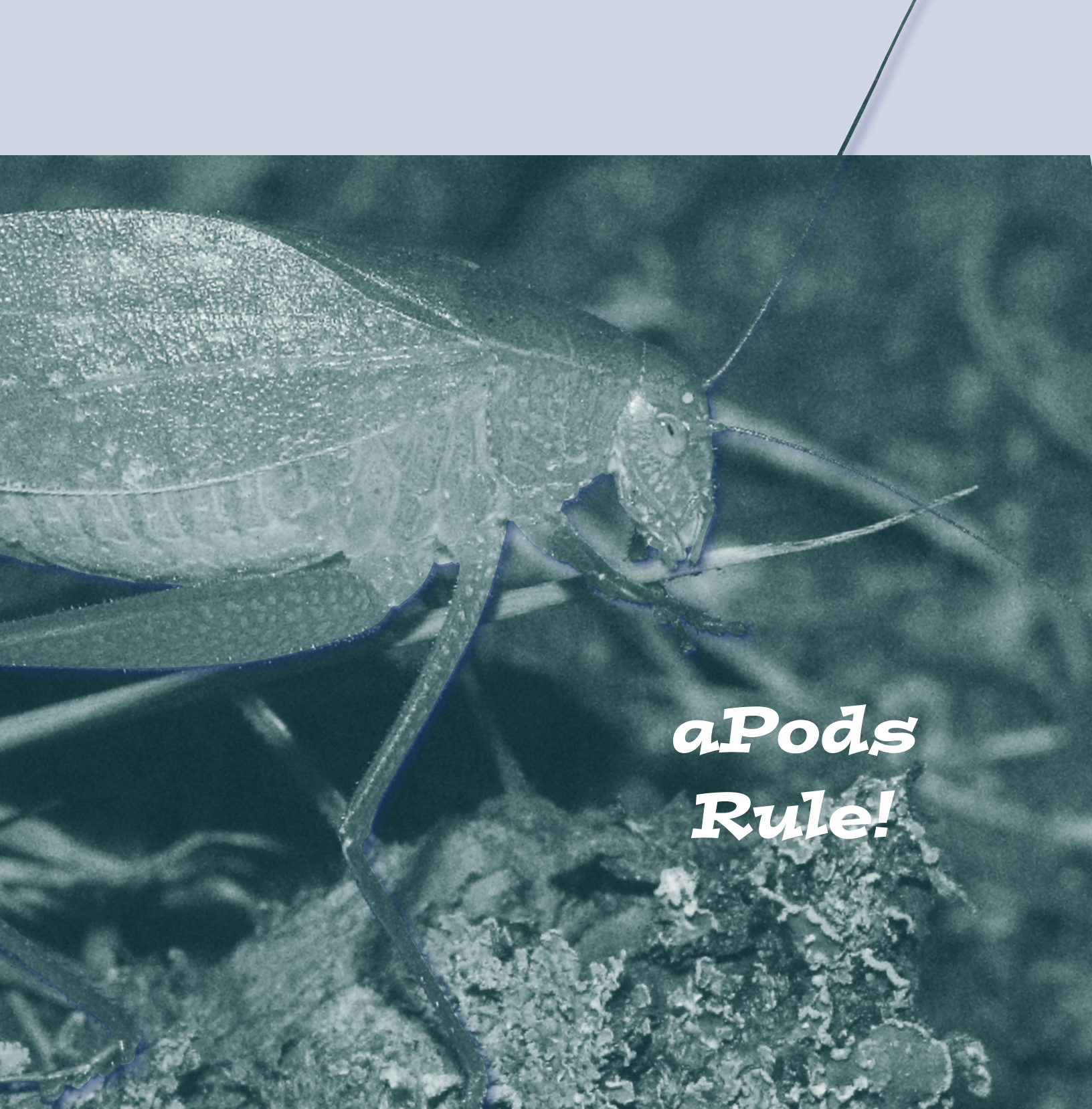
<http://www.fs.fed.us/r1/1910-centennial/index.html>

The Great 1910 Fire (includes good photographs)

<http://www.1910fire.com/>

Idaho Forest Products Commission: The 1910 Fires

<http://www.idahoforests.org/fires.htm>



**aPods
Rule!**

Photo by Susan Ellis, <http://Bugwood.org>.

***What Happens to Arthropods
Following a Wildland Fire?***

Meet the Scientists

Dr. Jim Hanula, Entomologist
(**en-tə-'mä-lə-jist**): My favorite experience as a scientist was discovering a new species. I was working on Japanese beetles at the time and kept finding larvae infected with a fungus. Other people had seen the fungus in the past but didn't realize it was a new species. When my co-worker and I looked at it closely (really closely) with an electron microscope we found out it was a new



genus and a new species of fungus. I had the chance to name them and describe both.

Dr. Susan Loeb, Research Ecologist: My favorite science experience is observing animals in their natural environment, whether they are small mammals, bats, or chimpanzees.



Dr. Joe O'Brien, Ecologist: When I was a graduate student, I studied the rain forest in Costa Rica. I was studying how climate influenced tree growth.

Sometimes, I had to take measurements of leaves in the forest **canopy**. Using a **crossbow**, I would send a rope into the top of a tree. Then, with my instruments, I would climb 150 feet up the rope to the tree canopy. At the forest floor, only 3 percent of sunlight comes through. It is dark and gloomy there. I would slowly inch my way up into the

bright, sunny, breezy canopy. I could see all kinds of wildlife up close. I saw toucans, parrots, monkeys, and butterflies. When I was finished, it was fun to **rappel** back down.

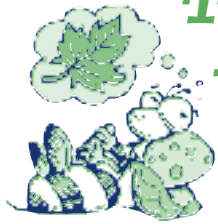


Thinking About Science

Before they do a study, scientists sometimes state a hypothesis. A hypothesis is a statement of an observation, usually about the relationship of one thing to another. A hypothesis can provide the basis for a scientific study, in which the observation is examined to determine if it is true or false.

Scientists usually state their hypothesis as what is called a null hypothesis. A null hypothesis states that there is no relationship between two or more **variables** being studied. After they do their study, scientists determine whether the null hypothesis is true or false. If it is false, it means a relationship appears to exist between two or more variables. Think of a time that you observed something about the relationship of two things. For example, if the sky is dark and cloudy, you might think it will rain. What would be the null hypothesis in this case?





Thinking About the Environment

Have you ever turned over an old log in the woods? If you have, you know that many small creatures live in and around these logs. Many of these creatures are arthropods ('är-thrə-pädz). Over 80 percent of all known animal **species** are arthropods, a group that includes insects, spiders, scorpions, ticks, mites, centipedes, and millipedes. In the ocean, arthropods include crabs, shrimps, and lobsters. Scientists have identified over 1,170,000 species of arthropods. Many more will probably be discovered over time.

Arthropods provide many **ecosystem services** to people. These services include pollination, food, **decomposition**, insect control, and beauty. Can you imagine what would happen if insects didn't help decompose dead animals and plants? It would be gross! Some arthropods bite or sting if they think people or other animals are trying to hurt them or their nests. For example, bees and scorpions can sting, and sometimes people get sick from some arthropod bites like mosquitoes or tick bites if they are carrying a disease.

The scientists in this study investigated one kind of arthropod. This type of arthropod lives among **leaf litter** on the forest floor. The scientists wanted to discover what happens to arthropods living among leaf litter after a forest fire moves through the area.

Introduction

Longleaf pine (*Pinus palustris*) (pī-nis pə-lus-trəs) once could be found from southeastern Virginia to eastern Texas (**figures 1 and 2**). This was an area covering 90 million acres or almost 82 million football fields.



Figures 1a and 1b. How do you think longleaf pine got its name? Photo by Rebekah D. Wallace, courtesy of <http://Bugwood.org> (1a) and David Stephens, courtesy of <http://Bugwood.org> (1b)

Number Crunches

🍁 About how many acres of longleaf pine forest exist today? To find out, multiply 90,000,000 acres by 0.05.



Figure 2a. Longleaf pine forests once covered much of the Southeast. Map courtesy of Southern Regional Extension Forestry.

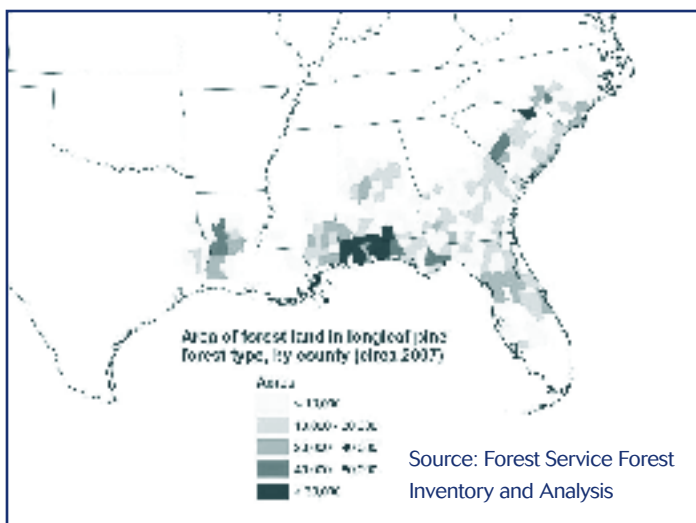


Figure 2b. The current range of the longleaf pine forests in the Southeast. Compare this with figure 2a.

Longleaf pines are not usually killed by fire. Because these pines need open spaces to survive, fire is a good thing for longleaf pines. Purposely set and controlled fires keep other plants and trees small, leaving more space for longleaf pines to grow. Even when longleaf pines are young, they can survive fires (**figure 3**). When old longleaf trees die and fall, the logs are also able to survive forest fires.

Over many years, much of the longleaf pine forests were cut for lumber. Since longleaf pine was hard to grow in nurseries for replanting and it grows slower than some other pines, longleaf pine was often replaced with those other pines. Also, because wildfires caused so much damage, forest managers tried to stop all fires because they wanted to protect the new forests. Land where longleaf pine grew was also used for other things like farming. These actions reduced the area where longleaf pine forests can still be found to about 5 percent of the area in figure 2a (**see figure 2b**).



Figure 3. A young longleaf pine in what is called its grass stage. Longleaf pines can remain in this stage for the first 5 to 12 years of their life. Photo by Rebekah D. Wallace, courtesy of <http://Bugwood.org>.

Now, however, many people are concerned about longleaf pine forests. In many areas, these forests are being managed to help them survive and grow. Fire is a necessary part of this process. Forest managers, therefore, set planned fires every few years in longleaf pine forests (**figures 4a and 4b**). These fires are tightly controlled so that they do not escape from the longleaf pine forest.

One reason for these controlled fires is to remove the leaf litter on the forest floor so that uncontrolled fires or wildfires will be less

likely to happen. Remember, however, that the old logs do not readily burn. The scientists in this study were interested in what happens to arthropods after a fire. They developed a hypothesis about the importance of old logs lying on the forest floor to leaf-litter-dwelling arthropods. The scientists thought that after a fire, arthropods living among leaf litter would move to the areas around old logs because they didn't have other places to hide. They stated their hypothesis as a null hypothesis.



Figure 4a. A forest manager igniting a controlled fire. Permits are required for controlled burning. To prevent fire hazards, authorized personnel should be involved with the process.



Figure 4b. A forest manager on a boom lift recording fire intensity. Forest managers record fire intensity using different devices.

Reflection Section

-  State the null hypothesis used by the scientists. (See “Thinking About Science” for a hint.)
-  Is fire a good thing for longleaf pine forests? How do you know?



Methods

The scientists studied an area in the Osceola (ä-sē-'ō-lə) National Forest in Florida (figure 5). The scientists divided the area into 24 separate areas (figures 6a and 6b). Each of these areas was 0.8 hectare in size.

In each of the 24 areas, the scientists placed a longleaf pine log in the center. Each log was three meters long. They placed four pitfall traps around each log. Pitfall traps are cups placed into the ground. An arthropod walking nearby may fall into the trap. The scientists placed a pitfall trap near each end of the log on both sides (figure 7).

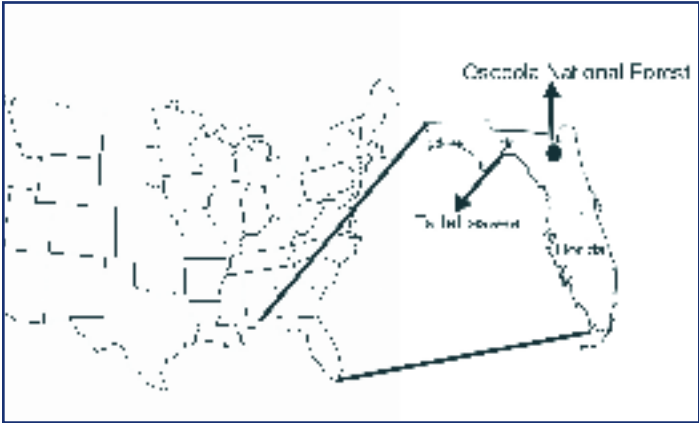


Figure 5. The Osceola National Forest is in northern Florida.

Six areas were burned every year	Six areas were burned every other year
Six areas were burned every 4th year	Six areas were not burned at all

Figure 6a. The scientists divided the larger area into 24 smaller areas.



Figure 6b. This area was burned every other year.



Figure 7. Logs were placed in the center of each area.

Number Crunches

How many acres large was each of the 24 areas? To find out, multiply 0.8 by 2.47.

Then, the scientists located an area 10 meters away from each log. They placed a solid aluminum fence, three meters long and about 20 cm high (to arthropods that is high) in this area (**figure 8**). They placed four pitfall traps around each fence, in the same positions as traps were placed around the log. The scientists used the fence because they were concerned that they might catch more arthropods around the logs simply because the logs acted like a fence. The fence would help direct any nearby arthropods into the traps. By using a fence the same length as the logs they could find out if the arthropods liked the logs because they were better places to hide or find food.



Figure 8. Drift fences, which are fences placed to direct animals into pitfall traps, were placed 10 meters away from the log.

The scientists used the pitfall traps for 6 months every year. They collected any arthropods caught in the traps. They identified the arthropod species and counted each one. They collected arthropods in the pitfall traps from 1994 to 2000.

The scientists compared the number of leaf-litter-dwelling arthropods captured near the log and near the drift fence for each of the four types of areas (**see figure 6a**).

Reflection Section



- Why did the scientists include areas that were not burned at all?
- Why did the scientists want to collect arthropods near the log and away from the log?

Findings

The scientists caught more leaf-litter-dwelling arthropods in traps near the drift fences than they did in traps near the logs. When they compared the sites that had been burned at different frequencies (**see figure 6a**), they found no difference in the number of arthropods captured. The scientists found no evidence to support the idea that leaf-litter-dwelling arthropods move close to logs after fire burns through an area.

Reflection Section

- Do you think the scientists accepted or rejected their null hypothesis? Why or why not?
- Do you think this study proves that leaf-litter-dwelling arthropods do not use logs as **habitat** after a fire? Why or why not?



Discussion

The scientists were surprised at their findings. They considered other reasons that fewer arthropods than expected were trapped near logs. One reason may be that drift fences, since they are hard to crawl over, are better at directing arthropods into the traps. Arthropods near logs, in contrast, may dig under or climb over logs, thus finding other routes away from the traps. Another explanation may be that fire, regardless of how often it comes to a longleaf pine forest, does not cause leaf-litter-dwelling arthropods to seek logs as habitat.

Reflection Section



- Is it important to understand what happens to arthropods following a fire? Why or why not?
- What are some advantages of being surprised at your findings?

Glossary

Canopy ('ka-nə-pē): Anything that covers like a roof. On a tree, the area of leaves that cover the ground.

Crossbow ('kròs bō): A tool used for shooting stones that consists of a short bow mounted on the end of a wooden stock.

Decomposition ((),dē-,käm-pə-'zi-shən): The act or process of breaking up, as by decaying or rotting.

Ecosystem services (ē-kō-sis-təm 'sər-vəs): Any of the various benefits provided by plants, animals, and the communities they form.

Habitat ('ha-bə-tat): Environment where a plant or animal naturally grows and lives.

Leaf litter ('lēf 'li-tər): The decaying leaf material on the surface of the forest floor.

Rappel (rə-'pel): To descend by sliding down a rope, usually outfitted with a special device to create friction.

Species ('spē-(,)shēz): Groups of organisms that resemble one another in appearance, behavior, chemical processes, and genetic structure.

Variable ('ver-ē-ə-bəl): Thing that can vary in number or amount.

Accented syllables are in **bold**. Marks taken from Merriam-Webster Pronunciation Guide.

This article was adapted from Hanula, J.L.; Wade, D.D.; O'Brien, J.; and Loeb, S.C. 2009. Ground-dwelling arthropod association with coarse woody debris following long-term dormant season prescribed burning in the longleaf pine Flatwoods of north Florida. *Florida Entomologist*. 92(2): 229–242. <http://www.srs.fs.usda.gov/pubs/ja/jahanula017.pdf>.

FACTivity



The question you will answer in this FACTivity is: What are the key characteristics of arthropods? You will create your own aPod based on the characteristics of arthropods and describe the creature's life history.

Time:

One class period

Materials:

Pieces of white construction paper for each student and markers or crayons

Your teacher will provide the following background to the students (or students may read it on their own): Arthropods are invertebrate (without a backbone) animals of the phylum Arthropoda. All arthropods have the following characteristics:

1. Invertebrate
2. A hard outer body covering called an exoskeleton
3. Specialized mouth parts
4. Jointed legs
5. Compound Eyes
6. Segmented body

Arthropods include insects, crustaceans (lobsters, crabs, shrimp, crayfish), millipedes, centipedes, horseshoe crabs, arachnids (spiders, ticks, and mites) and sea spiders. Together, arthropods comprise the largest and most varied group of invertebrate on Earth.

The bodies of arthropods are divided into different segments, each having a specialized role. The segments have numerous paired, jointed appendages (legs, antennae, claws, and external mouth parts) that serve many varied functions. The exoskeleton acts as a protective covering to the underlying segmented body. It also provides an attachment for muscles and a barrier to water loss for animals living on land. It is made mostly of chitin ('kī-tən), a rigid, complex carbohydrate, and is usually covered by a hardened, waxy cuticle. The cuticle acts as a hinge between segments, allowing the body to bend and move to the right or left. Periodically, the rigid exoskeleton is shed in a process called molting. The temporarily soft animal then swells in size, and its new, larger exoskeleton hardens.

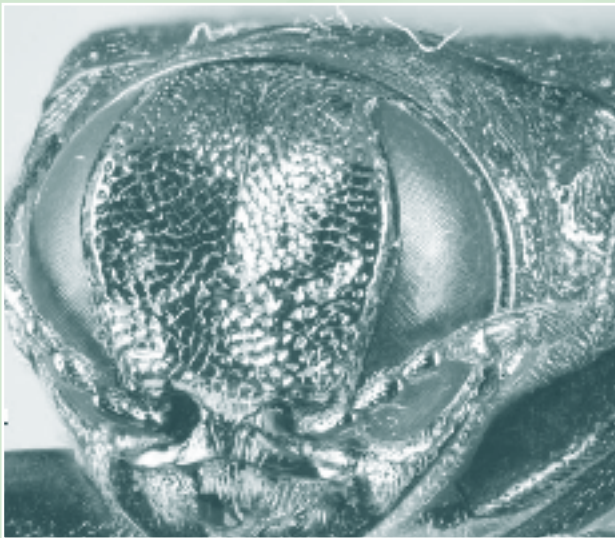


Figure 9. Emerald Ash Borer's compound eyes. Photo by Ken Walker, Museum Victoria Pest and Diseases Image Library, Australia, courtesy of <http://Bugwood.org>



Figure 10. Check out the segmented body on the Walking Cicada. Photo by Whitney Cranshaw, Colorado State University, courtesy of <http://Bugwood.org>



Figure 11. Check out the jointed legs on this Leaffooted Pine Seed Bug. Photo by Larry R. Barber, Forest Service, courtesy of <http://Bugwood.org>

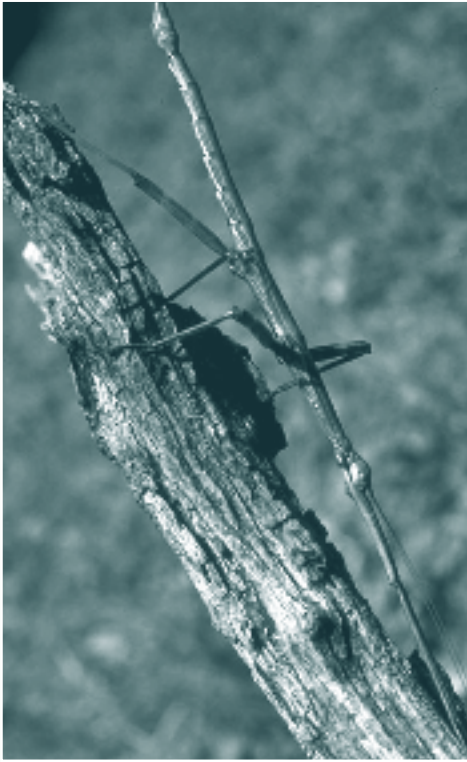


Figure 12. Check out this bizarre Walkingstick. Photo by Herbert A. “Joe” Pase III, Texas Forest Service, courtesy of <http://Bugwood.org>

Arthropods are divided into chelicerates (kə-**lis**-ə-rāts), meaning “claw-horned ones,” and mandibulates (‘**man**-də-bəl-ləts), meaning “jawed ones.” The bodies of chelicerates are divided into two parts: a fused head and thorax, and an abdomen. They have no antennae, and most have four pairs of jointed legs. They are named for their first pair of appendages, which are modified as clawlike fangs used for feeding. The chelicerates include the arachnids, the marine horseshoe crabs, and the sea spiders.

The mandibulates have one or two pairs of appendages that function as antennae on their head, with the next pair modified as jaws for feeding. Included in this group are the crustaceans (crabs, lobsters, crayfish), the millipedes and centipedes, and the insects.

Arthropods are so diverse and come in so many different shapes and sizes and specialized features! You now get to create your own aPod by thinking about the characteristics that all arthropods share and making your own creature.



Figure 13. Check out the Chaco golden knee tarantula’s specialized fangs! Photo by David Cappaert, Michigan State University, courtesy of <http://Bugwood.org>

- Use a piece of paper and markers or crayons.
- Review and reflect on the characteristics that all arthropods have in common.
- Design your own aPod.

Once the aPod is finished, write at least two paragraphs about your aPod's life history. Where does the aPod live? What does it eat? How does it move about (fly, crawl, jump, etc.) Be creative and have fun!



National Science Standards

Science as Inquiry:

Abilities Necessary To Do Scientific Inquiry;
Understanding About Scientific Inquiry

Life Science:

Structure and Function in Living Systems;
Regulation and Behavior;
Populations and Ecosystems;
Diversity and Adaptations of Organisms

Science in Personal and Social Perspectives:

Populations, Resources, and Environments;
Natural Hazards;
Risk and Benefits

History and Nature of Science:

Science as a Human Endeavor;
Nature of Science

Additional Web Resources

National Science and Technology Center: Soil Arthropods

<http://www.blm.gov/nstc/soil/arthropods/index.html>



Teachers:

If you are a Project Learning Tree-trained educator, you may use Activity #80, "Nothing Succeeds Like Succession" or #24, "Nature's Recyclers," as additional resources.

Keeping It Local:



Photo courtesy of Forest Service, Arapahoe-Roosevelt National Forest.

How Federal Wildfire Policy Is Implemented at the Local Level

Meet the Scientists

Ms. Stephanie Grayzeck-Souter, Social Scientist: My favorite science experience was spending a month in the tropical rainforest of Ecuador. I learned about tropical field biology while also exploring and experiencing cultures very different from my own. This picture was taken on the banks of the Napo River, a tributary of the Amazon.



Dr. Kristen Nelson, Environmental Sociologist: My favorite science experience was working with Mayan ('mī-ən) farmers and scientists to solve problems in Chiapas (chē-'ä-päs), Mexico. We worked on many different projects. In one community, we worked on projects with trees to reduce global warming. In other communities, we discovered how to provide good soil for growing coffee. We also discovered how to provide habitat for migratory birds. Migratory birds move from place to place for breeding or feeding. As you can see, there were many different problems to solve!



Thinking About Science

Social scientists study what people think, do, and believe. One way they discover this is to conduct interviews with the people about what they want to learn. Interviews are like conversations, except that the scientists try to guide the conversation so they find out specific information. They ask questions that can be well defined or that can be open-ended. A well-defined question might be: "How many brothers and sisters do you have?" An open-ended question asks something general. An example of an open-ended question is: "Tell me about the first time you fell off of your bicycle and got hurt."

The scientists try not to share any of their own opinions. In a good interview, the scientist rarely says much except to ask for more information. By interviewing different people using the same questions, scientists can learn about all the different ways in which people think about a topic.

Interviews are usually recorded. Later, while listening to the recording, the scientist types the interview, word for word. Then, the scientist organizes and summarizes what was said. Interviews can be done in person, over the phone, or even on the Internet. In this study, the scientists interviewed people in four towns in the Eastern United States.



Dr. Pamela Jakes, Research Forester: My favorite science experience was living in New Zealand for 6 months. While I was there I worked with scientists to discover what people living in New Zealand can do to reduce their wildfire risks. What I learned in New Zealand has helped me work with communities in the United States so that they can adapt to living with wildfire. This is a photograph of me in New Zealand.

Dr. Daniel Williams, Research Social Scientist: My favorite science experience is getting paid to visit some of the most beautiful places on earth as part of fieldwork. This is a photograph of me backpacking in the Sierra Nevada Mountains. Photo by Mike Patterson.



Thinking About the Environment

Some people live in or near large areas of forests. Often, people build homes near the edges of State or Federal **public land**. State lands include State parks and forests. Federal lands include national parks and national forests. When people build close to or within large areas of forest, they raise the chance of having their homes damaged or destroyed by wildfire. They also increase the chance that a fire will burn into the forest, as most forest fires in the East are started by people.

The Federal Government has defined communities that occupy land near or within these large natural areas as the wildland urban interface, or WUI. The WUI is an area where houses either meet or mix with wildland **vegetation**, including forests, prairies, or other natural areas. To help protect these communities from wildfires, the Federal Government has encouraged people living in the WUI to plan for wildfires. The Government wants people in these communities to think about ways to discourage wildfires and what they can do to protect their homes if a wildfire burns in their community.

Introduction

In the past, **forest managers** always put out wildfires. More recently, forest managers have discovered that fire can be a good thing for some **ecosystems**. Wildfires are now sometimes allowed to burn rather than always be put out. When a wildfire is threatening human communities, however, it is put out. Forest managers have added new strategies to help communities deal with wildfires.

The first strategy is to reduce fuel so if a wildfire threatens a community it has nothing to burn. Forest managers reduce fuels in two main ways. First, they might purposely burn small areas of land in a controlled manner to remove the fuel (**figure 1**). These fires burn cooler than wildfires, and only burn near the ground. Forest managers only start these controlled fires if the weather will help them manage the fire.

If a wildfire occurs in these areas, there is less material to burn, and the wildfire can be controlled or put out more easily. Forest managers may also use machines to cut and remove the brush and other vegetation (**figure 2**). Another strategy used to control the damage from wildfires is to help homeowners protect their home and property from fires. For example, people are

urged to remove trees and other plants that burn easily that are touching their home.

In 2003, the Federal Government made it easier for WUI communities to protect themselves from wildfire (See “Thinking About the Environment”). If a WUI community prepares a Community Wildfire Protection Plan, the Federal Government will work with the community to reduce wildfires on everyone’s property. In addition, in a Community Wildfire Protection Plan, local communities can have a say in how wildfires are managed on nearby public lands.

The Federal Government also urged WUI communities to describe their own WUI and draw boundaries that identify where their WUI is located. This area represents the land that the community values and wants to protect from wildfire.

If communities can agree on the definition and location of the WUI, they can more easily agree on the best way to reduce their risk from wildfires. Past research has shown that communities who do this are better prepared for wildfires. The WUI also shows public land managers where the community would like them to work to reduce wildfire risk.



Figure 1. A controlled fire. Photo by Terry Tompkins, courtesy of Forest Service Northern Region Archives.



Figure 2. Residents remove hazardous fuels during a Windcliff Work Day near Estes Park, Colorado. Photo by Bud Durya.

When the Federal Government passed the law to encourage communities to develop a Community Wildfire Protection Plan, they thought that communities would want to define and locate their WUI so they could show the area they wanted protected from wildfire. But many communities do not do this. The scientists wanted to learn about the communities that made the WUI part of their plan.

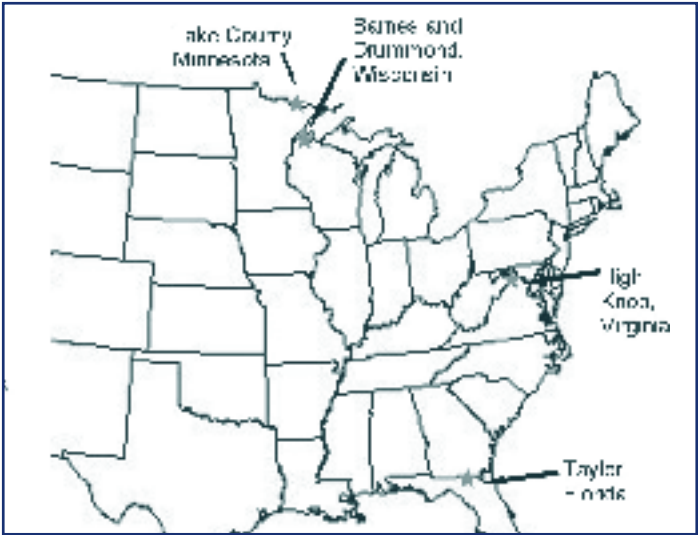


Figure 3. The four communities were located across the Eastern United States.

Community name	Number of people interviewed
Lake County, Minnesota	16
Barnes and Drummond, Wisconsin	13
High Knob, Virginia	18
Taylor, Florida	9

Figure 4. The number of people interviewed in each community.

Reflection Section



- State what the scientists wanted to know in the form of a question.
- How do you think the scientists answered their question?

Methods

The scientists decided to do four case studies. A case study is a detailed examination of one example. Social scientists might study one individual, one group, or one event. The scientists identified four WUI communities in the Eastern United States (**figure 3**). They traveled to each of these communities and interviewed people. The people they interviewed were all involved in the preparation of a Community Wildfire Protection Plan. They included people working in fire departments and local governments, forest managers, and homeowners.

The scientists interviewed 58 people in the 4 communities (**figure 4**). They recorded each interview. Later, they typed each interview word for word. One of the scientists organized and summarized all of the interviews.

Reflection Section



- A case study is a detailed look at one individual, one group, or one event. Think about something you have studied recently. How might you extend your examination by doing a case study? Who or what would you study?
- Why was it important for the scientists to interview a variety of people in the community?

Findings

Three of the four communities identified the WUI in their plan. These were the communities of Lake County, Minnesota; Barnes and Drummond, Wisconsin; and Taylor, Florida. Three things were most important to these communities as they identified their WUI (**figure 5**).

Although people understood the general definition of the WUI, each community defined the WUI that was important to them. In some communities, people working for Federal agencies helped the local people define their WUI. Federal workers did not have to be involved but, when they were, they were able to help people understand the risk of fire in their WUI. Federal workers also helped people understand what they could do to reduce that risk. Members of fire departments and other **professionals** also affected the way the WUI was identified and described.

Hazards	How much fuel is available to burn; how often wildfires occurred; how many fires were caused by humans; not enough planning by the community.
Values	What people feel is important to them; the value of their homes and other buildings; the importance of having forests for wood products.
Physical locations	Local fire departments; public land boundaries; distance from fire stations; the condition of the roads.

Figure 5. Things people considered as they described their own WUI.

The case studies showed that it is important to include local homeowners when describing the WUI. These people are familiar with the area and can help identify problems and opportunities. Also, when local people are involved in planning for an activity (like reducing the items that can burn close to their homes), they are more likely to do the activity.

The scientists discovered that when the local WUI is described as a part of the Community Wildfire Protection Plan, people with different opinions must come to an agreement. The description of the local WUI, therefore, is a community definition that everyone shares, and it helps local communities to better prepare for a possible wildfire.

Reflection Section



- Why do you think members of fire departments affected the way the WUI was defined and described?
- What was one benefit of having community members work together to define and describe their WUI?

Discussion

The Eastern United States is different from the Western United States in many ways. For one thing, most of the land in the East is privately owned, primarily by citizens and corporations. Another difference is that human communities are found almost everywhere. In addition, there is a lot of forested land in the East. Because of this, much of the land in the East can be considered as a kind of WUI. This makes it more challenging for communities in the East to identify the WUI as an area separate from everywhere else—the WUI is everywhere!

In spite of these challenges, there are advantages to defining and describing a local WUI. When communities get together and define and describe the local WUI, they come to an agreement about the hazards, values, and **resources** in the community. This helps them develop a better plan to protect the community from a possible wildfire. It also helps them work with public land managers to protect forests across the landscape.

Reflection Section



❖ Think about the large areas of undeveloped land in the Western United States. Do you think most of that land could be considered the WUI? Why or why not?

❖ Give another example of when getting together to discuss something resulted in a better plan of action.

Glossary

Ecosystem (ē-kō-sis-təm): Community of plant and animal species interacting with one another and with the nonliving environment.

Forest manager ('fōr-əst 'ma-ni-jər): Skilled individual who takes care of natural resources.

Professional (prə-'fesh-nəl): People that have specialized training in a particular area.

Public land (pə-blik 'land): Land that is owned by the people as a whole; land that is taken care of for the good of all of the people.

Resource (rē-'sōrs,): Something that takes care of a need.

Vegetation (ve-jə-'tā-shən): Plant life.

Accented syllables are in **bold**. Marks taken from Merriam-Webster Pronunciation Guide.

Adapted from Grayzeck-Souter, S. A.; Nelson, K.; Brummel, R.; Jakes, P.; and Williams, D. 2009. Interpreting federal policy at the local level: The wildland-urban interface concept in wildfire protection planning in the eastern United States. *International Journal of Wildland Fire*. 18: 278–289. <http://www.treesearch.fs.fed.us/pubs/33049>.



FACTivity

Time Needed

Three class periods

Materials

Paper, pencils

The question you will answer in this FACTivity is: What type of action plan can we create to help our school?

Procedure:

In this FACTivity, you will get together with other students and brainstorm a list of challenges or concerns at the school. These can be ongoing challenges or a challenge the school will meet in the future.

For example, a challenge may be that so many parents drive their kids to school that the traffic gets backed up and kids are late to school. Another example is that students have to take standardized tests at the end of the year, and they must prepare throughout the year to pass these tests.

Once a list of challenges has been compiled, your teacher will divide you and the other students into pairs or small groups. These are the Action Plan Teams. An action plan is a plan that can be put into effect to help make the challenging situation easier for the school. In the article just read, community members created plans to help them in case of a wildfire.

Each group will create an action plan for one of the challenges identified during the class discussion.

The action plan should include the following elements (Note: your teacher may have more requirements):

1. Title of action plan
2. Names of action plan team members
3. One or two paragraph summary of the challenge and why it is a challenge for your school
4. Three to five steps that can be taken by students, teachers, administrators, and parents to help improve this challenging situation
5. A timeline for implementing your suggestions
6. One or two paragraphs on why using the action plan will help improve the situation and how the school community would benefit from this improvement

Once the plans have been written, you and the other students will present these plans to the class. After each presentation, discuss the plan and see if there are other ideas that can be added to the plan from other classmates.

FACTivity Extension

These plans can be submitted to the school administration and implemented.



National Science Education Standards addressed in the article:

Science as Inquiry:

Abilities To Do Scientific Inquiry;
Understandings About Scientific Inquiry

Science in Personal and Social Perspectives:

Personal Health;
Natural Hazards;
Risk and Hazards

Science and Technology:

Understandings About Science and Technology

History and Nature of Science:

Science as a Human Endeavor;
Nature of Science

Additional Web Resources

University of Wisconsin-Madison's Wildland-Urban Interface Maps and Statistics

<http://silvis.forest.wisc.edu/library/WUILibrary.asp>

Forest Service Wildfire Prevention and Wildland Urban Interface

<http://www.fs.fed.us/r8/fireprevention/>

Firewise Communities

<http://www.firewise.org/>



Teachers:

If you are a PLT-trained educator, you may use Activity #35, "Loving It Too Much;" #36, "Pollution Search;" #37, "Talking Trash, Not!;" and #38, "Every Drop Counts," as additional resources.

Pecking Order:



***What Types of
Post-Fire Snag
Areas Do
Woodpeckers
Prefer?***

Photo by Terry Spivey, Forest Service, <http://Bugwood.org>.

Meet the Scientists

Dr. Chad Hanson, Forest and Fire Ecologist: My favorite experiences as a scientist are when I'm doing field work in burned forest habitat. I like working in fire areas where most of the trees were killed by fire. Many people assume that these areas are somehow damaged. In reality, the sights and sounds of native wildlife species, especially birds, are more evident in these types of forests than in others. ▼



▲
Dr. Malcolm North, Forest Ecologist: My favorite science experience was climbing into the top of a 175-foot-tall red fir to collect lichen samples during a wind storm.

Thinking About Science

As scientists continue to do research, they learn new things. In the past, for example, scientists believed the best thing to do after a severe wildfire was to cut down and remove most of the snags. Snags are dying or dead trees that are left standing after a fire, flood, wind, disease, or insect damage. More recent research, however, has shown that snags may provide **ecological** benefits to an area.



When science is used to solve a problem or make something better, it is called applied science. In this study, the scientists were doing applied science. This is because their research could be used to help forest managers take better care of the forest after a wildfire occurred.

Thinking About the Environment



Think about your friends at school. They may seem similar to each other, but none of them are alike. This is true, even though they may like the same activities and laugh at the same jokes. Like your friends at school, all wildfires may seem alike, but they can actually be very different. One of the ways that wildfires are different from each other is that they burn at different **severity levels**. Wildfires are classified as low-, moderate-, or high-severity fires. High-severity fires are where most or all of the trees are killed by the fire (**figure 1**). Low-severity fires still have trees that are living (**figure 2**).

Because wildfires do not burn evenly, a patch of forest that has experienced a high-severity burn may be almost surrounded by areas that have experienced low or medium severity wildfire.



Figure 1. A high-severity wildfire burned this area. You can see that most or all of the trees are dead. Photo by Randall Whitehall, Forest Service.



Figure 2. A low-severity wildfire burned this area. Although some of the trees' needles or leaves may be brown, few trees have been damaged by the wildfire. Photo by Randall Whitehall, Forest Service.

Introduction

Trees that are dead but still standing are called snags. Even though snags are dead, they are still important parts of the forest. Snags provide benefits to the environment, especially to the animals that live nearby. Some of the benefits include providing a home for birds, mammals, reptiles, and amphibians. Snags also are used as hunting perches by birds and perches for songbirds. Snags are a good source of food for some animals because snags provide **habitat** for insects, mosses, lichens, and fungi. Some woodpeckers use snags for food. The Black-backed woodpecker is one of the animals that needs snags to survive (**figure 3**).



Figure 3. Black-backed woodpecker. Photo by Terry Spivey, Forest Service, courtesy <http://Bugwood.org>.

The Black-backed woodpecker is considered a keystone species. A keystone species is one that can indicate problems in the environment. This is because these species are sensitive to environmental changes. If their population numbers fall, for example, this might mean that other species needing that same environment are in danger also. For example, in the 1870s there were a lot of Black-backed woodpeckers in the Sierra Nevada (**figure 4**). By the 1920s, however, there were relatively few of these woodpeckers. This drop in woodpecker population indicated that there was something changing in the environment that was causing problems for the woodpecker. There were probably problems for other **species** living there as well.

Forest managers usually leave between three to six large snags per acre after a wildfire. The rest are cut down and removed. Past records had showed that the Black-backed woodpecker seemed to live in forest areas with a lot of snags. Because the population of Black-backed woodpeckers had fallen in the Sierra Nevada, scientists wanted to study what types of **post-fire** habitats this woodpecker liked best. In this study, the scientists wanted to know what types of post-fire snag forests were best for the Black-backed woodpecker's **foraging**.

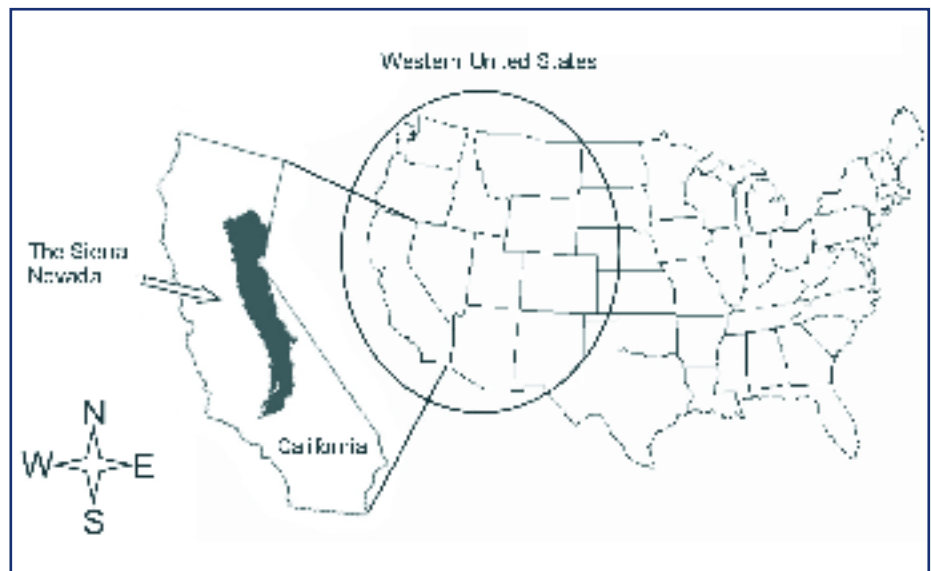


Figure 4. The Sierra Nevada is located in the Western United States.

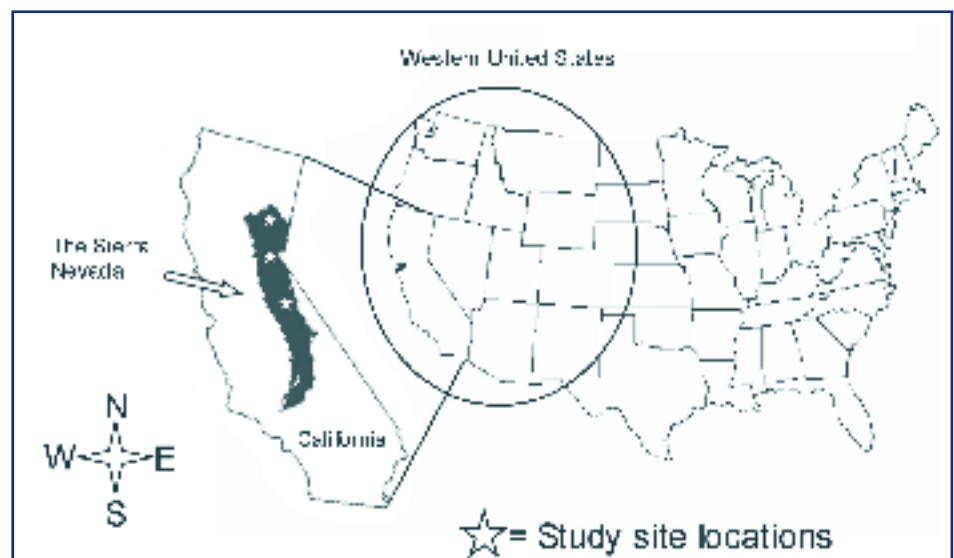


Figure 5. The location of the study sites in the Sierra Nevada.

Reflection Section



- 🍁 In the form of a question, state what the scientists wanted to learn in this study.
- 🍁 In your own words, describe why a keystone species is important.
- 🍁 Do you think it is important to improve the habitat for keystone species? Why or why not?

Methods

The scientists studied several different patches of forest in the Sierra Nevada (**figure 5**). Each patch was at least 12 hectares in size. The study took place from 2004 through 2006. Each patch was labeled as having experienced a moderate-severity or high-severity wildfire. The scientists also noted whether or not the area had any of its snags removed and how many snags were in each hectare (**figure 6**).

The scientists walked through all of the patches and recorded the presence or absence of the Black-backed woodpecker. The scientists started their observations 100 meters from the edge of the patch and moved toward the center (**figure 7**). Every 200 meters the scientists stopped and recorded the presence or absence of the woodpecker during an 8-minute time period. The same method was used in each patch.

Number Crunches

- Each patch was at least how large in acres? Multiply 12 by 2.47 to find out.
- How many total forest patches were studied by the scientists?

Habitat condition	Number of patches studied
Unburned	9
Moderate-severity and all snags left standing	8
High-severity and all snags left standing	10
High-severity and only 8-15 large snags left standing per hectare	9

Figure 6. The scientists studied four different post-fire conditions.

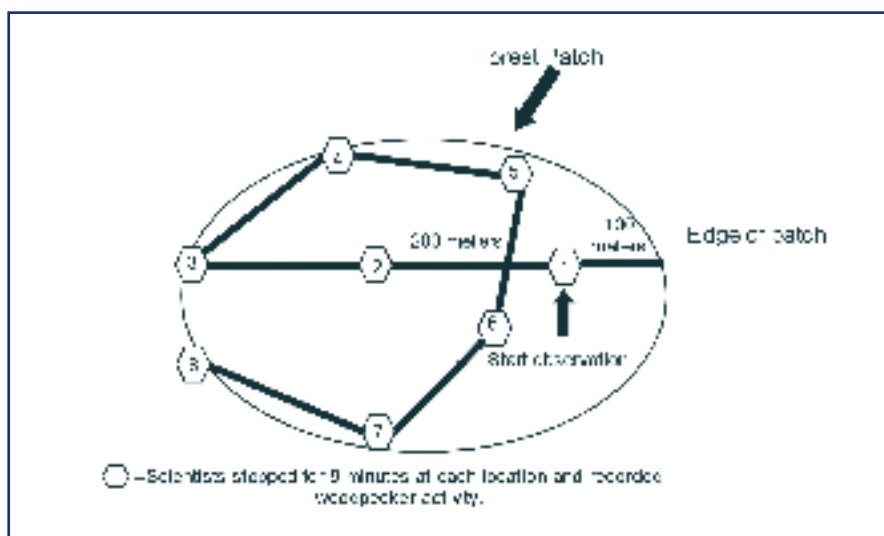


Figure 7. Each patch was surveyed in the same way for the presence or absence of the Black-backed woodpecker.

Reflection Section

- Why do you think the scientists noted how many snags were in the patches?
- Do you think it is important that the scientists used the same method in each patch to record the presence of the Black-backed woodpecker? Why or why not?



Findings

The scientists reviewed all the information they collected. They put their observations into a computer program to help them **analyze** the data. When they analyzed their observations, the scientists found that Black-backed woodpeckers were found in only one type of patch. The woodpeckers were found only in patches that had experienced high-severity wildfires and where all of the snags were left standing.

The scientists found that there was a difference between the number and size of snags in each type of patch (**figure 8**).

Reflection Section



Do you think that the number of large snags in each patch was related to the number of woodpeckers found there? Why or why not?



Why do you think the woodpeckers preferred patches with large snags left standing?

Habitat condition	Number of patches studied	Average number of medium size snags per hectare	Average number of large snags per hectare
Unburned	9	13.9	7.4
Moderate-severity and all snags left standing	8	110.8	53.4
High-severity and all snags left standing	10	127.5	124.2
High-severity and only 8-15 large snags left standing per hectare	9	169	18.5

Figure 8. The average number of snags per hectare in each of the patch types.

Discussion

The Black-backed woodpecker clearly prefers one type of habitat for foraging. Patches that experienced high-severity burns with snags left standing were the favorite areas for the woodpecker. This research suggests that, if forest managers want to support the population of Black-backed woodpeckers, they should not remove snags from patches that had experienced high-severity burns.

Reflection Section



In your own words, describe the habitat the Black-backed woodpecker prefers for foraging.



Why is this research useful for forest managers?

Adapted from Hanson, C.T. and North, M.P. (2008). Postfire woodpecker foraging in salvage-logged and unlogged forests of the Sierra Nevada. *The Condor*. 110 (4): 777-782. <http://www.treeseearch.fs.fed.us/pubs/33988>.

Glossary



Analyze ('a-nə-,līz): To separate something into its parts in order to examine them.

Ecological (ē-kə-'lā-jī-kəl): Having to do with ecology, the study of organisms and their relationship with their environment.

Forage ('fōr-ij): Food for animals usually taken by browsing or grazing; the act of taking such food.

Habitat ('ha-bə-,tat): Environment where a plant or animal naturally grows and lives.

Lichen ('lī-kən): Plant-like organisms that are made up of an alga and a fungus. They are found on rocks, on branches, and in many other places.

Post-fire ('pōst 'fi(-ə)r): After a fire.

Sample ('sam-pəl): A part or piece that shows what the whole group or thing is like.

Severity level: (sə-'ver-ə-tē 'le-vəl): A measure of the amount of trees that are killed due to a fire.

Species ('spē-(-,)shēz): Groups of organisms that resemble one another in appearance, behavior, chemical processes, and genetic structure.

Accented syllables are in **bold**. Marks taken from Merriam-Webster Pronunciation Guide.

FACTivity

Time Needed

One class period

Materials needed

pencils, notebooks

The question you will answer in this FACTivity is: What attracts Black-backed woodpeckers to their habitat?

Procedure:

Before beginning, you may download the following *Natural Inquirer* article from the *Natural Inquirer* Web site: "Wood Roaches for Dinner Again?" (<http://www.naturalinquirer.org/Fall-98-Edition-i-6.html>). You may use this article as part of your research about the habitat of various species of woodpeckers.

Using the media center, Internet, and other sources, you should become familiar with the nesting and eating preferences of woodpeckers in general. Then, you should focus your research on the Black-backed woodpecker. Answer questions such as "What do Black-backed woodpeckers eat? Where do Black-backed woodpeckers make their nests?"

Once you have learned about the habitat preferences of Black-backed woodpeckers, imagine what it might be like to be a Black-backed woodpecker. Pretending to be a Black-backed woodpecker, write a letter to another species of woodpecker. In the letter, describe your life as a Black-backed woodpecker in post-fire forests of the Sierra Nevada. Include information about where Black-backed woodpeckers live and why, what they eat, and where they find their food. Use information from this article to describe, from a woodpecker's perspective, the research that was done. Imagine and describe how Black-backed woodpeckers responded to the research being done between 2004 and 2006.

Share your letter with the class. In a class discussion, compare and contrast the letters. What was similar and different about the lives of the woodpeckers? What kind of responses did the woodpeckers have to the research being done by the scientists? Your teacher will have you explain why you wrote your letter as you did. Your teacher will then have you answer the question posed at the beginning of this FACTivity.

FAC'Tivity Extension

Students may compose pictures of Black-backed woodpeckers in their Sierra Nevada post-fire habitat. These may be paired with the letters and posted on the wall or in the school hallway.



National Science Education Standards addressed in the article:

Science as Inquiry:

Abilities To Do Scientific Inquiry;
Understandings About Scientific Inquiry

Life Science:

Structure and Function in Living Systems;
Regulation and Behavior;
Populations and Ecosystems;
Diversity and Adaptation of Organisms

Science in Personal and Social Perspectives:

Populations, Resources, and Environments;
Natural Hazards;
Risks and Benefits

History and Nature of Science:

Science as a Human Endeavor;
Nature of Science

Additional Web Resources

Snag and Den Tree Habitat for Wildlife

<http://gf.state.wy.us/downloads/pdf/habitat/Bulletin%20No.%2046.pdf>

Cornell University's Black-backed Woodpecker information

http://www.allaboutbirds.org/guide/Black-backed_Woodpecker/lifehistory

Wildfire Burn Severity Classification

<http://www.mt.nrcs.usda.gov/technical/fires/severity.html>



Teachers: If you are a PLT-trained educator, you may use Activity #81, "Living With Fire," and #22, "Trees as Habitats," as additional resources.

Trust Is a Must:



Photo courtesy of Forest Service Pacific Southwest Region.

***What Is Involved in Trusting
Those Who Manage Forest Fires?***

Meet the Scientists

Mr. Adam Liljeblad, Social Scientist: My favorite science experience was interviewing residents of a small town about the places that were important to them. They drew on maps as we talked. That way, I could see the places that were special to them as they talked about why they valued those places so much. ▼



▲
Dr. Bill Borrie, Social Scientist: My favorite science experience was researching snowmobilers and snowcoach riders in Yellowstone National Park. A snowcoach is like a van on skis or with a bulldozer-type of tread for moving in the snow. I love visiting the park in the middle of winter when it is quiet and full of mystery!

►
Dr. Alan Watson, Social Scientist: My favorite science experience was riding by motorcycle over 2,000 miles to the Monte ('män-tē) Azul (ah-zyül) Biosphere ('bī-ə-,sfīr) Reserve in southern Mexico. I was on my way to the 9th World Wilderness Congress. I was interested in learning what the local people were doing to protect this important area while keeping their old ways of life in the jungle of Chiapas (chē-'ä-päs).



Thinking About Science



Scientists can study just about anything. In the *Natural Inquirer*, the topics studied are always concerned with the natural environment. Most of them involve studying plants, animals, water, weather, or other natural topics. Some topics, however, involve people's relationships with each other and with the natural environment. These topics and others like them are studied by social scientists.

In this study, the social scientists wondered about trust. What is trust? If you trust someone, why do you do so? The scientists wondered how much trust some citizens in Montana have in those who are making decisions about wildland fire. When social scientists develop questions to study, these questions always involve human beliefs, attitudes, values, or actions.

Thinking About the Environment

The United States contains millions of acres of public land. Public land is land that is owned by all of the citizens of a government. At the Federal level, public land includes national parks, national forests, national wildlife refuges ('re-(.)fyüjs), and other types of land. These lands are **managed** by Government employees on behalf of citizens.

Some Government employees make decisions about managing wildland fires on public land. In some places, wildland fires could threaten homes and businesses. This is because in these areas, people's homes and businesses are located close to public land. In many places, however, fire is a natural part of nature and provides many benefits to the land, the animals, and the plants there. When people trust Government employees to manage public land in the best interest of the land and the people, the Government

employees can do a better job for people and the environment.



Introduction

Trust is a complicated emotion. In the past, many social scientists have studied trust. They discovered that trust involves a number of beliefs and emotions. The scientists in this study were interested in learning more about trust. They believed that **forest managers** can do a better job if people trust them to do what is best for citizens and the environment (**figure 1**).



Figure 1. When citizens trust forest managers, the managers can do a better job of managing the forest.

The scientists searched the library and Internet for information about trust. When there is trust, there must be a trustee and a person who trusts. The trustee may be an individual, a group, an organization, or even a whole community. This is the party that is trusted. The party who trusts is usually an individual. The scientists found that trust may be made up of three parts. **Figure 2** explains the three parts that make up trust.

The scientists wanted to know how much citizens trust forest managers to make good decisions about wildland fires on their behalf.

The Three Parts of Trust	The person who trusts...
Shared values	Believes that the trustee holds similar values, such as honesty, justice, or fairness
Belief that others will act on their behalf	Willingly believes that the trustee is worthy of being trusted; is willing to take a risk and put their well-being in the trustee's control; believes that the trustee is truly interested in their well-being.
Belief that others are capable of acting correctly	Believes that the trustee is capable, reliable, effective, and has previous experience.

Figure 2. The scientists found information claiming that trust is made up of three parts. Each of the three parts is made up of other beliefs and emotions.

Reflection Section

- Why is trust an important emotion in your life?
- Do you think that forest managers can do a better job if citizens trust them? Why or why not?



Methods

The scientists identified forest managers who manage wildland fires as the trustees. These forest managers work in the Bitterroot National Forest (**figure 3**). The Bitterroot National Forest is located in western Montana and part of Idaho (**figure 4**). These managers are Government employees who work for the Forest Service. These forest managers take actions to prevent large and destructive wildfires. When large wildfires occur, the forest managers take actions to control or **extinguish** the wildfires.

The scientists identified citizens living near the Bitterroot National Forest as those who may or may not trust forest managers. To get answers to their questions, the scientists developed a survey of questions to ask the citizens. The scientists asked questions of a **sample** of citizens living in the Bitterroot Valley of western Montana. The scientists used both land line and cell phones to speak with citizens. This valley had many recent wildfires, and those fires had occurred in areas not too far from the citizens' homes. **Figure 5** gives an example of some of the questions asked.

The scientists then put all of the answers together. Based on the three parts of trust shown in figure 2, the scientists determined which of those parts of trust the citizens felt about forest managers in the Bitterroot National Forest.



Figure 3. The Bitterroot National Forest. Photo by Garon Smith.



Figure 4. The Bitterroot National Forest is located in Idaho and Montana.

1. When managers of the Bitterroot National Forest speak on television, radio, in newspapers, or at public meetings about forest fires, how often, if at all, do they tell the truth?
2. How much confidence, if any, do you have in fire managers in the Bitterroot National Forest?
3. How often, if at all, do you think fires in the Bitterroot National Forest are managed according to a fair process?
4. How satisfied are you, if at all, with the way the Bitterroot National Forest staff deals with fires?
5. Based on your observations and experiences, what portion, if any, of the people who manage forest fires in the Bitterroot National Forest know what they are doing?
6. How much do you agree with this statement: Managers of the Bitterroot National Forest respond to the needs of local residents when fighting fires?

Figure 5. Some of the questions asked by the scientists.

Reflection Section



Match the six questions in figure 5 with the three parts of trust in figure 2. Which of the three parts does each question address?



In today's society, what are two disadvantages of using the telephone to ask questions of citizens?

Findings

Of all of the people the scientists tried to contact, 68 percent answered their questions. Of these, almost 90 percent said that they had been affected by smoke and fires in the Bitterroot Valley.

The scientists found that citizens think that forest managers act with honesty and care about citizens' needs. The scientists also found that citizens do not think managers pay attention to what people think. Although citizens are not completely satisfied with or entirely confident in the way fire is managed in the Bitterroot Valley, they are proud of the way it is managed. Citizens feel that forest managers are somewhat effective, reliable, and competent in managing fires.

Although all three parts of trust were important, the scientists found that "The belief that others are capable of acting correctly" was the most important to the citizens.

Reflection Section



What are some of the positive things citizens had to say about forest managers? What are some of the negative things citizens had to say about forest managers? If you were the scientists, what would you tell the forest managers to do to increase the level of trust?



Although all three parts were important, the scientists found that "The belief that others are capable of acting correctly" was the most important part of trust. Based on your own experience, which part do you think is most important and why?

Discussion

The scientists believe that studies like this can help forest managers do a better job of managing fire. By understanding what people believe and feel about the way forest managers manage fire, they can improve what they do. They can also communicate better with the public about their decisions.

The scientists caution, however, that citizens' opinions should not be the only way that success is measured. Forest managers, and especially those who manage fire, must consider many things. They must consider the animals and plants that live in the forest, for example. They

must consider the long-term health of the forest. The scientists concluded that understanding public trust is just one way to evaluate how well forest managers are doing. They believe, however, that understanding and building trust should be used more often as a way to evaluate how well forest managers are doing.

Reflection Section



- How can better communication build more trust between an individual and a trustee? Use an example from your own life.
- Think about any public land close to your home. This can be a local park, a State park, a national park, or State or national forest land. Do you trust the managers to do a good job of managing the land? Why or why not?

This article was adapted from Liljeblad, A.; Borrie, W.T.; Watson, A.E. 2009. Determinants of trust for public lands: Fire and fuels management on the Bitterroot National Forest. *Environmental Management*. 43: 571–584. <http://www.treesearch.fs.fed.us/pubs/34155>.

Glossary

Biosphere ('bī-ə-,sfīr): The part of Earth where life can exist.

Extinguish (ik-'stīŋ-(g)wīsh): To bring to an end.

Forest manager ('fōr-əst'ma-nī-jər): Skilled individual who takes care of natural resources.

Manage ('ma-nij): To have charge of or direct the work of.

Sample ('sam-pəl): A part or piece that shows what the whole group or thing is like.

Accented syllables are in **bold**. Marks taken from Merriam-Webster Pronunciation Guide.



FACTivity

In this FACTivity, the question you will answer is: How much do some adults trust Federal forest managers?

The method you will use to do this is the following:

Make a copy of the questions on the following page: One set of questions will be needed for each adult surveyed. You should survey between two and five adults.

After the information has been collected, share your results with the other students. Create a chart that shows the total numbers of answers to each of the questions. Determine the level of trust by adding the score for each adult who responded. A high trust level would be represented by a score between 30–35, a score showing moderate trust levels is between 21–29, and low trust level scores are between 9–20. Combine your information and determine how to display results in a graph or chart.

If you do not live near a public land area that is managed by Federal forest managers or State or local park managers, then survey adults about how much they trust their local fire departments.

What Do You Think?

Please circle the choice that best describes how you feel about Federal employees who manage public land (Federal forest managers). You may substitute local fire department employees for Federal employees if you do not live near Federal public land.

When Federal forest managers speak on television, radio, in newspapers, or at public meetings how often, if at all, do they tell the truth?

Always – 4
Mostly – 3
Less than half the time – 2
Never – 1
Don't know – Do not count

Generally speaking, how satisfied are you, if at all, with the way Federal forest managers fight fires?

Very satisfied – 4
Somewhat satisfied – 3
Somewhat dissatisfied – 2
Very dissatisfied – 1
Not sure – Do not count

How much attention, if any, have Federal forest managers paid to what people think when they decide what to do about forest fires?

A good deal of attention – 3
Some attention – 2
Not much attention – 1
Don't know – Do not count

Federal forest managers respond to the needs of local residents when fighting fires.

Strongly agree – 4
Somewhat agree – 3
Somewhat disagree – 2
Strongly disagree – 1
Don't know – Do not count

In the past, how pleased, if at all, have you been with the way fires in your local national forest were managed?

Very pleased – 4
Somewhat pleased – 3
Somewhat displeased – 2
Very displeased – 1
Does not apply – Do not count

Based on your observations and experiences, what portion, if any, of the people who manage forest fires know what they are doing?

All – 4
Most – 3
Less than half – 2
None – 1
Don't know – Do not count

In your community, how would you rate the effectiveness of your local Federal forest managers in dealing with fire- related issues?

Excellent – 4
Good – 3
Fair – 2
Poor – 1
Don't know – Do not count
Does not apply – Do not count

How sure, if at all, have you felt that forest fires threatening your community or your property would be put out in time?

Very sure – 4
Somewhat sure – 3
Somewhat unsure – 2
Very unsure – 1
Don't know – Do not count
Does not apply – Do not count

I find the local Federal forest managers to be reliable when managing fires.

Strongly agree – 4
Somewhat agree – 3
Somewhat disagree – 2
Strongly disagree – 1
Don't know – Do not count

FAC'Tivity Extension

Compare and contrast between Federal forest managers and local park managers. To do this, conduct more surveys, substituting "Federal forest managers" with "local park managers."

If you do not live near a public land that is managed by Federal forest managers or State or local park managers, then compare and contrast the trust level between the local fire department and the local police department.



Correlation to National Science Education Standards

Science as Inquiry:

Understandings About Scientific Inquiry;
Abilities Necessary To Do Scientific Inquiry

Science in Personal and Social Perspectives:

Natural Hazards;
Risks and Benefits

Science and Technology in Society:

Understandings in Science and Technology

History and Nature of Science:

Science as a Human Endeavor;
Nature of Science

Additional Web Resources

Bitterroot National Forest

<http://www.fs.fed.us/r1/bitterroot/>

Fire and Aviation Management

<http://www.fs.fed.us/fire/management/>

Forest Fires

<http://www.foresthistory.org/ASPNET/Policy/Fire/FamousFires/FamousFires.aspx>



Teachers: If you are a PLT-trained educator, you may use Activity #34, "Who Works in this Forest?" or Activity #81, "Living With Fire," as additional resources.

Can We Grow Now?



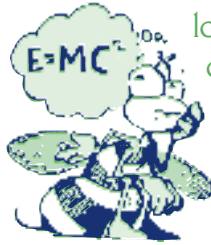
Photo by Dave Powell, Forest Service, <http://www.Bugwood.org>.

***Helping Bristlecone
Pine Trees To Take
Root and Grow***

Thinking About Science

When scientists complete their research, they communicate their results to other scientists. One way they do this is by writing a scientific paper. Within a scientific paper, scientists almost always use many ways to communicate. These ways include words, photographs, maps, drawings, tables, charts, and graphs. As you read *Natural Inquirer* articles or other scientific material, look carefully at the many ways scientists communicate their findings.

In this article, you will see photographs, charts, and maps that help you understand the research. In your own life, how do photographs, charts, and maps help you understand in a way that words do not? Have you recently looked at an hour-by-hour forecast of the temperature? How does that graph help you understand the coming weather in ways that words do not?



Thinking About the Environment

Bristlecone pine trees are special. They are special because they can live for long periods of time, some up to 4,500 years. This makes them the oldest living **species** on Earth. In the Ancient Bristlecone Forest in California, the oldest of these trees is named Methuselah (mə-**thü**-zə-lə). This tree was named for the oldest person named in the Bible. Methuselah is a Great Basin bristlecone pine. The scientists in this study examined Rocky Mountain bristlecone pine trees. Bristlecone pines can live in harsh environments, such as cold, windswept, rocky slopes (**figure 1**). They can also live in more favorable **habitats**, where they form **closed-canopy** forests (**figure 2**).

Rocky Mountain bristlecone pine trees are found in Colorado. Bristlecone pine trees provide a lot of benefits to the areas in which they grow. They provide seeds for birds and other wildlife. They hold carbon in their wood, which helps to reduce climate change. They contribute to the water cycle by pulling in water through their roots and **transpiring** it through their needles. They provide a special benefit to people who visit the old trees, or maybe just look at photographs of them. Can you name this benefit? The benefits provided by nature are called **ecosystem** services.



Figure 1. Rocky Mountain bristlecone pine.



Figure 2. Closed-canopy bristlecone pine forest.

Meet the Scientists

Dr. Jonathan Coop, Plant Ecologist: My favorite science experiences are learning something new about how nature works and sharing what I know with students, especially on top of a mountain. ▼



▲
Dr. Anna Schoettle, Plant Ecophysiolgist (ē-kō-fi-zē-'ä-lə-jist): My favorite science experience is exploring the relationships between plants and their environments. I also enjoy providing scientific information that helps **forest managers** take care of our beautiful public lands..

For more information on ecosystem services, see the Ecosystem Services edition of the *Natural Inquirer* at <http://www.naturalinquirer.org>. Click on "Search and order issues."

Introduction

Bristlecone pines have an interesting relationship with fire. When a fire occurs, it may open a once-closed area to sunlight. When this happens, bristlecone pine seedlings get a chance to grow. These trees grow slowly, however, and can take between 50 and 100 years to mature. A tree is considered mature when it begins to produce seeds. The seeds of a bristlecone pine have wings (**figures 3 and 4**). When wind blows, the seeds travel away from the parent tree. Most of the seeds land within 10 to 100 meters of the parent tree.

In the early 1900s, a fungus from Asia was brought by accident to the United States. This fungus is deadly to many pines, including bristlecone pine trees. This fungus is called white pine blister rust (**figure 5**). If white pine blister rust spreads across Colorado, the bristlecone pine trees could be in danger.

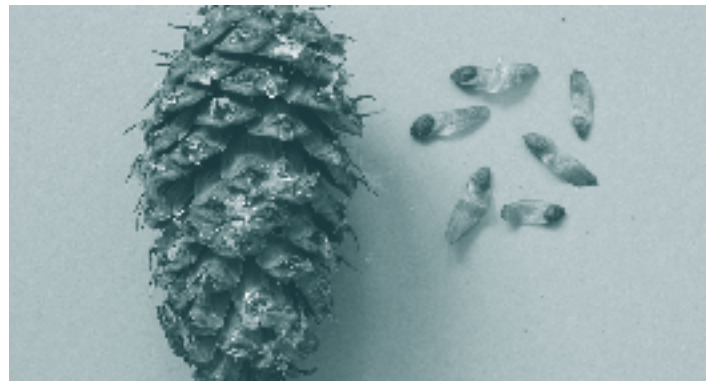


Figure 3. Bristlecone pine seeds.



Figure 4. Bristlecone pine cone. Why do you think these trees are called bristlecone pine trees?

Number Crunches

- How many yards away from the parent tree do most bristlecone pine seeds land? Multiply the number of meters by 1.09 to find out. How many feet away from the parent tree do most of these seeds land?

The scientists in this study wanted to know more about the best conditions for bristlecone pine tree seeds to take root and grow. If they better understood this, forest managers could do things to improve the conditions for seeds to take root and grow. One way to save bristlecone pine trees from white pine blister rust is to find trees that are not as easily affected by white pine blister rust. When scientists and forest managers find bristlecone pines that are resistant to this disease, they can plant those trees' seeds in the best locations.



Figure 5. A bristlecone pine infected by white pine blister rust.

Reflection Section

- In the form of a question, state what the scientists wanted to discover.
- Name two things that make it hard for Rocky Mountain bristlecone pine trees to survive.

Methods

The scientists identified two areas in Colorado that experienced a severe wildfire in 1978 (**figure 6**). These areas were in the Pike-San Isabel National Forest.

The areas were too large to examine entirely. The scientists developed a system to randomly select smaller areas within the larger areas. The scientists made sure that they studied areas that had experienced different levels of fire. They selected areas 15, 45, and 100 meters into each burned area. They also studied areas of forest at the edge of the burned area. The scientists placed each area they studied into one of three categories: (1) completely burned, (2) partly burned, and (3) unburned (**figure 7**).

Within each area they studied, the scientists counted the number of trees. They measured the size and height of each tree (**figure 8**). They also counted the number of saplings and seedlings. Saplings are young trees, and seedlings are even younger trees. They did this for every tree species in the area.

Number Crunches

- How many years have passed since the severe wildfires in Colorado?

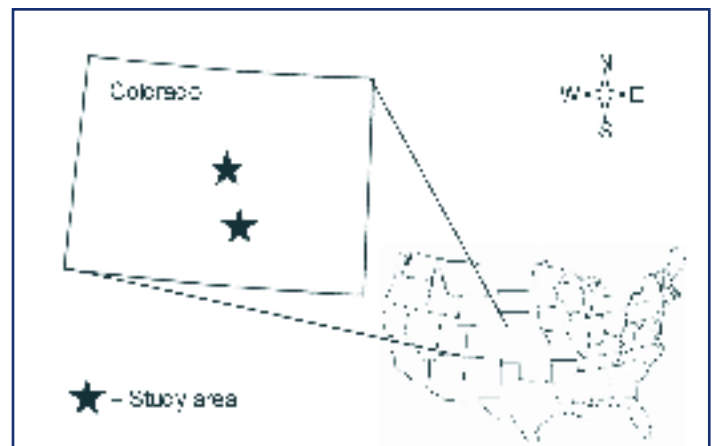


Figure 6. The areas studied by the scientists.

For every bristlecone pine seedling found, the scientists did something extra. They identified the three other objects nearest to each seedling. These other objects included boulders, stones, fallen wood, and standing tree trunks. They measured the distance from the seedling to each of the objects they found.

The scientists also randomly identified other points in each area. They measured the distance from each point to the nearest three objects found. (**figures 9a and 9b**).



Figure 7. The scientists studied three different kinds of areas.

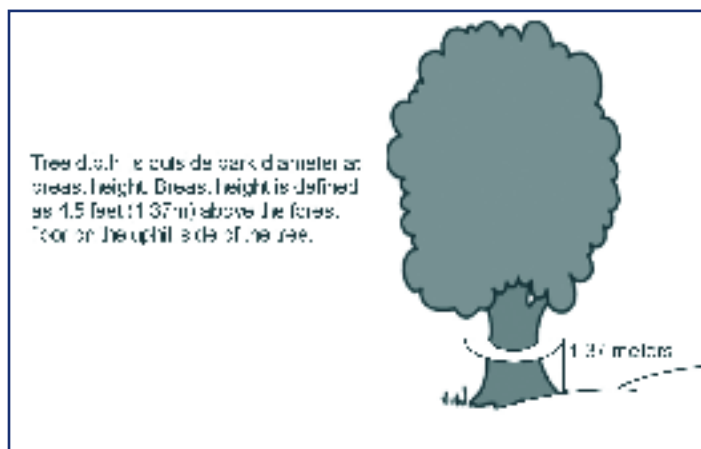


Figure 8. Scientists and foresters determine the size of a tree by measuring the diameter at breast height (d.b.h.).

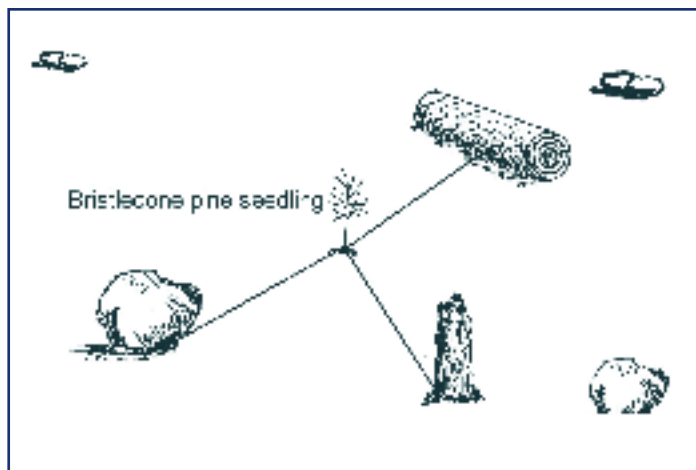


Figure 9a. The scientists measured the distance from each seedling to the three nearest objects.

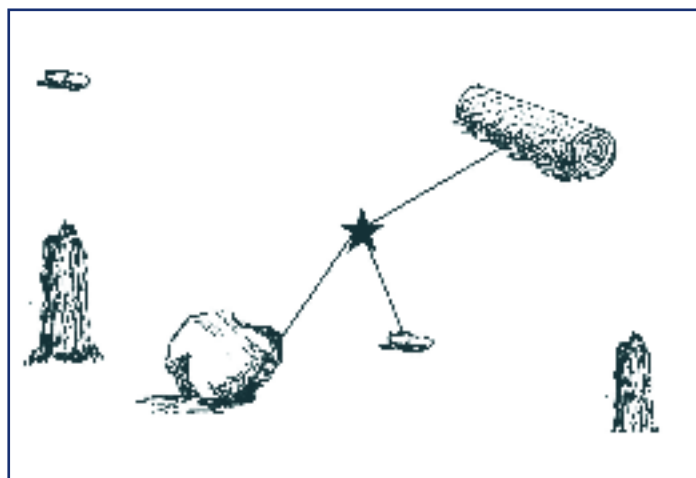


Figure 9b. The scientists measured the distance from randomly selected points to the three nearest objects to each point.

Reflection Section



- Why did the scientists select their study sites randomly?
- Why do you think the scientists measured the distance from each seedling to other objects?
- Why do you think the scientists measured the distance from randomly selected points to nearby objects?

Findings

The scientists found more bristlecone pine trees growing in partly burned areas than unburned and completely burned areas (**figure 10**).

Younger trees were found more often closer to mature trees. As the distance from a mature tree increased, fewer young trees were found.

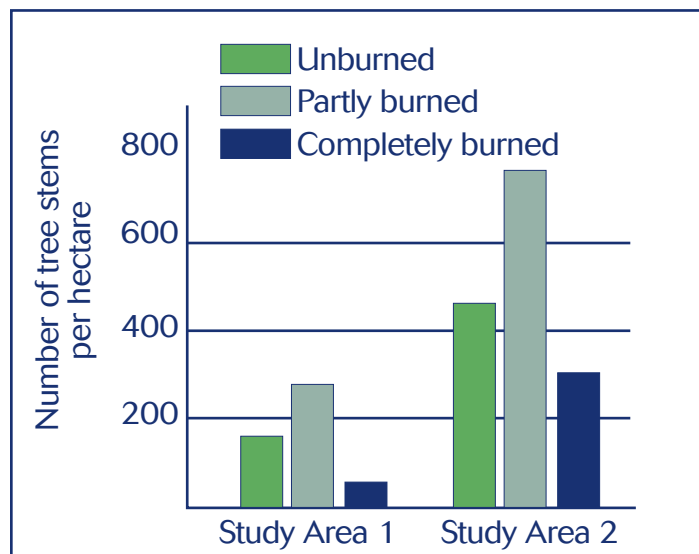


Figure 10. Partly burned areas had the most bristlecone pines. What do you notice about the two study areas?



Figure 11. You can see the seedling growing near the downed tree. The scientists call these other objects nurse objects because they appear to help the young trees grow.

The scientists found that seedlings were often growing near other objects, such as boulders, stones, fallen wood, and standing tree trunks (**figure 11**). They also found that, when compared with a randomly selected point, the seedlings were closer to these objects (**figure 12**).

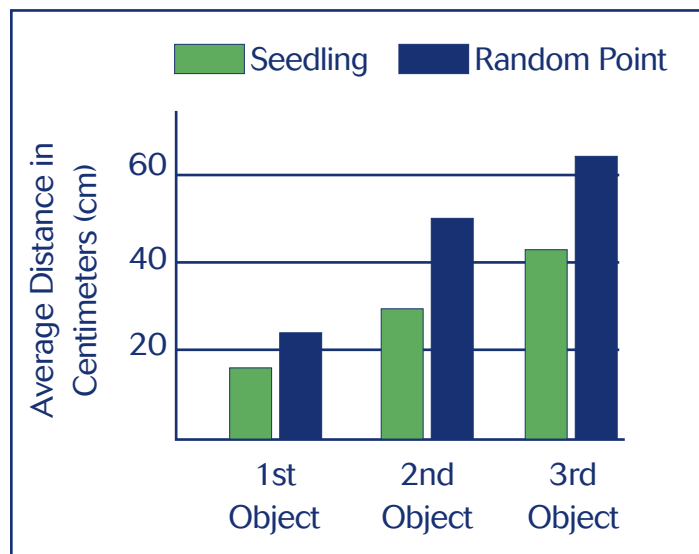


Figure 12. When compared with the distance from an imaginary point, seedlings were found growing closer to other objects than they would have been by chance.

Reflection Section



- Look at figure 10. You can see that more bristlecone pine trees were found growing in partly burned areas. What else does that chart tell you?
- Explain the evidence for calling boulders, stones, fallen wood, and standing tree trunks nurse objects.

Discussion

The scientists found that a partly burned area was more favorable for bristlecone pine tree growth than either unburned or completely burned areas. They concluded that partly burned areas are important for bristlecone pine trees.

The scientists also concluded that objects such as boulders, stones, fallen wood, and standing tree trunks helped seeds to sprout and young trees to grow. They believe that these objects protect the seeds and young trees from wind, ice, the hot sun, and animals that might eat the seeds.

The scientists suggested that forest managers could set controlled fires that create small openings. These small openings would be favorable places for bristlecone pine seeds to take root. In addition, forest managers could make sure these openings have nurse objects in them. Forest managers can create favorable areas on purpose. These areas will help more bristlecone pine trees to grow. When scientists find bristlecone pine trees that are more resistant to white pine blister rust, they can purposely plant seeds from those trees in these kinds of areas. By doing these things, scientists and forest managers can help to save the bristlecone pine.

Glossary



Closed canopy ('klōzd 'ka-nə-pē): A forest in which the leaves of trees are touching, providing a mostly shaded area beneath.

Ecosystem (ē-kō-sis-təm) Community of plant and animal species interacting with one another and with the nonliving environment.

Forest manager ('fōr-əst 'ma-ni-jər) Skilled individual who takes care of natural resources.

Habitat ('ha-bə-'tat): Environment where a plant or animal naturally grows and lives.

Randomly ('ran-dəm-lē): A way of selecting a smaller number from a group in such a way that all members of the group have the same chance of being selected.

Species ('spē-(.)shēz): Groups of organisms that resemble one another in appearance, behavior, chemical processes, and genetic structure.

Transpiring (tran(t)-'spī(-ə)r īŋ): The act of passing off in the form of a vapor. Trees give off water vapor through pores in their leaves.

Accented syllables are in **bold**. Marks taken from Merriam-Webster Pronunciation Guide.

Adapted from Coop, J.D. and Schoettle, A.W. 2009. Regeneration of Rocky Mountain bristlecone pine (*Pinus aristata*) and limber pine (*Pinus flexilis*) three decades after stand-replacing fires. *Forest Ecology and Management*. 257: 893–903, http://www.fs.fed.us/rm/pubs-other/rmrs_2009_coop_j001.pdf.

Reflection Section



🍁 Do you think forest managers should use fire as a tool to help save the bristlecone pine? Why or why not?

🍁 Name other ways that objects such as boulders, stones, fallen trees, and standing tree trunks provide benefits to the natural environment, anywhere they are found.

You will answer the following questions in the FACTivity: What are the ways different seeds move away from the parent plant? What are the characteristics that enable seeds to travel from the parent plant?

Time needed:

One class period (With prework in addition)

Materials needed:

Variety of seeds

For prework, collect three or more seeds from areas around your home, schoolyard, unmowed area, or wooded area. You may also collect seeds from fruits, such as from a tomato, apple, watermelon, or pumpkin. The entire fruit may be brought in as well.

Magnifying glasses or microscopes

Rulers

Blank paper

Pencil

For extension:

Fan

One small dry bean or seed (one for each student)

Paper

Scissors

Masking tape

Glue

Tape measure

The procedure to be used to answer the question is:

Using this article as a starting point, the teacher will explain that all seeds have a way to travel from the parent tree. This is called seed dispersal. Examples include wind, water, animals (either by purposely carrying seeds, eating fruits and later defecating the seeds, or having seed burrs stick in their fur), and mechanics (such as “explosions”). Bristlecone pine seeds are winged seeds and use wind as a way to travel. (Note that some seeds use more than one dispersal mechanism.)

Your teacher will create a station for each type of seed dispersal. Place your seeds at the station you think is the right one for each seed. A magnifying glass or microscope and ruler should be available at each station. (Multiple stations for each type of seed could be established if there is enough room.)

You will then move from station to station, observing the seeds at each station. On your piece of paper, draw an example of the seeds and make notes about how the seed’s physical characteristics enable it to travel.

After all students have visited all stations, your teacher will hold a class discussion about what was discovered. How do you think each of the seeds is dispersed from the parent plant? What are the physical characteristics that make dispersal possible for each type of seed? Be sure to answer the questions posed at the beginning of this FACTivity.

Compare whatever winged seeds you collected with the photograph of the bristlecone pine seeds (figure 3 in the article). How are the seeds similar? How are they different?

FACTivity Extension

Get a dry seed or bean, a piece of paper, scissors, and have access to the tape and glue. Design a wind-dispersed seed mechanism for your seed. Be creative in your design. After the seeds have been designed, each student will drop their seed from the same height, in front of the fan. Each student will get three tries. Calculate the average distance. Determine which design traveled the farthest.

Hold a class discussion about why the seed that traveled the farthest did so. What design was used and what made it successful?



National Science Education Standards

Science as Inquiry:

Abilities Necessary To Do Scientific Inquiry;
Understanding About Scientific Inquiry

Life Science:

Structure and Function in Living Systems;
Populations and Ecosystems;
Diversity and Adaptations of Organisms;
Reproduction and Heredity

Science in Personal and Social Perspectives:

Populations, Resources, and Environments;
Natural Hazards;
Risk and Benefits

History and Nature of Science:

Science as a Human Endeavor;
Nature of Science



Teachers: If you are a trained PLT teacher, you may use Activity # 43, "Have Seeds, Will Travel," as an additional resource.

This FACTivity was adapted from Discovery Education:
<http://school.discoveryeducation.com/lessonplans/programs/scatteringseeds/>

Additional Web Resources

The High Elevation White Pine Educational Web site
<http://www.fs.fed.us/rm/higherelevationwhitepines/>

NOVA: Explore the Methuselah Grove
http://www.pbs.org/wgbh/nova/methuselah/expl_grove.html

***Snake,
Rattle,
and Roll:***

Photo courtesy of Forest Service, North Central Research Station Archive, <http://Bugwood.org>.

***Investigating the Snakes
That Live in the Bosque Along
the Middle Rio Grande***

Meet the Scientists



◀ Dr. Heather Bateman, Ecologist, Wildlife Biologist, **Herpetologist, Ornithologist**: My favorite science experience has always been

working with wildlife. I have enjoyed banding long-eared owls in the Great Basin in Utah and enjoyed capturing lava lizards on the Galapagos (gə-'lä-pə-gəs) Islands of Ecuador. I enjoy watching wildlife, especially on the rare occasions where you see them before they know you are there. For example, this summer I saw a bobcat kitten with its mother near a stream in Nevada.

Dr. Deborah Finch, Research Wildlife Biologist: My favorite science experience was collecting bird and small mammal data on the Wallowa-Whitman National Forest in Oregon and Idaho. While I was there I lived in a trailer in the middle of a **wilderness**, surrounded by beautiful landscapes, and woke up each morning to singing by songbirds. ▶



▶ Dr. Alice Chung-MacCoubrey, Research Wildlife Biologist: My favorite science

experience was exploring the use of dogs to locate tree-roosting bats. In 2006, I conducted field tests to determine whether dogs could sniff out ground-dwelling or tree-roosting bats in **pinyon-juniper woodlands**. Dogs have a keen sense of smell and can alert their handlers to specific odors.

I worked with two wildlife detection dogs to see if they could locate bat scat (guano) in and around trees. I examined how the amount, distribution, and height of the guano in the tree affected the dogs' ability to detect the guano. I loved this project

because it combined my love for dogs with my work studying bat roost behavior. The idea for this project came to me when my dog, Chelsea, who accompanied me in the field, would sniff the area of the tree where the bats were roosting.



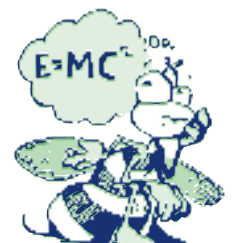
Thinking About Science

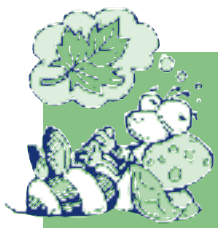
When scientists choose to conduct research on a certain topic, it is usually because the topic they want to research has not been completely studied. Scientists know this because they read to keep up with current research and information about the topic they are interested in studying.

Because science often focuses on solving problems or answering questions, a research topic can be thought of as a puzzle. Think of the last

time you completed a puzzle. There are many pieces to a puzzle to begin with. When you put all the pieces together you are able to see the whole picture.

When scientists notice a piece of a research puzzle that is missing, they conduct a study to find out about that piece. When they find new information, they place it in the puzzle. The scientists in this study were interested in how snakes fit into the land **restoration** puzzle.





Thinking About the Environment

The **riparian** forest land along the Rio Grande is locally referred to as the Bosque (Spanish word for forest) (**figure 1**). Riparian habitat occurs along streams where the water meets the land. The Rio Grande is a river whose **headwaters** are in Colorado. It runs through New Mexico and forms the border between Texas and Mexico. Flooding is a natural disturbance to which the Bosque is well suited.

Another natural disturbance of many areas is fire. However, the Bosque probably did not experience many fires in the past. Its **ecosystem**, therefore, is not well suited to fire. Today, most of the fires in the Bosque are started by humans. Because the Bosque is close to human communities who live near the Rio Grande, **forest managers** take action to discourage fires. After a fire occurs, they work to restore the Bosque to its natural condition. In this way, managers take action to reduce the chance for another wildfire to get started and spread in the Bosque and into nearby human communities.

Managers take two main actions to discourage wildfires in the Bosque. One action is to remove plants that are not **native**. The other is to remove downed and dead trees from areas that have not decayed with the help of natural floods. One way to maintain the important Bosque habitat is to reduce fires, which can kill native cottonwood trees.



Figure 1. The Bosque is a riparian forested strip along the Rio Grande.

Introduction

After an area has been changed by human or natural disturbances, forest managers often engage in restoration activities. In the Bosque, fire is both a human and a natural disturbance. This is because most fires in the Bosque are started by humans. Restoration activities are things that forest managers do to the land to help an area resemble how it functioned in the past (**figure 2**).

Restoration is sort of like reconditioning an old car or historic home. Some examples of these activities are clearing out nonnative plants, getting rid of piles of downed trees and logs, and planting native plants. Clearing out piles of downed trees and logs helps to reduce the risk of wildfire because wildfires use the downed wood as fuel to keep burning.

Restoration activities have an impact on many different things like animals, plants, and soil. In this study, the scientists wanted to know how the restoration activities affected snake populations. Snakes are important to the ecosystem because they are predators of different **vertebrates** and **invertebrates**. The scientists also wanted to find out what types of snakes were in the Bosque and what type of trap was better for catching snakes.



Figure 2. Scientists clearing an area of non-native species.

Reflection Section



- What are the questions the scientists wanted to answer?
- If there were fewer snakes in the ecosystem, what do you think would happen to the populations of vertebrates and invertebrates?

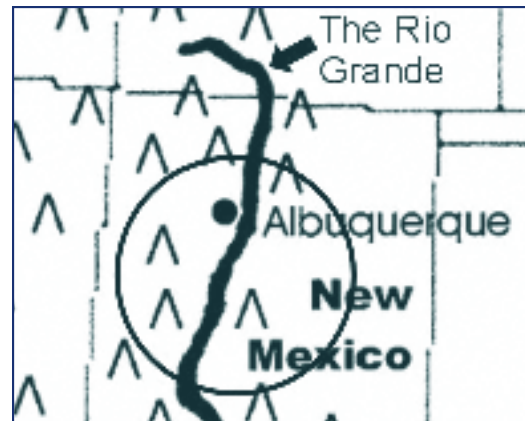


Figure 4. The location of the areas studied by the scientists.

Methods

The scientists examined the Bosque near the Middle Rio Grande in New Mexico (**figure 3**). The **climate** in this area ranges from **arid** to semiarid. The scientists monitored the snakes at 12 sites in this area from 2000 to 2006. They studied four sites in each of three different regions (**figure 4**). One site in every region was used as a **control**. In the control sites, no restoration activities were conducted. In the other sites, crews removed nonnative plants, burned piles of slash, and planted native shrubs (**figure 5**). Slash is the leftover tree and shrub parts from forest management activities such as thinning, **pruning**, and harvesting. The areas where downed wood, logs, and nonnative plants were removed were more open (**figure 6**).



Figure 5. An area filled with native plants. Photo by Arthur E. Miller, Forest Service, courtesy of <http://Bugwood.org>.

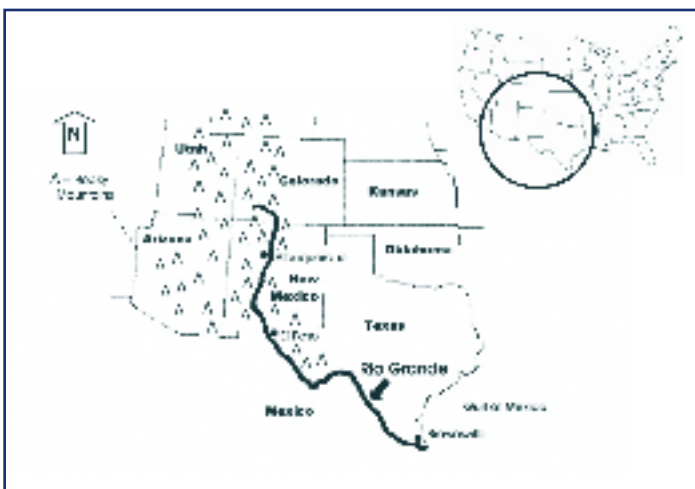


Figure 3. The Middle Rio Grande runs through New Mexico.



Figure 6. This southeastern forest is open along the forest floor.

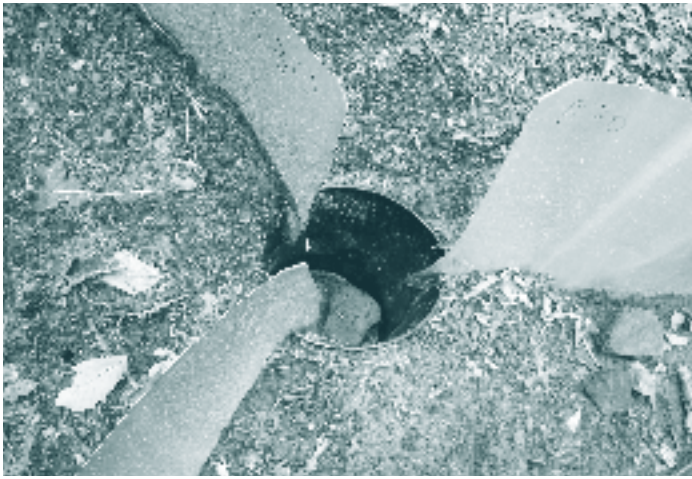


Figure 7. A pitfall trap can be a 5-gallon bucket placed into the ground so that animals fall into it.

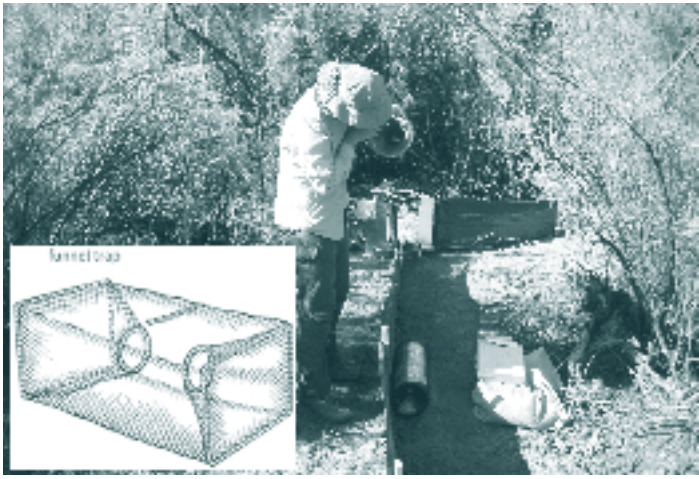


Figure 8. Dr. Heather Bateman checks a funnel trap near drift fences for snakes. Drift fences help to direct animals toward the traps.

To discover how snake populations were by affected these activities, the scientists used drift fences, pitfall traps, and funnel traps to capture the snakes (**figures 7-8**). The traps were used from June through mid-September every year. After the snakes were captured, counted, and identified, they were released back into the environment.

Reflection Section

Look at figures 7 and 8. Which trap do you think would work best for capturing snakes? Why?

Why do you think scientists had a control area in every region?

Findings

The scientists captured and released a total of 158 snakes from 2000 through 2006. The top five snakes caught are shown in the chart below (**figure 9**). The Common King snake was the most frequently captured snake (**figure 10**).

Snake Type	2000	2001	2002	2003	2004	2005	2006	Total
Common King snake	5	11	1	6	7	10	7	47
Gopher snake	0	4	0	9	5	10	1	29
Plains Black-headed snake	1	3	0	0	6	6	5	21
Plain hog-nosed snake	2	3	1	3	2	2	1	14
Common Garter snake	2	2	0	1	1	4	3	13

Figure 9. The total number of each type of snake captured each year.



Figure 10. The Common King snake, *Lampropeltis getula*, is often found on the ground but is an excellent climber and swimmer as well.

The scientists found that restoration activities did not have an effect on the number of snakes captured. They also found that more snakes were captured with funnel traps than with pitfall traps. More than half of all snakes captured were captured in funnel traps. Larger snakes like the Coachwhips and Gopher snakes were also captured more often in funnel traps (**figure 11**). The smallest snake species in this study, the Plains Black-headed Snake, was found most often in pitfall traps (**figure 12**).



Figure 11. Coachwhip snakes can be very long. Some of these snakes can be 8 feet in length. Photo by John (J.D.) Willson.



Figure 12. The Plains Black-headed Snake is a secretive snake, so the exact distribution of this snake is not known. However, it has been found in Kansas, Wyoming, Colorado, New Mexico, and Arizona.

Number Crunches

- How many total snakes do the top five snakes captured account for?

Reflection Section

- Look at the pictures of the funnel traps and pitfall traps (figure 7 and 8). Why do you think that funnel traps captured more snakes?
- Do you think it is important for the scientists to use pitfall traps? Why or why not?

Discussion

This study examined the effect of restoration activities on snake populations. Scientists found that restoration activities did not affect how many snakes were captured. However, the snakes captured did change depending on the time period and region in the Middle Rio Grande. Some summers were drier summers, which may have had an effect on the number of snakes captured.

The scientists noted that their results need to be **interpreted** carefully because the overall number of snakes captured was low. The **native** habitat may not have been fully restored yet, and the weather could have affected the number of snakes captured.

The scientists also found that funnel traps were more effective than pitfall traps in capturing snakes. Additionally, they found that funnel traps were better able to capture larger snakes. Therefore, populations of large snakes could be underestimated if scientists use only pitfall traps. The scientists recommended using both types of traps with drift fencing in future studies.

Reflection Section



Based on the scientists' findings, do you think this study should be done again at a later date? Why or why not?

Based on the results of this study, do you think that restoration activity to reduce the chance of wildfire in the Bosque is a good thing for snakes? Why or why not?

Glossary



Arid ('er-əd): An area that is extremely dry with little rainfall.

Bosque ('bäsk): Wooded areas near water or wetland areas.

Climate ('kli-mət): The average condition of the weather over large areas, over a long time, or both.

Conserve (kən-'sərv): To avoid wasteful or destructive use of something.

Control (kən-'trōl): A control is something used for comparison when checking the results of an experiment.

Ecosystem (ē-kō-sis-təm): Community of plant and animal species interacting with one another and with the nonliving environment.

Forest manager ('fōr-əst 'ma-ni-jər): Skilled individual who takes care of natural resources.

Headwaters ('hed-'wō-tərs): The source of a stream or river.

Herpetologist (hər-pə-'tä-lə-jist): A person who studies reptiles and amphibians.

Interpret (in-'tər-prət): To help explain something.

Invertebrate ((,)in-'vər-tə-brət): An animal lacking a backbone.

Native ('nā-tiv): Naturally occurring in an area.

Ornithologist (ōr-nə-'thā-lə-jist): A person who studies birds.

Pinyon-juniper woodland ('pin-'yōn 'jū-nə-pər 'wud-lənd): An area higher in elevation than the Bosque where pinyon pine trees and juniper flourish. Pinyon pine and juniper are well adapted to drought conditions and cold. For more information visit <http://cpluhna.nau.edu/Biota/pinyon-juniper.htm>.

Prune ('prün): To cut away or cut back parts of a plant to promote growth or better shape.

Restoration (res-tə-'rā-shən): Bringing back to a former condition.

Riparian (rə-'per-ē-ən): Areas along streams and rivers.

Vertebrate ('vər-tə-brət): An animal with a backbone. Examples include mammals, birds, reptiles, and fish.

Wilderness ('wil-dər-nəs): Area designated by Congress to be preserved in a wild and natural condition as part of the National Wilderness Preservation System.

Accented syllables are in **bold**. Marks taken from Merriam-Webster Pronunciation Guide.

This article is adapted from Bateman, H.; Chung-MacCoubrey, A.; Snell, H.; and Finch, D. (2009). Abundance and species richness of snakes along the Middle Rio Grande riparian forest in New Mexico. *Herpetological Conservation and Biology*. 4(1): 1–8.

Time needed:

Three class periods

Materials needed:

16-ounce plastic cups, landscape fabric (or some type of thin material that can be used to make the drift fence)

The question you will answer in this FACTivity is: What types of insects live on the grounds of our school?

Procedure:

You will do an experiment similar to what the scientists did in this article, except you will be studying insects on the ground instead of snakes. First, your teacher will break your class into small groups of three or four students. Each group will take a section of the schoolyard to monitor for ground-level insects. Once students have divided up the schoolyard into sections for each group, the groups will make two pitfall traps and two drift fences.

To make the pitfall traps, use two 16-ounce cups. Dig a hole and place each cup into the hole so that the lip of the cup is level with the ground. After the two cups are in the ground, use the material to make a drift fence toward the cup. Each drift fence should be 2 feet long and 1 foot high. Check the traps several times a day and

record the number of insects in the trap and what kind of insect it is or a general description of the insect. NOTE: Make sure that no one hurts the insects or touches them. Use eyes only to observe the insects. After recording, empty the cup of insects in another part of the schoolyard.

Following a day's worth of observation, compare results with the class and discuss. Some questions to help guide the discussion are:

1. What types of insects did you see the most? Was this surprising? Why or why not?
2. What is the problem with this type of trap and obtaining information about insects?
3. Was it easy or hard to make the traps and then monitor them? What challenges did you have?
4. If you were to make this experiment better, what kind of experiment would you design to find out what insects live on the grounds of your school?



Teachers: If you are a PLT-trained educator, you may use Activity #81, "Living With Fire," and #22, "Trees As Habitats," as additional resources.

Additional Web Resources

Joint Fire Sciences Program: Fuels Reduction and Restoration in the Bosque of the Middle Rio Grande
http://www.firescience.gov/projects/01-1-3-19/supdocs/01-1-3-19_01-1-3-19_FSbrief7.pdf

Fire in the Bosque

http://www.nmnaturalhistory.org/BEG/ActivityPages/Ch6_FireintheBosque.pdf

Bosque Restoration Projects (U.S. Army Corps of Engineers)

<http://www.bosquerevive.com/index.htm>

Middle Rio Grande Bosque Initiative

<http://www.fws.gov/southwest/mrgbi/index.html>

Middle Rio Grande Endangered Species Collaborative Program

<http://www.middleriogrande.com>

Common Kingsnake Information

http://animaldiversity.ummz.umich.edu/site/accounts/information/Lampropeltis_getula.html

University of Nebraska Coachwhip Snake page

<http://snr.unl.edu/herpneb/snake/Coachwhip.html>

Gopher snake information

<http://imnh.isu.edu/digitalatlas/bio/reptile/serp/pica/picafram.htm>

National Science Education Standards addressed in this article:

Science as Inquiry:

Abilities To Do Scientific Inquiry;
Understandings About Scientific Inquiry

Life Science:

Populations and Ecosystems

Science in Personal and

Social Perspectives:

Populations, Resources, and Environments;
Natural Hazards;
Risks and Benefits

History and Nature of Science:

Science as a Human Endeavor;
Nature of Science

Don't Judge a Soil by Its Color:

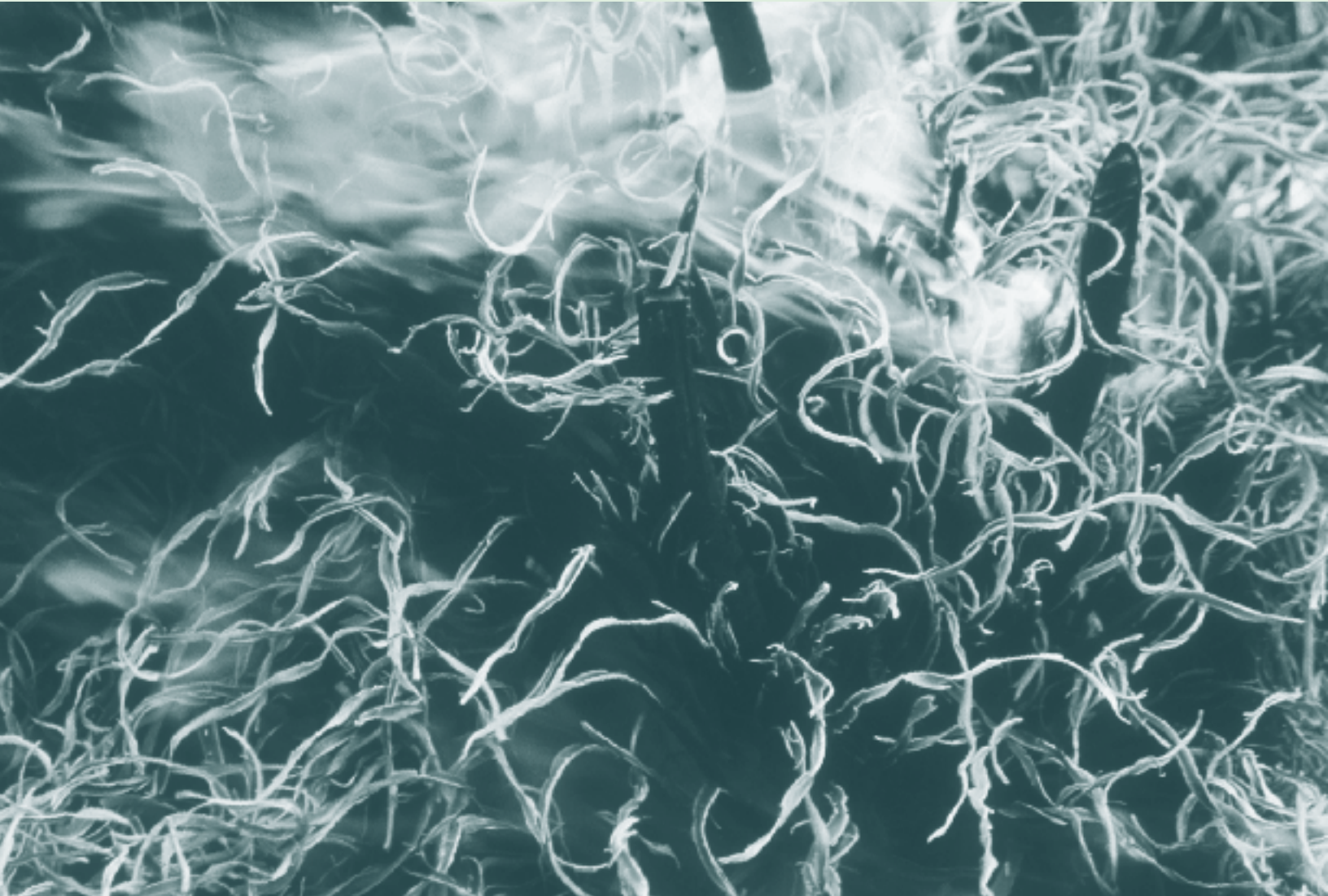


Photo by Kari Greer, National Interagency Fire Center.

Exploring Forest Soil Following a Wildfire

Meet the Scientists

Dr. Jane E. Smith, Research Botanist:

My most awe-inspiring moment as a scientist came when walking deep into an old-growth forest just a few weeks after a severe wildfire had killed all of the trees. The blackened trees towered in stark contrast against a background of reddish soil, which had practically no vegetation. The giant dark pillars towered in eerie silence.

What for many might have been seen as devastation was somehow strikingly beautiful and powerfully exciting! Long red areas marked the previous location of logs, completely removed by the fire. Was there life in the soil? When would the soil **microorganisms**, important to forest life aboveground, return? We were mesmerized by the power of nature and inspired by this research opportunity.



Ms. Cassie Hebel, Soil

Scientist: My favorite science experience is studying **mycology** (mī-'kă-lə-jē) and learning to identify all types of mushrooms. It is fun to look inside the wonderful kingdom of fungi. From the smallest underground truffle forming **mycorrhizal** (mī-kə-'rī-zəl) connections on plant roots to the largest conk decomposing dead logs, they are all fascinating. ▼



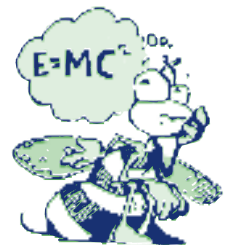
Thinking About Science

To become a research scientist, you must attend college and earn a series of **academic** degrees. After 4 or more years in college, you could earn a bachelor's ('bach-lərz) degree. A master's degree follows, usually after 2 to 3 more years of study. Finally, you may earn a doctoral degree, commonly called a Ph.D. (Ph.D. stands for Doctor of Philosophy (fə lă sə fē)).

It could take up to 4 more years to earn a Ph.D. For every year of study, a student becomes more expert in a particular area of study. One

can become an expert in almost any area—from art to **zoology**. To earn a masters or doctoral degree, most students must do a research study. For a master's degree, this study is called a thesis ('thē-səs).

The research in this study was done by a student earning her master's degree. The student learned that asking research questions and solving them was fun for her. If you are interested in learning new things, you might discover that you like to ask and solve research questions too!



Thinking About the Environment



Do you ever think about what happens underground? The soil is a world about which we seldom think. It is a busy place, full of **microscopic** organisms, including bacteria and fungi. Bacteria and fungi are decomposers. Decomposers break down dead and decaying material. They recycle once-living and nonliving material and make it available for other organisms to use. Bacteria live everywhere on Earth where life is possible.

You have probably seen the fruits of some fungi on the ground or growing on tree trunks. Did you know that some fungi live on the underground roots of plants? These fungi, called mycorrhizal fungi, have an interesting relationship with plant roots. These fungi need plant roots to live, and plant roots need the fungi. Plants create carbon as they photosynthesize, and some of the carbon is sent to the plant's roots. Plant roots then provide carbon to the fungi. The fungi help the plant take in mineral nutrients, such as phosphorus, from the soil.

In this study, the scientists were interested in learning about what happens to mycorrhizal fungi after a forest fire. They wanted to know what happens when a fire burns large pieces of wood on the ground, causing the soil to be intensely heated. They also wondered how this would affect the growth of new plants following the wildfire.

Introduction

When a wildfire burns across a forest, logs and stumps on the ground may completely burn up. When this happens the soil beneath and near the logs and stumps is intensely heated. Soils heated in this way turn a light red color (**figure 1**). These soils, not surprisingly, are called "red soils" by soil scientists.

Scientists know that red soils have been damaged by fire. Bacteria and fungi are killed, and the chemical properties of the soils change. During a wildfire, the soils that did not have logs

or stumps do not get as hot. The fire may burn shrubs and small trees, but the fire passes through quickly without hurting the soil. Soil scientists call these soils "black soils."

Many scientists believe that, following a wildfire, **nonnative invasive** plants are likely to spread into the area. This might happen because the burned area is cleared of **native** plants, opening it for invasive plants. Invasive plants can spread and grow rapidly, which means that their roots may grow rapidly as well.

The scientists in this study wanted to answer two questions: (1) What are the differences, if any, between the growth of nonnative invasive species and the growth of native species in red and black soils following a wildfire? (2) What happens to mycorrhizal fungi following a wildfire?



Figure 1. This is an area that had recently experienced a wildfire. Notice the different colors of the soil. The strips of lighter color are the red soils. They are in strips because a log completely burned, causing the soil beneath it to be intensely heated. Most of the soils, however, are black soils. Photo by Garrett Meigs.

Reflection Section



Explain why red soils are either found in strips or in round shapes following a wildfire. Do you think that more area is in red soils or black soils following a wildfire? Why?



If nonnative invasive plants grow more rapidly than native plants, how might mycorrhizal fungi be involved with this process?

Methods

The study was done in Oregon, in an area that had experienced a wildfire in the summer of 2003 (**figure 2**). This fire burned 36,733 hectares of forest.

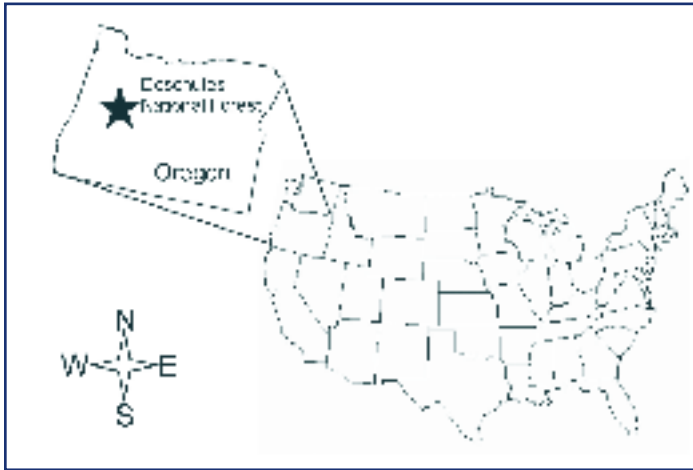


Figure 2. The study was done in the Deschutes (dā-'shüt) National Forest in Oregon.

The scientists collected seeds from three native plant **species** and three invasive plants species that could grow in the area (**figures 3 and 4**). They germinated the seeds and planted the seedlings in plastic pots. Each of the pots was filled with one of the soil samples. The seedlings were placed in a special room in a laboratory and allowed to grow for 10 weeks (**figure 5**).



Figure 3. One of the native plant species studied was snowbrush (*Ceanothus velutinus*). Photo by Dave Powell, courtesy of <http://Invasives.org>.

Number Crunches

🍁 How many acres burned in the Deschutes National Forest in 2003? Multiply 36,733 by 2.47 to find out.

In 2004, the scientists collected **samples** of red soil and black soil from 10 areas. They selected these areas **randomly**. The scientists collected the samples in pairs, so that each pair of red and black soil had been collected less than 1 meter apart. Each soil sample weighed at least 6.5 kg, and was taken from the top 5 centimeters of soil.

Number Crunches

🍁 How many total soil samples did the scientists collect? How heavy in pounds was each soil sample? Multiply 6.5 by 2.20 to find out. How deep in inches is 5 centimeters? Multiply 5 by 0.394 to find out.



Figure 4. One of the nonnative invasive plant species studied was spotted knapweed (*Centaurea maculosa*). Photo by James H. Miller, Forest Service, courtesy of <http://Bugwood.org>.

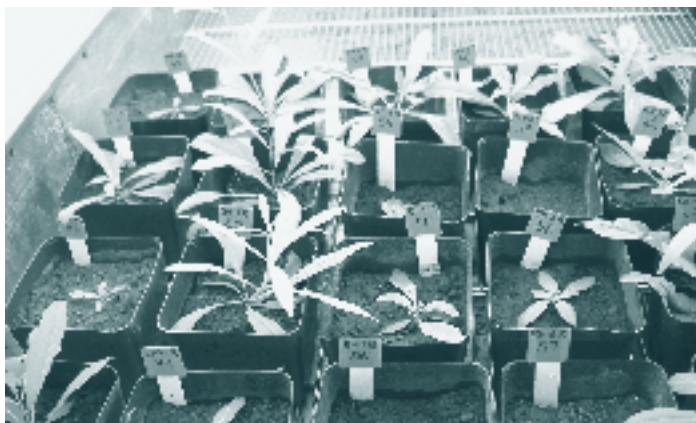


Figure 5. The seedlings were grown for 10 weeks in a special room. Photo by Cassie Hebel.

Number Crunches

How many total seedlings were growing in the pots?

After 10 weeks, the scientists cleaned off the roots of all seedlings and stained them with a special dye. Using a special microscope, the roots were examined (**figure 6**). The percentage of each root with mycorrhizal fungi was recorded.

In July 2005, the scientists went back to the 10 sites where the soil sample pairs had been collected. The type of plants growing on each of the 20 sites was identified and recorded.

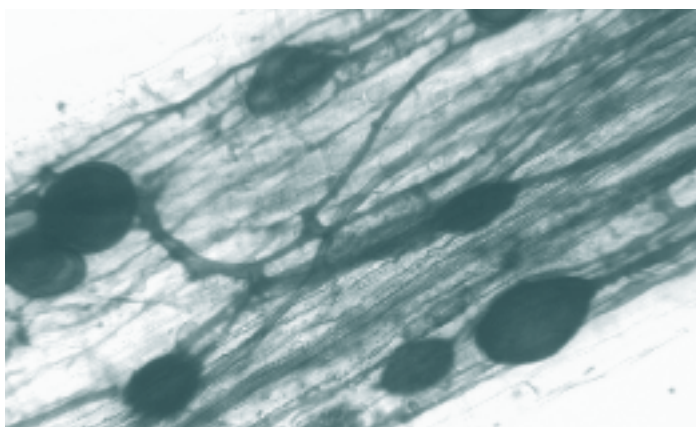


Figure 6. The roots were examined using a special microscope.

Reflection Section



- Why do you think the scientists only took samples from the top 5 centimeters of soil?
- Why did the scientists wait a year to go back and identify the species of plants growing in the red and black soils?

Findings

The seedlings grown in red soil had fewer fungi growing on their roots than seedlings grown in black soil. This was true of both native and invasive plants. Invasive plants grown in red soil had between 79 and 98 percent fewer fungi growing on their roots than plants growing in black soil. Native plants grown in red soil had between 61 percent and 98 percent fewer fungi growing on their roots than native plants growing in black soil.

Two years after the wildfire, the scientists found that areas with red soil had 50 percent less plant cover than areas with black soil. They found no invasive species growing in the area.

Reflection Section



- Why do you think plants growing in red soil had fewer fungi growing on their roots than plants growing in black soil?
- What effect did wildfire have on the growth of new plants in some of the areas that were burned?

Discussion

The scientists wondered why they found no invasive species in the areas they studied 2 years after the wildfire. One reason may be that there were few nonnative invasive species in the area before the fire. This would have limited the source of nonnative invasive plant seeds. Another explanation may be that nonnative invasive species are not able to compete well with native species in areas where a wildfire has severely heated the soil.

The scientists found that areas of forest that have a lot of logs and stumps may not recover as quickly after a wildfire. Plants that grow well in soils that have been heated by fire may be the first to take root and grow in red soils. In the first years after a fire, the type of native plants growing may be different than before the wildfire. When wildfire severely heats the top layer of soil and the roots found there, it appears to harm the fungi that were living on the roots.

Reflection Section



 If logs and stumps on the ground cause a slower recovery of a forest following wildfire, should the logs and stumps be removed? Why or why not?

 Do you think the fungi will ever come back to the areas of red soil? Why or why not?

Adapted from Hebel, C.; Smith, J.E.; and Kermit, C., Jr. 2009. Invasive plant species and soil microbial response to wildfire burn severity in the Cascade Range of Oregon, *Applied Soil Ecology*. 42: 150-159. <http://www.treeseearch.fs.fed.us/pubs/34600>.

Glossary



Academic (ə-kə-'de-mik): Having to do with an institution of learning.

Fledgling ('flej-liŋ): An inexperienced person.

Inquisitive (in-'kwi-zə-tiv): Inclined to ask questions.

Invasive (in-'vā-siv): Tending to spread or infringe upon.

Microorganism ('mī-(,)krō-'ōr-gə-ni-zəm): An organism or life form of microscopic size.

Microscopic ('mī-krə-'skä-pik): Invisible or nearly so without the use of a microscope.

Mycology (mī-'kä-lə-jē): The study of fungi.

Mycorrhizal ('mī-kə-'rī-zəl): The cooperative relationship between a fungus and the roots of a plant.

Native ('nā-tiv): Naturally occurring in an area.

Nonnative ((')nān-'nā-tiv): Not naturally occurring in an area.

Randomly ('ran-dəm-lē): A way of selecting a smaller number from a group in such a way that all members of the group have the same chance of being selected.

Sample ('sam-pəl): A part or piece that shows what the whole group or thing is like.

Species ('spē-(,)shēz): Groups of organisms that resemble one another in appearance, behavior, chemical processes, and genetic structure.

Accented syllables are in **bold**. Marks taken from Merriam-Webster Pronunciation Guide.

FACTivity

The question to be answered in this FACTivity is: What are some of the things that make up soil?

The procedure to be used to answer the question is an adaptation of the game Sudoku. This is Soildoko! Complete the Soildoko puzzle below by filling in the blank

spaces. Six different things that make up soil are listed in the puzzle. In each row and column of the puzzle, each of the six should appear only once. After the puzzle is finished, the answer to the question should be obvious. What are some of the things that make up soil?

Bacteria and Fungi	Clay, Silt, and Sand		Water		Minerals
Air		Bacteria and Fungi		Animals and Plants	
Clay, Silt, and Sand		Water		Minerals	Bacteria and Fungi
	Water				Clay, Silt, and Sand
Water		Minerals		Clay, Silt, and Sand	
	Bacteria and Fungi	Clay, Silt, and Sand	Animals and Plants		Air

This FACTivity was adapted from <http://www.soil-net.com>.

National Science Education Standards

Science as Inquiry:

Abilities Necessary To Do Scientific Inquiry;
Understanding About Scientific Inquiry

Life Science:

Structure & Function in Living Systems;
Populations and Ecosystems;
Reproduction and Heredity;
Diversity and Adaptation of Organisms

Science in Personal & Social Perspectives:

Populations, Resources, and Environments;
Natural Hazards;
Risk & Benefits

History & Nature of Science:

Science as a Human Endeavor;
Nature of Science



Teachers: If you are a PLT-trained educator, you may use Activity #24, "Nature's Recyclers," and #80, "Nothing Succeeds Like Succession," as additional resources.

Additional Web Resources

National Science and Technology Center:
Mycorrhizal Fungi

<http://www.blm.gov/nstc/soil/fungi/index.html>

Benefits of Soil Microbes

<http://www.rivenrock.com/soilmicrobes.htm>

Sentenced!

Unscramble the words in each line to create a sentence from the *Natural Inquirer* Wildland Fire edition.



trees special bristlecone are pine

fungi decomposers are and bacteria

seldom the soil a world about is think we which

at their scientists surprised the findings were

about just can anything scientists study

friends your at think school about

consider should and the people past carefully from learn

do people and study social think scientists what believe

examination is example of detailed a one study case a

individual history as you have an own your

research is historian in happened writes the individual past a who an about does and events that

Puzzle answers on page 84.

?? Who Or What Am I ??

(All of these can be found in the *Natural Inquirer* Wildland Fire edition.)

I was established in 1905 to manage forest reserves. _____

I am placed into the ground by a scientist. _____

Scientists have discovered over 1,170,000 of my species. _____

I am a research study completed as part of a master's degree. _____

I am part of Earth where life can exist. _____

I form the border between Texas and Mexico. _____

I study reptiles and amphibians. _____

I am used for comparison when checking the results of an experiment. _____

I am invisible and I am one of the ingredients of soil. _____

I study what people do, think, and believe. _____

I am a statement of an observation, usually about the relationship of one thing to another. _____

I am an area where houses either meet or mix with wildland vegetation. _____

I am on the ground, and I help young bristlecone pine trees to grow. _____

I am a complicated emotion that involves shared values. _____

I am a small and secretive snake. _____

Puzzle answers on page 84.

Note to Educators

As teachers of science, you want your students to acquire abilities that will enable them to conduct scientific inquiry, and you want them to gain an understanding of the scientific inquiry process. Scientific inquiry can best be taught by integrating minds-on and hands-on experiences. Over time, such experiences encourage students to independently formulate and seek answers to questions about the world we live in. As educators, you are constantly faced with engaging your students in scientific inquiry in new and different ways. In an age of abundant technology, standard teaching strategies can become monotonous to today's learners. The *Natural Inquirer* provides a fresh approach to science and a view of the outside world that is larger than the classroom and can still be used while in the school setting.

The *Natural Inquirer* is a science education resource journal to be used with learners from Grade 5 and up. The *Natural Inquirer* is written at the 7th grade level, but students from grade 5 upward have found the articles useful. The *Natural Inquirer* contains articles describing environmental and natural resource research conducted by Forest Service scientists and their research cooperators. These are scientific journal articles that have been reformatted to meet the needs of middle school students. The articles are easy to understand, aesthetically pleasing to the eye, contain glossaries, and include hands-on activities. The goal of the *Natural Inquirer* is to stimulate critical reading and thinking about scientific inquiry and investigation while learning about ecology, the natural environment, and natural resources.

The Format of a Natural Inquirer Article

Each *Natural Inquirer* article follows the same format. *Natural Inquirer* articles are written directly from a published science article, and all have been reviewed by the scientists for accuracy. Each article contains the following sections, which you may introduce to your students as they read:

Meet the Scientists: Introduces students to the scientists who did the research. Can be used in a discussion of careers in science.

Thinking About Science: Introduces something about the scientific process, such as a scientific habit of mind, or procedures used in scientific studies.

Thinking About the Environment: Introduces the environmental topic being addressed in the research.

Introduction: Introduces the problem or question being addressed by the research.

Method: Describes the method used by the scientists to collect and analyze their data.

Findings: Describes the results of the analysis.

Discussion: Discusses the findings and places them into the context of the original problem or question.

Citation: Gives the original article citation.

Glossary: Introduces possibly new scientific or other terms to students. The first occurrence of a glossary word is **bold** in the text.

FACTivity: This is a hands-on activity that reinforces an aspect of the research.

Science Education Standards and Evaluations

In the back of the journal, you will find a list that allows you to identify articles by the National Science Education Standards they address. You and your students may also complete evaluation forms online by visiting <http://www.naturalinquirer.org>.

If you have any questions or comments, please contact:

Dr. Barbara McDonald
Forest Service
320 Green St.
Athens, GA 30602-2044
706.559.4224
bmcdonald@fs.fed.us
(Please put "Educator Feedback"
in the subject line)

Educator Resources

Visit the *Natural Inquirer* Web site at <http://www.naturalinquirer.org>. From this site, you can read and download lesson plans, word games, and other resources to help you use the *Natural Inquirer* in your classroom. You can view and download a year-long lesson plan aimed at helping your students learn about the scientific process, or a number of generic lesson plans that can be used with any *Natural Inquirer* article.

Lesson Plan #1

Note: This lesson plan can be used with any *Natural Inquirer* article.

Learning Objectives:

Students will increase:

- (a) science reading comprehension,
- (b) question-posing ability, and
- (c) letter writing skills regarding science.

In small groups (or individually), students will read a *Natural Inquirer* article and write a letter to the scientist, asking for clarification on at least four questions.

In advance, make copies, or load onto the white board, the letter template given **(at right)**.

Amount of time needed:

Two class periods (90 minutes)

Materials needed:

Lined paper and pencils for students
Natural Inquirer article
Graphic organizer (**Page 80**)

Day 1:

In small groups (or individually), have students read one of the *Natural Inquirer* articles. You may allow them to select an article, or you may assign one. Students may take turns reading paragraphs out loud. Depending on the amount of time available, they may skip the Reflection Sections. As students finish each section, have them write a summary of what they have read in the graphic organizer. After they have read and summarized all sections, have them write any questions that they have thought of for each section, using the graphic organizer.

Day 2:

Show students the template for writing a letter. In their small groups (or individually), have them compose a letter to the first scientist listed in the “Meet the Scientist” section.

Hold a class discussion about:

1. The questions they had for the scientist. Why did they ask the questions they asked?
2. The process of writing a letter to a scientist. What are the advantages of writing a proper letter, rather than a text message or an email? Are there any disadvantages?
3. What did students learn from reading their article? Have students tell the class in rapid fire format.

Collect their letters and use the rubric on page 81 for evaluation.

If students would like to submit their letters, they may either send their hard copy letters to:

Natural Inquirer Scientist Letters
Forest Service
320 Green St.
Athens, GA 30602-2044

OR, they may send letters electronically to jessica@naturalinquirer.org.

Note: While the *Natural Inquirer* staff will attempt to answer questions sent in to our office, we cannot guarantee that all questions will be answered. If letters are sent hard copy, please include an email address so that we may reply electronically.

Students' names

Teacher's name (e.g., Mrs. Jones' 7th grade science class)

School name

School address (City, State, ZIP)

Date

Scientist Full Name (with title)

Scientist Affiliation

City, State

(If you are able to access the Internet, the scientist's exact address may be searched)

Dear [Title] [Scientist's last name]:

First Paragraph: Students should explain that they read [Article name] in the *Natural Inquirer*. After reading the article, they developed four questions that they would like to ask. This paragraph should be 4 to 5 sentences long.

Middle Paragraph(s): Students should provide the context for their questions and ask them. The context includes: (a) which article section the question concerns and (b) what about the article information prompted the question. Students may decide to write four small paragraphs, one for each question.

Ending Paragraph: Students should thank the scientist and note that they look forward to a reply.

Closing (such as Respectfully yours, Sincerely, etc.)

Student names and signatures

Student Name(s): _____

Natural Inquirer Graphic Organizer

Summary

Introduction	Methods
Findings	Discussion

Questions

Introduction	Methods
Findings	Discussion

Assessment Rubric

	Poor 1	Fair 2	Good/ Satisfactory 3	Exemplary 4	Score
Questions to Scientist	Included only one question for scientist	Included only two questions for scientist	Included only three questions for scientist	All four questions included	
Heading	Not at all in proper form	Partially in proper form	Almost in proper form	Completely in proper form	
First Paragraph	Not at all in proper form, length, or context	Partially in proper form, length, and context	Almost in proper form, length, and content	Completely in proper form, length, and context	
Middle Paragraphs	Not at all in proper form, length, and context	Partially in proper form, length, and context	Almost in proper form, length, and context	Completely in proper form, length, and context	
Grammar/ Punctuation	Too many grammatical/punctuation errors	Needed to demonstrate better use of punctuation and grammar	Proper use of grammar and punctuation, few errors	No grammatical or punctuation errors	
Final Paragraph	Did not complete final paragraph	Partially completed final paragraph	Thanked scientist/ Needed improvement in final paragraph	Properly thanked scientist and ended letter	
Closing	Did not complete or not at all in proper form	Partially in proper form	Almost in proper form	Completely in proper form	

Lesson Plan #2: Forest Poems

Note: This lesson plan may be used after reading any one of the articles in any *Natural Inquirer*.

The purpose of this lesson plan is to give students a chance to reflect on their reading and create poems to express what they have learned.

To create their poems, students will need paper and pencil.

Follow the reading guide and graphic organizer from the previous lesson plan. After students have read their article and formulated summaries and questions, they will read one or more of the following poems. These poems are from Guthrie, John. 1929. *Forest fire and other verse*, the American Forestry Association, 3rd printing (1935).

Begin with a discussion of the publication date of these poems. Students should be aware that the poems were written at least 80 years ago, and life was much different then. After reading each poem, students should answer the following:

- A. List three things the author said that you think are important.
- B. Why do you think this poem was written?
- C. What evidence in the poem helps you know why it was written? Quote from the poem.
- D. List two things the poem tells you about life in the United States at the time it was written.
- E. Write a question to the author that is left unanswered by the poem.

Oh! Wonderful Horse by H. R. Elliott

Oh horse you are a wonderful thing, no buttons to push, no horns to ring, you start yourself, no clutch to slip, no spark to miss, no gears to strip, no license buying every year with plates to screw on front and rear, no gas bills climbing up each day stealing the joy of life away. No speed cops chugging in your rear yelling summons in your ear. Your inner tubes are all O.K. and thank the Lord they stay that way, your spark plugs never miss and fuss, your motor never makes us cuss. Your frame is good for many a mile, your body never changes its style. Your wants are few and easy met, you've something on the auto yet.

The Forester's Life, no author given

The forester's life is full of ease;
A timber famine he foresees;
He tries to warn the he's and she's
Who will not listen to his pleas.
Then he gets down upon his knees
And plants the seed to grow the trees;
Their life he fondly oversees,
And talks about their pedigrees.
The people learn by slow degrees,
By ones, and twos, and even threes.
Then they, too hold some jubilees
And follow up with planting-bees.
'Tis only then the famine flees.
Why don't you plant some little trees?

Our Forests by Charles Allen

A safe retreat from summer's heat
Fresh green on winter's snow
Our forests stand in stalwart band
To greet the folks who know.

To weary souls they're restful goals
On nerves distraught with care
They spread a balm of soothing calm
No doctor can prepare.

Quite free to all who heed the call,
Supreme in scenic lure,
Their verdant arms outflung with charms
Inviting, safe, secure.

The Bargain of Forest and Stream by A. G. Jackson

The streams and the woods made a bargain,
That as long as the waters ran,
As long as the trees grew skyward
They'd follow this helpful plan:

The trees would shelter the rivers
And hold their flood-waters back.
The rivers would nourish the forest
And see that it ne'er would lack.

You never will have a river,
Steady and sure in its flow,
Unless in its upper reaches
Trees verdant and helpful grow.

And ne'er will you find a forest,
Wide and refreshing and grand,
Unless it is nourished by rivers
That flow through, renewing the land.

And man, who destroys the timber,
Leaving the mountain slopes bare,
Wonders what dried up the rivers
That once ran steadily there.

The Magic Change by Mrs. (Ranger) Dewey S. Wright

I do not know my world today,
The summer sun has gone away,
The touch of fall is in the air,
It can be seen now everywhere.

Close here at hand some poplars rise
And rear their heads up to the skies.
But yesterday their clothes were green,
But now today—a golden sheen.
A magic hand has dealt to vine
I knew so well in summer time,
A color one can scarce describe
And stand close there by its side

The sumac that could not withstand
The artist with the faultless hand.
He with deft touch from foot to head
Has changed it to a crimson red.

The only things familiar now
Are standing on the mountain's brow,
The little pines so green and fair
Will not be changed by frosty air.

In a class discussion (or in small groups), have students share their answers to the five questions. Could this poem have been written today? Why or why not?

Have students write a haiku based on the *Natural Inquirer* article they just read. A haiku is a Japanese poem that is usually written in response to an observation about or within nature. A haiku has the following structure:

Three lines

Lines 1 and 3 have five syllables
Line 2 has seven syllables
The lines do not rhyme.

An example to help you remember:

I am first with five
Then seven in the middle—
Five again to end.

Here is a “what am I” haiku example:

Green and speckled legs,
Hop on logs and lily pads
Splash in cool water.

Post student haikus in the hallway. You may send the haikus electronically to Jessica@naturalinquirer.org and we will post them on the *Natural Inquirer* Web site. If you choose to send them to the *Natural Inquirer*, please include the name of the *Natural Inquirer* article that inspired the haiku.

Answers to the puzzles

Sentenced!

Bristlecone pine trees are special.

Bacteria and fungi are decomposers.

The soil is a world about which we seldom think.

The scientists were surprised at their findings.

Scientists can study just about anything.

Think about your friends at school.

People should carefully consider and learn from the past.

Social scientists study what people do, think, and believe.

A case study is a detailed examination of one example.

You, as an individual, have our own history.

(As an individual, you have your own history.)

A historian is an individual who does research and writes about events that happened in the past.

Who Or What Am I?

Forest Service

Pitfall trap

Arthropods

Thesis

Biosphere

The Rio Grande

Herpetologist

Control

Air

Social Scientist

Hypothesis

Wildland Urban Interface

Nurse object

Trust

Plains Black Headed snake

Possible Answers to Reflection Questions

Fight or Light

Introduction

- **What are the questions the historian wanted to explore?** *What was the impact of the 1910 wildfires on fire policy of the Forest Service over the next century? Why did those fires have such a strong and lasting impact?*
- **How do you think the historian explored his questions?** *This is an individual question. Students should think about what a historian would need to do to get answers to his or her questions. Some possible answers include interview people who either lived through the fires or had some other connection to the fires, read newspaper accounts, read government documents, and look at photographs.*

Methods

- **Look at the photographs in figures 3 and 4. What are some of the advantages of having photographs if you are a historian?** *Students will need to come up with their own answers, and they should give logical reasons for their positions. Some ideas include that seeing photographs can add different information to whatever documents are available; photographs sometimes help you to understand more fully what happened; and photographs might include information that was not recorded in writing.*
- **Historians must write history as accurately as possible. A story of historical fiction must be clearly identified. Why should stories of historical fiction be clearly identified as such?** *A story of historical fiction is also called a historical novel. Historical novels, while based on real events, include events that*

are made up. If a historical novel is not identified as such, people may mistakenly believe they are reading an accurate account of a historical event.

Findings

- **What one thing is still out of the control of people in regard to wildfires?** *The weather.*
- **How has research helped foresters to do a better job of managing fire?** *Research has shown that fire suppression is not the best approach to managing wildfires. It has also shown that fire is healthy for some forested ecosystems. Forest managers can now use fire as a tool to reduce the severe impact of large wildfires in areas where people live and work.*

Discussion

- **Before reading this article, did you think all wildfires should be put out?** *All of the answers to this and the following questions in this reflection question are individual. Students should back up their answers with logic.* **How do you think your opinions about wildfires have been influenced by hearing about wildfires in the news? How is the shaping of your opinion similar to the reaction to the wildfires of 1910? How is it different?**
- **Describe another instance where learning about the past can help make decisions about the future.** *This is an individual question, and students may come up with a number of ideas. Some include the American Revolution and the Civil War, or the civil rights story of the 1960s. The story of invasive plants may also be noted. (People used to think that there was no danger in planting plants from other countries.) Students may come up with local examples.*

aPods Rule!

Introduction

- **State the null hypothesis used by the scientists.** (See “Thinking About Science” for a hint.) *Here are some possible null hypotheses: There is no relationship between old logs and the habitat of arthropods living in leaf litter after a fire has burned the forest floor. After a fire has burned the forest floor, old logs are not important to arthropods living among the leaf litter. There will not be an increase in the number of leaf-litter-dwelling arthropods living near old logs, compared with those living away from logs, following a fire. This last hypothesis is the best, because it brings in the idea of measurement. Students may come up with similar statements. It is important for students to understand that hypotheses are made as statements of relationship, and that a null hypothesis states the lack of a relationship between two variables.*
- **Is fire a good thing for longleaf pine forests? How do you know?** *Students should conclude that fire is a good thing for longleaf pine forests because fire is needed to open up areas so longleaf pines can grow, and longleaf pines have adapted to resist and survive fires.*

Methods

- **Why did the scientists include areas that were not burned at all?** *In many experiments, scientists use a control. A control gives scientists a way to compare their experimental treatments with what would happen if they did not do any of the experimental treatments.*
- **Why did the scientists want to collect arthropods near the log and away from the log?** *The scientists wanted to see if logs provided habitat for leaf-litter-dwelling arthropods following a fire. If they did not collect arthropods away from the log, they*

would have no way to know if more or fewer arthropods were living close to the logs.

Findings

- **Do you think the scientists accepted or rejected their null hypothesis? Why or why not?** *The scientists had to accept their null hypothesis as true, meaning they found no relationship between the number of leaf-litter-dwelling arthropods and the presence of logs following a fire.*
- **Do you think this study proves that leaf-litter-dwelling arthropods do not use logs as habitat after a fire? Why or why not?** *This is an individual question and each student must think this through for themselves. However, you may challenge students to consider other reasons that fewer arthropods were collected near the logs.*

Discussion

- **Is it important to understand what happens to arthropods following a fire? Why or why not?** *This is an individual question and students should present their position in a class discussion.*
- **What are some advantages of being surprised at your findings?** *Students should recognize that, when scientists are surprised by their findings, new questions are possible that might not have been possible had they discovered what they thought they would discover. In this case, the scientists may have discovered problems with their data collection. Alternatively, they may have discovered something unexpected about the preferences of leaf-litter-dwelling arthropods.*

Keeping It Local

Introduction

- **State what the scientists wanted to know in the form of a question.** *How do*

wildland-urban interface (WUI) communities describe and identify the boundaries of their WUI in a Community Wildfire Protection Plan?

- **How do you think the scientists answered their question?** *Students should have been clued in by “Thinking About Science.” The scientists interviewed people in four communities to answer their question.*

Methods

- **A case study is a detailed look at one individual, one group, or one event. Think about something you have studied recently. How might you extend your examination by doing a case study? Who or what would you study?** *This is an individual question. Students should be urged to think of how they might learn more about something by doing a case study. For example, let’s say your class had recently studied earthquakes. A case study might be done of one community that had recently experienced an earthquake.*
- **Why would it be important to interview a variety of people in the community?** *People living in communities have different opinions and experiences. To truly understand what happened in the community, many different people must be interviewed.*

Findings

- **Why do you think members of fire departments affected the way the WUI was defined and described?** *People working in fire departments would have a lot of information about fighting fires. They would know which areas were at greater risk of a wildfire. They would know the conditions of the roads and how long it would take for a fire engine to reach a fire.*
- **What was one benefit of having community members work together to define and describe their WUI?** *Differences of opinions could be discussed, and community members could come to an*

agreement. This eventually leads to a better plan, which offers better opportunities to protect areas from wildfires.

Discussion

- **Think about the large areas of undeveloped land in the Western United States. Do you think most of that land could be considered the WUI? Why or why not?** *Students should realize that vast amounts of undeveloped land should not be considered the WUI, since by definition the WUI includes some buildings.*
- **Give another example of when getting together to discuss something resulted in a better plan of action.** *This is an individual question, and students should be challenged to think of something in their own life or something in the news. An example from current events would be worldwide discussions about planning for climate change or discussions about developing a nuclear weapons reduction plan. An example at the local level is community land use planning. In the classroom, students may have collectively discussed and subsequently planned an event.*

Pecking Order

Introduction

- **In the form of a question, state what the scientists wanted to learn in this study.** *What types of post-fire snag forests were best for the Black-backed woodpecker’s foraging?*
- **In your own words, describe why a keystone species is important.** *Keystone species are important because they provide us with an early indicator that something is changing in the environment that may cause problems for other native species living there.*
- **Do you think it is important to improve the habitat for keystone species? Why or why not?** *This is an individual question.*

Students should back up their answers with logic. However, it would seem prudent to pay attention when the population of a keystone species is falling in numbers.

Methods

- **Why do you think the scientists noted how many snags were in the patches?** *The snags are where the Black-backed woodpecker finds food. The scientists wanted to know the best conditions for the woodpecker. Since the woodpecker forages in these snags, the number of snags in each hectare may be one of the most important conditions for the woodpecker.*
- **Do you think it is important that the scientists used the same method in each patch to record the presence of the Black-backed woodpecker? Why or why not?** *Yes, it is important to use the same method so that results are reliable and are consistent across all of the patches studied. Otherwise, they could not be compared.*

Findings

- **Do you think that the number of large snags in each patch was related to the number of woodpeckers found there? Why or why not?** *Students should look at figure 8 and realize that an unlogged, high-severity burn, which is the only patch where Black-backed woodpeckers were found, had a much larger average number of large snags per hectare.*
- **Why do you think the woodpeckers preferred patches with large snags left standing?** *These patches would have even more snags available for foraging than the logged patches.*

Discussion

- **In your own words, describe the habitat the Black-backed woodpecker prefers for foraging.** *The Black-backed woodpecker*

prefers patches of high-severity burned areas with a lot of snags (preferably large ones).

- **Why is this research useful for forest managers?** *Forest managers can directly apply these findings to how they currently manage forests that have recently experienced a high-severity wildfire if they want to improve the foraging ability of the Black-backed woodpecker.*

Trust Is a Must

Introduction

- **Why is trust an important emotion in your life?** *Students should be encouraged to explore whom they trust and why this is important. Examples of people they may trust include parents or guardians, grandparents, siblings or other family members, teachers, doctors, friends, etc. Explore the advantages of trust, and how one must act to gain someone's trust.*
- **Do you think that forest managers can do a better job if citizens trust them? Why or why not?** *You may also frame this question using a trustee such as Congress, the Governor, the police, or other similar trustee. This question has no right or wrong answer, but students should be able to provide reasons for their position.*

Methods

- **Match the six questions in figure 5 with the three parts of trust in figure 2. Which of the three parts does each question address?** *This can be used in a general class discussion. The answers are: 1: Shared values (honesty); 2: Capable of acting correctly (capable, effective); 3: Shared values (justice, fairness); 4: Shared values (similar values); 5: Capable of acting correctly (capable, effective); 6: Act on their behalf (trustee interested in their well-being). If students have different interpretations, allow them to state the reasons for their positions.*

- **In today's society, what are some disadvantages of using the telephone to ask questions of citizens?** *Students may come up with a host of reasons. Some include: 1: People no longer use land lines; 2) People are too busy to answer survey questions; 3: The phone may be busy or not answered because of caller ID.*

Findings

- **What are some of the positive things citizens had to say about forest managers?** *Citizens feel that forest managers are somewhat effective, reliable, and competent in managing fires. They think that forest managers are honest and care about citizens' needs.*
- **What are some of the negative things citizens had to say about forest managers?** *They do not pay attention to what people think, citizens are not entirely confident in the way forest managers manage fire, and citizens are not completely satisfied with the way fire is managed.*
- **If you were the scientists, what would you tell the forest managers to do to increase the level of trust?** *This is an individual question, but students should realize that forest managers should pay more attention to what people think, should look for ways to raise the confidence in their actions, and should find out why citizens are not completely satisfied with the way fire is managed.*
- **Although all three parts were important, the scientists found that "the belief that others are capable of acting correctly" was the most important part of trust. Based on your own experience, which part do you think is most important and why?** *This is an individual question, and students should be able to back up their position with logic and sound reasons.*

Discussion

- **How can better communication build more trust between an individual and a trustee? Use an example from your own life.** *This is an individual question, and students may be urged to think about how they might improve communication to increase trust. Students may consider themselves as being the trustee, or the person who feels trust.*
- **Think about any public land close to your home. This can be a local park, a State park, a national park, or State or national forest land. Do you trust the managers to do a good job of managing the land? Why or why not?** *This is an individual question. Students should provide logic and sound reasons to support their position.*

Can We Grow Now?

Introduction

- **In the form of a question, state what the scientists wanted to discover.** *What are the best conditions under which bristlecone pine seeds take root and grow?*
- **Name two things that make it hard for Rocky Mountain bristlecone pine trees to survive.** *(1) These trees need occasional fire, which opens up areas for seeds to take root and seedlings to grow; (2) The trees take between 50 and 100 years before they produce seeds; (3) The white pine blister rust is threatening to kill the trees.*

Methods

- **Why did the scientists select their study sites randomly?** *Because the scientists needed to make sure that the site selection was unbiased. If the scientists selected the sites just by choosing them, they could be affecting their results through their own preferences. For example, they might always select sites with more bristlecone pine trees.*

- **Why do you think the scientists measured the distance from each seedling to other objects?** *This is an individual question. Students should be challenged to think critically about why the scientists wanted to know if seedlings were found close to other objects.*
- **Why do you think the scientists measured the distance from randomly selected points to nearby objects?** *Students should be asked to think critically about why the scientists would do this. They did this so they could determine whether the seedlings' distance to objects was by chance or whether seedlings tended to grow closer to other objects. The scientists, therefore, compared the seedlings' average distance to objects with the average distance from just any other point.*

Findings

- **Look at figure 10. You can see that more bristlecone pine trees were found growing in partly burned areas. What else does that chart tell you?** *That unburned areas had more trees than completely burned areas, and that completely burned areas had few trees growing in them.*
- **Explain the evidence for calling boulders, stones, fallen wood, and standing tree trunks nurse objects.** *Students should be able to explain that seedlings were found growing closer to these objects than if they were growing there by chance. Therefore, these objects were thought to be helpful to the establishment and growth of bristlecone pine trees. Nurses are people who often help others to regain or maintain their health.*

Discussion

- **Do you think forest managers should use fire as a tool to help save the bristlecone pine? Why or why not?** *Students should realize that fire can be used as a tool to help*

save the bristlecone pine. You may also hold a discussion about whether fire should be used as a tool to protect natural resources. (Note that forest managers purposely use fire to promote or maintain the health of forests.)

- **Name other ways that objects such as boulders, stones, fallen trees, and standing tree trunks provide benefits to the natural environment, anywhere they are found.** *These objects are habitats for insects, reptiles, amphibians, and other small animals. Tree trunks may be used by woodpeckers, owls, and other birds to find food or for nesting. As fallen wood decays, it helps to build the soil. Students may come up with other ways that these objects benefit the natural environment.*

Snake, Rattle, and Roll

Introduction

- **What are the questions the scientists wanted to answer?** *How do restoration activities affect snake populations? What are the different types of snakes in the area? What type of trap is best for capturing snakes?*
- **If there were fewer snakes in the ecosystem, what do you think would happen to the populations of vertebrates and invertebrates?** *Populations of vertebrates and invertebrates that are prey for snakes may increase if the snake population decreases since there would be fewer predators.*

Methods

- **Look at figures 7 and 8. Which trap do you think would work best for capturing snakes? Why?** *This is an individual question that should be supported with logic and reasoning. Long snakes can climb out of the pitfall traps.*
- **Why do you think scientists had a control area in every region?** *Controls are used by scientists so that they can compare*

their findings and see if the treatment is really affecting an area rather than something else that is not accounted for in the study.

Findings

- **Look at the pictures of the funnel traps and pitfall traps (figure 7 and 8). Why do you think that funnel traps captured more snakes?** *This is an individual question that should be supported with logic and reasoning.*
- **Do you think it is important for the scientists to use pitfall traps? Why or why not?** *Yes, it is important to use both types of traps because the pitfall trap did catch some snakes. Without using both types of traps fewer snakes would be captured.*

Discussion

- **Based on the scientists' findings, do you think this study should be done again at a later date? Why or why not?** *Since the scientists were concerned that the overall number of snakes captured was low and that the native habitat may not have been fully restored, it would be a good idea to try to do this study again and see what the results are at a future time.*
- **Based on the results of this study, do you think that restoration activity to reduce the chance of wildfire in the Bosque is a good thing for snakes? Why or why not?** *Students should be urged to look at the first paragraph of the "Discussion" section. It did not appear that snakes were affected positively or negatively by restoration activity. However, the scientists cautioned that the weather was dry, and that the native habitat may not have been fully restored at the time of the study. Students should realize that sometimes a question cannot be answered at the end of a study.*

Don't Judge a Soil by Its Color

Introduction

- **Explain why red soils are found either in strips or in round shapes following a wildfire.** *These are the shapes of the logs or the stumps that were burned in the wildfire. Do you think that more area is in red soils or black soils following a wildfire? Why?* *This is an individual question. Students should reason that there is far less land covered with old logs and stumps in the forest than is covered with brush and small trees. They may look at figure 1 for a clue.*
- **If nonnative invasive plants grow more rapidly than native plants, how might mycorrhizal fungi be affected?** *If invasive plants grow more rapidly, their roots may grow more rapidly as well. This would make the roots of invasive species more available to mycorrhizal fungi. The mycorrhizal fungi, therefore, may begin growing on the invasive roots to take advantage of the carbon they have to offer.*

Methods

- **Why do you think the scientists only took samples from the top 5 centimeters of soil?** *Students should be able to give an answer and back it up with logic. Although roots may go deeper than 5 centimeters, the scientists selected 5 centimeters as their limit because seedlings will usually root within the top 5 centimeters of soil.*
- **Why did the scientists wait a year to go back and identify the species of plants growing in the red and black soils?** *The scientists wanted to give the area 2 years after the wildfire to allow native or invasive species to spread into, take root, and grow in the area.*

Findings

- **Why do you think plants growing in red soil had fewer fungi growing on their roots than plants growing in black soil?**

This is an individual question, and students should back up their answers with logic.

However, students should reason that the heat from the severe wildfire killed most of the fungi, and therefore less fungi was found growing on roots in the red soils.

- **What effect did wildfire have on the growth of new plants in some of the areas that were burned?** *In the severely heated areas, the wildfire slowed the growth of new plants. The wildfire did not appear to affect the areas that were not severely heated (the areas with black soils). Plants were found to be growing again in those areas.*

Discussion

- **If logs and stumps on the ground cause a slower recovery of a forest following wildfire, should the logs and stumps be removed? Why or why not?** *This is an individual question and students should back up their position with logic. Students should be challenged to think of the animals who depend on logs and stumps for habitat, such as arthropods and small mammals.*
- **Do you think the fungi will ever come back to the areas of red soil? Why or why not?** *This is an individual question, and students should back up their position with logic. However, it could be that eventually, since native plants began to grow in red soil within 2 years, the mycorrhizal fungi would eventually come back and begin living on the plant roots again.*



What Is the USDA Forest Service?

The Forest Service is a part of the United States Department of Agriculture (USDA). It is made up of thousands of employees who care for the Nation's forest land. The Forest Service manages more than 150 national forests and almost 20 national grasslands. These are large areas of trees, streams, and grasslands. National forests are similar in some ways to national parks. Both are public lands, meaning that they are owned by the public and managed for the public's use and benefit. Both national forests and national parks provide clean water, homes for the animals that live in the wild, and places for people to do fun things in the outdoors. National forests also provide resources for people to use, such as trees for lumber, minerals, and plants used for medicines. Some people in the Forest Service are scientists, whose work is presented in the journal. Forest Service scientists work to solve problems and provide new information about natural resources so that we can make sure our natural environment is healthy, now and into the future.

Which National Science Education Standards Can Be Addressed by This Edition of the Natural Inquirer?

	Fight or Light?	aPods Rule!	Keeping It Local	Pecking Order	Trust Is a Must	Can We Grow Now?	Snake, Rattle, and Roll	Don't Judge a Soil By Its Color
Science As Inquiry								
Abilities Necessary To Do Scientific Inquiry								
Understandings About Scientific Inquiry								
Life Science								
Structure and Function in Living Systems								
Reproduction and Heredity								
Regulation and Behavior								
Populations and Ecosystems								
Diversity and Adaptation of Organisms								
Science in Personal and Social Perspectives								
Personal Health								
Populations, Resources, and Environments								
Natural Hazards								
Risks and Benefits								
Science and Technology in Society								
Understandings in Science and Technology								
History and Nature of Science								
Science As a Human Endeavor								
Nature of Science								



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