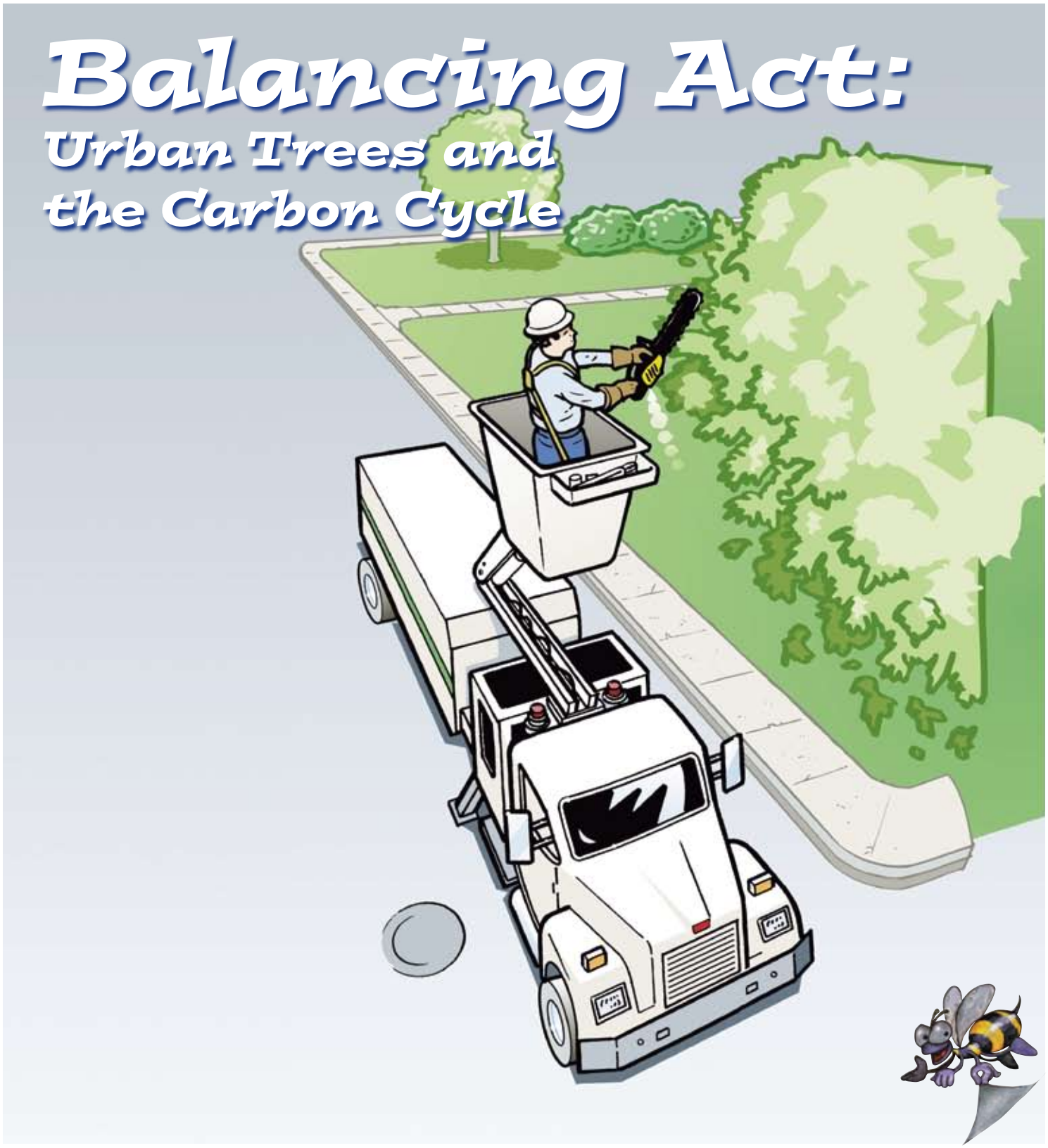
NATURAL INQUIRER

CLIMATE CHANGE EDUCATION COLLECTION • FALL 2008

Balancing Act:

Urban Trees and the Carbon Cycle



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Climate Change Education Collection • Fall 2008

Balancing Act:
Urban Trees and the Carbon Cycle

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With thanks to
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Contents

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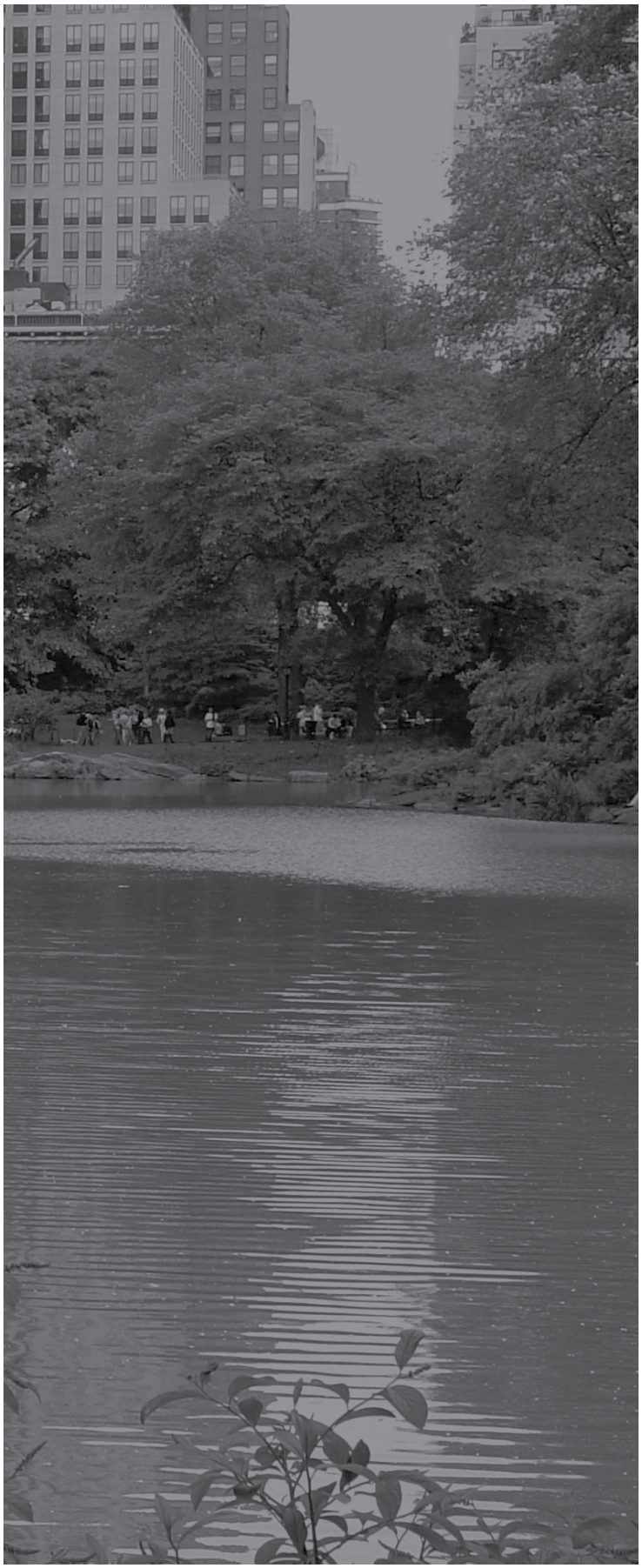


About the Natural Inquirer

Scientists usually report their research using a standard written form, called a scientific article. When a collection of articles are published together, the booklet is called a science journal. When a single article is published, the booklet is called a monograph.

This *Natural Inquirer* is a monograph and includes one scientific article. This monograph was created so that scientists can share their research with you and with other middle school students. The monograph tells you about scientific research conducted by scientists in the Forest Service. If you want to know more about the Forest Service, you can read about it on the inside back cover of this monograph, or you can visit the *Natural Inquirer* Web site at http://www.naturalinquirer.org.

All of the research in the *Natural Inquirer* is concerned with nature, such as trees, forests, animals, insects, outdoor activities, and water. First, you will "meet the scientist" who conducted the research. Next, you will read something special about science and about the natural environment. You will also read about a specific research project investigating climate change. Then, YOU become the scientist when you conduct the FACTivity associated with the article. Don't forget to look at the glossary and the special sections highlighted in each article. These sections give you extra information.

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

Welcome

to the Natural Inquirer Climate Change Education Collection!

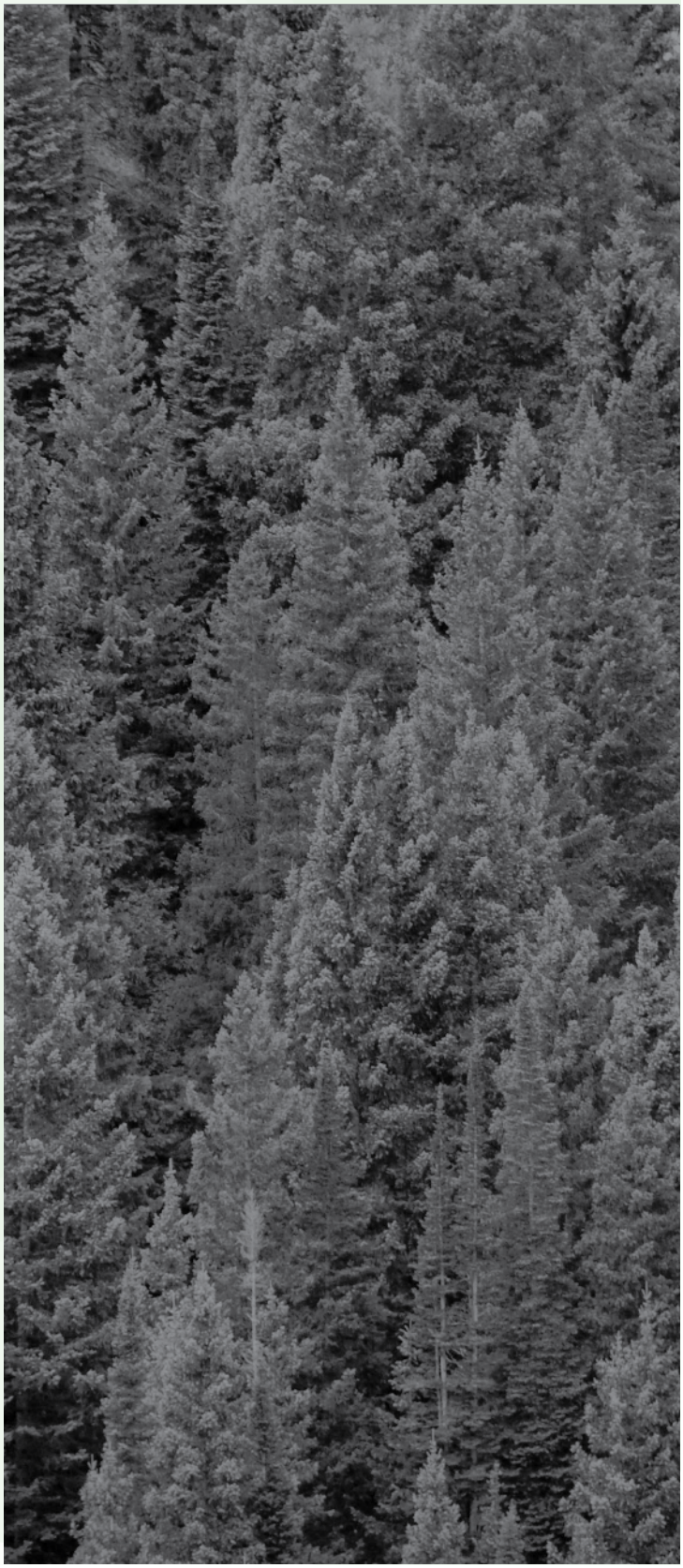
As a global citizen, you know that people around the world share similar environmental concerns. The changing climate is one concern shared by people everywhere. Some Forest Service scientists are interested in studying climate change and its relationship to forests, grasslands, air, and water. You will learn about one of these studies in this monograph.

As you know, scientific research is a continual process of discovery. Forest Service scientists are learning much about climate change, but there is still much we do not know.

This monograph is part of a collection of articles describing climate change research. You can order any of the *Natural Inquirer* monographs or journals by visiting http:www.naturalinquirer.org. The monographs and journals are free of charge.

Educators: Review "Note to Educators" on page 10 before using this *Natural Inquirer* monograph.

http://www.naturalinquirer.org



Meet the Scientists

Dr. Nowak: ▲My favorite experience in science is seeing people use the new information we generate to improve the urban environment.

Dr. Luley: ▲My favorite science experience is watching a tree go through each season and understanding what is happening to the tree. Each season has its own unique set of changes that we all can see. There is also a whole set of changes that occur in the tree at the cell and subcellular level that correspond to these visual changes. Making the connection between the two and understanding how we better manage our trees with this knowledge has been a very rewarding experience.

Mr. Stevens: ▲My favorite experience in science is being a part of the process of solving environmental problems that affect the health and well-being of urban residents.

Glossary:

emitted (e **mi** ted): Discharged or sent out.

fossil fuel (**fos** ul fyool): Fuel, such as coal, petroleum, or natural gas, formed from the fossilized remains of plants and animals.

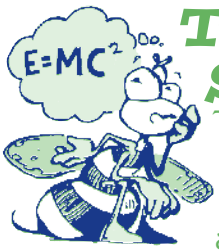
photosynthesis (**fo** to **sin** thuh sis): The process by which green plants use sunlight to form sugars and starches from water and carbon dioxide.

species (spe sez): Groups of organisms that resemble one another in appearance, behavior, chemical processes, and genetic structure

Pronunciation Guide

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

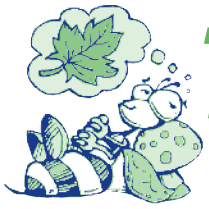
Accented syllables are in **bold.**



Thinking About Science

To discover new things, scientists must work with information. They may take old information and look at it in new ways. They may collect new information and consider it in ways that no one has done before. Often, the information that scientists collect and consider is in the form of numbers. The numbers represent quantities of whatever it is the scientists are studying.

In this study, the scientists were interested in carbon dioxide, or CO_2. The scientists estimated the amount of CO_2 absorbed by urban trees. They compared that number with another number. The other number indicated how much CO_2 was put into the atmosphere when machines were used to plant and maintain urban trees. Thus, they were looking at how much CO_2 was either being absorbed or emitted by planting and maintaining urban trees. By using numbers, the scientists could better understand how the management of urban trees affects the carbon cycle.



Thinking About the Environment

Carbon is one of the most interesting and widespread of elements. All plants and animals on Earth, including humans, are made up of carbon. Much of Earth's carbon is held deep in Earth as petroleum, coal, and natural gas. These forms of carbon are used by humans as *fossil fuels* to run machinery.

In the carbon cycle, carbon moves from the atmosphere, to Earth, into Earth, and back to the atmosphere (**figure 1**). When fossil fuels are burned in engines, carbon is taken from inside Earth and then *emitted* into the atmosphere as CO_2. If humans did not burn fossil fuels, the carbon cycle would stay in a natural balance. Too much CO_2 in the atmosphere disrupts Earth's climate and can cause the Earth's global temperature to rise.

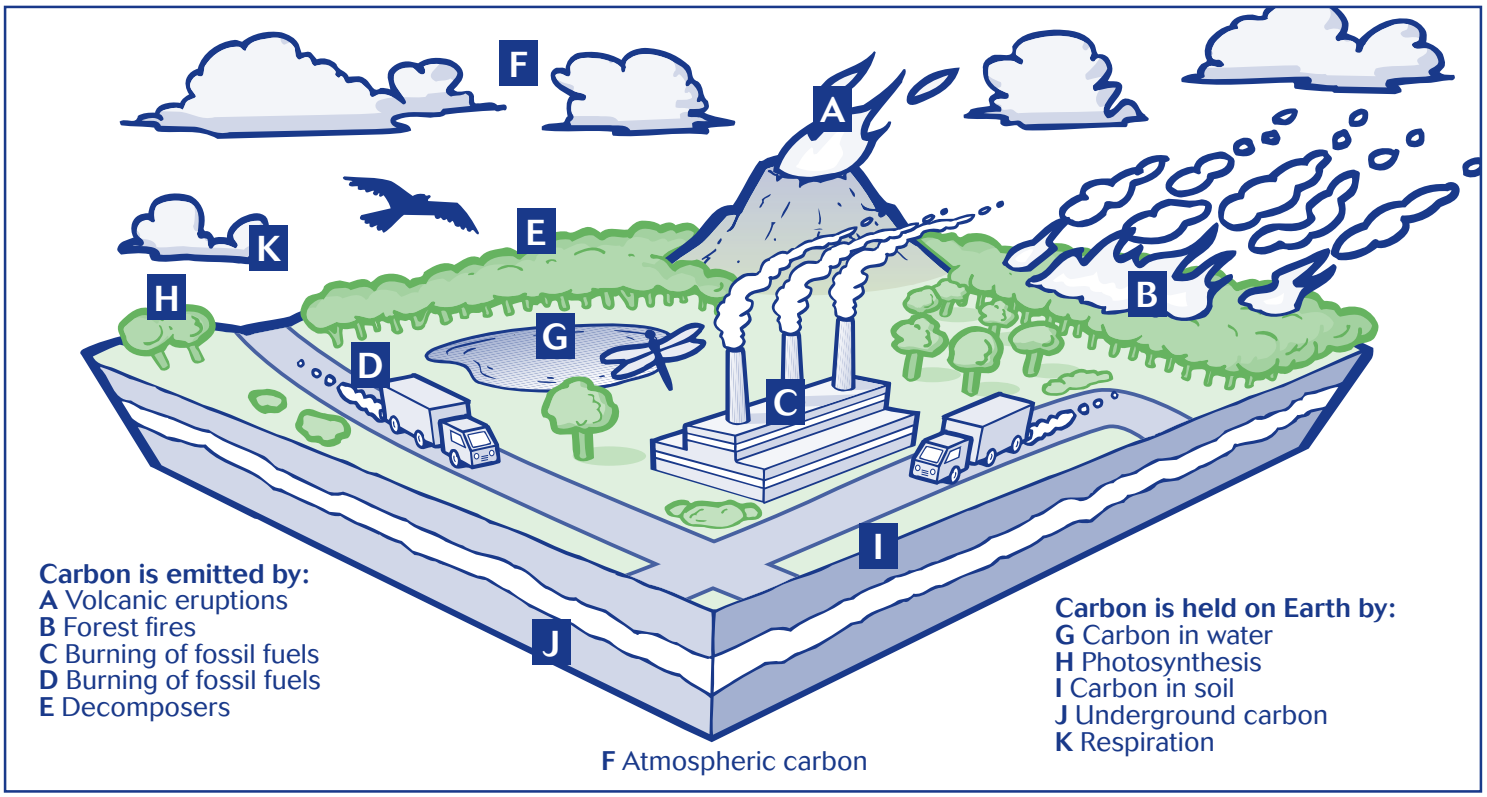


Figure 1. The carbon cycle.

Introduction

Too much carbon dioxide (CO_2) in the atmosphere is mostly caused by two things: burning fossil fuels and the loss of trees. Fossil fuels are made up of carbon. When they are burned as fuel, the carbon is released in the form of CO_2. Trees absorb CO_2 during *photosynthesis*. When trees are removed or die, their ability to absorb CO_2 is lost.

When people plant trees in urban areas, they expect the trees to do many things. Urban trees help to keep urban areas cooler, they hold soil in place, they make urban areas prettier, and they help to keep urban areas quieter. They also absorb CO_2 from cars, buses, and the many engines that are used in urban areas. When people think about the benefits of having urban trees, they often think of these things. There is also something that they may not think about.

When people plant and maintain urban trees, they usually use machines with engines. These machines include trucks, chainsaws, and other machines (**figure 2**). As you know, these engines emit CO_2. When people think about how much CO_2 is absorbed by urban trees, they should also consider how much CO_2 is emitted from the engines used to care for the trees. When a tree is cared for using machines with engines, there is a point in the tree's lifetime at which more CO_2 will be emitted from the engines than the tree has absorbed. The scientists wanted to know which tree *species* can grow the longest before reaching that point.

Figure 2. Urban trees are maintained using trucks and other machines that emit CO_2.

Reflection Section

- Think about how a part of the carbon cycle is illustrated by urban trees and urban tree maintenance. With that in mind, what is the question that the scientists were trying to answer?
- Why do you think the scientists wanted to know which tree species absorb the most CO_2 over time?

Method

The scientists thought about all of the ways that CO_2 is absorbed or emitted during the life of an urban tree. These included the growth of the tree, the engines that were used to plant and maintain the tree, and what happened to the carbon in the tree after the tree was removed at the end of its life (**figure 3**).

The scientists created 14 categories to describe the lifespan, growth rate, and size of urban tree species. The 14 categories were formed from some combination of tree species size, life span, and growth rate (**figure 4**). In other words, one category was a small tree with a short life span that grows slowly. Another category was a medium-size tree with a short life span that grows slowly. A third category was a small tree with a medium life span that grows slowly. By using different combinations of these three characteristics, the scientists created 14 separate categories.

The scientists studied one tree from each tree species for each of the 14 combinations of size, life span, and growth rate. They used existing information that estimated how much each type of tree would weigh every year of its life. From this estimate, they subtracted the estimated weight of the water in the tree. This gave the scientists a measurement of the weight of the dry matter in each tree. (Remember that scientists often put numbers on what they are studying.) To estimate the amount of carbon in the tree, they divided the weight of the tree's dry matter by two. They divided by two because half of the dry matter of a tree is composed of carbon. The amount of carbon in the tree was considered equal to the amount of CO_2 that the tree had absorbed.

Each tree was maintained exactly alike. This included things like planting the tree, pruning the tree, bringing water to the tree, and removing the tree at the end of its life. The amount of fossil fuel used every year was recorded. The scientists used existing mathematical equations to estimate how much CO_2 was emitted from the engines.

Ways that CO_2 is absorbed or is kept from being emitted	Ways that CO_2 is emitted
As a tree grows and gets larger with more leaves, more CO_2 is absorbed.	Trucks and shovels with engines are used to plant the tree.
When a tree is removed and its wood is used for furniture or other items, its carbon is not emitted.	Chainsaws and trucks are used for pruning the tree's branches and then chipping the branches into small chips for mulch. The engines emit CO_2. As the mulch decomposes, it also emits CO_2.
When a tree is removed and put into a landfill, only a small portion of its carbon is emitted.	Chainsaws and trucks are used to remove the tree at the end of its life. The tree may be chipped into small chips for use as mulch. CO_2 is emitted when machines are used and when the mulch decomposes.
When a tree is planted in the right location around a building, it can shade the building to reduce energy use and CO_2 emissions from power plants.	

Figure 3. Ways that CO_2 is absorbed and emitted during the life of an urban tree.

Size of tree species	Life span of tree species	Growth rate of tree species
Small Size (less than 40 feet)	Short (20 years)	Slow (less than12 inches per year)
Medium Size (40-60 feet)	Medium (40 years)	Moderate (12-24 inches per year)
Large Size (greater than 60 feet)	Long (60 years)	Fast (> 24 inches per year)
		Moderate to Fast

Figure 4. Characteristics that were used to create 14 categories of urban tree species.

The scientists now had two sets of numbers for each of 14 tree species for every year of each tree's life. One set of numbers had to do with the carbon dioxide emitted every year by equipment used to maintain the tree. The other was a measurement of the amount of carbon absorbed by the tree every year. They compared these numbers to answer their question.

Reflection Section

- What did the two sets of numbers represent?
- Why do you think each tree was maintained exactly alike?

Findings

Trees species with a long life span and a moderate growth rate lived the longest before the CO_2 emitted from trucks, chainsaws, and other machines was greater than the amount of CO_2 that the trees absorbed. In general, the longer a tree lived, the better the balance between CO_2 absorption and emission. This is partly because of the large amount of CO_2 that is emitted by engines when a tree is planted or removed. It is also because trees that live longer are usually larger and have more leaves. This means that they photosynthesize more and, therefore, absorb more CO_2 than smaller trees.

Thinking About Ecology

All living things exist on Earth because of the one-way flow of energy from the sun. Plants use sunlight to make sugars and starches from water and carbon dioxide, a process known as photosynthesis. Plants are eaten by animals, and some animals eat other animals. As plants and animals are eaten, their energy is transformed into energy that can be used by the one who is doing the eating. When plants and animals die, their bodies decompose, providing energy for microorganisms in the soil.

Over time, much of Earth's energy is held deep in Earth in the form of coal, petroleum, and natural gas. Although energy changes form, energy that comes from the sun cannot be created or destroyed by anyone or anything on Earth. ■

Reflection Section

- This research identified the amount of CO_2 emitted by equipment that was used to maintain urban trees. What might happen in the future to the design of the equipment used to maintain urban trees? How could that change affect the scientists' research?
- If people want to increase the amount of CO_2 that is absorbed in urban areas, should they plant more or fewer urban trees?
- Of the tree species characteristics in figure 4, which kind of species should they plant?

Discussion

We often consider doing things without looking at the complete picture. The scientists in this study suggest that people should think carefully before selecting an urban tree species to plant. People should compare the amount of carbon that the tree will absorb with the amount of CO_2 being emitted when the tree is planted and maintained using machines.

The scientists suggest that people should plant urban trees that live a long time and grow either fast or moderately fast. They also suggest that people use machines that are energy efficient, or they should do some of the things by hand. ■

Reflection Section

- This study looked at how much CO2 was emitted by engines used to plant and maintain urban trees. What is one way that CO2 emissions could be reduced without changing the type of tree species being planted?
- This study examined the advantages and disadvantages of planting and maintaining different urban tree species for balancing CO2. What might be some other advantages and disadvantages of different tree species?

From Nowak, D. J., Stevens, J. C., Sisinni, S. M., and Luley, C. J. (2002). Effects of urban tree management and species selection on atmospheric carbon dioxide. *Journal of Aboriculture*, 28(3):113-122.

FACTivity

As a class research project, create a list of different types of native trees for the area in which you live. In groups, research each tree and find out how long the tree lives and how fast it grows as well as leaf type, special characteristics of the tree, etc. Your group should make a presentation about your tree. After all of the presentations have been made, your class should vote on which type of tree to plant in your schoolyard. The tree should be successful in your particular schoolyard environment.

Teachers—

A possible extension to this Factivity is to have students engage in a service learning project. After researching the trees and voting on type of tree to plant, students can go out into the community and find businesses that would be interested in helping to plant urban trees. Schools could get businesses to donate funds to buy trees appropriate for the area and the students could plant them.

Note to educators

The mission of the Forest Service is to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations. For more than 100 years, our motto has been caring for the land and serving people. We recognize our responsibility to be engaged in efforts to connect youth to nature and to promote the development of science-based conservation education programs and materials nationwide. We have developed the *Natural Inquirer* Climate Change Education Collection to help you and your students better understand climate change.

Forest Service researchers have studied the impacts of climate change and air pollutants on forests and grasslands for more than 30 years. This research has identified climate change trends and subsequent effects to ecosystems across the United States and worldwide. For their research contributions to the Intergovernmental Panel on Climate Change (IPCC) Report, 13 Forest Service scientists were recipients of the Nobel Peace Prize in 2007. The Nobel Committee recognized "efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change."

The articles in the Climate Change Education Collection will introduce students to several of these scientists and their climate-change-related research. Students will learn about the scientific process used by the scientists and will be engaged in hands-on activities on climate change topics such as the carbon cycle, invasive species, vegetation changes, and urban and world forests.

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

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

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

Meet the Scientists: Introduces students to the scientists who did the research. This section may be used in a discussion of careers in science.
Glossary: Introduces possibly new scientific or other terms to students. The first occurrence of a glossary word is italicized in the text.
Thinking About Science: Introduces something new about the scientific process, such as a scientific habit of mind or procedures used in scientific studies.
Thinking About the Environment: Introduces the environmental topic being addressed in the research.
Introduction: Introduces the problem or question being addressed by the research.
Method: Describes the method used by the scientists to collect and analyze their data.
Findings: Describes the results of the analysis.
Discussion: Discusses the findings and places them into the context of the original problem or question.
Citation: Gives the original article citation.
FACTivity: Reinforces an aspect of the research through a hands-on activity.

Science Education Standards and Evaluations: In the back of the monograph, you will find a list that allows you to identify articles by the national science education standards they address. You and your students may also complete evaluation forms online by visiting http://www.naturalinquirer.org.
If you have any questions or comments, please contact:

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(Please put "Educator Feedback" in the subject line)

Educator Resources:
From this site, you can read and download lesson plans, word games, and other resources to help you use the *Natural Inquirer* in your classroom. You can also view and download a year-long lesson plan aimed at helping your students learn about the scientific process.

Visit the *Natural Inquirer* Web site at http://www.naturalinquirer.org

For more climate change information, visit: http://www.fs.fed.us/climatechange/

Lesson Plan for This Monograph

Time Needed:
One class period (50-60 minutes)

Materials Needed:
1 piece of plain white 8.5 X 11" paper for each student;
1 piece of plain paper for each group of 4 students
3 X 5" sticky notes (enough for at least 7 per student)

In class the day before:
Give each student a copy of the monograph, a piece of plain paper, and three sticky notes. The sticky notes should be placed on the paper and labeled "Science," "Environment," and "Prediction."

For homework:
Ask them to read "Thinking About Science" and "Thinking About the Environment." After they read each section, have them write the main idea of the section on the correct sticky note. On the third sticky note, they should predict what they think the article will address. Ask them not to read ahead in the monograph, but to use clues from the two sections to help them predict. They should also review the glossary before coming to class.

In class:
Introduce the *Natural Inquirer* monograph to the class. Include information about the sections they will be reading. (See "Note to Educator, The Format of a *Natural Inquirer* Article" on page 10.) (5 minutes)

On your whiteboard or clean chalkboard, label three areas "Science," "Environment," and "Prediction." Have each student place his or her sticky note in the correct area. Have a few students read some of the notes, one section at a time. Hold a class discussion about the similarities and differences of the notes in each section. Have students identify what clues they used to predict what the article would address and how the scientists might address it. (8 minutes)

Read "Meet the Scientists," "Introduction," "Method," "Findings," and "Discussion" Sections as a class. When you reach the end of each section, have students write the main idea of the section on a labeled sticky note. For now, skip the reflection questions. When the article has been completely read and all sticky notes completed, have students place their sticky notes on the whiteboard, under the correct heading (Introduction, Method, Findings, Discussion). (18 minutes)

Now, have each student select one sticky note from each category. They must not select their own sticky note. Place students in groups of four. Each group should compare and contrast their sticky notes for each section. On a sheet of paper, one student will write the four headings and under each heading, write the main ideas of each section as agreed on by the group. Each section's main ideas should be between 1 to 4 sentences long. (5 minutes)

Have each group read its main ideas for one or more sections (based on available time). Hold a class discussion to compare and contrast what each student group reported. (5 minutes)

Hold a class discussion about the research they have just read. What might happen to the environment in the future, given what they have learned? (5 minutes)

Make a list of actions they can take to reduce their carbon footprint (4 minutes). Examples include:

- Walk and bike more, ride in a car less.
- Eat more local produce; buy from local farmers' markets.
- Plant and maintain trees.
- Turn down the thermostat by 1-2 degrees in the winter.
- Turn up the thermostat by 1-2 degrees in the summer.
- Turn off appliances when not in use.
- Turn down the temperature in the hot water heater.
- Unplug your phones, etc., as soon as they have charged.
- Only do full loads in the dishwasher and clothes washer.
- Hang out clothes to dry.
- Consolidate car trips.
- Use energy-efficient light bulbs.
- Take shorter showers.

Day 2 (Optional): Do the FACTivity.

Lesson Plan Extension (This can be done in place of the FACTivity or as an extension on Day 3 if time allows.)

For homework, have students complete the reflection questions. They can use the same "sticky note" process to record their answers. In class on Day 2 (or 3, if you have done the FACTivity on Day 2), discuss their answers as a class. You may use the whiteboard to "mix up" the answers in the same manner as Day 1.

Reflection Section Answer Guide

Introduction

- **Think about how a part of the carbon cycle is illustrated by urban trees and urban tree maintenance. With that in mind, what is the question that the scientists were trying to answer?** Urban trees are a part of the carbon cycle because they absorb carbon dioxide (CO_2) from the air. Urban tree maintenance is part of the carbon cycle because the engines emit CO_2 from the burning of fossil fuels. The scientists wanted to discover which trees absorb the most CO_2 over the longest period of time. They wanted to find the point at which the engines used to plant and care for the tree emit more CO_2 than the tree is able to absorb.

- **Why do you think the scientists wanted to know which tree species absorb the most CO_2 over time?** Scientists wanted to know which tree species absorb the most CO_2 over time because these tree species will be the most beneficial to plant and maintain. They will cause less CO_2 to be emitted over time.

Method

- **What did the two sets of numbers represent?** They represented (1) the amount of carbon in the tree and (2) the amount of CO_2 that was emitted from the engines used to plant and care for the tree.

- **Why do you think each tree was maintained exactly alike?** Each tree was maintained eactly alike so that the scientists could compare the amount of carbon in each tree every year with the same amount of CO_2 being emitted by the machinery used to maintain each tree. If the amount of CO_2 being emitted by machinery was different for each tree, the comparisons would be meaningless.

Findings

- **This research identified the amount of CO_2 emitted by equipment that was used to maintain urban trees. What might happen in the future to the design of the equipment used to maintain urban trees? How could that change affect the scientists' research?** We could have more energy-efficient machines that either emit less CO_2 or use renewable sources of energy, such as hydrogen or solar power. If our equipment is more energy-efficient and emits less or no CO_2, you would not have to think as much about the balance of CO_2 absorbed by trees compared to the amount emitted by equipment. The scientists might not need to do this kind of research anymore.

- **If people want to increase the amount of CO_2 that is absorbed in urban areas, should they plant more or fewer urban trees?** They should plant more trees.

- **Of the tree species characteristics in figure 4, which kind of species should they plant?** They should plant trees that live a long time and grow fast or moderately fast.

Discussion

- **This study looked at how much CO_2 was emitted by engines used to plant and maintain urban trees. What is one way that CO_2 emissions could be reduced without changing the type of tree species being planted?** Trees could be planted and maintained without using machines, or the use of machines could be reduced. Also, more energy-efficient engines could be used.

- **This study examined the advantages and disadvantages of planting and maintaining different urban tree species for balancing CO_2. What might be some other advantages and disadvantages of different tree species?** One thing to consider is whether there are nuts that could fall from the trees. You might also consider whether the tree is more or less likely to get a disease. Another thing to consider is how much water the tree needs or how much space it needs to grow.

National Science Education Standards* Addressed with this Monograph:

	Balancing Act
Science as Inquiry	
Abilities Necessary To Do Scientific Inquiry	✔
Understandings About Scientific Inquiry	✔
Life Science	
Structure and Function in Living Systems	✔
Regulation and Behavior	✔
Populations and Ecosystems	✔
Science in Personal and Social Perspectives	
Personal Health	✔
Populations, Resources, and Environments	✔
Risks and Benefits	✔
Science and Technology in Society	✔
History and Nature of Science	
Science as a Human Endeavor	✔
Nature of Science	✔

* National Research Council, Content Standards, Grades 5-8.

What Is the USDA Forest Service?

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

http://www.fs.fed.us/

What Is the Cradle of Forestry Interpretive Association?

The Cradle of Forestry Interpretive Association (CFIA) is a nonprofit organization. It was founded in 1972 by a group of conservationists to help the Forest Service tell the story of forest conservation in America. The CFIA helps people better understand forests and the benefits of forest management.

http://www.cradleofforestry.com/interpretive_association/

United States
Department
of Agriculture

Forest Service
FS-809M
Fall 2008

Visit these Web sites for more urban forest information:

Northeast Center for Urban and Community Forestry:
http://www.umass.edu/urbantree/

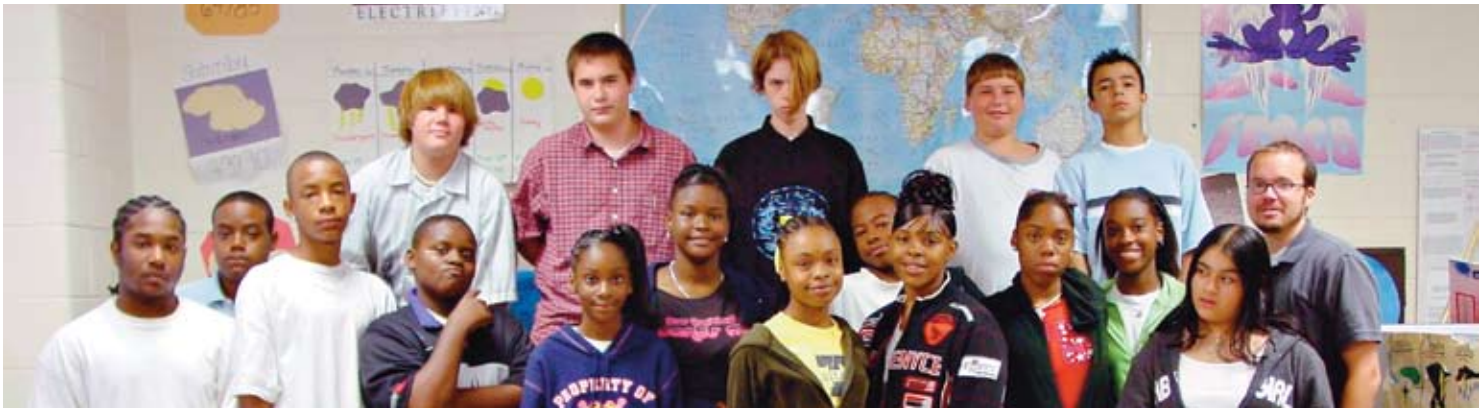
Midwest Center for Urban and Community Forestry:
http://www.na.fs.fed.us/spfo/urbanforestry/ucf.htm

Mid-Atlantic Center for Urban and Community Forestry:
http://www.fs.fed.us/na/morgantown/macucf/index.htm

Urban Forestry South Expo:
http://www.urbanforestrysouth.org

Center for Urban Forest Research:
http://cufr.ucdavis.edu/

Urban Forestry South:
http://www.urbanforestrysouth.usda.gov



Natural Inquirer editorial review board members. Every *Natural Inquirer* article is reviewed by a 7th grade science classroom. Student comments help to continually improve the *Natural Inquirer*. This is Mr. Todd Nickelsen's class in Athens-Clarke County, Georgia.