

Fire and Water:

Predicting Future Wildfires in a Changing Climate



PHOTO COURTESY OF THE GILA NATIONAL FOREST.

What Kinds of Scientists Did this Research?

ecologist: This scientist studies the relationship of living things with their living and nonliving environment.

meteorologist: This scientist studies the atmosphere.

Thinking About Science

Predicting what might happen is a challenge. To plan for the future, a range of possibilities must be considered. Although we do not know for sure what the future will bring, we can plan for the future with many possibilities in mind.



Consider your own future. You might think, “If I get an A in English this year, I will be asked to join the school newspaper staff next year.” Or, you might think, “If I get a D in English this year, I will not be allowed to join the soccer team next year.” Along with these different possible futures, it is helpful to have some idea of how likely you are to earn either grade. Otherwise, you might have a difficult time planning for your future.

The scientists in this study wanted to predict the future likeliness of wildfires and where in the Southern United States these wildfires might occur. To do this, the scientists considered four possible futures. Each of these four possible futures was built on different ideas about what might happen in the future.

Each possible future was described by a model. A model is a simplified example of something. These four models were built from mathematical equations that described a possible future. Each model, for example, contained a different number **projecting** the human population in 2060. Each model also contained a different number projecting the average yearly air temperature in 2060. Using numbers to describe possible future conditions enables scientists to predict what might happen in the future.



John Stanturf, ECOLOGIST:

My favorite science experience is getting to meet all kinds of people in many countries and seeing different kinds of forests.



Scott Goodrick, METEOROLOGIST:

My favorite science moment was when I first saw a time-lapse movie of clouds on TV when I was a kid. I watched a thunderstorm develop from a small puffy cloud to a majestic thunderhead over the course of a minute rather than an hour. Watching the cloud develop revealed some of the mysteries of these storms. Seeing things from a different perspective can open your eyes to new worlds.

Thinking About the Environment

Wildfires are a particular type of **wildland** fire. Some wildland fires are beneficial to a forest. This is because some kinds of forests need occasional fire to remain healthy (FIG. 1). Sometimes, wildland fires are purposefully set and managed to improve a forest's health. Beneficial fires burn at low temperatures and their flames stay close to the ground. These fires help to clean out brush and wood lying on the ground, but do not damage large trees. When fires are purposefully set, they are managed so that they can be easily put out. These kind of fires are called prescribed fires (FIG. 2).



Wildfires are a different kind of wildland fire. Wildfires may be **ignited** naturally, such as by lightning. They may also be ignited by careless human acts. Wildfires burn at high temperatures. Their flames reach high into **tree crowns** (FIG. 3). Wildfires are difficult to control and **extinguish**, and they may cause a lot of environmental and **economic** damage.

FIGURE 1. A LONGLEAF PINE FOREST NEEDS OCCASIONAL FIRE TO REMAIN HEALTHY. PHOTO BY RICKY LAYSON AND COURTESY OF [HTTP://WWW.BUGWOOD.ORG](http://www.bugwood.org).



FIGURE 2. A PRESCRIBED FIRE IS PURPOSEFULLY SET BY FORESTERS TO MANAGE THE FOREST. PHOTO BY DAVID CAPPAERT AND COURTESY OF [HTTP://WWW.BUGWOOD.ORG](http://www.bugwood.org).



FIGURE 3. WILDFIRES ARE LARGE WILDLAND FIRES WHOSE FLAMES REACH HIGH INTO TREE CROWNS. PHOTO COURTESY OF THE GEORGIA FORESTRY COMMISSION ARCHIVE AND [HTTP://WWW.BUGWOOD.ORG](http://www.bugwood.org)



Introduction

Wildfires often occur during times of **drought**. When rainfall is low, trees, wood lying on the ground, and **leaf litter** are drier, and therefore are more likely to burn (FIG. 4). Wildfires are more likely when droughts occur and during periods of high temperatures.

Successfully predicting where and when wildfires might occur is important. This prediction is important because of possible environmental and economic damage. As the climate warms, the possibility of wildfires might increase. The scientists in this study wanted to predict where and in what seasons wildfires might occur.

The scientists were particularly interested in the Southern United States (FIG. 5). Wildfires across the Southern United States burn fewer hectares than are burned in the Western United States (FIG. 6). These southern fires, however, destroy many more homes and buildings than western wildfires. The scientists wanted to look 50 years into the future to the year 2060.



FIGURE 4. WOOD LYING ON THE FOREST FLOOR, ALONG WITH LEAF LITTER, PROVIDES FUEL FOR WILDFIRES. PHOTO BY BABS McDONALD.

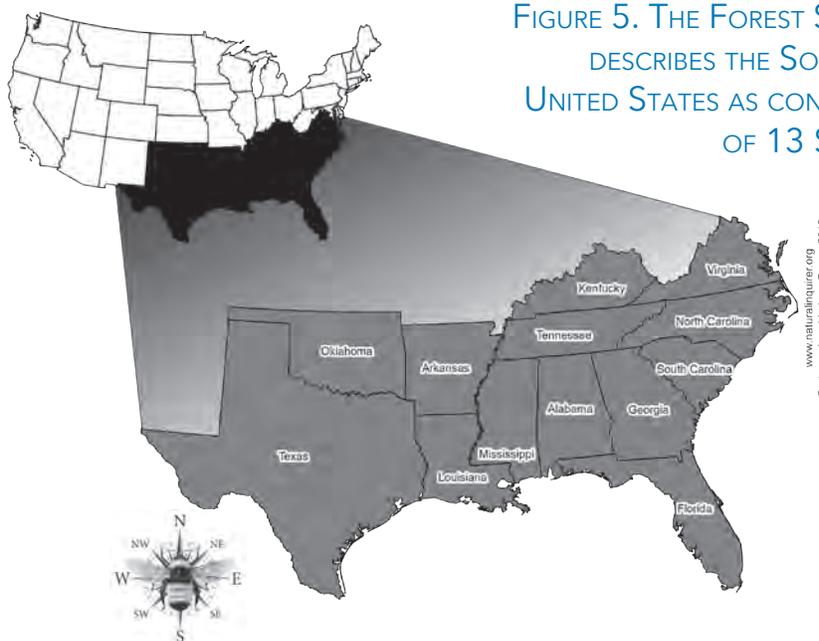


FIGURE 5. THE FOREST SERVICE DESCRIBES THE SOUTHERN UNITED STATES AS CONSISTING OF 13 STATES.

www.naturalinquirer.org
Cartographer: Lindsay Gamm, 2013

Number Crunch

► How old will you be in 2060?

Did You Know?

How Big Is a Hectare?

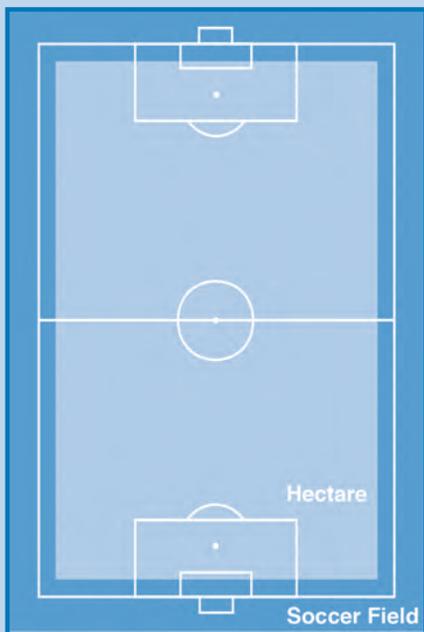


Figure 6. A hectare is a little smaller than a soccer field. One hectare is equal to 2.47 acres.

Reflection Section



- ➔ Why do you think southern wildfires burn more homes and buildings than western wildfires?
- ➔ In what ways could wildfires affect you in 2060?
- ➔ How might the successful prediction of wildfires be helpful to communities?

Methods

If the climate were not changing, scientists might predict that there would be no change in the occurrence of wildfires. Because the climate is changing, scientists believe that the occurrence of wildfires will change. An aspect of climate change of particular importance to wildfire prediction is rising temperatures. As average temperatures rise, the possibility of drought rises as well.

To predict potential wildfires, the scientists considered four possible futures (FIG. 7). These futures were based on different climate change models. A climate change model is a mathematical equation that makes different **assumptions** about weather and other conditions over time.

Future A (Climate model 1)	Future C (Climate model 2, with different human population projections)
Future B (Climate model 2)	Future D (Climate model 3)

FIGURE 7. THE FOUR POSSIBLE FUTURES WERE LABELED A, B, C, AND D. EACH OF THESE FUTURES WAS BASED ON A CLIMATE CHANGE MODEL. EACH MODEL MAKES DIFFERENT ASSUMPTIONS ABOUT THE FUTURE. EACH CLIMATE CHANGE MODEL, FOR EXAMPLE, **ASSUMES** THAT THE TEMPERATURE WILL RISE BY A DIFFERENT NUMBER OF DEGREES. EACH ASSUMES DIFFERENT PATTERNS OF RAINFALL. BECAUSE SCIENTISTS DO NOT KNOW FOR SURE WHAT WILL HAPPEN IN THE FUTURE, THEY CONSIDER DIFFERENT POSSIBLE FUTURES.

The scientists then measured the potential for wildfire in each of these possible futures. This measurement took two things into account. These two things are potential evapotranspiration (ē **v**ap ō tran spīr ā shən) and how much **precipitation** is predicted to fall (FIG. 8).

The scientists calculated potential evapotranspiration based on the predicted weather variables in each of the four models. The scientists then subtracted predicted precipitation from potential evapotranspiration for each model.

What Is the Difference Between Weather and Climate?

The difference between weather and climate is a measure of time. Weather is the conditions in the atmosphere over a short amount of time. Weather includes daily temperatures, relative humidity, and wind speed, for example. Climate is a long-term average of weather measurements. Climate change is changes in the long-term average of weather measurements.

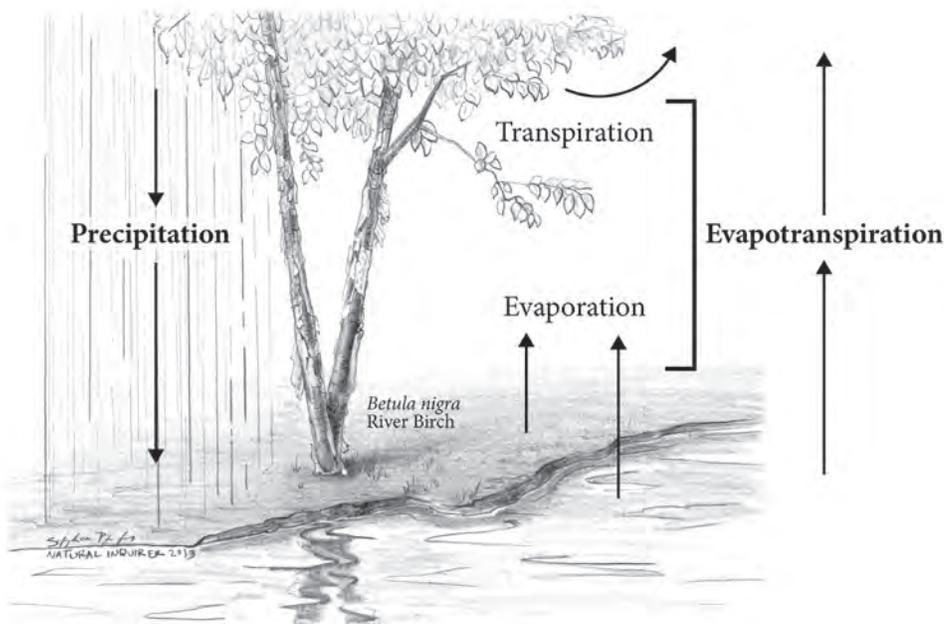


FIGURE 8. POTENTIAL EVAPOTRANSPIRATION IS A MEASURE OF HOW MUCH WATER CAN MOVE FROM THE SURFACE OF EARTH TO THE ATMOSPHERE. PRECIPITATION IS A MEASURE OF HOW MUCH WATER MOVES FROM THE ATMOSPHERE TO EARTH. ILLUSTRATION BY STEPHANIE PFEIFFER.

What Is Potential Evapotranspiration?

Potential evapotranspiration is a measurement used by scientists to determine how much evaporation would occur from our planet's surface if enough water was available. Potential evapotranspiration is affected by temperature, wind, and other weather **variables**. It is not affected, however, by the amount of water available because adequate water supply is assumed.

Reflection Section



- ➡ Why did the scientists consider four possible futures instead of just one?
- ➡ What is the relationship between precipitation and wildfire?

In drier areas, potential evapotranspiration is higher than precipitation (FIG. 9). Drier areas may be more likely to experience wildfires. Using this process, the scientists identified areas in the Southern United States that may be more likely to have wildfires. They used this process for each of the four possible futures in the year 2060.



FIGURE 9. WHEN POTENTIAL EVAPOTRANSPIRATION IS GREATER THAN PRECIPITATION, AN AREA EXPERIENCES DROUGHT (A). WHEN POTENTIAL EVAPOTRANSPIRATION IS LESS THAN PRECIPITATION, AN AREA EXPERIENCES WET CONDITIONS (B). YOU WILL NOTICE IN PHOTO B THAT THERE IS A LIGHTER AREA AT THE FRONT OF THE PHOTO. THIS LIGHTER COLORED AREA IS WATER. PHOTOS COURTESY OF TOM MILLER, UNIVERSITY OF KENTUCKY, AND [HTTP://WWW.BUGWOOD.ORG](http://www.bugwood.org) (A), AND DAREN MUELLER, IOWA STATE UNIVERSITY, AND [HTTP://WWW.BUGWOOD.ORG](http://www.bugwood.org) (B).

Findings

All four possible futures showed similar wildfire potential in 2010 (FIG. 10A). Areas in the western part of the Southern United States had a higher potential for wildfire because of drier conditions and higher temperatures.

Prescribed fire is used frequently in the South to reduce the amount of fuel on the ground. As the wildfire season gets longer in the future, the need for fuel reduction will be greater. Unfortunately, drier conditions will also make using prescribed fire more dangerous. Some of the greater dangers of prescribed fire in drier conditions include the following:

- **More chance of fire escaping**
- **More damage to natural and human-built resources**
- **More smoke-related air pollution, causing health problems**
- **More smoke in the air, creating dangerous driving conditions**

Instead of using prescribed fire, managers may need to use other procedures to reduce ground-level fuels. Other procedures include cutting or chopping and removing ground-level plants or using chemicals to kill the plants. Unfortunately, these other methods usually cost more than prescribed fire, and these methods provide fewer environmental benefits than prescribed fire.

If the chance for wildfire increases into the future, more fires will contribute even more to climate change. When forests are green and growing, they hold carbon on Earth. When trees and other plants are burned by wildfire or prescribed fire, the carbon contained in the trees is released into the atmosphere.

To better understand how conditions might change in the future, the scientists compared the map of wildfire potential in 2060 (FIG. 10B) with the map of areas experiencing wildfires in 2010 (FIG. 10A, PAGE 50).

The scientists found that, in 2060, the driest areas were not always the areas with wildfires. Dry areas may have little vegetation and therefore no fuel to burn in a wildfire. Areas predicted to have the greatest number of burned hectares were areas with the most precipitation. Many hectares burn in these areas because high precipitation causes forest growth. Many trees provide a lot of fuel for wildfires.

In 2060, all four possible futures predicted drier conditions than in 2010. Future A showed the most extreme dry conditions. All of the areas experiencing wildfires in 2010 are predicted to become drier in 2060 with a higher potential for wildfire.

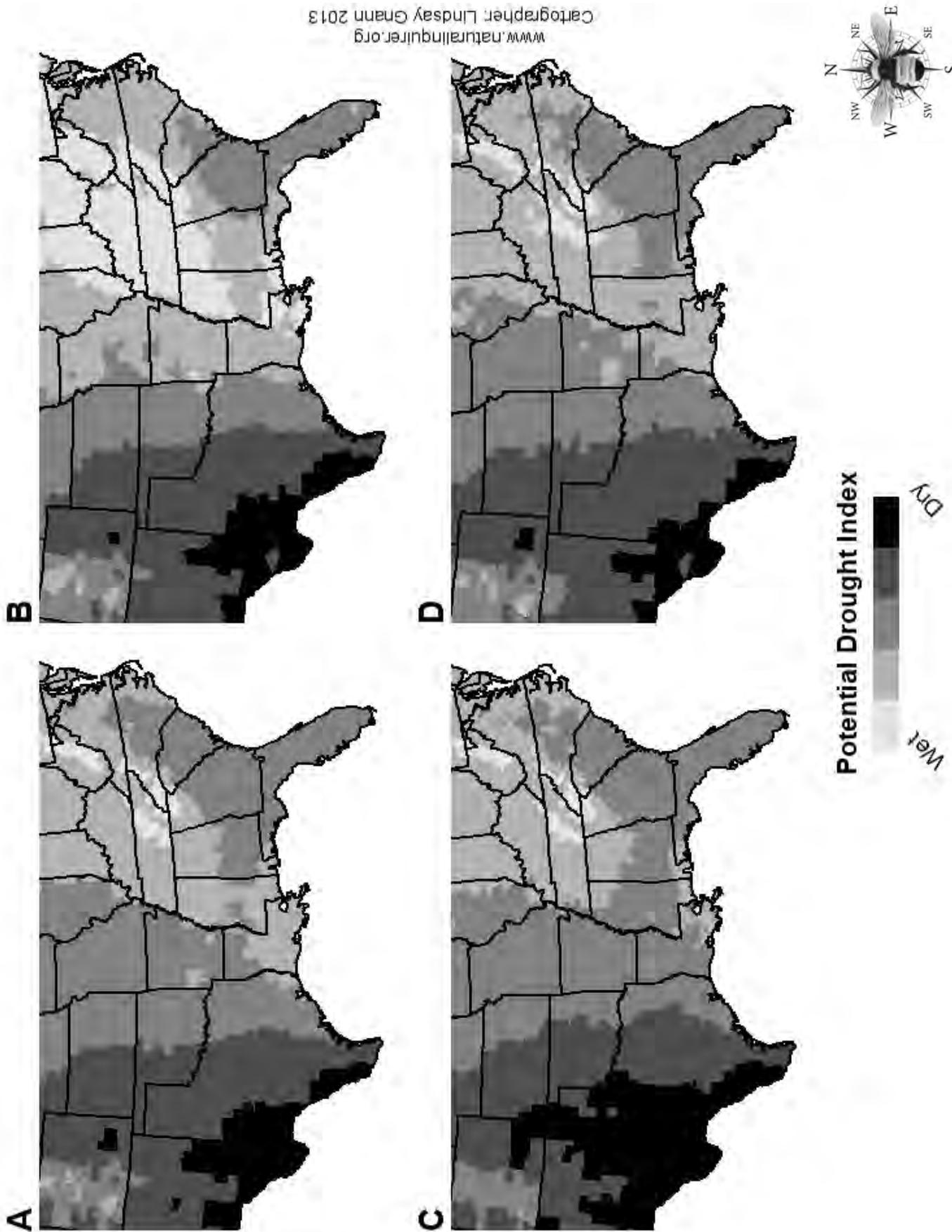


FIGURE 10A. WILDFIRE POTENTIAL AS A FUNCTION OF POTENTIAL DROUGHT IN THE SOUTHERN UNITED STATES IN 2010 FOR FOUR POSSIBLE FUTURES.

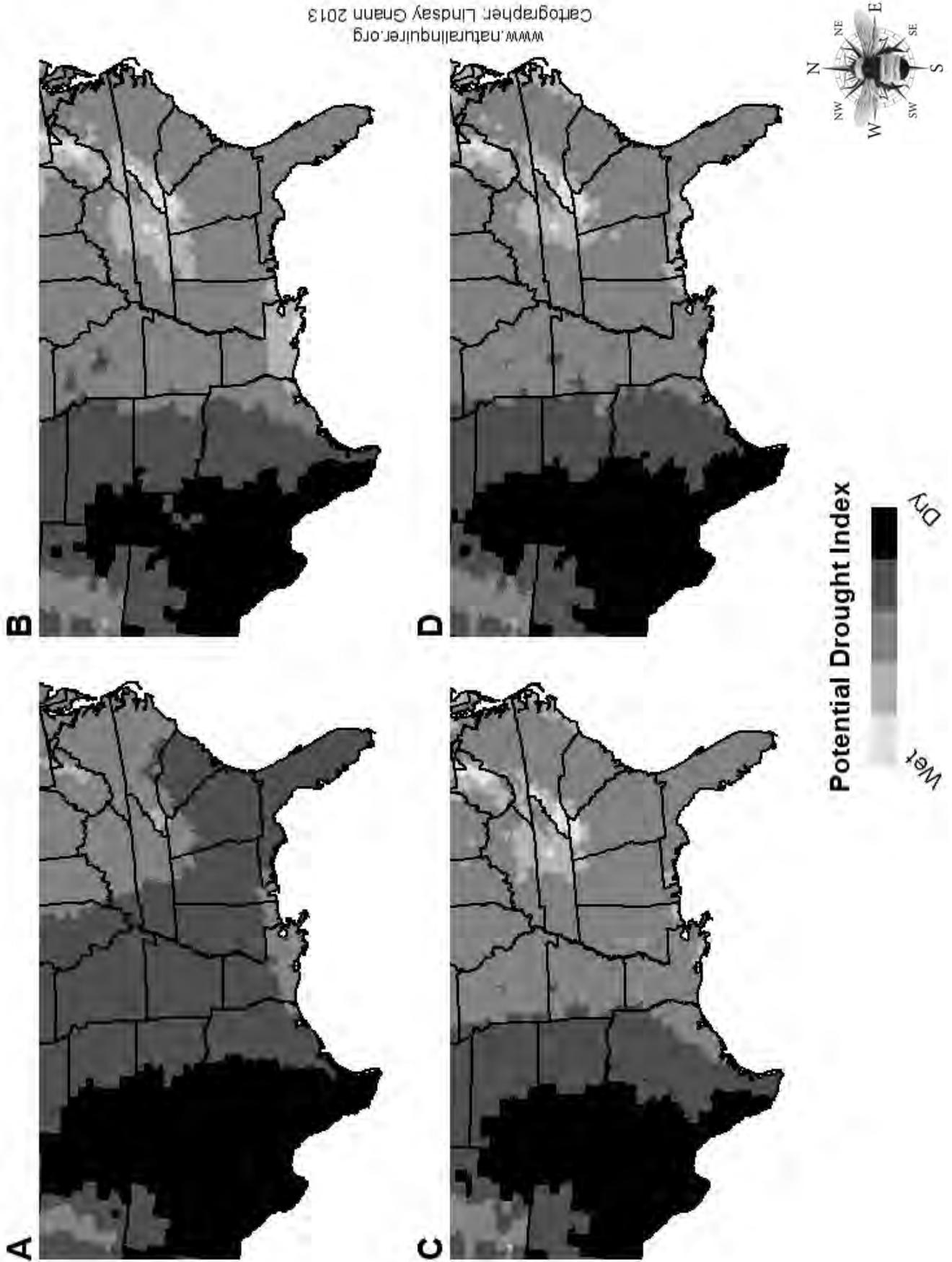
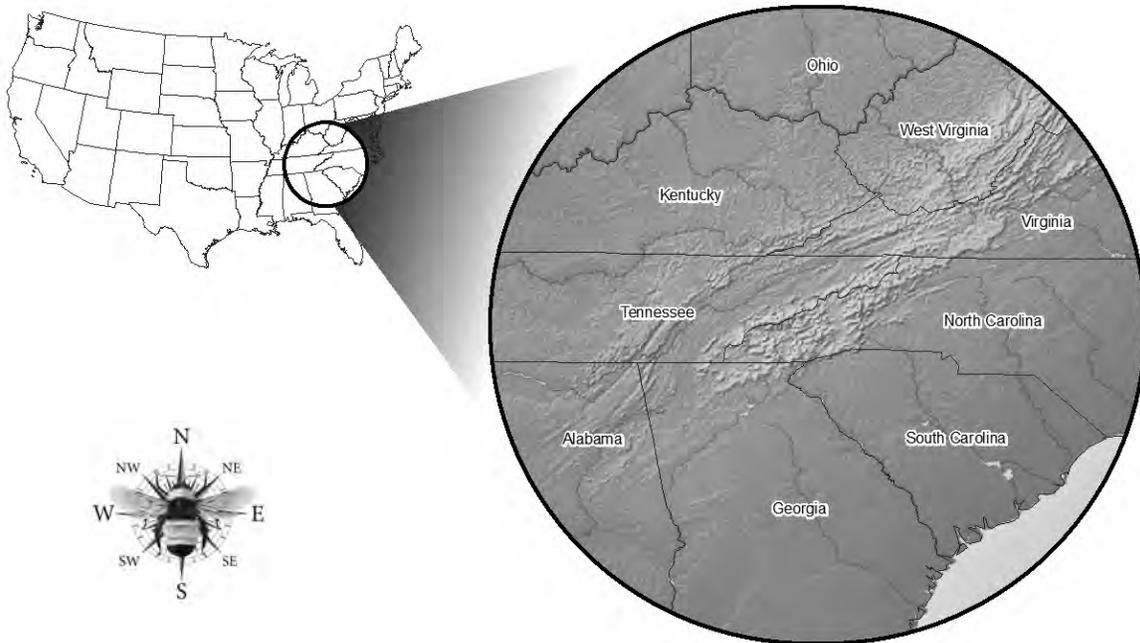


FIGURE 10b. WILDFIRE POTENTIAL AS A FUNCTION OF POTENTIAL DROUGHT IN THE SOUTHERN UNITED STATES IN 2060 FOR FOUR POSSIBLE FUTURES.

Reflection Section



- ➡ If areas currently experiencing wildfires become drier in the future, what will happen to the wildfire potential?
- ➡ Look at figure 10b. What landform is predicted to be the South's wettest area in 2060? If you do not know, look at the **topographic** map below. What is it about this landform that creates a wetter area?



Discussion

The scientists concluded that wildfire risk will increase slightly over the next 50 years. The scientists also predicted that rising temperatures will increase the chance of wildfires occurring in the spring and fall. If this happens, the risk for wildfires will be higher in the spring, summer, and fall of each year.

The population of the Southern United States is predicted to rise. More urban development in and near forests is expected. A rising population and more development will mean more people living in and near forests. The scientists caution that more people could mean more wildfires because some careless actions can cause wildfires, and more people will be living near and in forests.



Glossary

- assume** (ə sūm): To take information as granted or true.
- assumption** (ə səm(p) shən): A fact or statement taken for granted.
- drought** (draut): A period of dry weather with little or no rain.
- economic** (e kə nā mik): Of, relating to, or based on the production, distribution, and consumption of goods and services.
- evident** (ev ə dent): Clear to the sight or the mind.
- extinguish** (ik stɪŋ (g)wɪʃ): To bring to an end.
- ignite** (ig nīt): To cause to burn.
- leaf litter** (lēf li tər): The top layer of dead and decaying leaves, small sticks, and twigs that lay on the forest floor.
- precipitation** (pri si pə tā shən): Rain, hail, snow, mist, or sleet.
- project** (prə jekt): To plan, figure, or estimate for the future.
- topographic** (tō pə gra fik): Of, related to, or concerned with the physical features that make up the topography (tə pā grə fē) of an area, such as mountains, valleys, plains, and bodies of water.
- tree crown** (trē kraun): The upper green section of a tree with leaves or needles.
- variable** (ver ē ə bəl): Something that is able or apt to vary.
- wildland** (wīld land): Forested or other natural environment that does not contain buildings or other human construction.

Reflection Section



- ➡ According to this research, how is a changing climate affecting the future potential for wildfire in the Southern United States?
- ➡ The scientists noted that more people living in the Southern United States may mean two things: more wildfires being ignited by careless people and more homes and buildings near and in forests. What is one thing that could be done to reduce the number of potential wildfires?

Adapted from Stanturf, J.A.; Goodrick, S.L.[In press]. Fire. In:Wear, David N.; Greis, John G., eds. The Southern Forest Futures Project: Technical Report. Gen. Tech. Rep. SRS-178. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. <http://www.srs.fs.usda.gov/futures/reports/draft/pdf/technicalreport.pdf>

Accented syllables are in **bold**.
Marks and definitions are from
<http://www.merriam-webster.com>.



FACTivity

Time Needed

1 class period, more time may be needed for independent research

Materials

- Blank paper or science notebook
- Pencil
- Poster board
- Felt markers (various colors)
- Access to media center or the Internet

The question you will answer in this FACTivity is: How would I use technology to communicate wildland fire safety in the year 2050?

Background

The Forest Service is an agency of the U.S. Department of Agriculture. The Forest Service has three main branches. Research and Development is one of the branches. The research in this article was done by scientists working in the Research and Development branch of the Forest Service. Another Forest Service branch is called State and Private Forestry. Educators working in this branch communicate important information to students and adults. Often, these educators develop educational materials based on the work of Forest Service scientists.

In this FACTivity, you will time-travel to the year 2050. The scientists who conducted this research predicted certain things might happen by the year 2060. By the year 2050, most of the predicted changes will likely be **evident**. If you need to review the scientists' predictions, reread the "Findings" and "Discussion" sections on pages 49-53.

Methods

It is the year 2050. You are a wildland fire safety educator with the Forest Service. You have decided to develop a wildfire safety poster and distribute it to students across the United States.

First, review the scientists' wildfire and climate predictions in this article. You should do additional research in the media center or on the Internet. Good Web sites to visit are <http://www.smokeybear.com/wildfires.asp> and <http://www.firewise.org/information.aspx>. Using felt markers and poster board, create an educational poster about wildfires and wildfire safety. You may also use magazine photos and other resources to create a collage.

Back in the second decade of the 21st century, almost 40 years ago, technology such as smartphones and tablets were changing the way people communicated. Now, in the year 2050, technology has advanced even more. Use your imagination to develop a plan using this advanced technology to distribute your poster to students across the United States.

The first step will be to organize into small groups of 3 to 5 students. Brainstorm for 5 minutes to generate ideas for how and what technology will be used in 2050. When you brainstorm, do not criticize others and let your creative juices flow! You should assign one group member to record your group's ideas. The remainder of the FACTivity may be done individually or in your small group.

Use the graphic organizer in this FACTivity to help you develop your plan. Then, write out your plan using complete sentences, proper grammar, and proper punctuation. If you have time, make oral presentations to the class, describing how technology is helping you to educate others about wildfire safety.

Then, draw your poster using the blank paper and markers. Present your plan and poster to your class. Post the posters in your school. What new technology did you develop? Hold a class discussion about how technology might aid education in the future. Note: You may also send a photo of your poster to jessica@naturalinquirer.org. Some of these posters may be chosen for display on our Web site.



Web Resources

Smokey Bear and Wildfire Information
<http://www.smokeybear.com/wildfires.asp>

Firewise Communities Information
<http://www.firewise.org/information.aspx>

Fire Adapted Communities
<http://www.fireadapted.org>



If you are a trained Project Learning Tree-educator, you may use *Living with Fire* as an additional resource.

Graphic Organizer for Wildfire Safety Education Plan, 2050

What is the wildfire situation in 2050? (For example, are wildfires frequent? Is the average temperature warmer than it was in the second decade of the century so that wildfires are more likely? Are wildfires less likely? Why?)

What is the specific topic of your poster? Develop this topic from your research in the media center or on the Internet.

What are the two main messages of your poster?

What grade level(s) will you reach with your poster?

Your poster will be digitized or otherwise turned into an electronic file. What new technology will you use to share the digital file? Identify at least one technology that you will use in 2050.

Wildfire Safety Education Plan

This Plan Was Developed By:

Poster Title

Specific Poster Topic

Primary Poster Messages

Primary Audience (Grade Level, Type of School)

Digitized Filename

Describe How Your Electronic Poster File Will Be Distributed