The Investi-gator
Northern States Edition

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Editorial Review Board At Work

Comments about individual articles in this edition from the *Investi-gator* editorial review boards

Lyman Hall Elementary and Myers Elementary
Hall County, Georgia

- I liked the FACTivity (for the ozone article).
- I liked the layout, but I'd like color pictures.
- I think that it is a great article for kids my age.
- I liked the glossary but would like to have the word defined on the page where the word is located.
- Number crunch was confusing.
- You should give a little more information in the captions.
- It would be good to have an index at the end.
- Make sure to show pictures of the important facts.
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 scientist, you must:

- **Be curious:**
  You must be interested in learning.

- **Be careful:**
  You must be accurate in everything you do.

- **Be open-minded:**
  You must be willing to listen to new ideas.

- **Be enthusiastic:**
  You must be interested in a particular topic.

- **Question everything:**
  You must think about what you read and observe.
Welcome to the Northern States Edition of the *Investigator*!

Have you ever thought about where you live on Earth? Earth is like a round ball which spins on its *axis* (*aks* is). Earth’s axis is an imaginary line connecting its north pole and its south pole (figure 1). The equator divides the northern half of Earth from its southern half. Areas near the equator are warmer. The position of the sun’s rays keep this area warmer. Areas near the poles have a brief summer and are cold compared with other areas of Earth.

**Figure 1.** Can you see the line between the north pole and the south pole? The Earth’s axis is slightly tilted.

The land between the poles and the equator is different. It is different because the *climate* (*kli met*) changes during the year. The climate is the average condition of the weather over large areas, over a long time, or both.

In general, areas close to the equator are warmer. Areas close to the poles are cooler. There are other things that affect an area’s climate too, like *altitude* (*al tuh tud*) and Earth’s ocean currents. Altitude is how high an area is above sea level. An area in the mountains is cooler than an area closer to sea level. The ocean currents affect weather. Weather affects climate.

This *Investigator* journal focuses on scientists working in a particular area on Earth. That area is the Northern United States (figure 2). This area has a cool climate compared with areas near the equator. Because of this, scientists working in the Northern United States might study different topics than scientists elsewhere. On the other hand, some scientific topics are the same, no matter where a scientist is working.

**Figure 2.** The Northeastern United States is made up of twenty states.

In this journal, you will read about four topics. The scientists did their research in the Northern United States, but the topics are important no matter where you live. The first article explains why some tree leaves turn red in the fall of the year. The second article explains how the chemical ozone affected trees in Wisconsin. The third article examines how we protect the environment through policies. The fourth article discusses how soil activity changes in the wintertime. Forest Service scientists have all been a part of the research in these articles. You can learn more about the Forest Service by reading the inside back cover of this journal, or by visiting [http://www.scienceinvestigator.org](http://www.scienceinvestigator.org)
About the Investi-gator

The Investi-gator is the newest member of the Natural Inquirer family. The Natural Inquirer, for middle school students, and the Investi-gator, for upper elementary level students, present science the way scientists most often share their research with each other. That process is the written scientific paper.

Each Investi-gator article presents research conducted by Forest Service scientists and their cooperators. All of the research in the Investi-gator is concerned with nature or with society’s relationship to nature.

Each article is organized the same way and includes the following sections:

Meet the Scientist
An introduction to the scientist or scientists who conducted the research.

Glossary
Possible new terms you will find in the article. Glossary words are printed in bold in the article.

Thinking About Science
A short introduction to something about the scientific process that is related to the research being presented.

Thinking About the Environment
A short introduction to something about the natural environment that is related to the research being presented.

Introduction
The part of the written scientific paper that introduces the scientific problem or question the scientists wanted to solve or answer.

Method
The part of the written scientific paper that describes how the scientists collected and analyzed their data or information.

Findings
The part of the written scientific paper that describes what the scientists discovered.

Discussion
The part of the written scientific paper that summarizes the research and offers any new insights.

Reflection Sections
These are questions placed behind the Introduction, Methods, Findings, and Discussion sections. The purpose of the questions is to help students think about what they have read.

FACTivity
This is an activity that you can do in your classroom.
Dr. Schaberg

My favorite science experience is getting an unexpected result to an experiment. Sure, it is great to develop a hypothesis and test it in an experiment. A hypothesis is an idea that has not been proven yet. After you test it, then you may get results that show your hypothesis was correct. But sometimes you get results that are surprising and interesting—results that teach you something totally new. These unexpected results can be very exciting. They help open up your imagination to unique thoughts and lead to the development of new hypotheses, new experiments, and new insights about the natural world.
Ms. Murakami

My favorite science experience is the opportunity to learn new things! Whether it is in the laboratory or in the woods, there is always something new to be discovered. Recently I spent a lot of time figuring out how to measure different activity in the leaves of sugar maple trees. This was often a difficult and frustrating experience. I enjoyed the challenge, however, and learned a lot along the way. I am anxious to use my newly acquired skills to examine fall color and plant growth.

Mr. Shane

My favorite science experience was figuring out the movements of the moon and their effects on the moon’s nightly arc over all different moon phases and seasons. It was the first thing I figured out completely on my own based solely on observation and logic. (Sure hope I am right about it!)

Dr. van den Berg

I currently do research on the maple sugaring process. One of my favorite science experiences is talking to maple sugarmakers about the results of a research project. It’s a great feeling when a study which required lots of time and effort to conduct has produced information that sugarmakers can apply to benefit their own operations!
Thinking About Science

Scientists learn things through observation. Observation is carefully examining something to understand it better. Sometimes scientists observe plants to learn about them. In this study scientists observed leaves. They observed leaves on deciduous (de sij oo us) trees. These trees lose their leaves in the fall or winter (figure 1a and 1b). The scientists observed the change in leaf color. They did this because they wanted to know why and when leaves change color.

Have you ever gone to the mountains to see the leaves change color? If so, you are not alone. Many people go to the mountains to see the leaves change color in the fall. Scientists knew that if they can predict when leaves will change color, this information will help people plan their trips.

You can see that science helps people in many ways. In this case, it can help people to enjoy the leaf color change in the fall. Science also helps people in other ways. You will learn about one of those other ways by reading “Thinking About the Environment” section.
Thinking About the Environment

A change in leaf color can tell us important things about trees (figure 2). Think about a plant in your house. Have you ever seen the leaves change color? What happens when the leaves change colors? Leaf color change could be a sign of trouble. Leaves may change color because of sickness or stress. Imagine that some tree leaves change color in June. What do you think this means? It is probably a sign that the tree is unhealthy. Understanding leaf color change can help scientists understand a tree’s health.

Introduction

In the fall, thousands of people visit forests. Do you know why? They are probably coming to see the leaves change color! Leaves change color in the fall. Cooler temperatures in the fall cause the chlorophyll (klôr o fil) in leaves to break down. Chlorophyll is the green color found in plants. When chlorophyll begins to break down in leaves, the yellow color becomes more visible. For some leaves, a red color becomes more visible, too. Red color happens because there is a build up of a chemical called anthocyanin (an thuh si uh nin).

In this study, the scientists wanted to know if air temperature, the length of daylight, or the chemicals in the leaves was more likely to result in leaf color change in sugar maple trees.

Figure 2. This photo shows leaves changing color in the fall. To see this picture in color, visit http://www.scienceinvestigator.org.
Method

Sixteen sugar maple trees were studied in South Burlington, Vermont (figure 4). A number of leaves from each tree were collected on 12 different dates. They were collected from June to October. Some of the leaves were studied for water, sugar, and nitrogen content.

Figure 4. Vermont is located in the northeastern part of the United States. South Burlington, Vermont is located in the northwestern part of Vermont.

The other leaves were used to measure leaf color. To do this, scientists scanned leaves with a computerized color scanner (figure 5). They then used a computer program to calculate the amount of red, yellow, and green color on each leaf.

Reflection Section

What was the research question the scientists wanted to answer?

Do you think it is important for people to know when fall leaf color will be at its most colorful? Why or why not?
Once they had this information for some of the leaves from each tree, they were able to estimate the amount of each color on the entire tree. The scientists also collected data about the length of each day (from sunrise to sunset) and air temperature.

Then the scientists used math. They used mathematical equations (é kwa zhuns) to understand what they found. An equation is a sentence in math like 2 + 2 = 4. They looked at the data to figure out which information would help to predict red color development. The scientists compared how the leaf content of sugar, water and nitrogen, air temperature, daylength, and red color development all influenced each other.

Findings

The scientists found that the leaves first started to show some red in late September. Then, the leaves changed more completely from green to yellow or red in the middle of October. Scientists found that nitrogen was the best predictor of red color change. They discovered that leaves with less nitrogen turned red earlier. Also, those leaves turned a more complete red than other leaves (figure 6).

Figure 6. This photo shows a variety of red colored maple leaves. To see this picture in color, visit http://www.scienceinvestigator.org.

Reflection Section

Why do you think the scientists decided to collect leaf samples from June to October instead of from October to June?

Why is it important for the scientists to take a number of leaves from several trees and not just one or two?

This study was done in South Burlington, Vermont. Do you think late October would be the best time to view red leaves in Southern Georgia? (See figure 7.) Why or why not?
Discussion

Collecting and studying the information about the leaves, air temperature, and day length helped scientists. It helped the scientists to understand when leaves were most likely to change color. This information is useful for the following reasons:

- This information is important for understanding a tree’s health.

- This information is used each year to estimate dates when leaves will be changing color.

- Tourists find this information helpful because it helps them plan their visits to forests.

- It is also helpful to people in towns where tourists visit. Store owners and people who run hotels and gas stations use this information. They use it to plan supply orders. They also use it to schedule enough employees for the times when many tourists are visiting.

As you can see, understanding when leaves will be changing color is good for a lot of people.

Figure 7. Georgia is located closer to the equator than Vermont.

Understanding when fall leaf color is at its peak is good for a lot of people. What is one of the benefits for store owners?

Give another example of something seasonal that attracts tourists to an area. If possible, think of an example from an area close to where you live.
FACTivity

In this FACTivity, you will imagine what sugar maple trees in the northeastern United States might look like at four different times during the fall. To do this FACTivity, you will need four sheets of plain white paper and crayons or colored pencils. At the bottom of the first sheet, write “September 1.” On the bottom of the second, write “September 30.” On the bottom of the third, write “October 7.” On the bottom of the fourth, write “October 15.”

Take a large sheet of white paper and divide into four even sections. Label each section with each of the dates listed above. The pictures will be of either sugar maple leaves or trees. You can create a picture of just a few leaves or of an entire forest. Before coloring each picture, think about what you learned in this article. After you complete your pictures, share them with the class by posting them on the wall. What color were the leaves on each of the four dates? Why did you choose those colors? What was happening to the leaf pigments on October 7? The students should compare their pictures and identify their similarities and differences.

FACTivity Extension

Pigment is the material in cells and tissues that gives color to plants and animals. In this article, you learned about pigment in plant leaves. Humans have pigments, too. Look around your classroom and observe your classmates. As a class, identify three places that you can see where pigment affects a person’s color. Which of those might change color over a person’s lifetime?

If you are a PLT-trained educator, you may use PLT Activity #42, “Sunlight and Shades of Green,” as an additional resource.

Useful Web Resources:
Starting in September, there is a Fall Color hotline on the Forest Service website where students can track fall leaf color change. http://www.fs.fed.us/

Environmental Education for Kids—Leaves
http://www.dnr.state.wi.us/org/caer/ce/eek/veg/treestreecolor.htm

Science News for Kids—A Change in Leaf Color Article
http://www.sciencenewsforkids.org/articles/20060927/Feature1.asp

Maine’s Fall Foliage Video • http://www.maine.gov/doc/foliage/kids/movie.html

Nitrogen Cycle for Kids • http://www.eo.ucar.edu/kids/green/cycles7.htm

No Littering O-Zone:
How Rising Ozone Levels Affect Tree Growth

Meet the Scientists!

Dr. Liu
Ecologist (Ekôl o jist)

The great thing about being an ecologist is you are always on the way to discovering the secrets of nature. To answer a scientific question, you need to design an experiment, collect and interpret the experimental data, and then draw a conclusion. During those processes, I learn new knowledge. Most importantly, I can help keep our planet healthy by sharing my findings with other scientists and the public.

Dr. King
Forest Ecologist and Physiologist (Fiz e ôl o jist)

There are so many rewards to a career in science that it is difficult to pick a single favorite experience. The thing I like best about it is the ability to have an impact, that is, to do something good for people or the environment. Every time I publish a scientific paper or help a student to become a scientist, I feel that I help the world to be a better place. Also, I work on many different questions in many different places, so my work is always interesting! In the picture I am giving a talk to foresters in North Carolina.
Dr. Giardina
Forest Ecologist

My favorite science experience was traveling to the Central American country of Belize (beh lez) and wandering in a really cool and really big cave called the Rio Frio (re o fre o) cave near the western border with Guatemala (gwa tuh mal uh). The mouth of the cave is covered all around its rim with the most amazing trees. There were hundreds of types of giant trees. The roots of the trees were ringed all along the outside of the rim of the cave, and the cave was full of bats.
Thinking About Science

Scientists want to discover the correct information about our world. To do this, they often set up experiments. They want these experiments to be as close to the real world as possible. In this study, the scientists wanted to know how increasing the amount of ozone might affect some types of trees. You will learn about ozone in the next section.

One way to find out how ozone affects trees might be to put potted trees into a room. Then the scientists could increase the amount of ozone in the room. Does this seem like the real world to you? It did not seem that way to the scientists either! Instead, the scientists planted trees outside in a special area. They constructed towers that released ozone into the wind. The wind carried the ozone to the trees. This allowed scientists to observe how the trees respond to ozone in a more natural environment.

Thinking About the Environment

Have you heard about the chemical ozone? Ozone is a gas that contains oxygen. Ozone is found in the atmosphere. Sometimes ozone can be helpful and sometimes it is harmful.

The atmosphere has different layers (figure 1). The troposphere is the layer of atmosphere closest to Earth.
(figure 2). When ozone is found in the troposphere, it is harmful. Ozone is the main ingredient of smog (smawg). Smog is polluted air and is a danger to human health.

Ozone is also found in the stratosphere (strat o sfer). The stratosphere is a higher level of the atmosphere (see figure 1). In the stratosphere, ozone provides a layer of protection from the sun’s harmful rays. This example shows how ozone can also be helpful.

You can see that ozone can both protect and harm life on Earth. Humans can create more ozone. For example, fossil fuels (fôs ul fyoools) are fuels that are formed from the remains of animals from the past (figure 3). Gasoline is an example of a fossil fuel. When people burn fossil fuels, the amount of ozone in the troposphere rises. The increase in ozone impacts humans as well as other living things. The scientists in this study wanted to know how trees might be affected by rising levels of ozone in the troposphere.

Figure 2. This is a picture of Earth’s atmosphere from space. The atmosphere is the light colored band. Sally Ride, the first woman in space, took this picture. Photo is courtesy of NASA.

Figure 3. This diagram shows you how fossil fuels are made. Do you think this process is quick or slow? Why?
Introduction

Every fall, deciduous (dē sij əʊ us) trees drop their leaves to the forest floor. Deciduous trees are trees that lose their leaves in the fall or winter. These fallen leaves are called leaf litter (lef lit ūr) (Figure 4). After a while, the fallen leaves begin to break down.

Figure 4. This is a picture of leaf litter. What do you notice about it?

When leaf litter breaks down, it provides nutrients (njuːtrənts) for the soil (Figure 5). Nutrients are any substance found in foods that are necessary for plants and animals. This movement of nutrients from leaves to the soil is important. It helps new plants grow. Two of the main nutrients from fallen leaves are carbon and nitrogen. These nutrients are important to continue the cycle of plant growth on Earth.

Nutrients that go into the soil are affected by two things. First, the number of leaves that grow every season is important. Second, what the leaves are made of is important, too. If something happens to change the number of leaves on trees or their makeup, the soil might be changed as well.

In recent years, humans have been burning more and more fossil fuels. Fossil fuels are oil, natural gas, and coal. One of the extra products created by burning fossil fuels is ozone. Since the level of ozone is rising, the scientists wanted to know how this affects how trees grow. Tree growth starts in leaves. Therefore, scientists started by looking at the leaves. They looked at how many leaves were produced. They also looked at the amount of nutrients in the leaves.
In your own words and in the form of a question, state what the scientists wanted to learn.

Think about trees growing inside a building and trees growing outside. Name three things that make observing trees outside more natural than observing them inside.

Method

The study took place near Rhinelander, Wisconsin (figure 6). The scientists divided a large area of land into three blocks. In each block, they planted small areas with aspen and birch trees. These trees are fast-growing (figures 7a and 7b). The scientists waited until the trees were six years old to take their measurements. They did this because they wanted information about older trees where the tops of the trees are touching (figure 8).

In one area, the scientists did not spray ozone gas into the trees. The scientists used this area as a control (kän tröl). A control is something used for comparison when checking the results of an experiment. In this experiment, the control is an area where no ozone is sprayed. In the second area, the
The scientists sprayed ozone gas into the trees (figures 9 and 10). The scientists sprayed these trees for six years until it was time to measure them.

Figure 9. This photo shows the experimental site. The sprayers can be seen as small ovals in this photo. These sprayers sprayed ozone into the wind. The wind carried the ozone to the trees.

The scientists placed baskets under the trees in each of the areas. Baskets were placed in a circle in the middle of the trees. The baskets were evenly spaced. The baskets caught leaf litter falling from the trees. The contents of the baskets were collected every two weeks. This continued from June through October until all leaves had fallen off the trees.

After collecting the leaf litter, the scientists dried it. Drying it removed any moisture. The scientists weighed the dried litter. This helped the scientists determine how much living material was in the leaf litter and how much leaf litter was produced.

Next, the type and amount of nutrients in the leaf litter were measured. This helped scientists know how ozone affected the leaves. Finally, the scientists compared the measurements of leaves collected from trees that had not been sprayed with ozone gas with leaves from trees that had been sprayed with ozone gas.

Reflection Section

When people rake leaves in the fall, they take nutrients away that could one day become a part of the soil. What do people do to their lawns to make up for this?

Do you think scientists must have patience to do some of their experiments? What evidence of this can you find in the “Method” section?
If the scientists collected the leaf litter every two weeks from the beginning of June until the end of October, how many times in all did they collect the leaf litter?

Findings

The scientists compared the trees sprayed with ozone to the trees growing under normal conditions. Trees growing in higher levels of ozone had lower levels of living material in their leaf litter. Overall, the amount of carbon and nitrogen was lower in leaf litter from trees grown in higher ozone levels. In addition, the trees also had fewer leaves.

Discussion

In areas with higher ozone, the way leaves were made caused the leaf litter to break down more slowly. Additionally, smaller amounts of leaf litter were produced. Therefore, there were fewer nutrients available to growing plants. The leaf litter also contained less carbon and nitrogen. These nutrients are important for the plant growth cycle.

Reflection Section

Based on the findings and discussion in this study, do you think humans should try to reduce the amount of ozone being produced? Why or why not?

What is the answer to the scientists’ question? Reread the end of the “Introduction” if you have forgotten the scientists’ question.

If less leaf litter is produced, would growing plants be helped or hurt? Explain your answer.
FACTivity

The question you will explore in this FACTivity is:
How does ozone in the troposphere and stratosphere impact Earth?

The method you will use to do this is:
The class will divide into groups of four students. One half of each group will study the impact of ozone that occurs close to Earth, in the troposphere. The other half will study the impact of ozone that occurs in the upper atmosphere, in the stratosphere. You can do your research in the library and on the internet.

Gather information about the effects of ozone, and how human activities are affecting ozone. After each team of two students has collected their information, the team should summarize the information about ozone. In the summary, include information about where the ozone occurs. Each group of four students should then share and compare the summarized information within their group. As a group, discuss how ozone is both beneficial and harmful. Compare ozone’s benefit and harm with where the ozone is found in each situation. Develop recommendations about what people can do in relation to ozone in the troposphere and in the stratosphere. Document your learning by creating a poster, which you will share with the class.

Hold a class discussion about what each group learned about ozone. Compare ozone in the troposphere with ozone in the stratosphere. What are the differences and similarities?

Some search terms each team might use:

<table>
<thead>
<tr>
<th>Tropospheric ozone team</th>
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<tbody>
<tr>
<td>Tropospheric ozone</td>
</tr>
<tr>
<td>Ozone pollution</td>
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<table>
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<tr>
<th>Stratospheric ozone team</th>
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</thead>
<tbody>
<tr>
<td>Stratospheric ozone</td>
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<tr>
<td>Ozone UV radiation</td>
</tr>
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Useful Web Resources:

EPA’s Sunwise Kids Ozone Layer information
http://www.epa.gov/sunwise/kids/kids_ozone.html

National Geographic for Kids Ozone Article
http://kids.nationalgeographic.com/Stories/SpaceScience/Ozone

Environmental Education For Kids—Ozone Layer
http://www.dnr.state.wi.us/Org/caer/ce/eek/earth/air/ozonlayr.htm

Dr. Bengston
Research Forester

My favorite science experience was learning about urban growth and urban policies in South Korea. I learned about them when I was a visiting scientist at Seoul (Sôl) National University during the summer of 2004. Managing urban growth is important. It was exciting to see the effects of Korea’s policies (päl uh ses) to manage urban growth and protect the environment. Policies are like rules we must follow. A highlight was hiking the heavily used recreational trails that surround Seoul. Seoul is an urban area of more than 20 million people (which is more than twice the population of New York City!).

My favorite science experience was working with Mayan (mi yun) farmers and scientists to solve problems in Chiapas (che op us), Mexico. We worked on several 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 (hab uh tat) for migratory (mi gruh tör e) birds. Habitat includes the physical things that plants and animals need to survive. Migratory birds are birds that move from place to place for breeding or feeding. Finally, in another community we examined what happened when crocodiles and fishermen wanted to be in the same place in the forests and estuaries (es chu air es). Estuaries are places where the ocean tide meets a river current.
Thinking About Science

Scientists learn as much as possible about their topic. They research the Internet, libraries, and other sources (figure 1). They do this to discover what other scientists have found out. Once they have found the information, they have to understand it. To do this, scientists compare and contrast what they have found. Then they summarize the information in one document. You do this very thing when you prepare a paper for class. When scientists do this, it tells them two things. These things are: 1) what information is already known about a topic, and 2) what information is not known. Once they have learned as much as possible, they move forward with their own research.

Thinking About the Environment

The United States population is increasing. This increase causes changes in the environment. As a society, we pass laws and make policies (päl uh ses) to manage these changes. Many of the policies and laws help to keep the environment healthy. Policies are like rules we must follow. Environmental policies can do two things to reduce unwanted changes in the environment. Policies can either manage urban growth (ür bun gróth) or protect open space (figures 2 and 3). Urban growth is the growth of a city. This growth is caused by an increasing population.

Figure 1. Scientists use books, the Internet, and many other sources for their research.

Figures 2a and 2b. These two photos show urban growth. Have you seen urban growth where you live?
Figures 3a and 3b. Open spaces are areas in your community that are not highly developed areas. Examples of open areas are parks and pastures.

Pronunciation Guide

a as in ape
ä as in car
e as in me
i as in ice
o as in go
ô as in for
u as in use
ü as in fur
oo as in tool
ng as in sing

Accented syllables are in bold.
Introduction

Over the next 25 to 45 years, scientists think the Nation’s population will double. As the population increases, cities, suburbs, and towns use more and more land. In order to keep some open space, the government makes environmental policies that everyone must follow.

These policies fall into three types. The policies either punish people or reward people for following the policy. The first type of policy limits or controls urban growth. Penalties are placed on people or organizations when they do not follow the rules. Penalties are used to protect the environment. In the second type, policies reward people or organizations for doing things to limit urban growth or protect open space. Rewards are used to protect the environment. In the third category, the government owns and takes care of the land.

Most of these policies are made by local governments. Some examples of local governments are cities, counties, townships, or parishes. State and federal governments also make environmental policies. Not much is known about how successful these policies have been in managing urban growth and protecting open space. This question is important. It is important because if society wants to reduce unwanted changes in the environment, we need to know which types of policies are most effective.

The scientists in this study wanted to answer two questions. The first question is: What are the characteristics of the policies that have been used to manage urban growth and protect open space? The second question is: Which of these types of policies has been most effective?
Method

The scientists did their research. They looked for documents that described environmental policies. They read science journals, books, government reports, and web sites. They found many environmental policies. In fact, they found so many policies that they had to figure out which ones to use.

They had to set criteria (kri ter e uh) for what they would include in their study. Criteria are standards or measures that are used in making a decision. They came up with three criteria. The scientists only included policies made after 1980. Second, the policies had to be made in the United States. Third, these policies had to be made by local, state, or federal governments.

When the scientists found a policy that fit their criteria, they placed it into one of three policy types. Two of those policy types are described in the “Introduction” section above. The third type was for any land purchased or managed by a government on behalf of the public (figure 4).

If a policy was made in 1981, how many years old would the policy be today?

The scientists then studied the policies in each of the three policy types. They took notes on each policy. Then they compared the policies by looking for similarities and differences. Some of the policies had been evaluated (e val u ated) to see if they were effective or ineffective. Evaluated means examined and judged carefully. The scientists took notes on why the policy was judged to be effective or ineffective.

Figure 4. The three types of environmental policies are shown below.

- Policies that use penalties.
- Policies that use rewards.
- Policies that call for buying and managing land for public use, such as public parks, forests, and recreation areas.
Findings

The scientists found 87 documents that fit their criteria. Examples for each of the policy types are shown in figure 5.

The scientists looked to see what policies had been evaluated. The scientists found that not many of the policies had been evaluated. Therefore, it was difficult to figure out which types of policies were most effective. Although the scientists did not find much information, the scientists drew these conclusions from studying the policies:

A policy was more effective if:

1. The land area it affected was clearly identified.
2. Someone kept a close check on whether the policy was being followed.
3. Any required paperwork was easy to fill out.
4. The policy was started quickly.

The scientists also discovered that it was better to use several policies at one time. The use of several policies protected more open space and limited urban growth better. For example, using a combination of the policies from figure 5 would bring more success than just using one.

Finally, the scientists found that communication is important. Policies were more successful when the policies were discussed with the people they would affect.
### Types of policies

<table>
<thead>
<tr>
<th>Government purchase and management of land</th>
<th>Goal of policies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managing urban growth</td>
<td>Protecting open space</td>
</tr>
<tr>
<td>Public ownership of parks, recreation areas, forests, wildlife areas, wilderness areas to manage urban growth</td>
<td>Public ownership of parks, recreation areas, forests, wildlife areas, wilderness areas to protect open space</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Control and punishment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Placing an upper limit on the number of new buildings allowed to be built every year</td>
<td>Requiring developers to set aside some open space for every new home constructed in a subdivision</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reward</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowering taxes for new businesses to take over existing but unused buildings, rather than building new buildings</td>
<td>Lowering taxes on land that is to be kept as open space</td>
</tr>
</tbody>
</table>

**Figure 5.** Examples of each type of environmental policy are listed below.
Look at the list of four reasons a policy was more effective. Which of the four applies most to the policies that you must follow at home?

In most communities, people can be fined if they throw litter on the ground. Into which row and column in figure 5 would you place this policy? Why would you place it there?

Discussion

Based on this research, the scientists decided several things. The scientists decided that citizens should be involved in making policies for the environment. Citizens should also be involved in putting them into practice. Better communication would make policies for the environment more successful. As the Nation’s population continues to grow, we must find ways to manage urban growth and protect open space.

Think about the conclusions of the scientists, outlined in the “Discussion” section, above. Based on these conclusions, what is one important aspect of implementing a successful policy?

Do you think it is important to manage urban growth and protect open space? Why or why not?
In pairs or in groups, identify five policies that exist in your school. Complete the following chart for each policy you choose.

<table>
<thead>
<tr>
<th>Policy 1</th>
<th>Policy 2</th>
<th>Policy 3</th>
<th>Policy 4</th>
<th>Policy 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name or description of the policy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What is the goal of the policy?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Who developed the policy?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Who implements the policy?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the policy use rewards or penalties?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whose support is needed for the policy to succeed?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How does the school identify if the policy is succeeding?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Who or what benefits from the policy?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How could the policy be improved?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
After all groups have completed their figures for the policies, hold a class discussion about the policies. Use these questions to get started:

1. How many different policies were identified?

2. As a class, place the policies into different categories. Categories can be made up by the students. Some examples include hallway behavior, classroom behavior, lunch room procedure, and policies to keep people safe.

3. What categories did you develop?

4. What do you think, overall, is the goal of these policies?

5. Which policies are effective?

6. Why are the policies effective or not effective?

Factivity Extension

Identify policies in your school that are specifically intended to protect the school’s natural environment. Complete the same table on page 33 for these policies.

If there are no policies specifically intended to protect the school’s natural environment, then your groups will begin to develop some policies. In your groups, develop two new policies aimed at improving the school’s natural environment. Fill out the table on page 33 for your new policies. Develop a plan to get the policies implemented. Some examples to get you started include:

- No littering on school grounds.
- Recycle paper, cans, and plastic within the school.
- Use only recycled paper.
- Increase the use of computers.
- Plant five trees every year on school grounds.
- Develop and maintain a wildflower garden on school grounds.
- Develop and maintain a small pond on school grounds.
- Support bird life with bird houses and bird baths on school grounds.
- Reduce the use of pesticides and herbicides on school grounds.

Useful Web Resources:

NASA’s Urban Sprawl
http://science.nasa.gov/headlines/y2002/11oct_sprawl.htm

Kids and Community—Learn about an Urban Planner!
http://www.planning.org/kidsandcommunity/

**Dr. Campbell**

My favorite science experience was seeing the **aurora** (uh rôr uh) **borealis** (bôr e al is) (northern lights) while hiking back from a long day of fieldwork in Adirondack Mountains in New York.

**Dr. Mitchell**

I am most interested in understanding how climate change is affecting **watersheds** (wä tür sheds). A watershed is an area of land from which all of the water drains into one stream or river. Specifically, I am interested in watersheds with forests during the winter. This work has included efforts at various sites in the northeast United States including Hubbard Brook Experimental Forest and Huntington Forest. I am also studying the effect of climate change in East Asia. Most recently, I have been working on a project at Lake Hovsgol in northern Mongolia.

The picture shows me at Lake Hovsgol in summer 2008 where I was doing field work related to watersheds.
Dr. Groffman

My favorite science experience was when we looked at the chemical results from our field experiments. We saw that our experiment had worked and that our **hypotheses** (hi *poth* uh ses) about the effects of winter climate change were correct. A hypothesis is an unproven idea. With a complicated field experiment, so many things have to be done exactly right to get scientific results. It’s great fun when it all happens the way it is supposed to!

Dr. Christenson

It is difficult to pick just one experience; science can be really fun (most of the time!). So if I have to choose just one, it would be tracking moose through the snow to find their fresh droppings! I collect the ‘moose poop’ then analyze it for a number of elements back in the laboratory. This allows me to better understand how moose interact with their **habitat** (hab uh tat). A moose’s habitat is the natural area in which it lives.
Thinking About Science

Scientists discover new information. This new information affects the work of other scientists. Can you guess why this is so? New information creates new scientific questions. In this study, evidence of a changing climate caused scientists to ask questions they had never asked before.

Wintertime in the northeastern United States (figure 1) seems like a time when everything slows down. Scientists thought this was also true of some natural processes. The reports of warming temperatures caused scientists to start thinking about wintertime.

They wondered how rising temperatures would affect wintertime natural processes. Scientists thought about this question a lot. They also read work of other scientists to see what other scientists thought about the question.

Thinking About the Environment

Do you ever wonder what happens under the ground? Is the soil just dirt? (figure 2). Is it a home for plants and animals? Although soil often looks like it...
is just dirt, it is a busy place! For example, earthworms live in the soil. You probably know about earthworms, but there are other organisms in the soil. An organism is any living thing.

Did you know that tiny organisms, called microbes, live in the soil? Most microbes are too small to see with your eye alone. Microbes include algae, plants, bacteria, and other animals. One gram of soil contains millions of these small individual organisms! One gram of soil is about the weight of a paper clip. Some of these organisms eat material that is naturally in the soil. Others eat the waste products of other organisms. Although you cannot see microbes at work, their activity creates the soil. All life depends upon this soil. What are two ways that people depend on soil?

**Introduction**

Scientists have done research on soil during the winter. Much of this research has happened in alpine and arctic areas. Alpine areas are found in high mountains, where there are few or no trees. Arctic areas are found in the far north, where winters are long and the ground stays frozen most of the year. In these areas there is little tree cover and winters are long (figures 3 and 4).

In the past, scientists did not spend much time studying wintertime soil in the
Scientists believe that Earth’s climate is getting warmer. If the climate continues to get warmer, then there could be more cycles of freezing and thawing. The scientists wondered what would happen to the microbes in the soil if there were more cycles of freezing and thawing. By studying other scientists’ research, the scientists found that some scientists had already tested the impact of thawing and freezing on soil.

When these scientists did their study, they first tested it in a laboratory setting. A laboratory setting is usually inside a building where conditions may not be the exact same as conditions outside. It is a more controlled environment than a natural environment. In a laboratory setting, scientists can control the temperature and other factors to study the effects of thawing and freezing on soil.

By studying other scientists’ research, the scientists learned a lot. They found out that during the winter in alpine and arctic areas, many natural processes do not stop. The soil, in particular, is a busy place even during the winter. When snow covers the ground, it protects the ground from freezing. This allows many of the soil activities to continue during the winter. If this is true for soil in the northeastern United States, then snow-covered ground provides an important ecological benefit to the plants and animals who live there. An ecological benefit means that there is a good relationship between the organism and the environment.
setting, things like temperature and lighting can all be easily controlled. In the laboratory setting, the scientists found that freezing and thawing increases the activity of microbes. Scientists think that some of the microbes may die when the soil freezes and then the microbes that are left eat the dead ones to survive. The scientists wanted to know what happens to the activity of microbes if the freezing and thawing cycle happens in the natural environment instead of a laboratory setting.

### Method

The scientists read the research of other scientists. Some of this research had been done in other places with cold winters. Two of the places researched were Colorado (figure 7) and Canada. Colorado has cold winters in the mountainous areas of the State (figure 8). Canada’s winters are cold because Canada is far from the equator (figure 9). The scientists also read about research done in the northeastern United States.

**Figure 8.** Can you guess what time of year it is in the Rocky Mountains of Colorado?

---

**Reflection Section**

What question did the scientists want to answer?

If soil that never froze before began to freeze during the winter, do you think soil activity would be affected? If so, how do you think soil activity might be affected?

---

**Figure 7.**

Colorado is located in the western United States.
Figure 9. Canada is located far from the equator, where the climate is warm.

In this study, the scientists wanted to see what would happen to the activity of microbes when the freezing and thawing happened in a natural setting. To do this, scientists caused the soil to freeze outside by removing the top layer of snow during the winter (figure 10).

Figure 10. Snow was shoveled from an area in the Hubbard Brook Experimental Forest in New Hampshire to observe the effect of changing temperatures on winter soils.

Do you think that wintertime soil activity in the northeastern United States is similar to wintertime soil activity in Canada? Why or why not?

Do you think the scientists should have read about research done on wintertime soil activity near the equator? Why or why not?
Findings

Do you remember that microbes live in the soil? These microbes are quite busy. They produce heat when they are active in the soil (figure 11). This heat causes the soil temperature to rise. This heat helps to keep the soil warm throughout the winter. When snow falls and the temperatures are cold, the snow stays on the ground throughout the winter. The snow insulates (in suh lats) the ground. Insulation keeps the area warmer. The warm ground enables the microbes to continue their activity.

The scientists found that the freezing and thawing cycle in a natural setting did not cause microbe activity to increase. This finding was quite different than what the scientists in the laboratory setting found. Do you remember what they found in the laboratory setting?

Figure 11. A compost pile contains leaves and other waste products. If you put a thermometer in a compost pile, you would be able to see the temperature is warmer because of the heat generated by the soil microbes.

Discussion

Scientists do not know a lot about soil activity during the winter in the northeastern United States. However, they know that plants and animals are more active during the winter.
than previously believed. From this study, the scientists learned that in a natural setting there was a different outcome than in a laboratory setting. In the natural setting, the scientists found that when soil was frozen, microbe activity did not increase. However, in the laboratory setting, scientists found that soil microbe activity increased. Scientists think that it may not have gotten as cold outside as it did in the laboratory setting and therefore they got different results.

This study shows why it is important to conduct a scientific study in an area that is as similar as possible to the environment the scientist is interested in studying. This study also shows why it is important that studies are repeated several times by different scientists before any conclusions are made.

If you were the scientist, how would you explore whether higher average temperatures affect soil activity over the entire winter?

Why do you think scientists first tested soil microbe activity in a laboratory setting?

In this FACTivity, students will investigate the soil in their school yard and some soil from home. You will need at least five empty plastic bins, five small hand trowels, magnifying lens, plastic spoons, plastic sandwich bags, permanent markers, rulers, plastic containers or sinks with water, and science journals.

Divide students into small groups of three or four students. Give each group a plastic bin and a hand trowel. Take students outside to collect two samples of the soil. Before students collect samples of soil, have student note-takers write down a description of the area from which each soil sample will be taken. The soil sample from the student’s neighborhood should be brought back with the student the next day.

After each group has collected its soil samples, bring the samples to an area where students can sift through the soil and make notes about what they find in their soil sample. Students will use the chart provided to make their notes.

Student Procedure:
1. Using your spoon and plastic bags, you will collect three different looking types of soil to investigate. Choose at least one from your neighborhood and two from the school grounds. The one from your neighborhood should be brought back with you tomorrow. Be sure to label the plastic bag with information about where you collected the soil.
2. Complete the chart above.

3. After students have filled in their charts and had time to examine the soil, have a class discussion about the different types of soil the students found. As a class, you can create a soil chart of the different soils that were found.

*This FACTivity was adapted from “Scoop, There it is!” by Todd R. Nickelsen.

<table>
<thead>
<tr>
<th>Observations</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where did you collect this sample?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Describe the sample site (i.e., sunny, moist, dry, shaded, forested—you don’t have to use these terms)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How deep did you dig to get your sample?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What color is the sample?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What does the sample smell like?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What does the sample feel like?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is there any evidence of living or dead plants or animals? Describe.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the sample contain iron? How could you check?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Describe the particles. What about their size? Shape? Color?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Useful Web Links:
To learn more about soil microbes, visit http://rivenrock.com/soilmicrobes.htm.

Underground Virtual Adventure—The Field Museum
http://www.fieldmuseum.org/undergroundadventure/virtual_tour/index.shtml#

Discovery Education Soil Safari
http://school.discoveryeducation.com/schooladventures/soil/soil_safari.html

Bureau of Land Management Just For Kids Soil Biological Communities
http://www.blm.gov/nstc/soil/Kids/soilcrus.html


If you are a PLT-trained educator, you may use PLT Activity #24, “Nature’s Recyclers,” as an additional resource.
Across:
2. Something that is used as a comparison when checking an experiment
5. A good relationship between the environment and an organism
8. Careful examination
9. An idea that has not yet been proven
11. The average condition of weather over large areas, over a long time, or both
12. Trees that lose their leaves in the fall or winter
14. An element that helps humans breathe

Down:
1. Fuels that are formed from the remains of animals from the past
3. Areas that are not highly developed
4. An element found in the atmosphere that plants need
6. Trees that do not lose their leaves
7. How high an area is above sea level
10. The imaginary line on Earth connecting north and south poles
13. A place where ocean tide meets river current
Investi-gator Word Search 1

W Q Z
E R X T N W L
A B R Y N Q A V W
G K N E E C T X G O I
D W W P T M H N P B K C W
Y G O M S T H L P S M K A Z Q
Y N D M I I K O E S K J C U Q
E R I E Y S L U R C K O I T E F S
P M I T C A E F V O U Y H P P R F T H
L E Z R I Q H A A P Z C A K O N R T X
N N Y O D M T E F H C O D N U R J U E
U H Y G U I O L Z Y M T N E I R T U N
K T E O G P F F L R J E E Y N M B
C N U F Y V F L G Z P J O E Z
E T S V H E T K F A C I C H K
P G Y U N W P D S T U H R
X S K X I A A
R N P U I
W Z Q C D
E E Y
R X M
W D E
F O U
I O C
K B L

1. chemical that helps create the red color in leaves
2. the green color found in plants
3. trees that lose their leaves in the fall or winter
4. a mathematical sentence
5. an idea that has not yet been proven
6. fallen leaves
7. an element that is found in the atmosphere and is important to plant life
8. any substance found in foods that are necessary for plants and animals
9. careful examination
10. a gas that contains oxygen
11. polluted air
12. layer of the atmosphere closest to Earth
Investi-gator Word Search 2

N
C H U
S O H C M
B W A D I H S
A T O I G N T E Q
H T W O R G N A B R U
X V E H A E G S A O L W G
H A B I T A T E A O R B V Q T
U O U S O Z I I E U N C C D D R H
O P R S R B R C R T R A I F T H H V P
W W O M Y C I X C A D S M S B I P R Z C
D O L I L L K F A L A Y H X M D C G J
Z K F O M E T A U L A V E W S F N
C P S K T F J S P H R R D Z V
C D B J Q I N I S B D H R
C G A F L I N S S A F
O T G X G E Q O N
F L A L I W U
J K S F I
X P Y
S

1. areas found high in the mountains where there are few or no trees
2. areas in the far north where winters are long and the ground stays frozen most of the year
3. standards or measures that are used in decision making
4. examine or judge carefully
5. natural area in which living things live
6. to keep an area warmer or protected
7. tiny organisms that are too small for you to see with your eye alone
8. moving from one place to another for breeding and feeding
9. any living thing
10. rules we must follow
11. growth of a city
12. area of land from which all of the water drains into one stream or river
Note to Educators

Science education is increasingly in the spotlight as society recognizes the importance of scientific literacy to the Nation’s future. As teachers of science, you are being asked to prepare your students by providing both breadth and depth in science topics and process. The Investigator is a resource to help you teach both scientific content and process to your students. The Investigator integrates science with a number of disciplines, including language arts, geography, math, and social studies. Therefore, the Investigator can be used for team teaching or simply to reinforce the interdependent nature of learning and knowledge to your students.

You understand the importance of hands-on learning. While hands-on experience is a critical component of student scientific learning, science education standards have increasingly also highlighted the role of minds-on learning. True scientific literacy occurs when students can critically think about scientific questions, processes, and findings, as well as participate in data collection, observation, and analysis. You can use the Investigator to introduce science as a process that integrates minds-on learning with hands-on learning. At the end of each article, an easy-to-do activity, called a FACTivity, is provided to highlight a topic or process concept from the article. A reference to appropriate Project Learning Tree (PLT) activities are also provided for those educators certified in PLT. For more information about PLT, visit http://www.plt.org.

Help Us Improve the Investigator

On pages 52 and 53 of this journal and on http://www.naturalinquirer.org, you will find student and teacher evaluation forms. These forms give you an opportunity to provide feedback that will help us improve the journal. Please take a moment to complete the evaluation form and if possible, invite your students to evaluate the journal as well. By completing the evaluation form, your students can learn the importance of providing assessment, much as you do when you assess their achievement. For more information, to ask questions, or to provide comment, contact:

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In subject line, please put: Educator feedback

Visit these web sites for other useful information:
U.S. Forest Conservation Education
http://fs.usda.gov/conservationeducation

Cradle of Forestry
http://www.cradleofforestry.com

How To Use This Journal In Your Classroom

The Investigator is written at the fifth grade level. Each article is written from an actual published scientific paper presenting contemporary environmental research. At the back of this journal, you will find two resources to help you use the journal more effectively. A matrix is given which indicates which national science education standards can be addressed by each article. A lesson plan is also provided that can be used with all four of the articles. The lesson plan helps you apply a reading strategy that will increase student comprehension. Along with the FACTivity, the lesson plan will help you integrate minds-on and hands-on scientific learning.

Visit the Investigator Web site at http://www.scienceinvestigator.org
Lesson Plan for the *Investi-gator*
Vol. 1, #1, Summer 2009

**Materials and Supplies:**
The *Investi-gator* Vol. 1, #1, Summer 2009
2 X 3 ½ inch sticky notes (11 for each student)
pencils
2 blank unlined pieces of 8 x 11 inch paper for each student

**National Science Education Standards addressed:**
Content Standards A, C, and F
A: Abilities necessary to do scientific inquiry
A: Understandings about scientific inquiry
C: The characteristics of organisms
C: Organisms and their environments
F: Changes in environments
F: Types of resources

**Time needed:** Two days, 1.2 classroom periods
(First classroom period: Fifteen minutes)

**Classroom Period 1:**

**Fifteen minutes:** Introduce the scientific process, as expressed in scientific writing, to your students. Explain that scientists communicate with each other in writing by completing a scientific paper. A scientific paper is similar to what they do when they write a research paper. A scientific paper may have a number of sections, but they usually include:

1. **Introduction section.** The introduction gives the background of the research problem. It explains what the problem is and why it is a problem. It usually ends with a statement of the question the scientist wanted to answer or the specific problem to be solved.

2. **Methods section.** The methods section explains what kind of data or information the scientist collected, how it was collected, and how it was analyzed.

3. **Findings section.** The findings section presents the results of the data analysis and usually includes an interpretation of the analysis. An interpretation of the analysis is different than the analysis itself. The analysis is a process of data or information reduction, and may include mathematical and statistical processes. Mathematical and statistical analysis are not mandatory, as many forms of analysis may include non-numerical processes. The interpretation is the meaning given to the analysis. Different scientists could even interpret the same data or information in different ways.

4. **Discussion (or Implications) section.** In this section, the scientist usually discusses the findings and interpretation in light of the original problem presented in the Introduction section. In addition, this section often suggests new questions or problems to be answered or solved.

Explain to your students that there are many ways to solve scientific problems or answer scientific questions. The type of data or information collected and the way it is analyzed depends on the problem or question. Introduce the *Investi-gator* by telling them that they will be reading a scientific paper written at their grade level. Tell them that this paper is based on an actual scientific paper written by scientists working for the U.S. Forest Service, a United States government agency.

Hand each student an *Investi-gator*. For homework, ask students to read the article that you have chosen. Students should read the entire article, but they do not need to read the FACTivity or the Reflection Questions.
Classroom Period 2: This will take the entire classroom period.

Twenty minutes: Before getting started, give each student 11 sticky notes and two pieces of unlined white paper. Students will fold one sheet of paper in half and then into quarters. Then they will unfold the paper. In the first quadrant, have them write “Thinking About Science.” In the second, have them write, “Thinking About the Environment.” They should put their name on both pieces of paper.

Divide your class into eight groups. Assign article sections to each group as follows:

Group 1—Introduction (and Reflection Question #1)
Group 2—Introduction (and Reflection Question #2)
Group 3—Method (and Reflection Question #1)
Group 4—Method (and Reflection Question #2)
Group 5—Findings (and Reflection Question #1)
Group 6—Findings (and Reflection Question #2)
Group 7—Discussion (and Reflection Question #1)
Group 8—Discussion (and Reflection Question #2)

(If there are three Reflection Questions, select two for this exercise. If there is one reflection section question, assign the question to two groups.)

All students should silently read “Thinking About Science” and “Thinking About the Environment.” When they have finished each section, they should write the main idea of each section on one sticky note and place it on the paper in the correct quadrant. In the third quadrant, students should write the article section title to which they have been assigned (Introduction, Methods, etc.). Then, each student will silently scan that article section, including the Reflection Question to which they have been assigned. Students should write what they believe to be the main idea or main sentence of each paragraph on one sticky note, and place each sticky note in one of the remaining quadrants. (Have extra blank sheets available if needed.) Students should number each sticky note in order (#1 for the first paragraph, #2 for the second, etc.). Remind students to examine the photos, illustrations, and tables in their section.

Ten minutes: Each group will focus specifically on the article section and reflection question to which they have been assigned. For example, students in groups 1 and 2 will focus only on the Introduction. Using the sticky note paragraph summaries, groups should discuss and develop an answer to their reflection question. One student will be appointed recorder and one student will be the presenter. The reflection answer should be summarized so that its presentation will take no longer than one minute to answer. The summarization should include a rationale for the answer, if necessary. For example, “We answered this way because.....”

Twelve minutes: The presenter from each group will present the reflection section answer and rationale to the class. Have the student read the reflection question before giving the answer and rationale.

Note that possible answers to the Reflection Section questions are on page 55.

If you have time, hold a class discussion about the article. What did students learn? What did they like and dislike about the article? Challenge students to discuss how the research they just read might affect them personally. How might it affect their community?

Assessment: Have students turn in their sheets. You should have a “quadrant sheet” from each student, and a summary sheet from each group. You can assess student comprehension by examining their paragraph summary statements.
## Assessment Rubric

<table>
<thead>
<tr>
<th>Quadrant sheet</th>
<th>Poor 1</th>
<th>Fair 2</th>
<th>Good/ Satisfactory 3</th>
<th>Exemplary 4</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did not attempt to make quadrant sheet</td>
<td>Made quadrant sheet - not completed</td>
<td>Completed quadrant sheet - missed one section</td>
<td>Complete quadrant sheet</td>
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</table>

<table>
<thead>
<tr>
<th>Understanding of Material</th>
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<th>Fair 2</th>
<th>Good/ Satisfactory 3</th>
<th>Exemplary 4</th>
<th>Score</th>
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</thead>
<tbody>
<tr>
<td>Did not demonstrate understanding of material</td>
<td>Limited understanding demonstrated</td>
<td>Demonstrated understanding of assignment and material</td>
<td>Added extra evidence to support answers</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Grammar/ Punctuation</th>
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<th>Fair 2</th>
<th>Good/ Satisfactory 3</th>
<th>Exemplary 4</th>
<th>Score</th>
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<tbody>
<tr>
<td>More than 8 errors</td>
<td>4–8 errors</td>
<td>1–3 errors</td>
<td>No errors</td>
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</table>

<table>
<thead>
<tr>
<th>Group Summary Sheet</th>
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<th>Good/ Satisfactory 3</th>
<th>Exemplary 4</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group did not turn in summary sheet</td>
<td>Showed limited support to group sheet</td>
<td>Met most of criteria for group summary sheet</td>
<td>Completed group summary sheet with full participation from all members of group</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Score</th>
<th>Poor 1</th>
<th>Fair 2</th>
<th>Good/ Satisfactory 3</th>
<th>Exemplary 4</th>
<th>Score</th>
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<tbody>
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</tbody>
</table>
STUDENTS!
Tell Us What You Think About The *Investi-gator*!

1. The article I read was entitled:________________________________________________

   Circle the answer that best describes how you feel about the article you just read.

2. The article was:  Easy to understand  Hard to understand  Very hard to understand

3. The article was: Very interesting to read Somewhat interesting to read Not interesting to read

4. Did you learn something from reading the article?   Yes   No

5. Did you try to answer the Reflection Questions?   Yes   No   Some of them

   If you read and tried to answer any of the reflection questions, did they help you to think about the article?   Yes   No

6. Would you like to read another article?   Yes   No

7. How old are you?    7    8    9    10    11    12    Other age:

8. What grade are you in?   2nd   3rd   4th   5th   6th   Other

9. Are you a girl or a boy?   Girl   Boy

Now write in your answer:

10. What did you learn from reading the article?_____________________________________

    ___________________________________________________________________________

    ___________________________________________________________________________

11. What is your favorite subject in school?_____________________________________

    ___________________________________________________________________________

    ___________________________________________________________________________

Along with your class or by yourself, please send this form to:
Dr. Barbara McDonald
Forest Service
320 Green St.
Athens, GA 30602-2044

Thank You!
PLEASE COPY THIS FORM BEFORE COMPLETING

The Investi-gator Teacher’s Evaluation

For each article that you read, please answer the following:

Name of Article:

1. Would this article help you meet any of the required statewide science curriculum standards?  
   Yes       No

2. How close to the appropriate reading and comprehension level for your students is this article written?  
   Very close       Somewhat close       Not close

3. If the article is somewhat close or not close to the appropriate reading and comprehension level, is it:  
   Too hard       Too easy

4. Would or did you use this article in your classroom as an educational resource?  
   Yes       No       Why or why not?

5. Please rate the article sections on a scale of 1 to 5. One means the section was not useful at all, five means the section was very useful.

<table>
<thead>
<tr>
<th>Section</th>
<th>Not useful</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Very useful</th>
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<tbody>
<tr>
<td>Meet the Scientist</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td>Glossary</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Methods</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Results</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Graphs, figures, photos</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Reflection Questions</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>FACTivity</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

PLEASE CONTINUE THIS EVALUATION ON THE NEXT PAGE.
For any of the sections you rated with either a one or a two in question 5, please indicate why the section was not useful or how it can be improved:

Meet the Scientist

Thinking About Science

Thinking About the Environment

Glossary

Introduction

Methods

Results

Graphs, figures, photos

Reflection Questions

FACTivity

6. Was the “Note to educators” useful to you?
   Yes   No   Somewhat

7. What grade(s) do you teach?

8. What subject(s) do you teach?

9. Other comments or suggestions:

Thank You!
Possible Answers to the Reflection Sections

Note to Educator: The purpose of the Reflection Section Questions is to encourage students to think critically about what they have read. The following “answers” are only suggestions to assist you in using these questions in the classroom.

Are You Red-dy to Change? Learning What Affects Leaf Color Change

Introduction
What was the research question the scientists wanted to answer? Are the air temperature, the length of daylight, or the chemicals in the leaves more likely to result in leaf color change in sugar maples?

Do you think it is important for people to know when fall leaf color will be at its most colorful? Why or why not? This is an individual question and must be answered individually. Students should support their answers with logical explanations.

Method
Why do you think the scientists decided to collect leaf samples from June to October instead of from October to June? Deciduous trees drop their leaves in the fall and winter. If they collected leaves from October to June, they would only be able to collect leaves in October and November.

Why is it important for the scientists to take a number of leaves from several trees and not just one or two? Scientists need to collect leaves from more than one or two trees so that they get a good sample of leaves from the trees. If they only collected leaves from one or two trees, there might be something different about those two trees than all the other trees. This would throw off their results.

Findings
This study was done in South Burlington, Vermont. Do you think late October would be the best time to view yellow leaves in Georgia? Why or why not? This is an individual question and must be answered individually. Students should support their answers with logical support.

Discussion
Understanding when fall leaf color is at its peak is good for a lot of people. What is one of the benefits for store owners? One of the benefits for store owners is to plan supply orders or they also use it to schedule enough employees for the times when many tourists are visiting.

Give another example of something in nature that attracts tourists to an area. If possible, think of an example from an area close to where you live. This is an individual question and must be answered individually. Students should support their answers with logical support. Some examples are beaches in the summer and snow for skiing in the winter.

No Littering o-Zone: How Rising Ozone Levels Affect Tree Growth

Introduction
In your own words and in the form of a question, state what the scientists wanted to learn. How do rising ozone levels affect tree growth? Here tree growth is determined by how many leaves were produced and the amount of nutrients in the leaves.

Think about trees growing inside a building and trees growing outside. Name three things that make observing trees outside more natural than observing them inside. This is an individual question and must be answered individually. Students should support their answers with logical support. Examples of some answers are the sun is outside, there is rain and other changing weather conditions, and insects and animals use the trees as habitats.
Method
When people rake leaves in the fall, they take nutrients away that could one day become a part of the soil. What do people do to their lawns to make up for this? They add fertilizer to their lawns.

Why do you think the scientists measured the chemical content of leaf litter from trees that were not sprayed with higher levels of ozone? The scientists measured the chemical content of leaf litter from trees that were not sprayed with higher levels of ozone so that they could estimate how ozone was affecting the forest by comparing the measurements between the two sets of trees.

Do you think scientists must have patience to do some of their experiments? What evidence of this can you find in the section above. Yes, scientists must be patient. There is evidence of this because they have to collect leaves from June through October and then come up with their results. Also scientists had to wait six years for their results.

Findings
Based on the findings, do you think that higher levels of ozone would be good for trees and other plants growing in the forest? Why or why not? Higher levels of ozone are not good for trees and other growing plants because there are lower levels of leaf litter, carbon, and nitrogen which are all important for tree and plant growth.

If less leaf litter is produced, would growing plants be helped or hurt? Explain your answer. Less leaf litter hurts growing plants because there are fewer leaves for photosynthesis: and each leaf has fewer nutrients, which also lowers photosynthesis, and finally fewer nutrients are returned to soil as leaf litter falls to the ground.

Discussion
Based on the findings and discussion in this study, do you think humans should try to reduce the amount of ozone being produced? Why or why not? Humans should try to reduce the amount of ozone produced every year so that trees and plants will have better growing conditions.

What is the answer to the scientists’ question? Reread the end of the “Introduction” if you have forgotten the scientists’ question. The scientists wanted to know how rising levels of ozone will affect how trees grow. They discovered fewer leaves will grow on trees, and that the levels of carbon and nitrogen in the leaves will be lower.

Out of the Penalty Box: Protecting the Environment Through Policies
Introduction
Environmental policies either use penalties or rewards to achieve their objectives. Think of two policies that you must follow at home or school, one based on penalties and the other based on rewards. Think about whether you would follow the policy without the penalty or the reward. Is one type of policy more effective than the other or are they equally effective? Why or why not? You must think beyond whether you like the policy. This is an individual question and must be individually answered. Students should be able to back up their thinking with logic and sound reasons.

What are the questions the scientists wanted to answer in this study? The first question is: What are the characteristics of the policies that have been used to manage urban growth and protect urban space? The second question is: Which of these types of policies has been most effective?

Method
Name at least two of the criteria used by the scientists to select which environmental policies to study. 1) Policies made by local, State, or Federal governments, 2) Policies made after 1980, or 3) Policies made in the United States.

Think about the last time you chose to buy something. This could be a piece of clothing, a CD, or any other item. Name two criteria that you used when you decided which item to buy. This is a personal question, but the student should offer valid criteria. For a CD, for example, criteria might include that the music be hip hop, and that it not cost over $14.

Examine figure 4. The third category is land that is or was purchased by a government and managed for the public good. Name one area in your community that would fit into that category. This is an individual question, but students should think about their school grounds, public parks and recreation areas, local forests, or other public lands.

Findings
Look at the list of four reasons a policy was more effective. Which of the four applies most to the policies that you must follow at home? Someone keeping a close check on whether the policy is being followed.
In most communities, people can be fined if they throw litter on the ground. Into which row and column in figure 4 would you place this policy? Why would you place it there? Control and punishment and protecting open space. Because a fine is a penalty and litter on the ground could hurt the quality of open space.

**Discussion**

Think about the conclusions of the scientists, outlined in the “Discussion” section, above. Based on these conclusions, what is one important aspect of implementing a successful policy? Communication among everyone involved. Citizens should be involved.

Do you think it is important to manage urban growth and protect open space? Why or why not? This question is individual and must be answered by each student. The student should be able to back up their answer with reason and logic.

**Snowed In? A Closer Look at Soil Activity in the Wintertime**

**Introduction**

What question did the scientists want to answer? The scientists wanted to know what happens to the activity of microbes if the freezing and thawing cycle happens in the natural environment instead of a laboratory setting.

If soil that never froze before began to freeze during the winter, do you think soil activity would be affected? If so, how do you think soil activity might be affected? Students must answer this individually. However, logic would suggest that soil activity would slow down or stop if the ground freezes.

**Method**

Do you think that wintertime soil activity in the northeastern United States is similar to wintertime soil activity in Canada? Why or why not? Students should answer this using logic, and they should back up their answers with reason. Logic suggests that wintertime soil activity in the northeastern United States would be similar to wintertime soil activity in Canada.

Do you think the scientists should have read about research done on wintertime soil activity near the equator? Why or why not? Students should be aware that the equatorial zone is warm year-around, and that research done there would not help them understand what happens in cold climates during the winter. If this is not clear to some of the students, you can use Figure 9 to contrast the climatic zones of the equator and the northeastern United States.

**Findings**

Does the human body produce heat as a result of activity? How do you know? Yes. This is evident from perspiration. When a person becomes active, they get hotter.

Restate in your own words what the scientists discovered. The scientists found no evidence of greater microbe activity when the study was completed in a natural environment. This finding was different from what they found in a laboratory setting. In the laboratory setting, the scientists found that soil microbe activity increased.

Why do you think the scientists had two different findings depending on whether it was a laboratory setting or a natural setting? This is an individual question. Students should discuss this as a group and make a list of possible differences between the two settings and discuss which setting may be better for this study.
### Which National Science Education Standards can be addressed by this edition of the *Investigator*?

<table>
<thead>
<tr>
<th>Science Education Standard</th>
<th>Article</th>
<th>No Littering O-Zone</th>
<th>Out of the Penalty Box</th>
<th>Are You Red-dy to Change?</th>
<th>Snowed In?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LIFE SCIENCE</strong></td>
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<tr>
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<td>Life Cycles of Organisms</td>
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<td>Organisms and Their Environments</td>
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</tbody>
</table>
The Northern Research Station is a collection of scientists and others working at laboratories across 20 States (figure 1). These States include some of the country’s largest cities. These 20 States also have some of the country’s most heavily forested areas. Across these 20 States, many scientists focus their research in four broad areas:

1. Protecting people and forests from unwanted effects of disturbances. Disturbances include events like floods, hurricanes, and the spread of unwanted insects and diseases.

2. Improving the quality of life in urban areas by taking care of the area’s natural resources. Natural resources include water, minerals, oil and other things that are provided naturally and provide a source of wealth.

3. Maintaining and enhancing the benefits that people receive from forests. These benefits include forest products as well as things like clean air and water, scenery, and outdoor recreation.

4. Increasing the production of clean air and water for people.

5. Studying and understanding our natural resources.

For more information, http://www.nrs.fs.fed.us.

Figure 1. The Northeastern United States is made up of 20 states.
Investigator Review Boards

Lyman Hall Elementary School, Hall County, Georgia

Myers Elementary School, Hall County, Georgia