KNOCK ON WOOD

Understanding the Relationship Between the Red-Cockaded Woodpecker, Longleaf Pine, Fire, and Carbon

MEET THE SCIENTISTS!

◀ DR. KATHERINE MARTIN,
Ecologist and Ecosystem Scientist

My favorite science memory was conducting a 70-acre **prescribed fire** in a longleaf pine forest to understand management in action.

Photo courtesy of Dr. Katherine Martin, used with permission.

◀ DR. MALCOLM NORTH,
Research Ecologist

My favorite science experience is climbing into the top of a 200-foot tall tree and seeing the forest as a squirrel might experience life in the canopy. In the photo, Matt Hurteau, Katie Martin, and I in the top of a large sugar pine.

Photo courtesy of Dr. Malcolm North, used with permission.

◀ DR. MATTHEW HURTEAU,
Forest and Fire Ecologist

My favorite science experience was when I was sampling big sagebrush on a **mesa** in northern Arizona and got to see my first mountain lion.

Photo courtesy of Dr. Matthew Hurteau, used with permission.

◀ DR. BRUCE HUNGATE,
Ecosystem Scientist

My favorite science experience is taking deep cores in sandy soils near the ocean where pure, white sand, suddenly became a black and soft soil horizon, about 3-inches thick. It smelled like compost, and it was… the remains of old, dead plants (we later found out the carbon was from 30,000 years ago!).

In this photo, Dr. Hungate is using liquid nitrogen to quickly freeze soil samples so that they will be preserved as he found them in the field.

Photo courtesy of NAU Marketing.

Photo courtesy of Dr. George Koch, used with permission.

◀ DR. GEORGE KOCH,
Ecologist

My favorite science experience is climbing the tallest redwoods and using high-tech instruments to understand how these giants of the plant world make a living. A part of what we've learned is that gravity interacts with the **hydraulic** system of the trees to cause increasing water stress in the uppermost parts of the crown as the trees grow taller. So, their height growth slows, but they still gain **girth**—just like people!

WHAT KIND OF SCIENTISTS DID THIS RESEARCH?

ECOLOGIST: A person who studies the relationship between living things and their environment.

ECOSYSTEM/SYSTEM ECOLOGIST: A scientist who studies ecological systems, especially ecosystems.

FIRE ECOLOGIST: A scientist who studies the origins of wildland fire and its relationship to the living and nonliving environment.

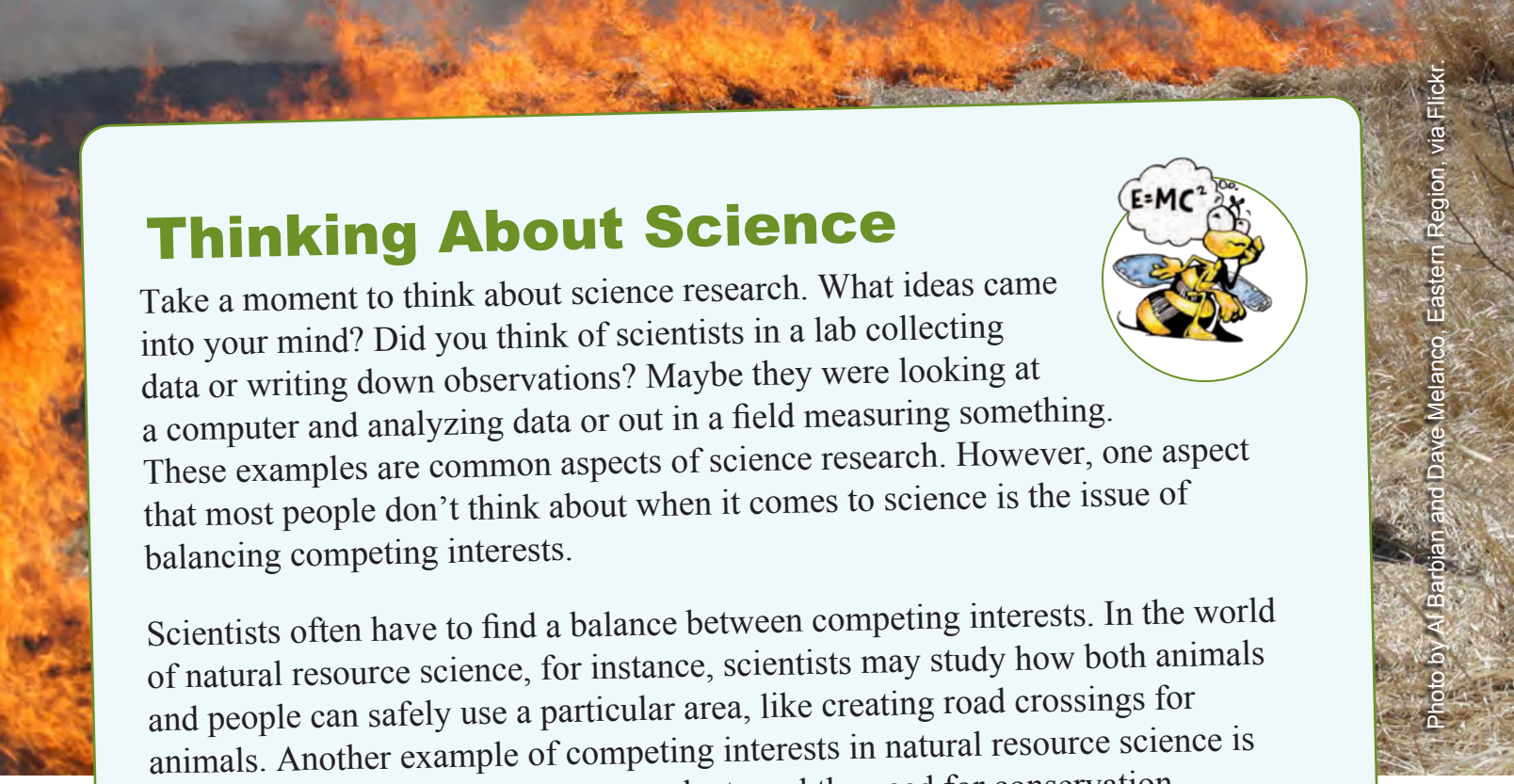


Photo by Al Barbian and Dave Melanco, Eastern Region, via Flickr.

Thinking About Science

Take a moment to think about science research. What ideas came into your mind? Did you think of scientists in a lab collecting data or writing down observations? Maybe they were looking at a computer and analyzing data or out in a field measuring something. These examples are common aspects of science research. However, one aspect that most people don't think about when it comes to science is the issue of balancing competing interests.

Scientists often have to find a balance between competing interests. In the world of natural resource science, for instance, scientists may study how both animals and people can safely use a particular area, like creating road crossings for animals. Another example of competing interests in natural resource science is balancing the need to use trees as products and the need for conservation.

In this research, the scientists are looking at how to balance **land use** issues. In particular, they are examining how to balance an animal's habitat needs with the needs and benefits of a particular tree species. You will learn more about the specific details as you read further along. As you read, think about the challenges and rewards of doing research about natural resource issues that involve competing interests.

Thinking About the Environment

An endangered species is a species that is at serious risk of extinction. Often, scientists and the public must find ways to protect endangered species while also protecting local economies. In the research in this article, the endangered species is the red-cockaded woodpecker (figure 4). The red-cockaded woodpecker is a habitat specialist. A habitat specialist means that the woodpecker strongly prefers one type of habitat. In this case, the scientists believe that the woodpecker's preferred habitat is **old-growth forests**. In particular, these woodpeckers prefer old-growth forests that include longleaf pine trees (figure 5). They also prefer those forests to have openings where they can **forage** for food.

Figure 4. An endangered red-cockaded woodpecker is feeding young at its nest. The nest is located in a **cavity** of a longleaf pine in Georgia.

Photo courtesy of John Maxwell, U.S. Fish & Wildlife Service.

Figure 5. Longleaf pine forests are native to the Southeastern United States. Longleaf pine trees can reach a height of 100 to 120 feet. Photo courtesy of Scott Horn, USDA Forest Service.

did you know?

Red-cockaded woodpeckers prefer old forests with openings so they can forage for food. For nesting, they prefer longleaf pine trees that are at least 60 years old!

Longleaf pines are an important tree species in the Southeastern United States. Longleaf pine forests are important because these forests are diverse ecosystems with over 600 different types of plant and animal species, including 29 **threatened species** or endangered species. For example, the endangered gopher tortoise lives in the longleaf pine habitat (figures 6, 7a, and 7b). Gopher tortoises are endangered in certain parts of their habitat and threatened in other areas of their habitat.

Figure 6. A young gopher tortoise walks through grasses in a longleaf pine ecosystem. Gopher tortoises can grow up to 15-inches long and weigh between 8 and 15 pounds.

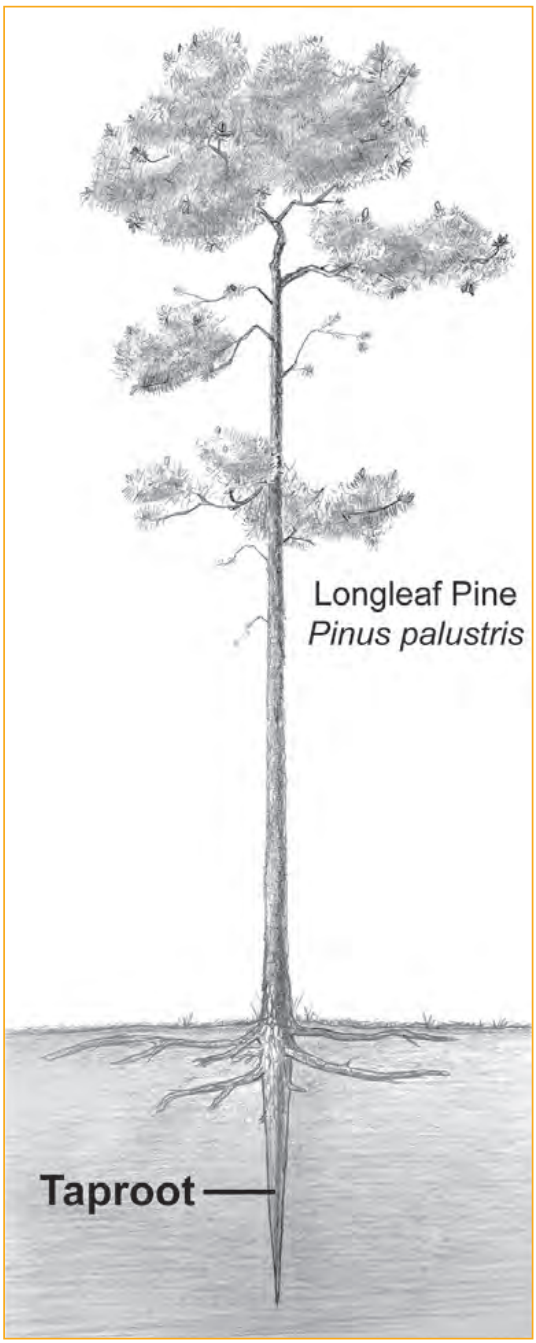
Photo courtesy of Randy Browning, U.S. Fish & Wildlife Service.

Figure 7a. An older gopher tortoise heads into a burrow. Burrows can range from 3 to 52-feet long and 9- to 23-feet deep.

Photo courtesy of Randy Browning, U.S. Fish & Wildlife Service.

Figure 7b. Can you spot the gopher tortoise burrow? (Hint: Look in the middle of the photo!)

Photo courtesy of William Pfeiffer, used with permission.



Longleaf pine has an extensive **taproot**, which enables it to be tolerant of drought conditions and hurricanes (figure 8). Longleaf pine is also resistant to attacks by southern pine beetles. Longleaf pine tree forests used to be common in the Southeastern United States. At one point, 92 million acres in the region were covered in longleaf pine forests (figure 9a). Today, approximately 4.3 million acres are left (figure 9b). Longleaf pine forests need periodic fire to maintain a healthy ecosystem. Typically, the periodic fire interval is 5 to 10 years for longleaf pine. The periodic fire helps the longleaf pine growth cycle and clears out underbrush. Certain animals like the red-cockaded woodpecker prefer to have some areas that are cleared out so that they can forage for food.

Figure 8. A taproot is a plant's main root. It grows straight down into the soil in search of nutrients, and smaller roots grow out from its sides.
Illustration by Stephanie Pfeiffer.

did you know?

Did you know gopher tortoises are considered a keystone species? A keystone species means that an animal or plant plays a critical, unique role in the health of the ecosystem. In the case of the gopher tortoise, the burrows that the gopher tortoise creates can become a shelter for over 350 different species. Wow!

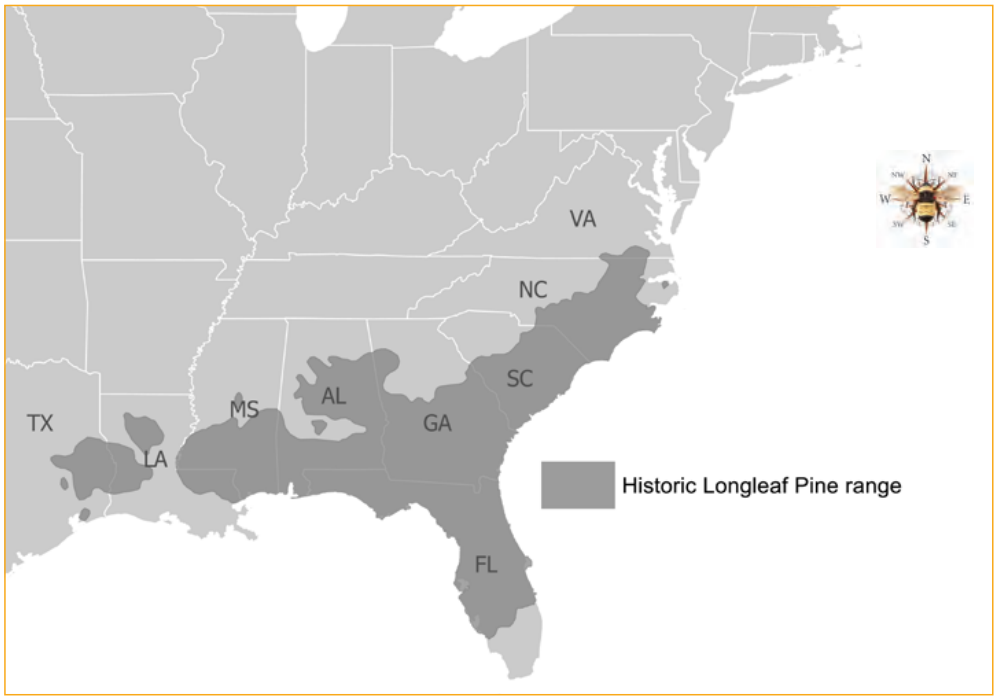


Figure 9a. This map shows the historic longleaf pine range.
Map by Carey Burda.

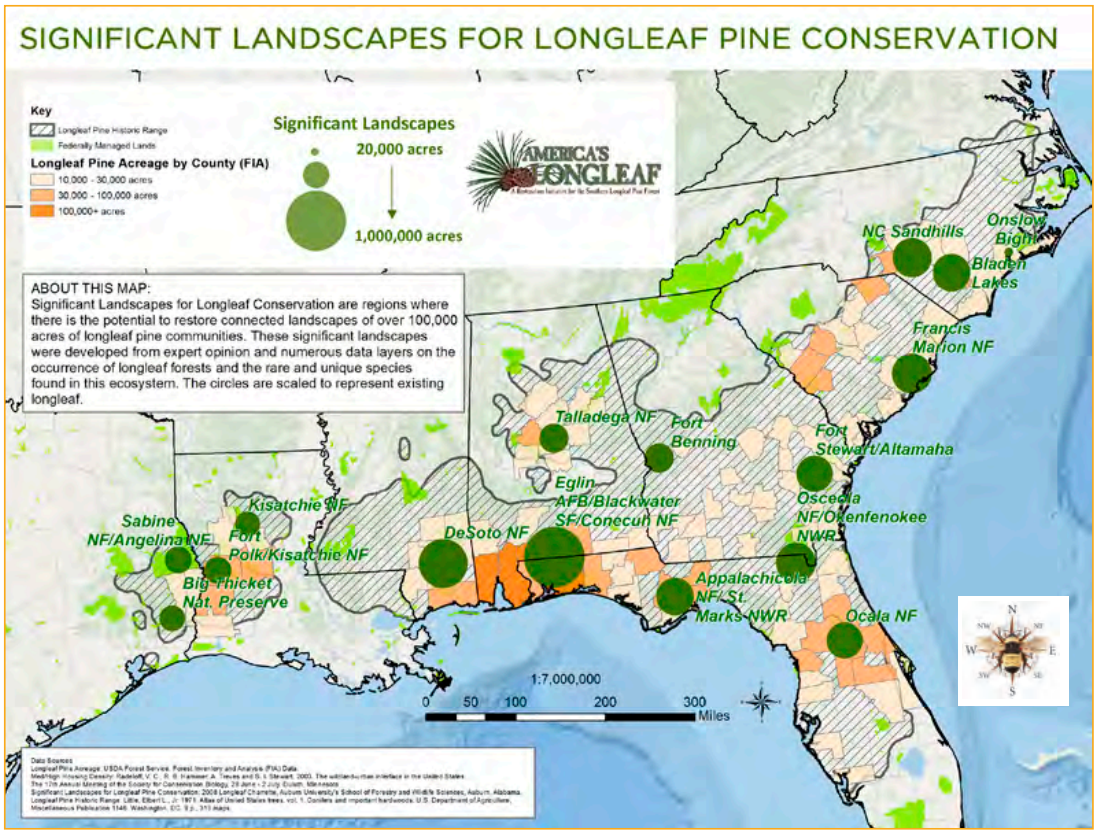


Figure 9b. This map shows significant landscapes for longleaf conservation. These significant landscapes may be connected to increase the area where longleaf pine grows.
Map courtesy of The Conservation Fund.

Introduction

All forests play an important role in the carbon cycle (figure 10). The carbon cycle refers to the movement of the element carbon through our world. Carbon is found in all living things. Humans are approximately 18 percent carbon. That means if you weigh 100 pounds, then 18 pounds of you is carbon! Plants are approximately 45 percent carbon. Forests are filled with plants and animals; therefore, forests contain a lot of carbon. Forest soils also contain carbon. When a place contains or stores a lot of carbon, it is called a carbon sink.

When carbon is not stored, it can combine with other elements. When carbon combines with oxygen, carbon dioxide (CO^2) is created. Carbon dioxide is a greenhouse gas. That means that when carbon dioxide is in the atmosphere, it helps keep some of the sun's warmth close to the Earth. If carbon dioxide and other greenhouse gases did not exist, Earth would be cold. Earth would not be the planet we know today because it could not support life as we know it. However, too much carbon dioxide means that too much

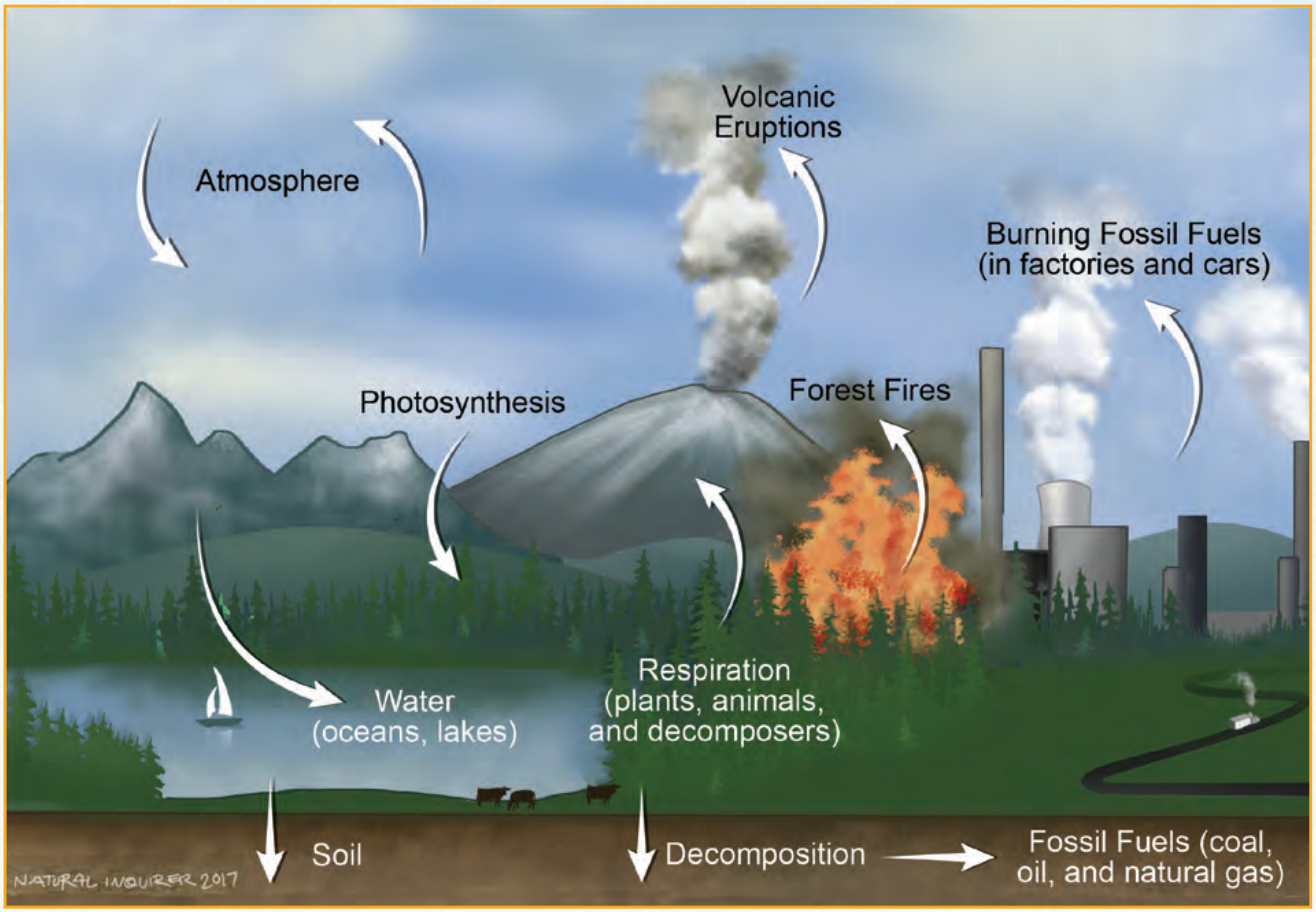


Figure 10. The carbon cycle shows how carbon moves through the environment.

Illustration by Stephanie Pfeiffer.

heat is kept in the Earth's atmosphere. Earth's atmosphere, therefore, maintains a fine balance that keeps our planet livable. In today's world, a lot of carbon dioxide is produced by our lifestyle. Forests and other carbon sinks, such as oceans and soil, help keep the carbon cycle in balance.

Natural disturbances, such as fire, can reduce carbon storage in the forests and release CO_2 into the atmosphere. However, many forests need occasional fire to remain healthy. Forest managers may conduct a prescribed fire or forest thinning activities to manage a forest and reduce the chance of destructive wildfire that will release large amounts of CO_2 into the atmosphere. Prescribed fires are planned fires (figures 11–14). Plans are written by fire specialists who describe the ideal weather and timing of the burn. Forest managers follow these plans when they implement the burn, and they closely monitor the fire. Prescribed fires are managed so that they are safe for people and the environment.

Figure 11. Chequamegon-Nicolet National Forest wildland firefighters and a team from the Midewin Interagency **Hotshot Crew** conducted a 3,400-acre prescribed fire in the Moquah Barrens, Wisconsin. This fire is one of the management techniques that the USDA Forest Service is using to restore the **pine barrens** ecosystem at Moquah Barrens. This ecosystem has evolved naturally over time with fire being the key component of a healthy ecosystem.

Photo courtesy of Chequamegon-Nicolet National Forest (USDA Forest Service, Eastern Region), via Flickr.

Figure 12. Firefighting crews monitor the Canyon 66 prescribed fire in Ochoco National Forest in Oregon, September 2019.

Photo courtesy of USDA Forest Service, Pacific Northwest Region, via Flickr.

Figure 13. Drip torches are often used during a prescribed fire.

Photo courtesy of U.S. Department of the Interior, Bureau of Land Management, Oregon, via Flickr.

The scientists in this study were interested in looking at how prescribed fire affects longleaf pine forests and their ability to store carbon. The scientists also wanted to know how red-cockaded woodpecker habitat is affected by prescribed fire. Recall that the red-cockaded woodpecker, which lives in longleaf pine forests, is an endangered species. Therefore, the woodpecker's health and protection must be considered when thinking about any management action. To learn more about the red-cockaded woodpecker, read the "Thinking About the Environment" section above.

Figure 14. Prescribed fire can be used to achieve different management objectives. In this photo, forest managers are burning 23 acres of **invasive**, non-native grasses at Lower Table Rock in Oregon.

Photo courtesy of U.S. Department of the Interior, Bureau of Land Management, Oregon, via Flickr.

In your own words and in the form of a question, what did the scientists want to learn in this study?

Based on what you have read so far, why do you think the ability to store carbon or have a carbon sink is important?

Methods

The scientists conducted their study at the Fort Benning military post in Georgia (figure 15). Across the landscape of Fort Benning, trees range in age from less than 10 years to over 100 years.

The scientists collected data from 223 plots that represented the wide variety of tree ages as well as different types of red-cockaded woodpecker habitat (table 1). The scientists also assigned prescribed burn management for different sections including the following: no management; burn only (burn every 3 years); and thin and burn (burn every 3 years and thin every 30 years). Thinning is a management practice that involves cutting a certain percentage of trees in the forest to restore forest health.

The scientists used an elemental analyzer with an isotope-ratio mass spectrometer to determine the total carbon. An elemental analyzer is a machine that helps scientists figure out what kinds of elements and how much of each element are in an item. The scientists also took measurements of the amount of surface fuel litter and coarse woody debris. Surface fuel litter and coarse woody debris are the leaves, sticks, dead wood, and other material on the forest floor (figure 16). The amount of this forest fuel and woody debris in an area gives scientists an idea of how fire may move through an area.

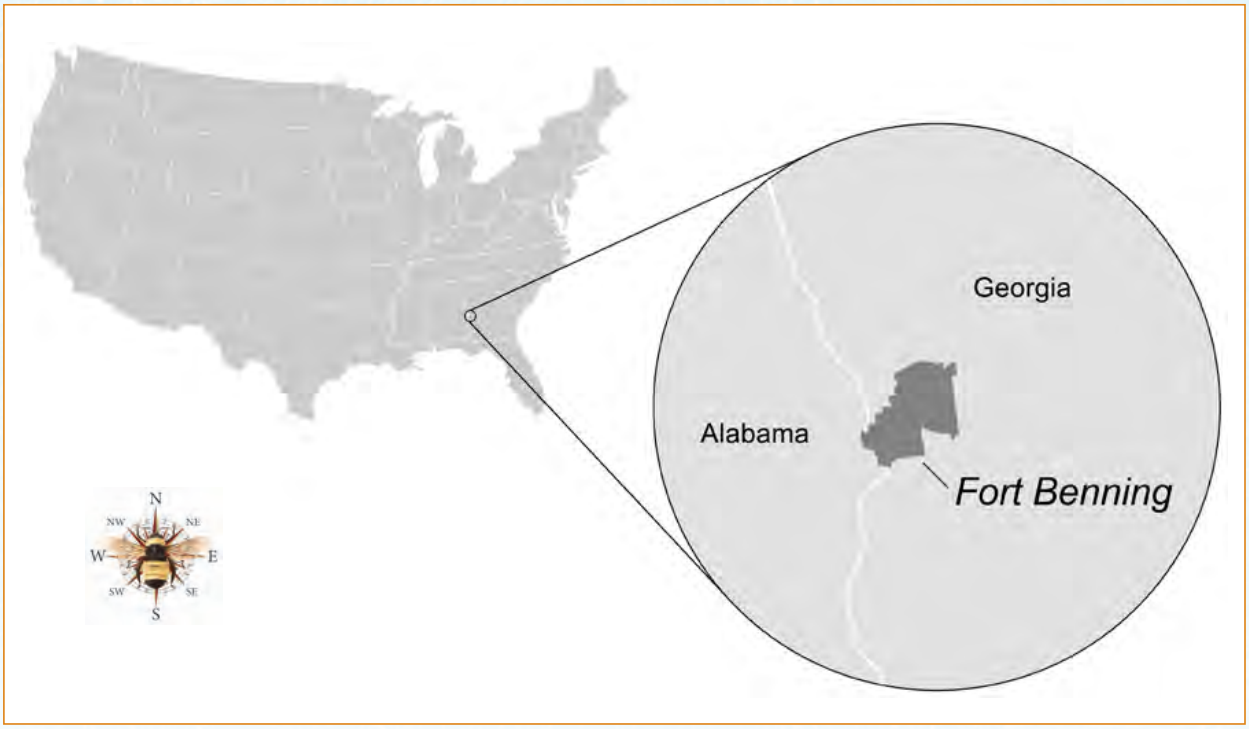


Figure 15. Fort Benning is located on the Georgia/Alabama border.
Map by Carey Burda.

Number of Plots	Age of Trees on Plot	Type of Red-Cockaded Woodpecker (RCW) Habitat
63	Younger (less than 10 years old)	Sites that are being restored and are future RCW habitat
88	Mature (30-60 years old)	RCW foraging habitat
72	Older (greater than 60 years old)	RCW roosting habitat

Table 1. The scientists collected data from 223 plots that represented the wide variety of tree ages and red-cockaded woodpecker habitat.

Figure 16. Surface fuel litter and coarse woody debris are the leaves, sticks, dead wood, and other material on the forest floor.

Photo by Jessica Nickelsen.

For example, as forest fuel and woody debris accumulate over time, it changes the forest structure. As more fuel accumulates, the forest becomes overcrowded, and there are more pathways for a fire to move up into the tops of the trees. Typically, the tops of trees are closer together, enabling fire to spread quickly. These types of fires are known as crown fires. They are intense fires and difficult to control.

Scientists also took a variety of measurements from the trees in the plots. Some examples of these measurements include tree species, height, diameter at breast height (DBH), and whether the tree was alive or dead. DBH is a measurement that is taken at the same height aboveground for every tree. In the United States, the measurement is taken at 4.5 feet (figure 17a and 17b).

Number Crunch

How many meters is 4.5 feet? Hint: 1 meter equals 3.281 feet.

The scientists took all the information they gathered and put the data into computer models. The models represented different scenarios of prescribed fire (no management, burn only, and thin and burn).

The scientists examined the different models to look at the effects of managing for red-cockaded woodpecker habitat and carbon storage in the longleaf pine forests.

Figure 17a and 17b. Scientists commonly measure the diameter at breast height of trees. Every tree is measured at the same height above the ground. This measurement enables scientists to compare different trees using the same measurement.

Photo by Paul Scowcroft and illustration by Stephanie Pfeiffer.

Reflection Section

Think about the type of trees near where you live. Do you have pine trees? Do you have **hardwoods** like oak or maple? What type of tree stands out most to you? Why?

Explain in your own words why it is important to be aware of the amount of forest fuel there is in a certain area.

Findings

The scientists found that each of the three treatments gained carbon over time, but they gained the carbon at different rates (figure 18). The unmanaged treatment provided the greatest carbon storage, but habitat for the red-cockaded woodpecker was lost and the risk of destructive wildfires increased. Treatment with thinning and prescribed burning helped expand red-cockaded woodpecker habitat because longleaf pine became more prevalent. This type of treatment also helped reduce the density of the forest. Reducing the density of the forest helps create open space and reduces the risk of destructive wildfires. The open spaces are used by certain animals, like the red-cockaded woodpecker, for foraging. However, 22 percent less carbon was stored in this treatment area.

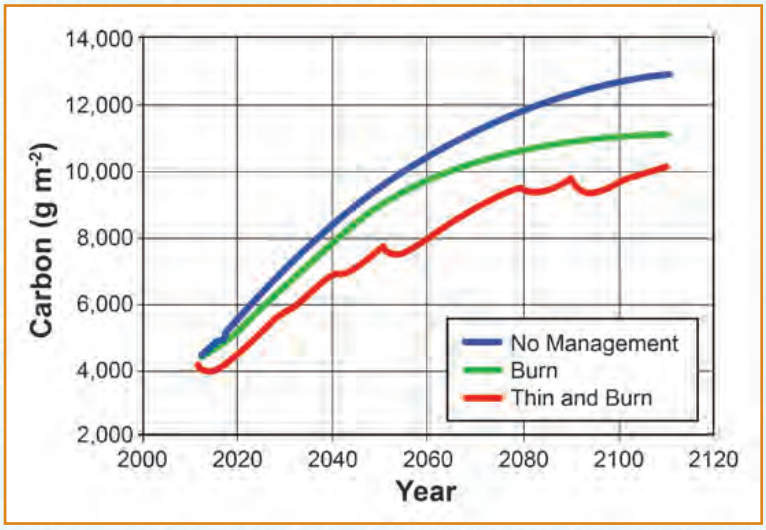


Figure 18. Notice how all of the treatments (no management, burn only, and thin and burn) gained carbon over time.

Illustration by Stephanie Pfeiffer.

Why do you think the unmanaged treatment resulted in greater carbon storage? Why did the treatments that included fire result in less carbon storage? Examine Figure 10 if you need a clue.

In your own words, describe what the scientists found.

Discussion

The results show that carbon storage, habitat for the red-cockaded woodpecker, and conservation of longleaf pine ecosystems can be achieved. The study suggests that forests where fire is **suppressed** hold more carbon. Fire suppression means that fires that might normally burn, if there was no human intervention, are stopped by humans.

However, the suppression of fire leads to less biodiversity. More frequent prescribed fire can also reduce the area's **susceptibility** to wildfire by reducing the surface fuel load available. There are tradeoffs, but depending on the needs of the community where this problem occurs, there can be several management scenarios to achieve a variety of objectives.

Based on what you have read, do you think it is important for forest managers to balance the competing interests of storing carbon and using prescribed fire to foster healthy longleaf pine habitat? Why or why not?

In everyday life, we often have to make tradeoffs. Think of a recent time that you experienced a situation where you had to choose between two or more things. What did you do that helped you make the decision? Discuss with a classmate.

Adapted from Martin, Katherine L.; Hurteau, Matthew D.; Hungate, Bruce A.; Koch, George W.; North, Malcolm P. 2015. Carbon tradeoffs of restoration and provision of endangered species habitat in a fire-maintained forest. Ecosystems. 18(1): 76-88.

KNOCK ON WOOD
GLOSSARY

Cavity (**ka** və tē): A hollowed out space; in this case, a hollowed out space in a tree.

Forage (**fȯr** ij): To wander in search of food.

Girth (**gərth**): A measure around a body.

Hardwood (**härd** wůd): (1) The wood of a tree without cones; (2) A tree without cones.

Hotshot Crew (**hät** shät **krü**): A highly trained fire crew used mainly to build firelines by hand.

Hydraulic (hī **drȯ** lik): Of or relating to water or other liquid in motion.

Invasive (in **vā** siv): (1) Tending to spread or infringe upon; (2) Tending to spread; (3) Movement into an area by an object or organism that is likely to cause harm.

Land use (**land yüs**): (1) Ways humanity has used the land; (2) The way the land is being used, such as for homes, agriculture, roads, or forests; (3) How people are using the land.

Mesa (**mā** sə): A flat-topped hill with steep sides.

Old-growth forests (ōld **grōth fȯr** əsts): Forests that contain trees that are hundreds or sometimes thousands of years old.

Restored (ri **stȯr**): (1) To put or to bring back into a past or original state; (2) To bring back to an earlier or normal condition.

Prescribed fire (pri **skrīb**ed **fīr**): (1) The controlled application of fire to wildland fuels under certain weather conditions as a forest management tool; (2) Human application of fire to wildland vegetation under certain weather conditions as a forest management tool.

Pine barrens (**pīn ber** ən): An ecosystem characterized by sandy soil that is low in nutrients. It has acidic water, adapted to fire, and often contains pine trees and shrubs.

Suppress (sə **pres**): To inhibit the growth or development of; in this case, fire.

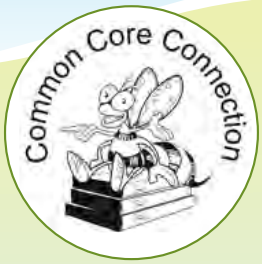
Susceptibility (sə sep tə **bi** lə tē): Lack of ability to resist some extraneous agent (such as a pathogen or drug).

Threatened species (**thre** tənd **spē** shēz): Legal term meaning the existence of the species is likely to become endangered in the future.

Taproot (**tap** rüt): A primary root that grows vertically downward and gives off small lateral roots.

Accented syllables are in **bold**. Marks and definitions are from https://www.merriam-webster.com. Definitions are limited to the word's meaning in the article.

FACTivity



Time Needed

Two class periods

Materials

- Various art supplies (paper, colored paper, markers, colored pencils, scissors, etc.)
- Pencils
- Brainstorming sheet

FACTivity **Background**

In this research article, you learned that prescribed fires are an important management tool used by land managers. Prescribed fires are different than wildland fires and have a variety of benefits.

The question you will answer in this FACTivity is:

What character or mascot can I create to teach people about prescribed fires?

FACTivity **Methods**

You (or your team) will be provided with a variety of art supplies and a brainstorming sheet. First, fill out the brainstorming sheet.

After you have completed your brainstorming sheet, work on creating a character or mascot that could teach people about prescribed fires. Make sure to name your character/mascot. Also include a fact sheet about prescribed fire with your character/mascot design. You should have five to seven facts about prescribed fire.

You will present your design to the class when everyone is finished.

Brainstorming Sheet

Names: _____

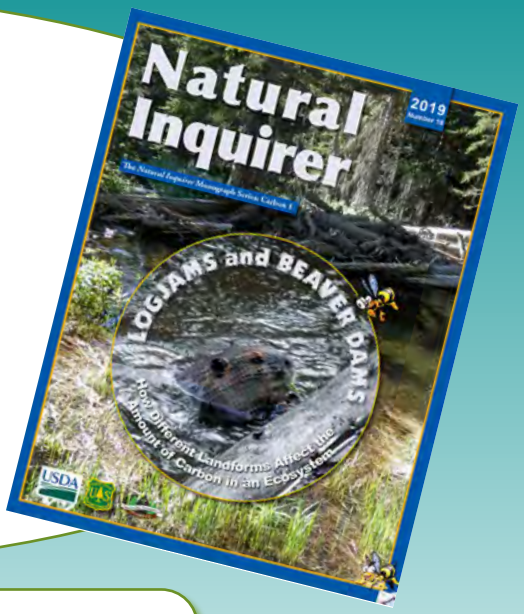
Facts about prescribed fire	Character/ Mascot Design Draft
What is prescribed fire and why is it used?	
Who uses prescribed fire?	
What are the benefits of prescribed fire?	
Any additional information you would like to include about prescribed fire?	
Possible Character/Mascot Names	

Natural Inquirer Connections

You may want to reference this *Natural Inquirer* article for additional information and FACTivities:

- For more information on carbon storage, read the *Natural Inquirer* Logjams and Beaver Dams monograph.

This article, along with others, can be found at: http://www.naturalinquirer.org/all-issues.html.



If you are a trained Project Learning Tree educator, you may use "Plant a Tree" as additional resources.

WHAT'S IN A NAME?

The "Knock on Wood" title alludes to the common saying, and sometimes action, of knocking on wood. People often say knock on wood in order to avoid bad luck or to bring good luck. Particularly, this saying or action is used right after mentioning a good luck situation or something that may happen in the future.

WEB RESOURCES

The Cornell Lab of Ornithology: Red-Cockaded Woodpecker
https://www.allaboutbirds.org/guide/Red-cockaded_Woodpecker/id

U.S. Fish & Wildlife Service Red-Cockaded Woodpecker
https://www.fws.gov/endangered/esa-library/pdf/woodpecker.pdf

U.S. Fish & Wildlife Service Gopher Tortoise Fact Sheet
https://www.fws.gov/northflorida/GopherTortoise/Gopher_Tortoise_Fact_Sheet.html

USDA Forest Service "Influence of Forest Structure on Wildfire Behavior and the Severity of Its Effects"
https://www.fs.fed.us/projects/hfi/2003/november/documents/forest-structure-wildfire.pdf

USDA Longleaf Pine Fact Sheet
https://plants.usda.gov/factsheet/pdf/fs_pipa2.pdf