Moving on Up:

Photo courtesy of Paul Wray, Iowa State University, http://www.bugwood.org.

The Possible Impact of Climate Change on Forest Habitat

Meet the Scientists

Dr. Louis Iverson, Landscape Ecologist: My favorite science experience is finding out new (to me) patterns, trends, or functions of nature. It really is amazing how organisms interact with other organisms and their environment! One great way to do this is to get out into as many places in nature as possible.

▼ **Mr. Anantha Prasad**, Landscape Ecologist: My favorite science experience is combining what I have learned and gaining insights. For example, I like to look at information about climate change, **topography,** where different plant and animal species are found, and the properties of soils in a particular area. Then, I can tie these different characteristics of the area together to better understand how they relate to each other.

▼ **Mr. Matthew Peters**, Geographic Information Systems (GIS) Analyst (a **nə** ləst): A Geographic Information System, or GIS, is a system that collects, stores, manages, and presents information that is linked to a specific place on Earth. As a GIS Analyst, I work with geographic information to help solve problems. My favorite science experience has been collecting vegetation information in the Western United States for a project addressing forest fires. I was on a 6-month internship with the Student Conservation Association (SCA). During that time, I identified plant **species** in wilderness locations to improve our identification of these species using satellite data.

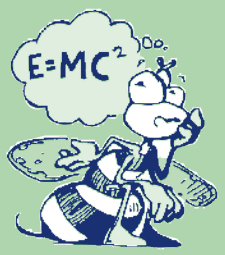
▼ **Dr. Stephen Matthews**, Wildlife Landscape Ecologist: My favorite science experience is coming up with new research questions based either on my current work or a new area of ecology. Then I like to go out and try to solve the problem in an attempt to advance my understanding of the natural world.

Thinking About Science

When scientists study climate change, they often look toward the future. The job of these scientists is to predict what might happen as the climate changes over time. Because no one knows for sure what will happen in the future, predicting it is a big challenge for scientists. In general, scientists take two main steps to predict what might happen.

First, they look at past or current situations. Often, scientists track what has happened over time, from a time period in the past to the present. This is called a trend. For example, scientists have tracked changes in the **average** yearly temperature since 1880 (**figure 1**).

The second thing scientists do to predict the future is create a computer model. A model is a mathematical representation of a **system**. For example, consider figure 1. If everything continues to be the same in the future as it was in the past, scientists can imagine what the line in figure 1 might look like in the future. They do this by taking the same information collected in the past and applying it to the future. Scientists studying climate change sometimes use different models to represent different possible futures. This is because what happened in the past might be different than what will occur in the future. In the case of rising temperatures, for example, scientists might consider both a future with a small rise in average temperatures, and one with a larger rise in average temperatures.



In this study, the scientists used one model that assumed people will continue to burn **fossil fuels** at an increasing rate for decades into the future. They used another model that assumed people will **conserve** fuels by doing things like driving less and using less electricity. In the second model, the amount of **carbon dioxide emitted** to the atmosphere was expected to be less than the amount emitted in the first model.

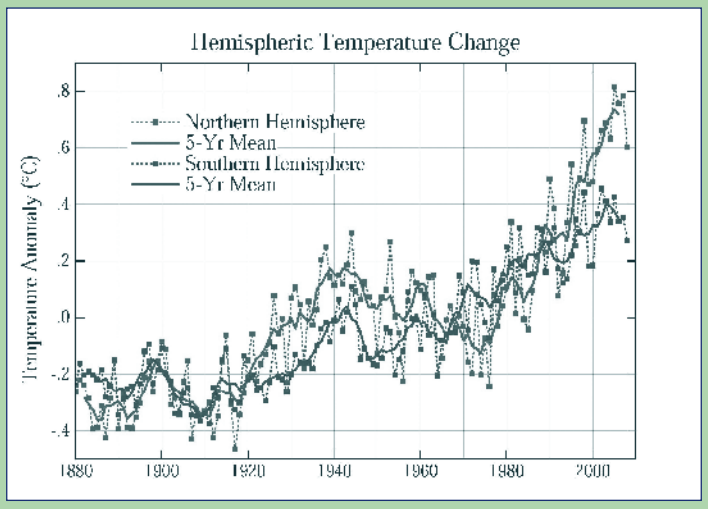
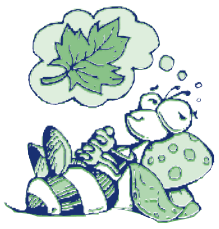


Figure 1. The trend in average yearly temperature since 1880. What trend do you see in this graph? (From http://data.giss.nasa.gov/gistemp/graphs/Fig.A3.pdf)

Thinking About the Environment

Almost everyone lives in a community. Did you know that trees live in communities too? These communities are different than human communities. Forest communities are made up of different species of trees that are commonly found living in the same area. Foresters name these forest communities after the most common species of trees living there.

The scientists in this study were interested both in individual species of trees and in forest communities. To understand how forest communities might change in the future, the scientists had to study individual species of trees. They did this because although trees in the same community live in the same general **habitat**, some trees can survive in other habitats as well. As the climate changes, therefore, some trees in the community might die off, and others might survive. If this happens, the forest community will change.



Introduction

Global climate change is likely to affect plants worldwide. One type of plant that will be affected is trees. Groups of different tree species are found together in forests because the habitat is well suited to those tree species' survival. Some elements of habitat include the amount of yearly rainfall an area receives, the average temperature in each season, the steepness of the land, the area's **elevation**, and the type of soil.

If any of the elements of an area's habitat change, some tree species may not be able to survive. For example, if the average temperature of the area rises, some trees species may not survive long term. If the temperature rises, however, in nearby areas that had previously been too cold for those species in the past, the seeds from those tree species may be transported away from the tree, **germinate**, and begin to grow in the new, warmer areas.

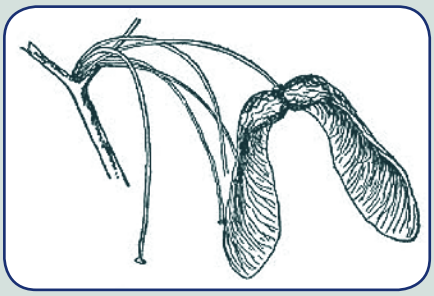
The scientists in this study were interested in trees that live in the Eastern United States (**figure 2**). They wanted to explore how the habitat of these trees might change in the future as the climate changes. They also wanted to know how different tree species might move in response to a changing climate.

Figure 2. The Eastern United States.

How do trees move?

As you know, individual trees cannot move from place to place. Through time and seed **dispersal,** however, the places a tree species lives may change. If the climate in a particular area changes, a tree species may no longer thrive in that original habitat.

The seeds of trees can spread in many ways. Birds and other animals may eat the seeds. Later, they will **defecate** and deposit the seeds in a new area. Seeds can be carried by animals in their fur or even in their mouths and then dropped in another location. Seeds are also blown away by wind or carried by water. If climate change causes the preferred habitat of some tree species to move in one direction or the other, those tree species, over time, will follow the preferred habitat through the movement of their seeds.



Reflection Section

- What questions were the scientists trying to answer?
- Do you think a changing habitat may also affect the animals that live in the Eastern United States? Why or why not?

Methods

The scientists wanted to predict how different tree habitats and forest communities in the Eastern United States might change over time. Scientists believe that the amount of carbon dioxide going into the atmosphere affects Earth's average temperatures. As higher levels of carbon dioxide go into the atmosphere, the average temperature rises. It is important to remember, however, that a certain range of carbon dioxide in the atmosphere is necessary to support life on Earth.

The scientists considered two different possibilities for future levels of carbon dioxide going into the atmosphere. First, they assumed that what happened in the past will continue to happen in the future. The amount of carbon dioxide going into the atmosphere has been rising over time. Therefore, the scientists assumed that the amount of carbon dioxide going into the atmosphere will continue to rise in the future. The scientists used existing information to estimate future average temperatures and future average rainfall in the Eastern United States, if this were the case.

Then, the scientists considered the possibility that people will begin to burn less fossil fuels in the future. This would mean that lower amounts of carbon dioxide would go into the atmosphere. The scientists then used existing information to estimate future average temperatures and future average rainfall in the Eastern United States. This time, however, they assumed that less fossil fuels would be burned than is currently predicted. The scientists considered the preferred habitat of 134 different tree species. Habitat includes things like the amount of rainfall and the average temperature preferred in each season by each species. Then, based on the two possible amounts of carbon dioxide going into the atmosphere, they created maps to show where the center of the preferred habitat of each tree species may be in the future.

Reflection Section

- Why did the scientists consider what may happen if people burn less fossil fuels in the future?
- What is one advantage of using maps to show research results?

Findings

The scientists discovered that, in both possible futures, the preferred habitats of tree species may move in a northerly direction. For the trees already living in the Northeastern United States, some of the preferred habitats may shift into Canada (**figure 3**). For trees living in the far Southeastern United States, their habitat might move across a larger area of the Southern United States (**figure 4**).

Regardless of the habitats studied, the scientists found that the preferred habitats of trees will likely move north if the amount of carbon dioxide going into the atmosphere continues to increase. Even if people burn less fossil fuels in the future, the preferred habitats of eastern tree species may move northward. They will not, however, move as far north from their existing location as compared with the other possibility.

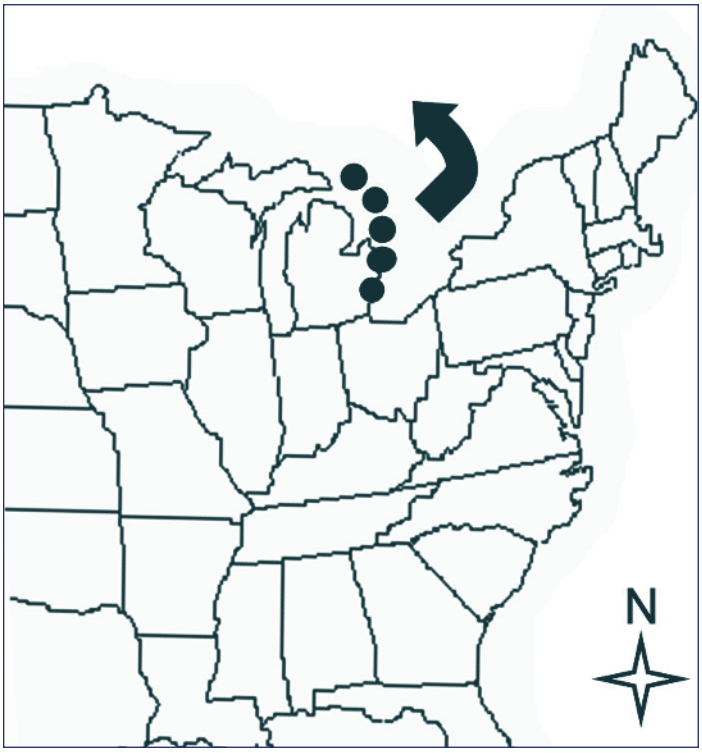


Figure 3. The center of the preferred habitat for sugar maple living in the Northeastern United States will move into Canada.

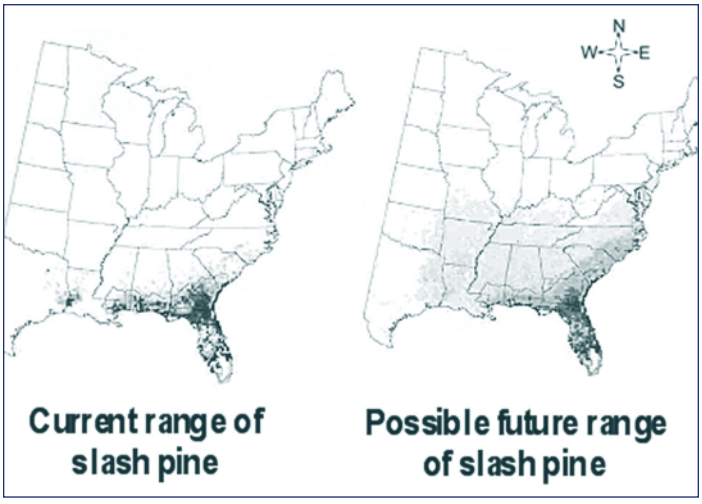


Figure 4. The future preferred habitat for the slash pine tree living in the Southeastern United States will likely move across the south. In which direction is the preferred habitat likely to move? The left map was created from Forestry Inventory and Analysis data, Forest Service. The right map was created using a General Circulation Model (GCM) of climate change.

Reflection Section

- If the preferred habitat of sugar maple trees moves farther into Canada, what possible impact might this have on U.S. businesses that sell the sweet product of maple trees?
- Why will the preferred habitats of most tree species move in a northerly direction?

Discussion

The forest communities of the Eastern United States are likely to change as the climate changes. Not all the possible changes are considered negative. For example, the habitat of some trees may expand. Other tree species, however, may experience a loss in habitat, which would not be a good thing for those tree species. As these changes occur, the forest communities will also begin to change.

Along with changes in forest communities, there may be increasing chances of threats to the trees' health. Examples include danger from invasive animals, plants, and insects. Other possible dangers include diseases, fire, floods, droughts, and changes in how the land is being used by people.

Reflection Section

- The scientists considered what might happen if people burned less fossil fuels in the future. If people burn even less fossil fuels in the future than the scientists considered, how might the predicted movement of eastern tree species change?
- What is one way people might respond to this knowledge of changing forest communities?

Glossary

average (a **v(ə-)**rij): The usual kind or amount. The number obtained by dividing the sum of two or more quantities by the number of quantities added.

carbon dioxide (**kär**-bən **dī** äk sīd): A gas made up of carbon and oxygen with no color or smell.

conserve (kən **sərv**): To avoid wasteful or destructive use of something.

defecate (**de** fi kāt): To have a bowel movement.

dispersal (**di** spər səl): The scattering or spreading in all directions.

elevation (e lə **vā** shən): The height above sea level.

emitted (ē **mit** əd): To throw out or eject.

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

germinate (**jər** mə nāt): To start growing or developing.

habitat (**ha** bə tat): Environment where a plant or animal naturally grows and lives.

invasive (in **vā** siv): Tending to spread.

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

system (**sis** təm): An ordered gathering of facts or processes to form a whole.

topography (tə **pä** grə fē): Detailed, precise description of a place or region. Physical features that make up the topography of an area include mountains, valleys, plains, and bodies of water.

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

FACTivity

Time Needed

2 class periods

Materials needed per student group:

- Tree identification books (and/or Internet access) and other resources about trees.
- Two blank maps of the United States.
- Two pieces of blank white 8.5″ X 11″ paper.
- Markers.

The question you will answer in this FACTivity is: What is the geographic distribution of a particular tree species?

Process for each student group:

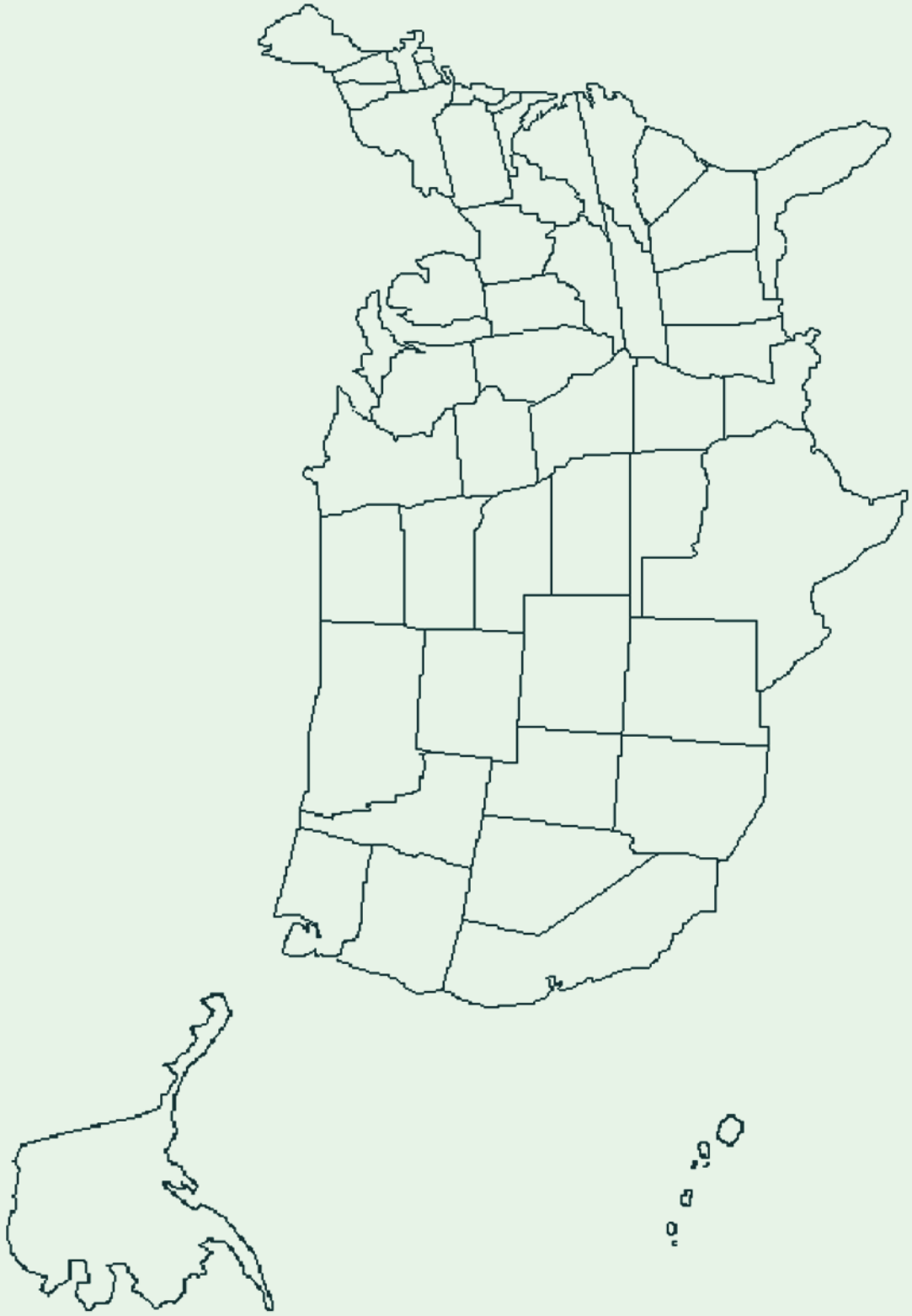
First class period:

Choose a tree species that you would like to study that lives in the United States. Use a tree identification book, the Internet, or the library.

Research information about this tree species. Find the following information about the tree:

Where is the tree species' habitat? When you find out about the areas in which it lives, mark those areas on one of the blank maps provided. Label this map "Current Geographic Distribution of [tree species]."

- What is the climate of the current habitat for the tree species?
- What is the average size of a tree of that species?
- What does the tree look like?
- What is the expected life span of the tree species?
- Do any invasive plants or insects threaten the tree species?



Second class period:

Use this information and any other interesting facts to create a Tree Fact File. The Tree Fact File should be displayed on two 8.5- X 11-inch pieces of paper.

One map should have already been filled out with the current areas where the tree species is found. You will use the other map to make a prediction about where you think the tree species will live as the climate becomes warmer. Think about what you read in the article to help you make this map. Label this map "Predicted Geographic Distribution of Tree Species."

As you make this map, think about your own predictions about how much fossil fuels will be burned in the future.

Once all of the groups have created a Tree Fact File and completed the two maps, the files and maps can be compiled into a class book.

After answering the question posed at the beginning of this FACTivity, consider and discuss this question: "Why is it important to predict the future condition of our natural resources?"

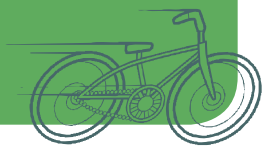
Extensions

If you have already read or will read "There's Snow Place Like Home," compare your maps of the tree species geographic distribution with the wolverine article animal geographic distribution.

- How are the maps similar?
- How are the maps different?
- What conclusions can you draw from comparing these maps?

What You Can Do:

Because keeping carbon emissions down will help the environment, maybe you could ride your bike or walk to school. Make sure it is safe to do so. If you can't walk or ride your bike, take the school bus or have your family carpool with other families in the neighborhood.



If you are a PLT-trained educator, you may use Activity #22: "Trees as Habitats," Activity #77: "Trees in Trouble," and Activity #85: "In the Driver's Seat."

National Science Education Standards

Standards addressed in this article include:

Science as Inquiry:
Understandings About Scientific Inquiry

Life Science:
Regulation and Behavior,
Populations and Ecosystems,
Diversity and Adaptions of Organisms

Science in Personal and Social Perspectives:
Risks and Benefits

Additional Web Resources

U.S. Environmental Protection Agency's Carbon Cycle Movie
http://www.epa.gov/climatechange/kids/carbon_cycle_version2.html

World Almanac for Kids' Carbon Cycle
http://www.worldalmanacforkids.com/WAKI-ViewArticle.aspx?oldpin=xca041350a&pin=x-ca041350a

The Great Plant Escape- Seed Germination
http://urbanext.illinois.edu/gpe/case3/index.html

Student Conservation Association
http://www.thesca.org

Adapted from Iverson, L.R.; Prasad, A.M.; Matthews, S.N.; and Peters, M. (2007). Estimating potential habitat for 134 eastern U.S. tree species under six climate scenarios. *Forest Ecology and Management*. 254: 390-406.