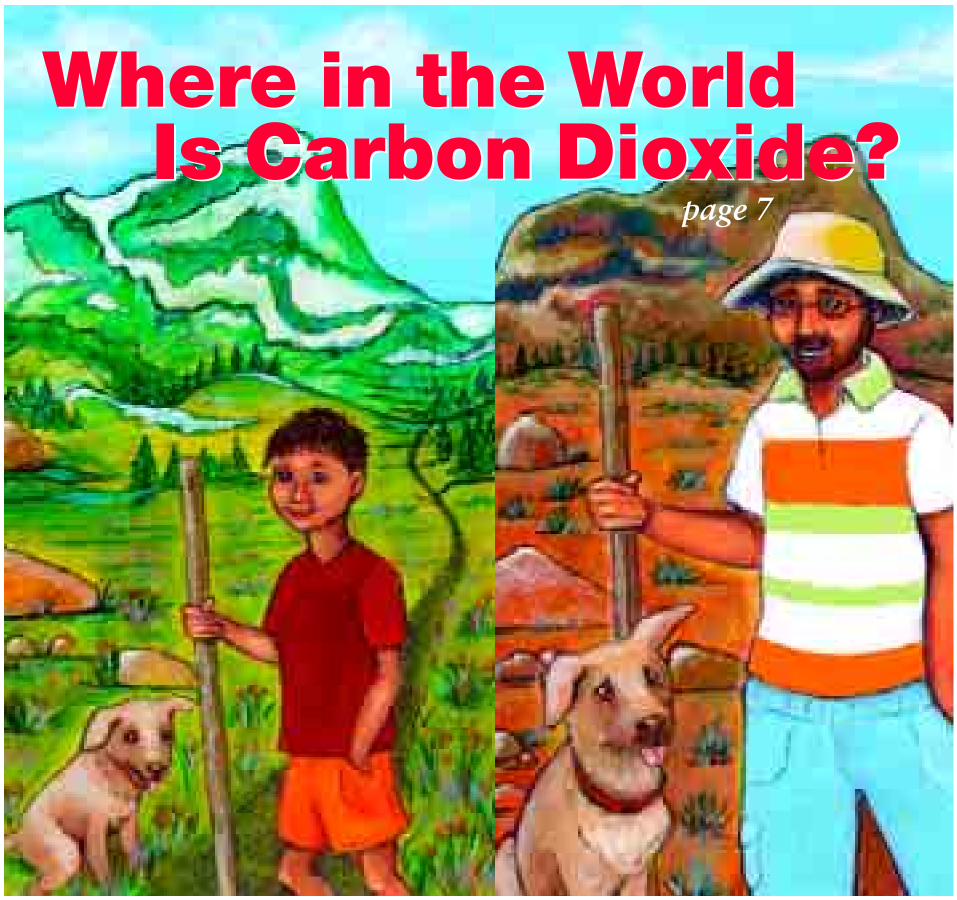
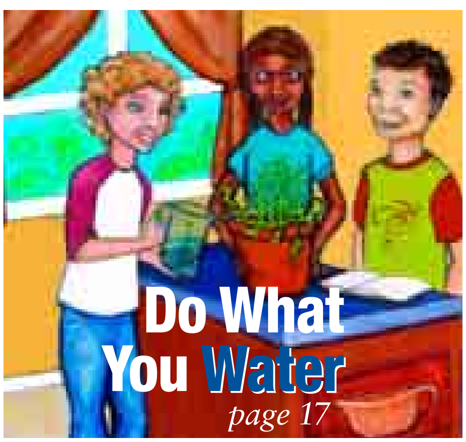
Facts to the Future Edition

VOLUME 5, NUMBER 1 • USDA FOREST SERVICE

NATURAL INQUIRER





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Facts to the Future Edition

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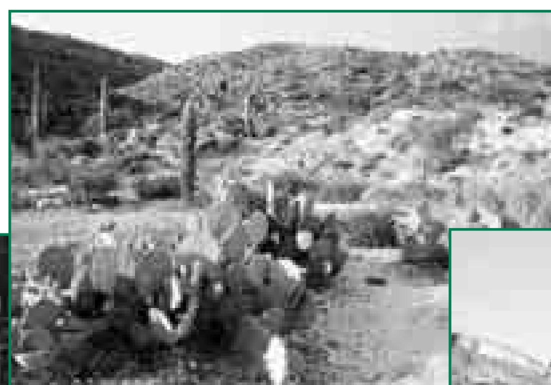

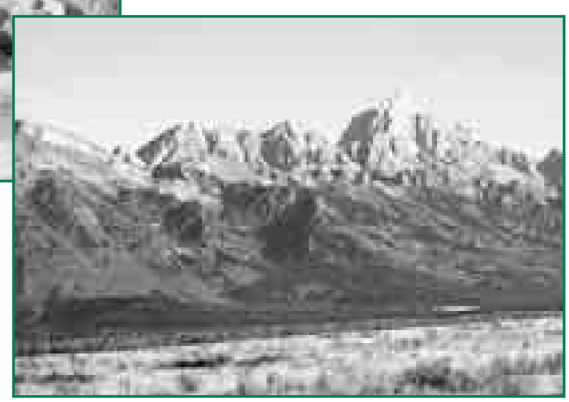

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Teacher's Note

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 bigger than the classroom that can be used while still 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 USDA Forest Service scientists and their cooperators. These are scientific journal articles that have been reformatted to meet the needs of middle school and higher students. The articles are easy to understand and 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.

Science Education Standards and Evaluations:

In the back of the journal, you will find a matrix that allows you to identify articles by the national science education standards that they address. You will also find evaluation forms in the back of the journal. Please make copies of these evaluation forms and have your students complete them after they complete an article. Please note the form for teachers to complete also. Please send the evaluation forms to the address listed at the end of the forms. You and your students may also complete the forms online by visiting www.naturalinquirer.usda.gov.

This journal was created by Environmental and Science Education, an education program of the USDA Forest Service. If you have any questions or comments, please contact:

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Teacher's Manual:

Please visit the *Natural Inquirer* Web site at www.naturalinquirer.usda.gov. From this site, you may read the teacher's manual online, download it, or request a hard copy.

Visit www.naturalinquirer.usda.gov for previous issues of the *Natural Inquirer,* sample lesson plans, word games, the teacher's manual, information about the USDA Forest Service, and other resources.

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Features

The *Natural Inquirer* is reproduced on recycled paper with soy-based inks. Please pass this journal along or recycle it when you have finished using it.

About The *Natural Inquirer*

Scientists report their research in journals, which are special booklets that enable scientists to share information with one another. This journal, the *Natural Inquirer*, was created so that scientists can share their research with you and with other middle school students. Each article tells you about scientific research conducted by scientists in the USDA Forest Service. If you want to know more about the USDA Forest Service, you can read about it on the back cover of this journal, or you can visit the *Natural Inquirer* Web site at www.naturalinquirer.usda.gov.

All of the research in this *Natural Inquirer* is concerned with nature, such as trees, forests, animals, insects, outdoor activities, and water. In each article, you will "meet the scientist" who conducted the research. Then you will read something special about science and about the natural environment. You will also read about a specific research project. This is written in the format that scientists use when they publish their research in journals. Then, YOU will become the scientist when you conduct the FACTivity associated with each 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. These questions are not a test! They should help you to think more about the research. Your teacher may use these questions in a class discussion.

What Are Scientists?

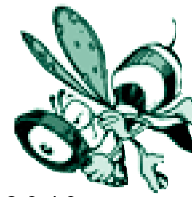
Scientists are people who collect and evaluate information about a wide range of topics. Some scientists study the natural environment. To be a successful environmental scientist, you must:

- **Be curious—**You must be interested in learning.
- **Be enthusiastic—**You must be interested in an environmental topic.
- **Be careful—**You must be accurate in everything that you do.
- **Be open minded—**You must be willing to listen to new ideas.
- **Question everything—**You must think about what you read and observe.

Scientists at work.

Welcome to the

Facts to the Future Edition of the *Natural Inquirer!*



In 1974, Congress decided that the United States needed an evaluation of the Nation's renewable (re **noo** uh bul) natural resources. Renewable natural resources are environmental products and services that can be replenished even as they are being used.

Examples of renewable natural resources are water, minerals, and trees. Congress believed that one of the best ways to take care of our renewable natural resources is to gather the best information that we can about them. Then, armed with the best information, we can make good decisions about the use and protection of our nation's renewable natural resources.

Congress decided that the USDA Forest Service could provide this kind of information. They passed legislation (lej is **la** shun), called the Resources Planning Act of 1974, or RPA for short. The act requires the Secretary of Agriculture to ensure that the research is completed and reported every 10 years.

Scientists working in the USDA Forest Service conduct the required research about these renewable natural resources. (You can read about the USDA Forest Service on the back of this journal, or on the Web site by clicking on "About the Forest Service.") Through their research, the scientists determine the current situation and the probable future of renewable natural resources, 40 years into the future.

The articles in this *Natural Inquirer* include just a few of the renewable natural resources studied by USDA Forest Service scientists. By reading these articles, you will learn about the condition of the resources in the year 2000, and you will learn what might happen to them by the year 2040. In the year 2040, how old will you be? Do you think that the condition of the Nation's renewable natural resources will be important to our society in 2040? Why or why not?

The articles in this journal will help you to think about the future of global climate change, the Nation's wildlife, our fresh water, our fish, the trees that grow in our cities and towns, and the conditions that tell us whether our forests and rangelands are healthy. As you read the articles, remember that it is hard to predict the future. Although scientists do the best job they can, many things can change in the future. One of the things that can change is how people take care of our renewable natural resources. To keep our environment healthy into the future, we need to take care of our natural resources today!

Where in the World Is Carbon Dioxide?

The Potential Impact of Rising Levels of Carbon Dioxide on U.S. Forests

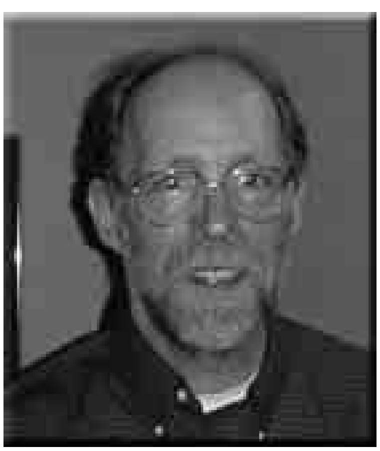
Meet Dr. Joyce:

I like being a scientist because I can explore how *ecosystems* work and use the power of mathematics to describe the processes in ecosystems.

Dr. Joyce

Meet Dr. Birdsey:

I like being a scientist because it is exciting to be involved in research that could help solve *climate* change, which is a global problem. It is quite a thrill to have the opportunity to make a difference.

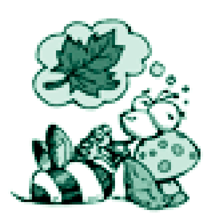


Dr. Birdsey

Thinking About Science

Do you think that the climate of the Earth is changing? When scientists first reported that they had scientific evidence to show that the Earth's climate is changing, many scientists were *skeptical*. This is a normal reaction of scientists to new discoveries. Scientists check the accuracy of new scientific discoveries by questioning each other.

One way they question each other is to do more research that may or may not support the other scientist's findings. Science is a process of learning. When something new is discovered, it can take many years before the discovery is widely accepted as being true or false.



Thinking About the Environment

Can you guess what forests have to do with carbon dioxide in the atmosphere? Plants use *photosynthesis* to take carbon dioxide from the air and turn it into complex *carbohydrates*, which are part of the chemical makeup of plants. When a plant dies, the carbon in the plant goes into the soil or returns as carbon dioxide to the atmosphere. When large areas of forests burn, the carbon in the leaves, branches, and roots is released as carbon dioxide into the

Glossary

ecosystems (e ko sis temz): Communities of plant and animal species interacting with one another and with the nonliving environment.

climate (**kli** met): The average condition of the weather over large areas, over a long time, or both.

skeptical (**skep** tuh kul): Having or showing doubt.

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

carbohydrates (**kär** bo **hi** drat): Substances made up of carbon, hydrogen, and oxygen, including sugars and starches.

analyzing (**an** uh liz): Separating something into its parts in order to examine them.

weather (**weh** thür): The temperature, wind, cloudiness, rainfall or snowfall, and humidity of a place for a short period of time, such as a few days.

vegetation (vej uh **ta** shun): Plant life.

coniferous (kä **nif** ür us): Plants or trees that have cones.

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

broadleaf (**brôd** lef): Plants or trees that have flat, broad leaves.

deciduous (de **sij** oo us): Plants or trees that shed their leaves every year; not evergreen.

average (**av** rij): The number gotten by dividing the sum of two or more quantities by the number of quantities added.

elevation (el uh **va** shun): The height above sea level.

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**.

atmosphere. For green plants to take up carbon through photosynthesis and release carbon back into the atmosphere are normal processes.

When plants are growing and photosynthesis is greatest, the plants are absorbing the greatest amount of carbon dioxide from the air. The plants store the carbon dioxide in their leaves and wood, reducing the amount of carbon dioxide in the atmosphere. This reduction can be seen in the amount of carbon dioxide in the atmosphere measured over Hawaii from 1959 to 1998 (figure 1, page 9).

The burning of coal, oil, and natural gas, and the clearing of forests around the Earth has increased the amount of carbon dioxide in the atmosphere. You can see the rising amount of carbon dioxide in the figure. The levels of carbon dioxide in the atmosphere are now higher than they have been for at least 400,000 years.

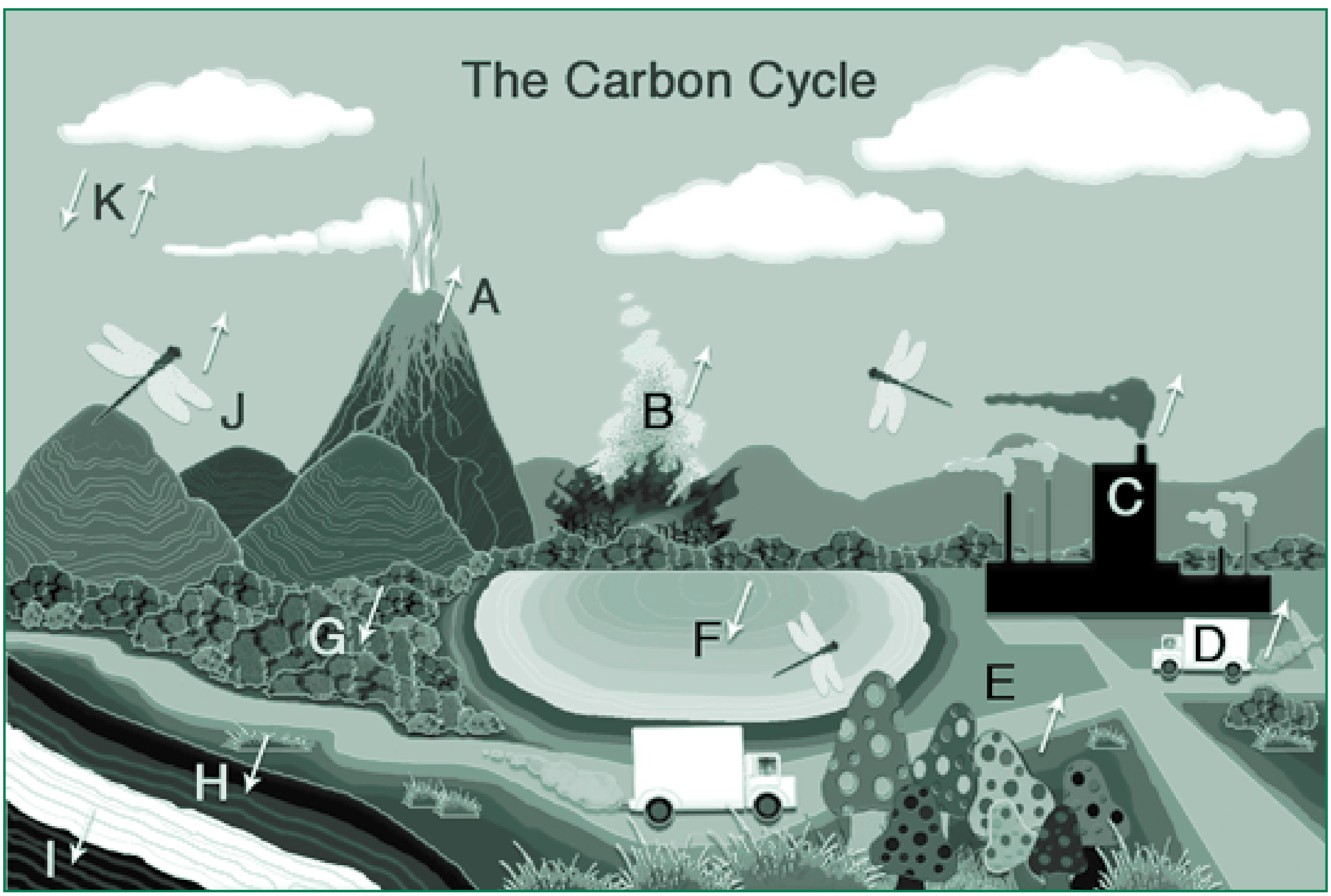
Introduction

Most scientists think that evidence from different studies shows that our global climate is changing in many ways, such as getting warmer, more rain falling in shorter amounts of time, and more drought. These scientists have studied the past climate by *analyzing weather* observations that have been collected over a long period of time.

Carbon Cycle Key

↑ = Released into atmosphere ↓ = Held on Earth

- A Volcanic eruptions release carbon held underground into atmosphere
- B Forest fires release carbon held in vegetation
- C & D Burning of fossil fuels from underground such as oil, gas, & coal, releases carbon
- E Decomposers like fungi use oxygen respiration to release CO2
- F Carbon is held in oceans & bodies of water
- G Photosynthesis from vegetation removes carbon dioxide from air
- H Carbon is held in soil
- I Coal & oil (fossil fuel) underground contain carbon
- J Oxygen-based respiration releases carbon dioxide
- K Carbon & mostly carbon dioxide in the atmosphere



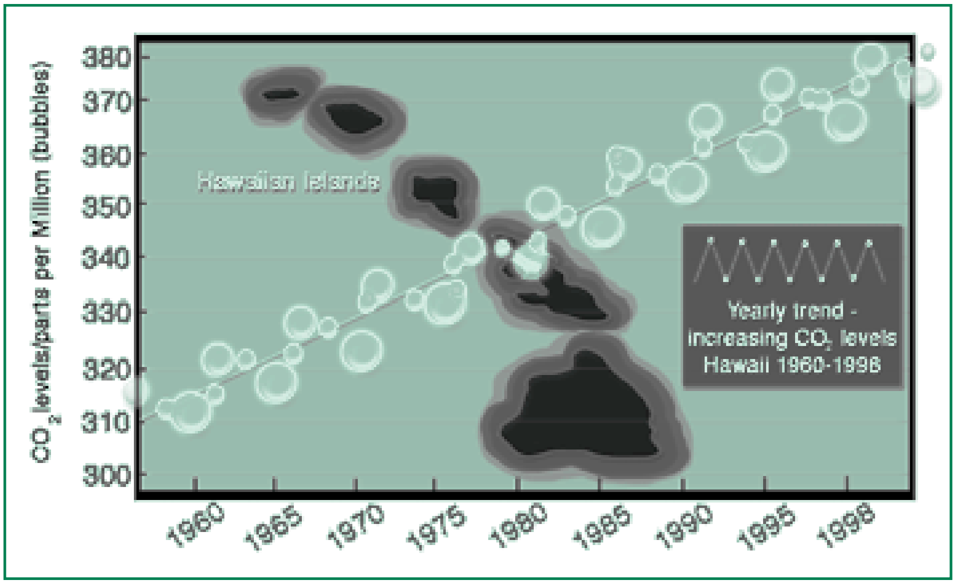


Figure 1. Amounts of carbon dioxide in the atmosphere over Hawaii.

Other scientists are studying the possible ways that climate could continue to change over the next 100 years by using mathematical formulas that run on computers. The scientists in this study used mathematical formulas to study what kind of impact these changes in the Earth's climate might have on *vegetation*.

Reflection Section

- What is the difference between weather and climate?
- If the global climate continues to change, do you think that there will be any change in the type of forests and other vegetation growing across the United States? Why or why not?
- What was the question the scientists were trying to answer?

Method

The scientists focused on 10 types of vegetation in the United States (table 1 and figure 2, pgs 10 and 11).

Information that described the environmental conditions needed by each type of vegetation were entered into a computer program. An example is the number of inches of rainfall needed over 1 year. Other environmental conditions included hot and cold temperature limits. Then, numbers representing higher temperatures and changes in rainfall and snowfall were put into the formulas in place of the current amounts.

The results from these new environmental conditions described how possible climate change might cause vegetation to change across the United States. For example, in one formula the *average* temperature for the United States was increased by 4 °C by the year 2100. The mathematical formulas predicted what kind of vegetation would grow in each area of the United States, if everything was the same as it is now except for the temperature and the amount of rainfall and snowfall.

Reflection Section

- How would you describe the climate where tundra vegetation grows? How is the climate there different from the climate where tropical broadleaf forests grow?
- Think about arid lands in the United States (see table 1). What might happen to the vegetation in arid lands if that area receives more rainfall in the future?

Findings

The mathematical formulas predicted that boreal forests and taiga-tundra vegetation will move northward and upward in *elevation*, and the southern areas of current boreal forests will die. For example, the boreal forest that now grows in Minnesota was predicted to disappear if the climate gets warmer. Forests in the Pacific Northwest and the Southeast will initially expand in size, then get smaller. This is because the increased amount of carbon dioxide will at first enable the trees to absorb more carbon dioxide and carry out more photosynthesis.

Table 1. The scientists examined 10 types of vegetation in the United States and North America.

	Type of Vegetation	Description	Location in the United States
A	Tundra	Permanently frozen soils with shrubs, mosses, grasses, and lichens.	Above the Arctic Circle in northern Alaska
B	Taiga-Tundra (**Ti** guh-**Tun** druh)	Cold or frozen soils. Contains mosses, grasses, lichens, dwarf shrubs, and short, herb-like plants.	Near the Arctic Circle in northern Alaska, and also in the highest mountain areas of the Western United States
C	Boreal (**bor** e ul) *coniferous* forest	Contains few tree *species*, such as spruce, fir, cedar, hemlock, and pine that can live in intense winter cold and drought. Contains a few *broadleaf* species, such as aspen and birch.	Just south of the arctic taiga-tundra in northern Alaska, and in the mountain areas of the Western United States
D	Temperate (**tem** pür et) evergreen forest	Contains large coniferous trees such as Sitka spruce, Douglas fir, and redwoods.	Along the northwest U.S. coast from Canada to northern California
E	Temperate mixed forest	Contains some broadleaf *deciduous* trees, such as oak, hickory, maple, poplar, beech, and sycamore; and some coniferous evergreen species.	Throughout the Eastern United States to the area of the great plains
F	Tropical broadleaf forest	Broadleaf forest that grows where it is hot and there is a lot of rainfall. Contains some deciduous trees and some evergreens.	Puerto Rico, the U.S. Virgin Islands, and Hawaii
G	Savanna woodland	Contains scattered shrubs and small trees.	Central United States
H	Shrub woodland	Contains dense cover of evergreen shrubs. May also contain a few trees that can live with little water, such as pines and scrub oak.	Mostly flat areas of the mountainous Western United States and the Southwest
I	Grasslands	Tall-grass, mixed-grass, and short-grass prairies that contain mostly grasses.	Central United States plains, Southwest United States, and flat areas of the mountainous Western United States
J	Arid lands	Desert lands, with warm to cool temperatures and low amounts of rainfall. Vegetation includes cacti and other plants that require little rainfall.	Southwestern United States and southern California

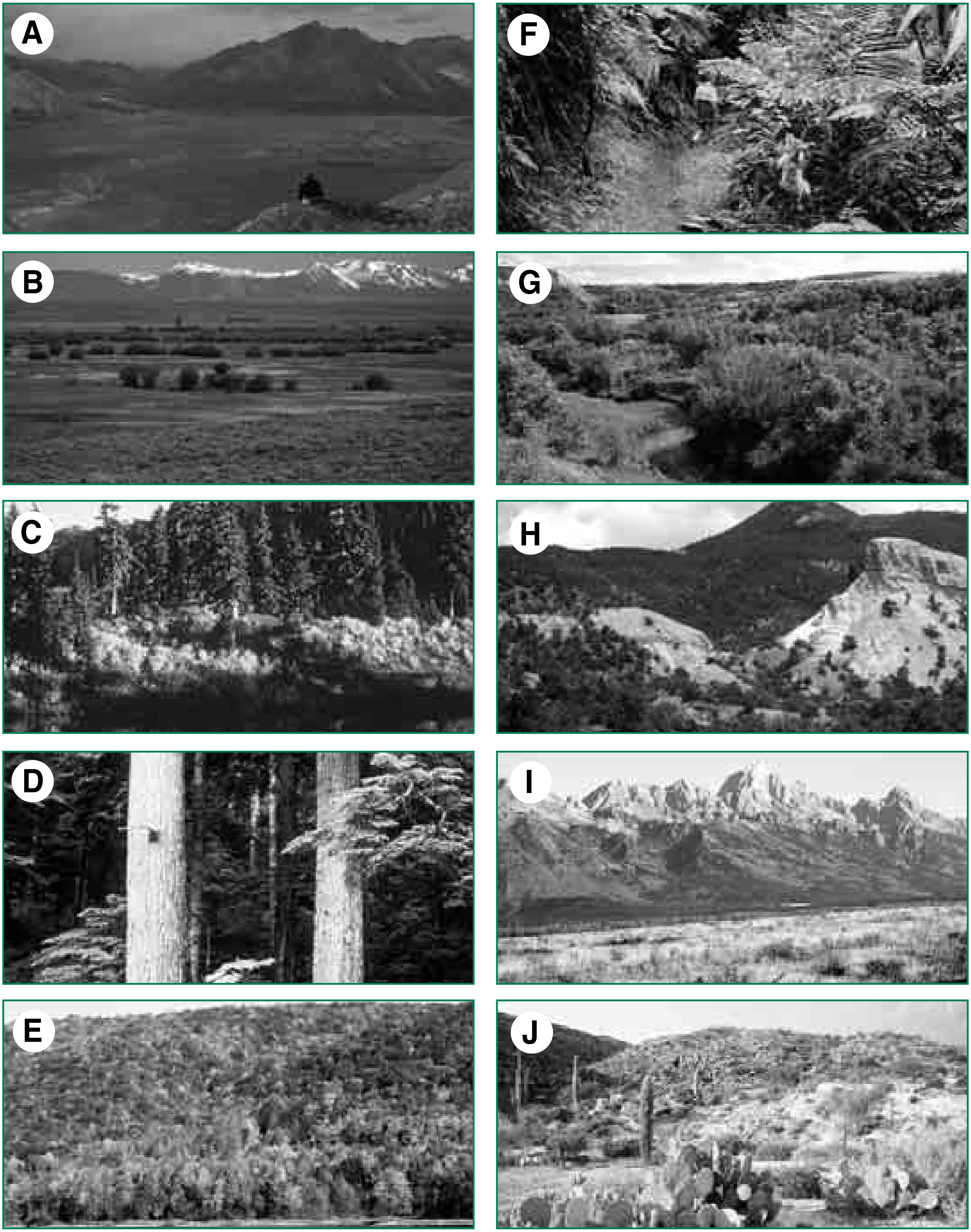
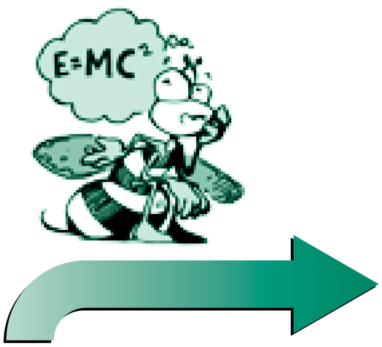


Figure 2a - 2j. The 10 types of vegetation.

If the temperature rises and the pattern of rain and snowfall changes, some trees would die from too little water. The large temperate mixed forest would break up into many smaller areas because of a lack of water in some areas. Many of the trees would die, leaving vegetation of a few trees and many grasses. In the Southwest, rainfall was predicted to increase. If that happens, the amount of arid land would shrink, and the area of grasslands would increase (figure 3).



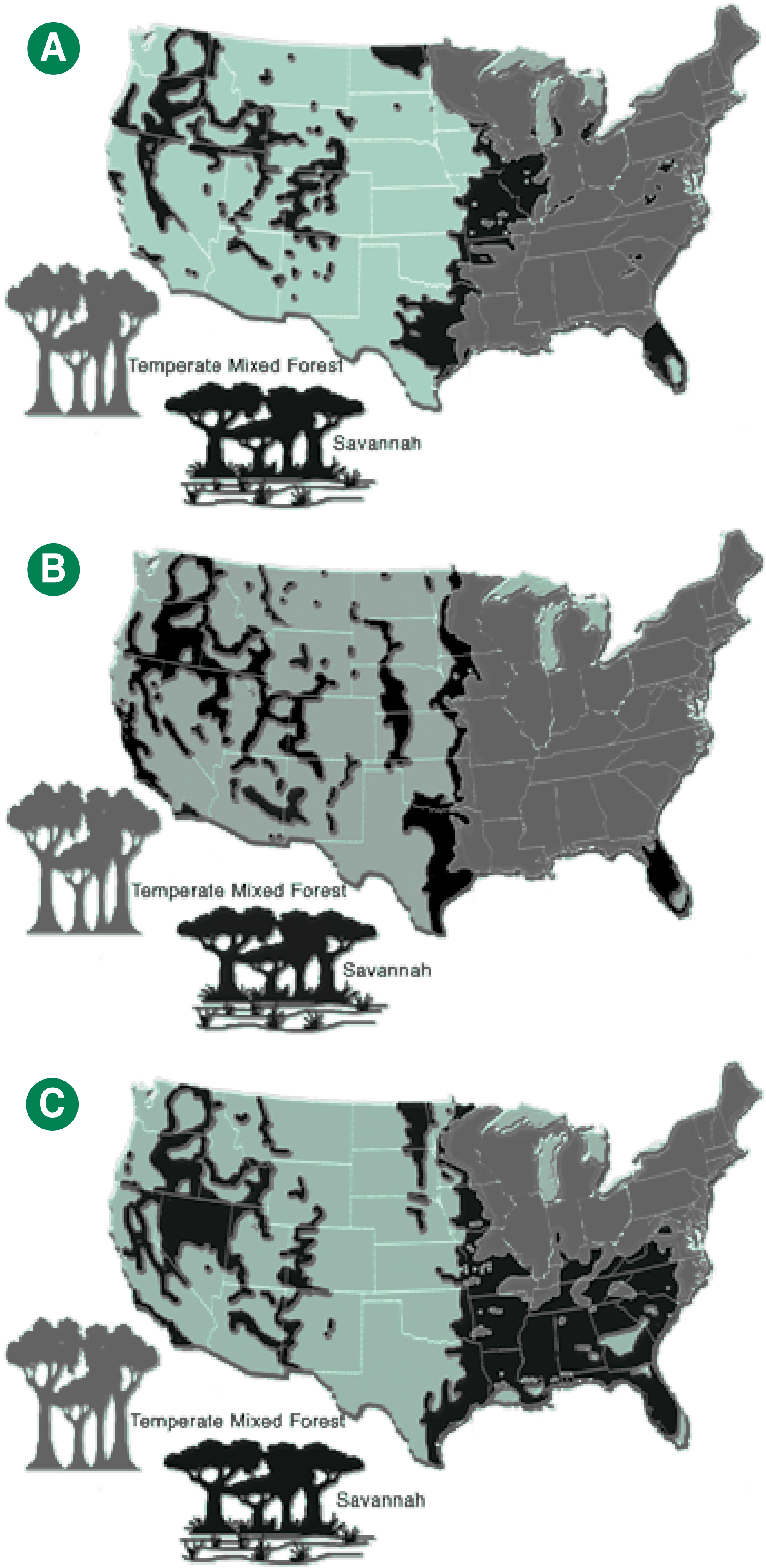
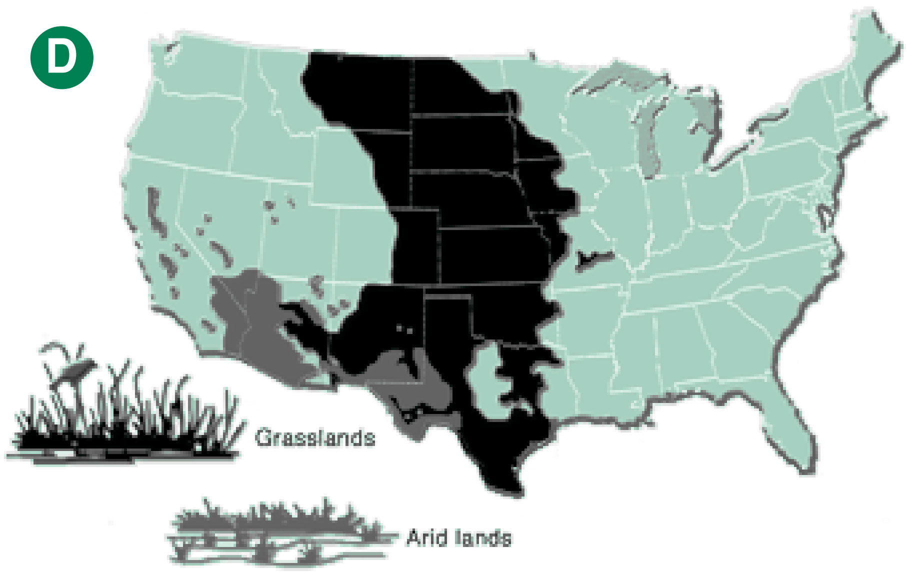
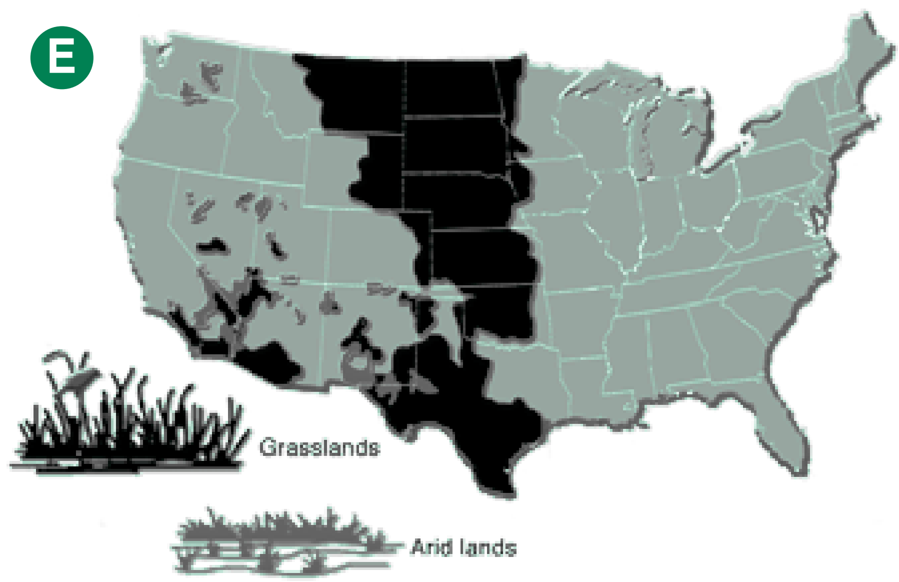
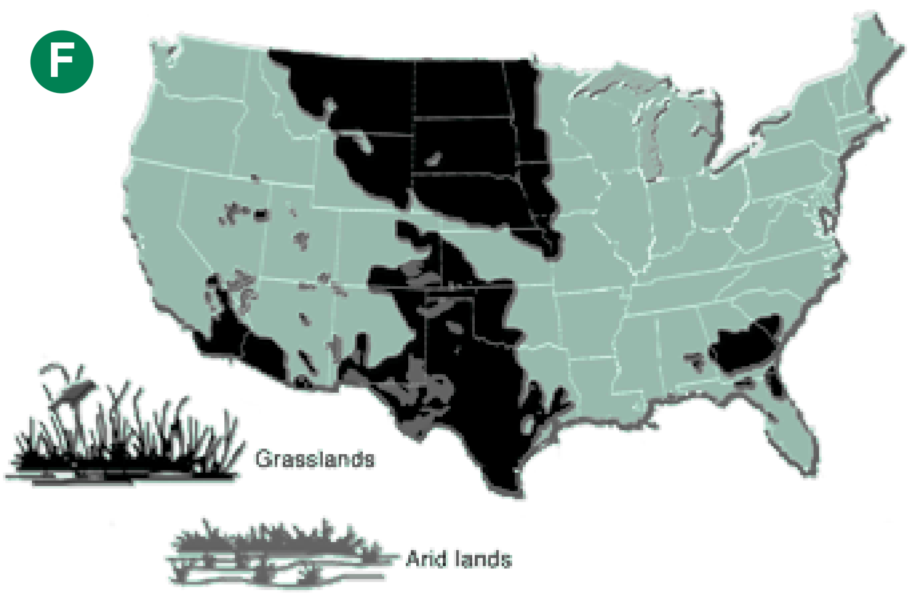


Figure 3. Current location of 4 (of the 10) vegetation types across 48 States (Figures 3a and 3d) and the potential change in the range of those vegetation types under two different possible future climates (Figures 3b, 3c, 3e, and 3f). In Figures 3c and 3f, the average future temperature is higher than in Figures 3b and 3e. Rainfall and snowfall increase in both possible future climates, but the pattern of rainfall and snowfall is different from what we know today. Rainfall and snowfall fall for shorter periods of time, leaving periods of drought in between.







Reflection Section

- Select an area of the United States with which you are familiar. Compare the current vegetation type with predicted changes in vegetation (see figure 3). Is there a difference? If so, what is it? How might that change the environment for people who live there?
- Do you think that these changes will definitely occur in the future? Why or why not?

Implications

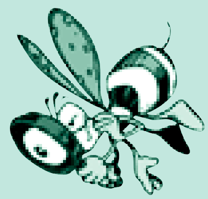
Although the mathematical formulas predicted changes in United States vegetation, the scientists said that the results must be considered with caution. First, these climate futures are possible futures and the actual future climate may be different. It may not be as warm or it may have more rainfall than predicted. Second, the predicted amount of carbon dioxide in the atmosphere may not be correct. Third, other effects, such as the pattern of rainfall and snowfall, may not happen the way the formulas predicted. Many other things might happen that the computer model could not predict.

The scientists suggest that there are things we can do today to lower the amount of carbon dioxide going into the atmosphere. For example, we could turn some of our poorer crop land and pasture land into forests. Forests absorb a lot more carbon dioxide than crop or pasture land. We could minimize the amount of forests that we are cutting down for other uses, such as for agriculture or for building homes and businesses. We can continually improve the way we take care of the forests that we have. We can recycle more paper and wood products, and we can plant more trees in urban and suburban areas.

Reflection Section

- It is hard to predict the future. The predictions made by the computer model may not be correct. How would you recommend that people use the computer model's predictions?
- The scientists identified things that can be done now to reduce the amount of carbon dioxide going into the atmosphere. Of those things, which can you and your classmates do?

From: Joyce, Linda A.; Birdsey, Richard, technical editors. 2000. *The impact of climate change on America's forests: A technical document supporting the 2000 USDA Forest Service RPA Assessment.* Gen. Tech. Rep. RMRS-GTR-59. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station. 133 pp.



FACTivity

In this article, you have learned that different climates have different kinds of vegetation. The question you will answer in this FACTivity is: Does it take much of a change in climate to cause a change in the type of vegetation growing in an area? In this FACTivity, the only measure of climate you will be considering is temperature. In reality, climate is composed of many other factors in addition to temperature.

The method you will use to answer this question is: Think about what scientists have said about possible future temperatures. In the Methods section, you read that "in one formula, the average temperature for the United States was increased by 4 °C by the year 2100." According to scientists at the Intergovernmental (**in** tür guh vürn **men** tul) Panel on Climate Change, the global average temperature of Earth's surface may increase by between 0.2 °C and 0.5 °C by the year 2020. (The panel is a part of the United Nations Environment Program.) Thus, the average temperature may increase slowly for the next 20 years or so, then the increase may become more rapid through the rest of the 21st century.

On the following page is a table of yearly average temperatures for some U.S. cities. Each of these cities lies in one of the vegetation types from the study. You can see that the last five columns of the table are empty. Your job will be to calculate possible future temperatures for each of these cities and complete this table.

To do this, you will first need to convert the possible increase in temperature from Fahrenheit to Celsius (Column 3 to Column 4). To convert Fahrenheit to Celsius, subtract 32 from the Fahrenheit number, then multiply by 5/9 and write that number in Column 4 for each city. Now that you have the temperature in Celsius, you can add the estimated numbers to the Celsius temperature. To complete Column 5, add 0.2 to the number in Column 4 for the lower end of the range, and add 0.5 to get the higher end of the range. To complete Column 6, add 4 to the number in Column 4. What do the numbers 0.2 and 0.5 represent? What does the number 4 represent?

To compare the temperature in Column 3 with the estimated increases in temperature, you need to convert the Celsius temperatures in

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
City and State	Vegetation Type	Average Yearly Temperature in °F	Average Yearly Temperature in °C	Possible Average Yearly Temperature Range in °C (Year 2020)	Possible Average Yearly Temperature in °C (Year 2100)	Possible Average Yearly Temperature Range in °F (Year 2020)	Possible Average Yearly Temperature in °F (Year 2100)
Fairbanks, Alaska	Taiga-Tundra	26.9	-2.83	-2.63 – -2.33	1.17	27.27 - 27.81	34.11
Los Angeles, California	Shrub woodland	63					
Wichita, Kansas	Grasslands	56.2					
Honolulu, Hawaii	Tropical broadleaf forest	77.2					
Des Moines, Iowa	Savannah woodland	49.9					
Charlotte, North Carolina	Temperate mixed forest	60.1					
Glenwood Springs, Colorado	Boreal coniferous forest	45.7					
Albuquerque, New Mexico	Arid lands	56.2					
Salem, Oregon	Temperate evergreen forest	52.1					
Barrow, Alaska	Tundra	9.42					

Columns 5 and 6 to Fahrenheit and complete Columns 7 and 8. To do this, multiply the Celsius number by 9/5, then add 32. Fairbanks, Alaska, is completed as an example.

Now compare the current average temperature with the possible future average temperatures for all of the cities. Does the difference seem very big? Read the Findings section again, and look again at figure 3. Are you surprised at the possible changes in vegetation, given the amount of temperature change? What does this information tell you about the relationship between average yearly air temperature and the type of vegetation growing in an area?

Do What You Water:

The Current and Possible Future of Fresh Water in the United States

Meet Dr. Brown:

I like being a scientist because it is challenging to figure out how to solve a problem or design the right experiment. It is also challenging to gather good *data* and to write about the study so that it is interesting to others. I also like being a scientist because I have a chance to do something useful.

Tom Brown

Thinking About Science

Have you ever said something to someone and had them ask you in return, “What do you mean?” To answer, you have to be more specific about what you are saying. When scientists study something, they answer that question many times.

In this study, the scientist was studying how much fresh water people in the United States use every year. To do this, he had to explain exactly what he meant by fresh water. He also had to explain what kind of uses of fresh water were included in his study:

- Did he include the drinking water that comes from rivers and *reservoirs?*
- Did he include swimming in pools as a fresh water use?

When scientists decide to study something, they have to explain exactly what they mean by everything that they say and do. If they do not do

Glossary

data (**dat** uh): Facts or figures studied in order to make a conclusion.

reservoirs (**rez** ür vôrz): Places where something, especially water, is collected and stored for use.

aquifers (**ak** wuh fürz): Underground reservoirs; Areas of sand, gravel, or bedrock that contain a high amount of water.

irrigation (er uh **ga** shun): The act of watering by means of canals, ditches, pipes, or sprinklers.

natural resources (**nach** ur ul **re** sôrs ez): Things in nature that take care of a human need, such as oil.

conserve (kän **sürv**): To avoid wasteful or destructive use of something.

variables (**ver** e uh bulz): Things that can vary in number or amount.

groundwater (**ground** wa tür): Water that sinks into the soil and is stored in *aquifers*.

surface water (**sur** fus **wat** ür): Water that does not seep into the ground or evaporate into the atmosphere.

analysis (uh **nal** uh sis): Separating something into its parts to examine it.

categories (**kat** uh gôr ez): Divisions of a main subject or group.

livestock (**liv** stäk): Animals kept or raised on farms.

census (**sen** sus): An official count of all the people in a country, including other information such as their sex, age, and occupation.

average (**av** rij): The number gotten by dividing the sum of two or more quantities by the number of quantities added.

assumptions (uh **sump** shunz): Things that are taken for granted.

efficient (e **fish** ent): Bringing about the result wanted with the least amount of time, waste, or materials.

downstream (**down** strem): In the direction in which a stream is flowing.

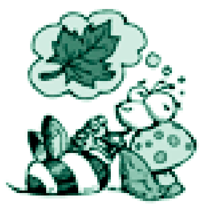
analyzing (**an** uh li zing): Separating something into its parts and examining them.

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**.

this, people cannot properly understand the study's findings. Can you think of a situation in which you have been asked to be more specific? Sometimes that is very hard to do!

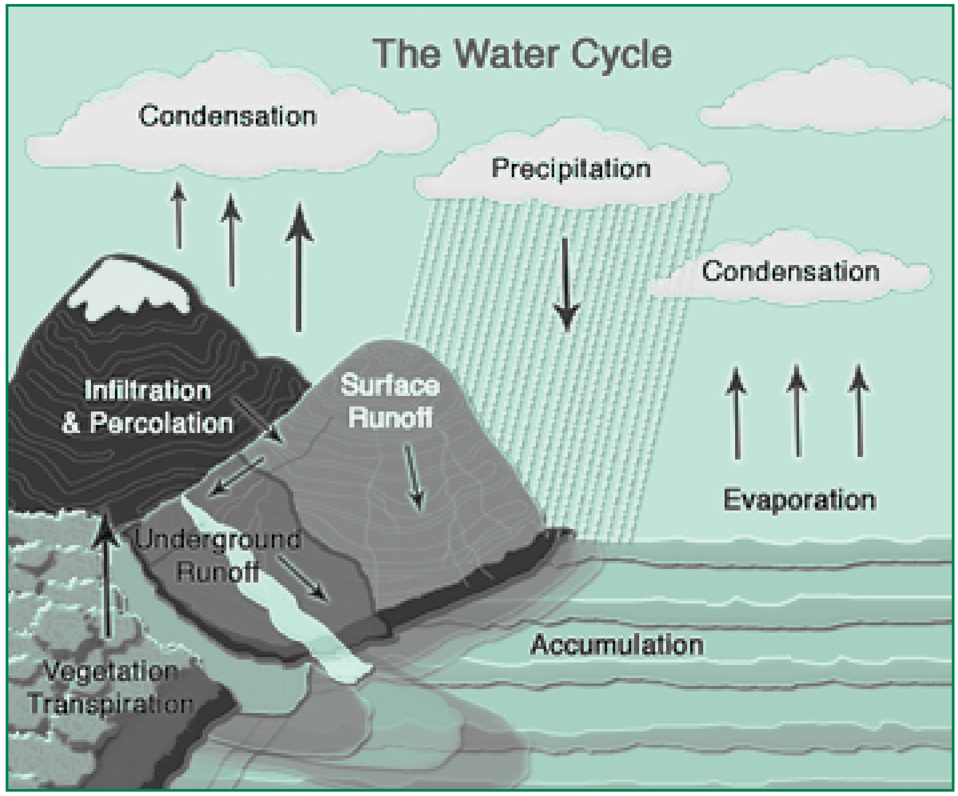


Thinking About the Environment

Life on planet Earth cannot exist without water. Many plants and animals, including humans, need fresh water to live. Fresh water is water that does not have salt in it. The oceans and most coastal waters are made up of salt water. Water farther from the ocean is usually fresh water.

Most bodies of fresh water are rivers and lakes, including lakes built by humans. Fresh water can also be found in *aquifers*. Besides using fresh water for drinking, we also use fresh water for uses in our homes such as washing dishes and clothes, and for bathing. Fresh water is also used for *irrigation*; for washing away the wastes of different kinds of industry, including the food animal industry; and for producing electric power.

As you can see, plants, humans, and other animals must have fresh water. Unfortunately, fresh water may not always be available in the amounts that humans would like to have it. That is why it is important to understand how much fresh water humans will need in the future.



Water moves from the atmosphere, to the surface of and into the Earth, into the oceans and back to the atmosphere.

Introduction

Some scientists in the USDA Forest Service have a special job to do. They have been asked to predict how much of certain *natural resources* people in the United States will use in the years ahead. By predicting this, people who make decisions about how we should use our natural resources will be able to do a better job.

For example, if scientists predict that in the future there will be less land available to grow food, we can *conserve* land today for growing food in the future. In this study, the scientist was asked to predict how much fresh water people living in the United States will use from the year 2000 to the year 2040. (How old will you be in 2040?)

Reflection Section

- What is one barrier to accurately predicting how much fresh water people will use in the future?
- What do you think is one of the most important *variables* affecting how much total fresh water will be used by people in the future?

Methods

The scientist used data from another Federal Government agency to help answer his question. That other agency is called the United States Geological (**ge** o **law** juh kol) Survey, or the USGS. Every 5 years since1950, the USGS has estimated the amount of water being used by Americans (figure 1). The scientist used data about water coming from *groundwater* sources and from *surface water*.

Because people use fresh water for many reasons, the scientist wanted to simplify his *analysis*. He took all of the uses of fresh water and divided them into water use *categories*. He defined water use as any use of fresh water. This included fresh water coming from a steam, river, lake, or surface reservoir. It also included water pumped up from a groundwater aquifer. The water use categories he developed include:

- *Livestock*—Providing water for animals or to wash away animal wastes.
- Home and public use—Cooking, washing, or for things like swimming pools or water fountains (figure 2).
- Industrial and commercial—Using water for cooling machinery or cleaning equipment.
- Thermoelectric (**thür** mo e **lek** trik)—Using water to cool power-generating equipment.
- Irrigation—Watering agricultural fields, such as those growing soybeans, corn, or other plants.

Figure 2. Drinking water, for people or for their companion animals, is a home water use.

To predict what might happen in the future, the scientist examined how much water people used in each of these water use categories for each year, and compared it with the United States population for that same year (figure 3). Then, the scientist used predictions of population growth to the year 2040 from the United States *census*. Based on past water use and the population for each year, he estimated how much water might be used by a growing population of Americans every 10 years until the year 2040.

Do you remember the fairy tale about Goldilocks and the Three Bears? In that fairy tale, there were always two

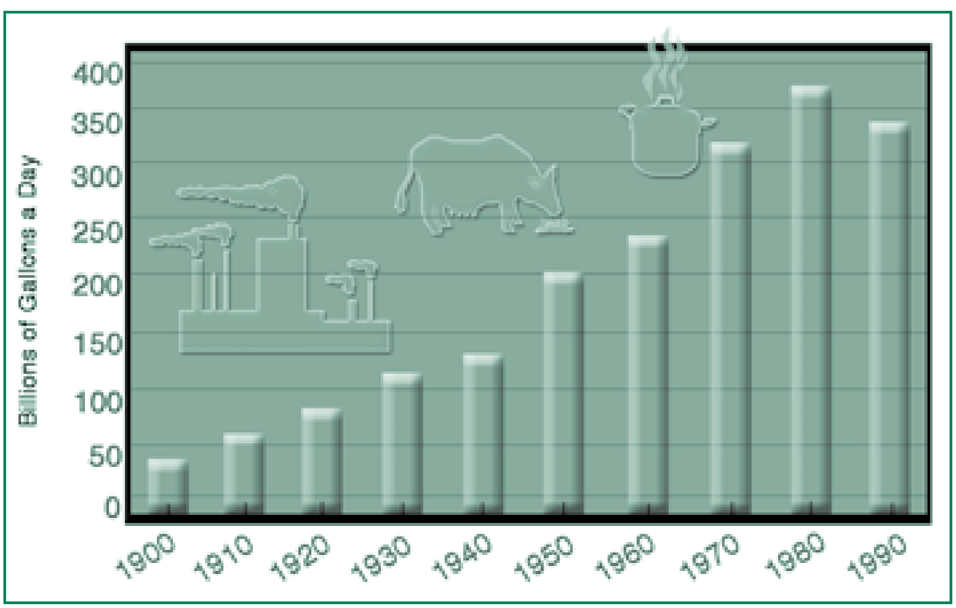


Figure 1: The amount of fresh water used by Americans from 1900 to 1990.

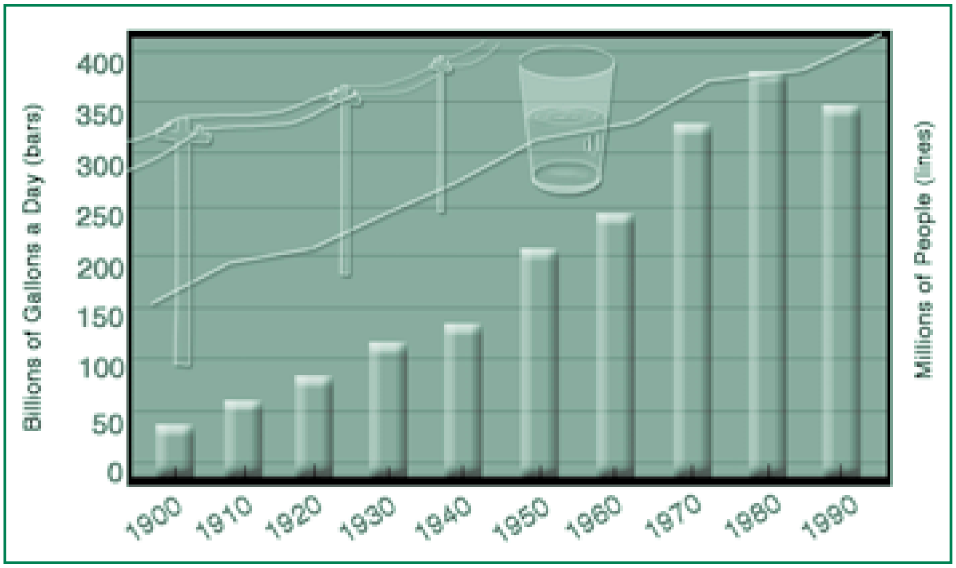


Figure 3: The amount of fresh water used by Americans compared with the United States population, 1900-1990.

extremes and one thing in the middle, such as the hardness and softness of the beds and the temperature of the porridge.

In this study, the scientist looked at three estimates of population growth to the year 2040. The first estimate assumed the highest growth rate, the second assumed the lowest growth rate, and the third was in the middle. In his report, the scientist used the middle estimate of population growth (figure 4).

Reflection Section

- Scientists often use information that has already been collected by other scientists. What are some examples of when you use information that had been collected by others?

- What is the most important variable affecting how much fresh water will be used in the future?

Findings

The scientist reported water use for the five categories listed (figure 5, page 21).

After he looked at each water use separately, the scientist wanted to present an estimate of all water use put together. Overall, water use is expected to rise by 7 percent between 1995 and 2040. The greatest amount of water will be used for irrigation and thermoelectric use. However, the greatest percentage increases are in home and public use and in livestock use.

Reflection Section

- Fresh water use is expected to increase by 7 percent overall. Compare this with the estimate of population growth to the year 2040, which is 41 percent. Does this mean that on the *average* and across all uses, each person is estimated to be using more or less water in the year 2040 compared with our use today?

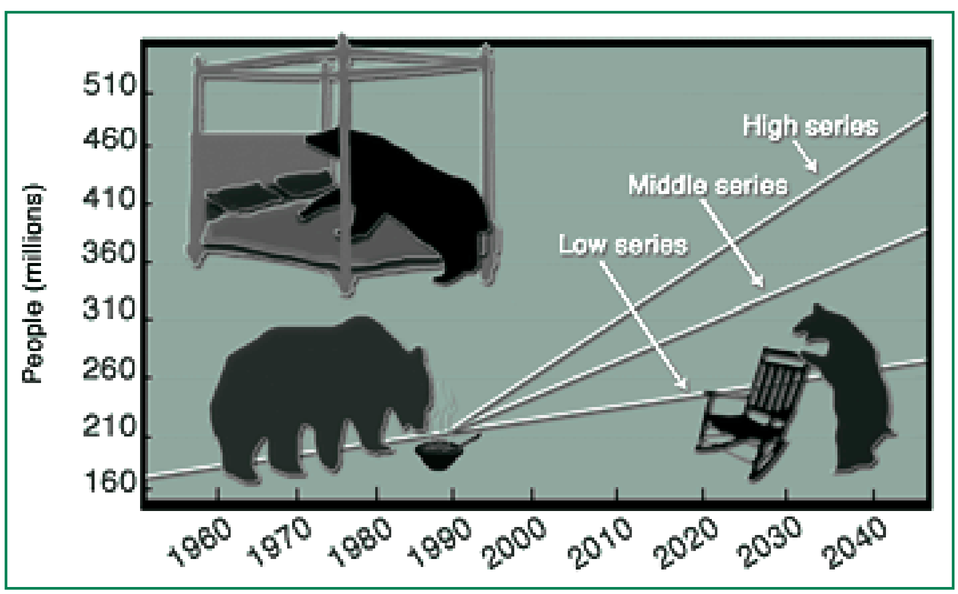


Figure 4. The scientist used the middle series of estimates of population growth.

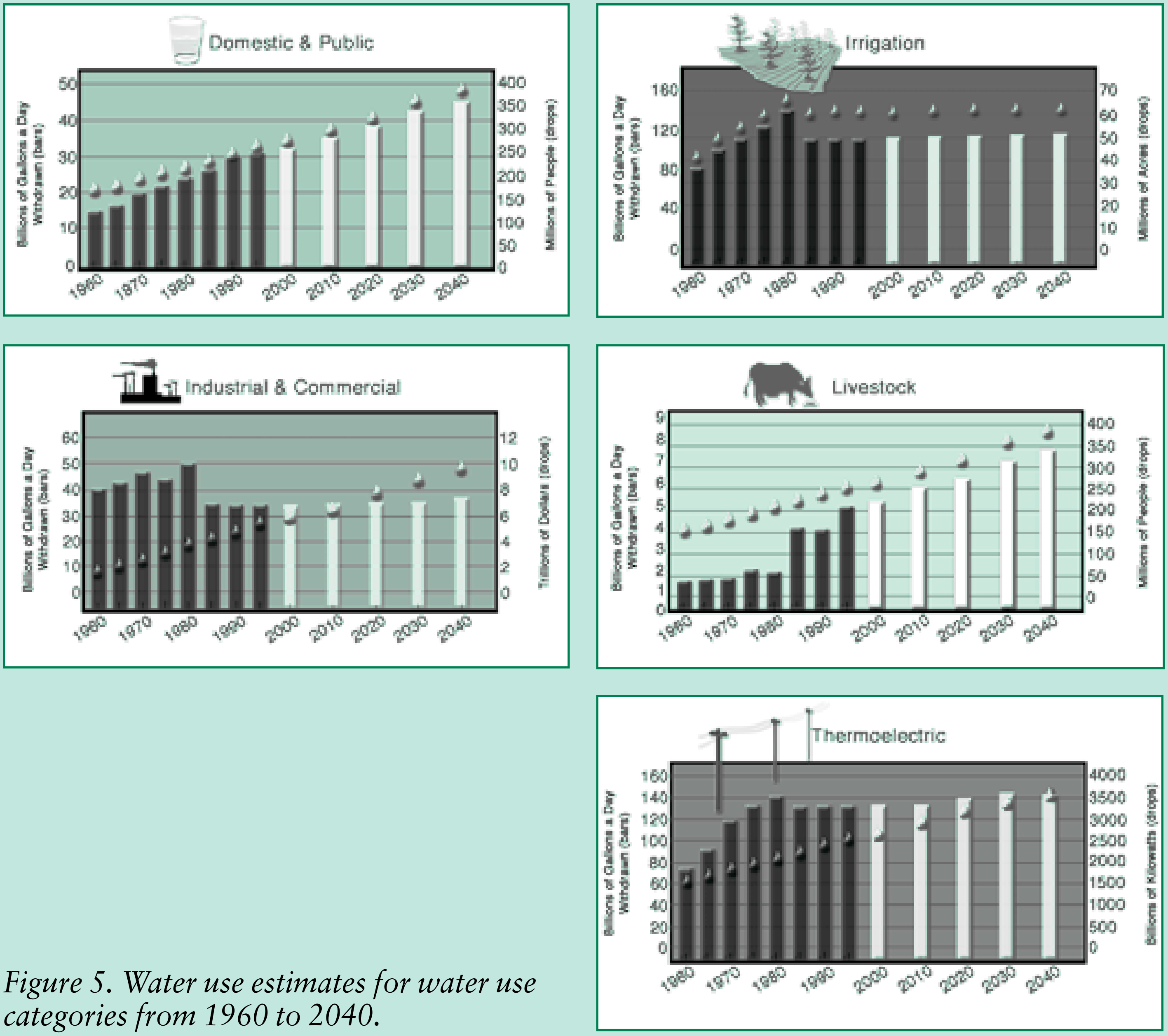


Figure 5. Water use estimates for water use categories from 1960 to 2040.

- Look at the percentage increases for home and public use and for livestock use (table 1). What other percentage is similar to those percentages? (Hint: See the previous reflection question.) Do you think that it is just a coincidence (k<u>o</u> **in** suh dens) that these percentages are so close? Why or why not?

	Low Series	Mid Series	High Series
Population	9%	41%	74%
Withdrawal			
• Livestock	9%	41%	75%
• Domestic/Public	10%	42%	76%
• Commercial/Ind.	-17%	6%	32%
• Thermoelectric	-17%	9%	36%
• Irrigation	-3%	-3%	-3%
Total	-8%	7%	24%

Table 1: Estimates of changes in fresh water use from 2000 to 2040.

Implications

When the scientist developed his water use estimates, he made *assumptions* about things like population growth and the availability of water in the future. These assumptions may not be accurate. If the assumptions are not accurate, the estimates may not be accurate.

One assumption made by the scientist is that we will continue to become more *efficient* in our use of water for things like irrigation, in industry, and even in our homes. A second assumption is that we will have enough rainfall to meet our needs for water. If areas of the United States experience below average rainfall for a few years in a row, two things could happen.

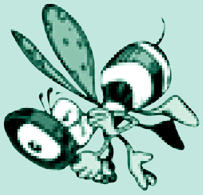
First, there may not be enough fresh water to meet the need, causing people to have to conserve water. Second, plants and animals *downstream* may be affected. When people remove water from streams and rivers for their use, there may not be enough rain to make up for the water that people take out. Lower water levels affect the plants and animals that live in and around the streams and rivers. We need to protect the health of streams and rivers, and to make sure people have enough fresh water. To do this, we need to find more ways to conserve water now and into the future.

Reflection Section

- The assumptions made by the scientist may not be accurate. What is one thing the scientist can do in the future to improve our understanding of water use into this century? (Hint: What has he already done? Should he do it again in 5 years and 10 years?)
- What might happen to plants and animals living downstream if the water level goes down?
- What are some ways that you could conserve water in your home?

For more information on this study, visit www.fs.fed.us/rm/value/docs/projecting_freshwater_withdrawals/. This Web site presents a short version of the results of this study.

From: Brown, Thomas C. 1999. *Past and future freshwater use in the United States: A technical document supporting the 2000 USDA Forest Service RPA Assessment*. Gen. Tech. Rep. RMRS-GTR-39. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station, 47 p.



FACTivity

The question you will answer in this FACTivity is: How much fresh water do you use during a typical day at home? The method you will use to find the answer is completing and *analyzing* the following questionnaire. Each person in your class should complete the questions below. Then, using the guide given below the questions, each person will calculate the number of gallons of fresh water he or she might use in a typical day while at home. These numbers are not exact. For example, you might turn the water off while you brush your teeth, while your classmate might leave the water running. You might decide to wash the car or water your flowers.

Remember that you are calculating an estimate, not an exact amount. Then, your class will calculate an estimate of the total number of gallons used by the whole class in a typical day, and an estimate of the *average* number of gallons used by each person in the classroom. Answer only for your own activities. Answer the questions below for a typical day spent at home on a Saturday. Write your answers on a blank sheet of paper. Number your paper from 1 to 11.

- How many baths do you take?
- How many showers do you take?
- How long is each shower in number of minutes?
- How many times do you brush your teeth?
- How many times do you wash your face and/or hands?
- How many times do you shave your legs or face?
- How many dishwasher loads do you run?
- How many sinks full of dishes do you wash by hand?
- How many loads of clothes do you wash?
- How many times do you flush the toilet?
- How many 8-oz. glasses of water do you drink?

Now, use the guide below to estimate how much fresh water you use on a typical Saturday.

- Multiply the number of baths you took by 50 gallons.
- Add the total number of minutes you spent in the shower, then multiply that number by 2 gallons.
- Multiply the number of times you brushed your teeth by 1 gallon.
- Multiply the number of times you washed your face or hands by 1 gallon.
- Multiply the number of times you shaved your legs or face by 1 gallon.
- Multiply the number of times you washed a load of dishes in the dishwasher by 20 gallons.
- Multiply the number of times you washed a sink full of dishes by 5 gallons.
- Multiply the number of times you washed a load of clothes by 10 gallons.
- Multiply the number of times you flushed the toilet by 3 gallons.
- Multiply the number of 8 oz. glasses of water you drank by 8. Then divide that number by 64 to calculate how many gallons of water you drank.

Now, add the numbers you calculated using the guide to get an estimate of your fresh water use in number of gallons on a typical Saturday. To find out how many gallons your whole class used, add every student's total gallons together. To calculate the classroom average, divide the classroom's total number of gallons by total number of students.

Now hold a class discussion about fresh water usage. Are you surprised at how many gallons you probably use on a typical Saturday? Is your personal total greater or lower than the average for the class? Can you think of ways to reduce the number of gallons you use? Remember, it is important to bathe regularly, wash your hands frequently, and brush your teeth after every meal. As you look for ways to conserve water, do not cut out any of these activities.

This FACTivity was adapted from the "Water Science for Schools" Web site: wwwga.usgs.gov/edu/sq3.html. You can do this activity on-line by visiting the web site.

Born To Be Wild:

The Current Situation and Possible Future of Wildlife in the United States

Meet Dr. Flather:

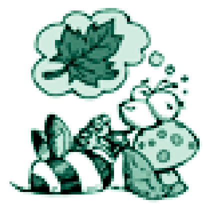
I like being a scientist because it is essentially problem solving—and in my case, the problems deal with the *conservation* of wildlife. Working on wildlife conservation problems can be very satisfying when their solution leads to better management of the *habitats* where *wildlife* live.

Dr. Flather:

Thinking About Science

Scientific studies can be carried out at a variety of *scales*. Scales can vary by size and by time. For example, a small-scale study may be conducted at the *molecular* level, or it might only cover a time period of a few seconds or minutes. A large-scale study may be focused on the stars beyond our solar system, or it might cover a period of years or decades.

The scale of this study was large, covering the entire United States and a time period of over 40 years. But there was something very different about the long-time scale of this study! Instead of conducting the research over a period of years, the scientist predicted what might happen in the future. In this study, the scientist was asked to describe the current situation and potential future of different wildlife *populations*, 40 years into the 21st century.



Thinking About the Environment

In the natural environment, every living thing has a role to play to help keep its *ecosystem* healthy. Animals do their part to *sustain* their environment. Bees, for example, *pollinate* flowers. Some animals eat fruit and later *defecate* the seeds, which then *germinate* in the soil. Other animals catch seeds in their fur, and later the seeds fall off and germinate. Animals such as earthworms digest dead plant and animal matter. Worm wastes, called castings, provide nutrients for the soil. Animals use plants for food, shelter, and as a place to raise their young. As you can see, plants and animals depend upon each other

In this study, the scientists wanted to predict the future of different types of wildlife. Will the populations of different animal *species* go up, down, or stay the same in the future? By knowing something about the possible

Glossary

conservation (kän sür **va** shun): The care and protection of natural resources such as forests and water.

habitats (**hab** uh tat): Environments where a plant or animal naturally grows and lives.

wildlife: (**wild** lif): Animals that live in the wild.

scales (ska lz): A series of steps or degrees based on size, amount, rank, etc.

molecular (mo **lek** yoo lür): Having to do with molecules, which are the smallest particles of a substance that can exist alone without losing their chemical form.

populations (pop yoo **la** shunz): The total number of individuals of separate types of plants or animals occupying an area.

ecosystem (**e** ko sis tem): Community of plant and animal species interacting with one another and with the nonliving environment.

sustain (suh **stan**): To keep up or maintain.

pollinate (**päl** uh nat): To place pollen on the pistil of a flower, which fertilizes the flower and causes seeds to develop.

defecate (**def** uh kat): To get rid of waste matter from the bowels.

germinate (**jür** muh nat): To start growing or developing.

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

status (**staht** us): The state or condition of something.

trends (trendz): The directions or courses that things take.

grasslands (**gras** landz): Open lands with grass growing on them.

cavities (**kav** i tez): Hollowed out spaces.

migrate (**mi** grat): To move from one place to another.

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

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**.

future of different animal species, we can perhaps help those species to stay healthy, and, therefore, help to keep the natural environment healthy.

Introduction

As you know from reading "Thinking About the Environment"(above), animals play an important role in maintaining the health of our natural environment. It is important to know the *status* of different kinds of animal populations, both now and into the future. This is important for many reasons.

One reason is that healthy animal populations probably mean that the whole natural environment is also healthy. If some species become endangered, it might be a clue that the environment is not as healthy as it could be.

Another reason is that different animal species have different values for people. For example, some people like to feed and watch birds in their backyard (figure 1). For these people, it is important to know whether the number of birds in their backyard might go up, go down, or stay the same in the future.

One of the questions the scientist in this study wanted to answer was: What are the *trends* in different wildlife populations? In other words, the scientist wanted to predict whether the population of certain animals species will go up, go down, or stay the same into the 21st century.

Reflection Section

- What kinds of wildlife live near your home or school? Wildlife includes all kinds of animals that have not been tamed by people. Make a list of as many different kinds of wildlife as you can.
- How are different kinds of wildlife important to different people? List at least four reasons people might value wildlife.

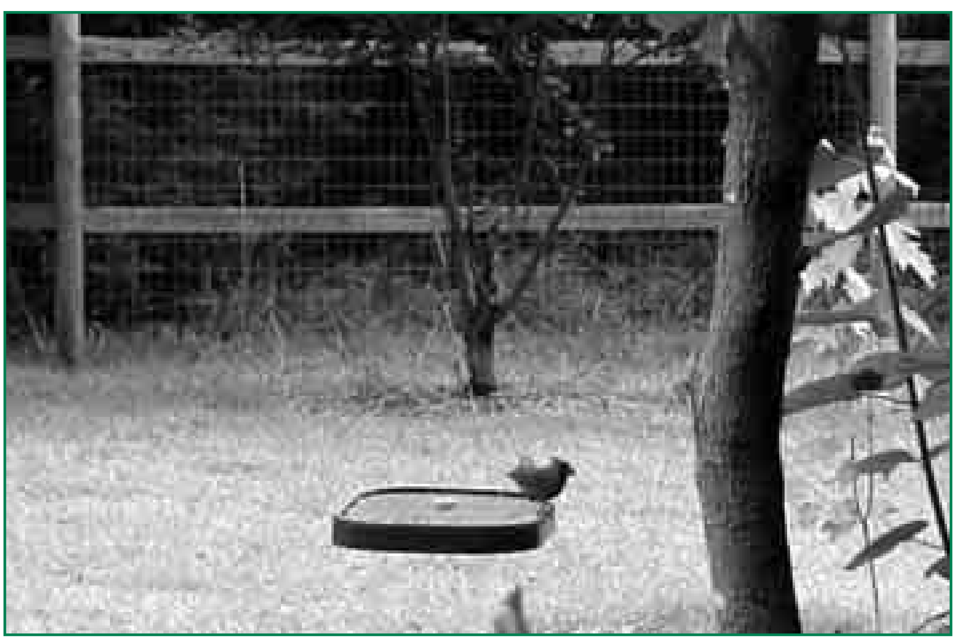


Figure 1. Bird at a backyard feeder.

Method

Often, scientists like to collect their own information. Sometimes, however, the questions they are trying to answer cannot easily be answered by collecting their own information. When scientists have to collect information at a large scale, it takes a lot of time and money. To answer his question, the scientist in this study asked other scientists who had been collecting smaller pieces of similar information.

For example, the scientist asked people who work for different State governments to share information on wildlife populations in their State. He also asked some of these people to predict whether the number of animals living in the wild would go up, down, or stay the same in the future. He also asked scientists working for other organizations to share their information. By doing this, the scientist received information from many different places. Then, he put it all together to learn what is going on with wildlife populations nationally.

When you prepare a paper for a school project, you should also collect information from many sources and put it all together. When you do that, you are like the scientist in this study!

Reflection Section

- What is one advantage of asking other people to share information that they have collected?
- What is one disadvantage of asking other people to share information that they have collected?

Findings

The scientist could not collect information on every species of animal. Remember, he had to rely on information collected from other scientists. In this article, you will learn what the scientist discovered about ducks, birds, turkey, deer, bear, squirrels, and rabbits.

The scientist found that duck populations increased from 1990 to 1995, ending a period of declining populations since 1980 (figure 2). The scientist thinks that this increase in the numbers of ducks is related to an increase in wetlands available to ducks during their breeding season. Because the United States experienced high amounts of rainfall during the early 1990s, there were more wetlands available.

The scientist used information from a yearly survey of birds to report the population of different bird species. He reported that the number of species with increasing populations is about equal to the number of species with decreasing populations (figure 3).

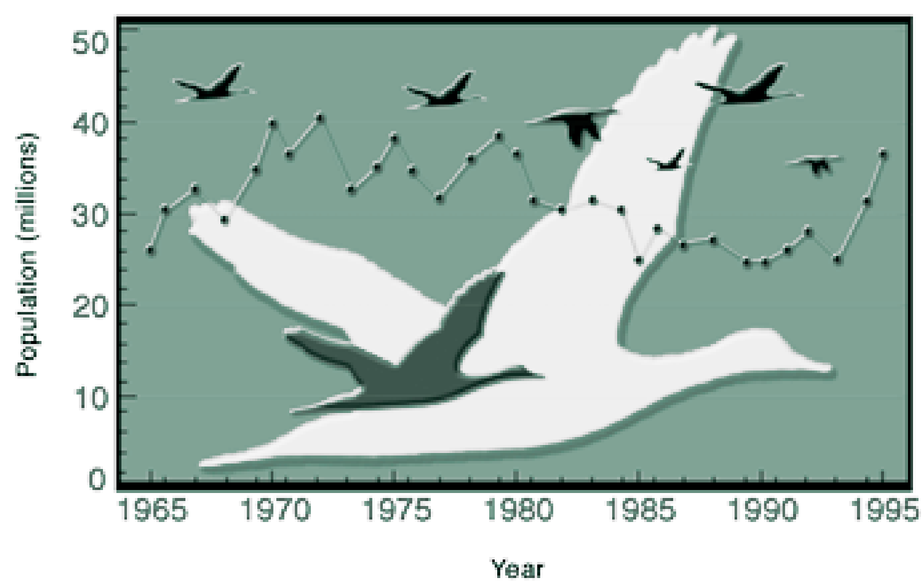


Figure 2. Changes in duck populations from 1965 to 1995.

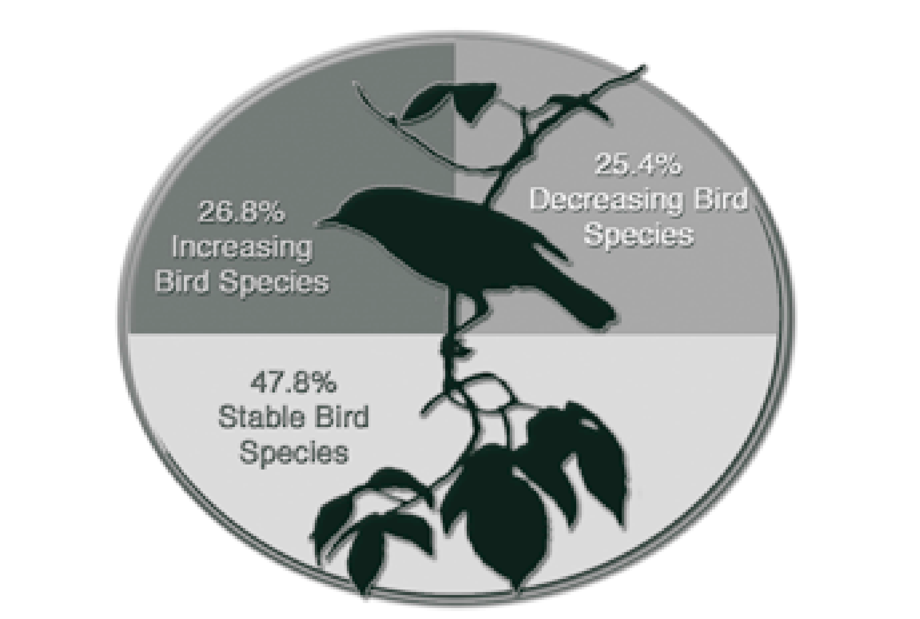


Figure 3. The number of bird species with increasing populations is almost equal to the number of bird species with decreasing populations, 1966-1996. There is a proportion of bird species whose populations is staying the same.

The scientist reported that most of the bird species with decreasing populations were birds that nest in or near urban areas, in *grasslands*, or on or near the ground (figure 4). The bird species with increasing populations were birds that nest in wetlands or on open water such as bays and oceans, in tree *cavities*, or birds that *migrate* short distances.

The scientist found that the populations of some other species of wildlife were predicted to go up in the future, some were predicted to go down, and others were predicted to stay the same (figures 5-12).

You probably have heard about threatened and endangered species. The future existence of threatened species may be in danger if special care is not taken to protect the areas where they breed and live. Endangered species are species whose existence is already in danger.

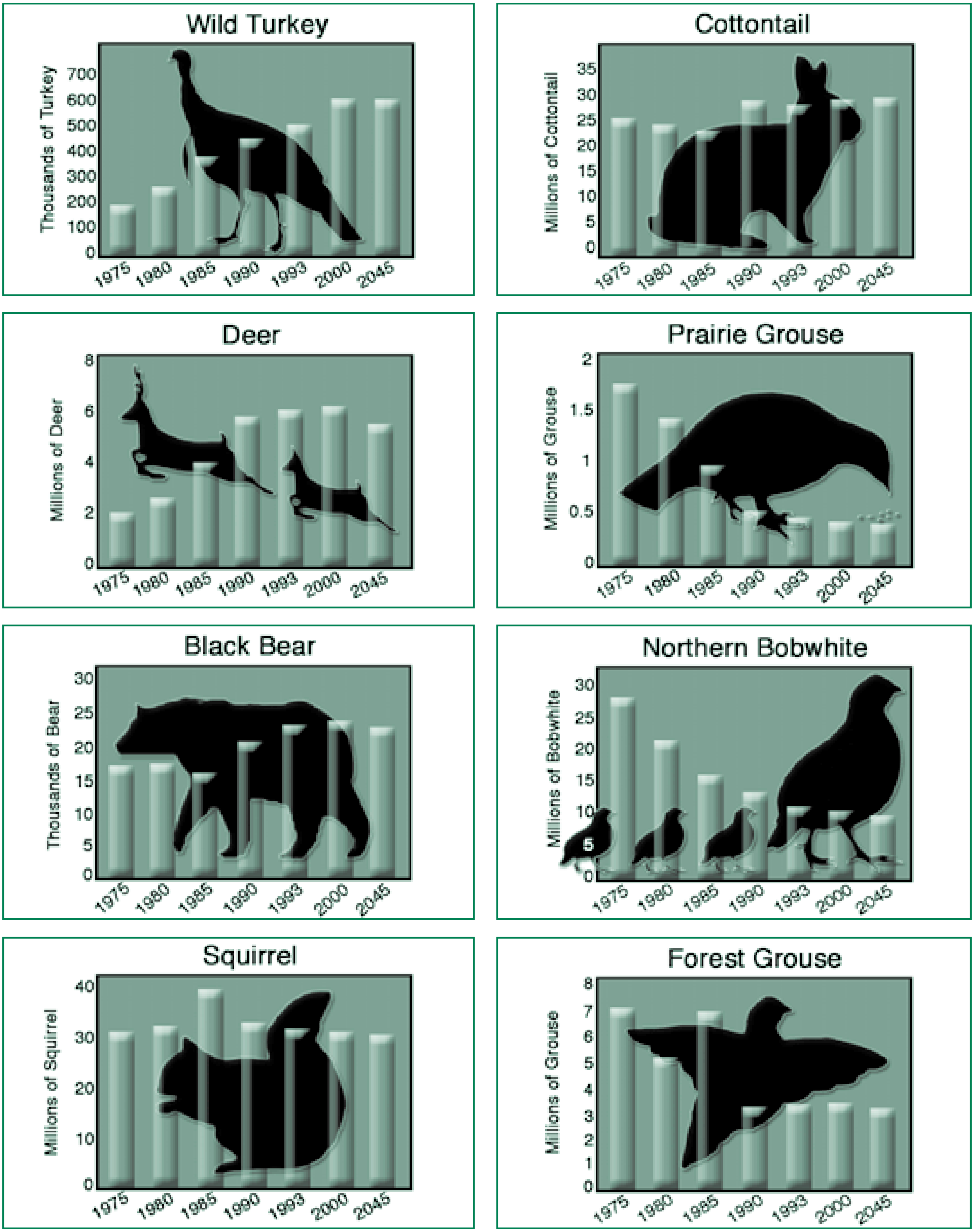
The scientist wanted to find out if there are areas of the United States with more threatened and endangered species than other areas. He discovered that the coastal United States has a high number of threatened and endangered species (figure 13, pg. 30).

The scientist studied predictions about the future of the natural environment in the United States. This included predictions of temperature changes, human population growth, how much forest land might be cleared, how many wetlands there might be, and other ways that the land might change in the future. He combined this information with what he already knew about the areas of the United States with a high number of threatened and endangered species (see figure 13). From this information, the scientist predicted which areas of the United States will have the greatest increases in the number of threatened and endangered species in the year 2020 (figure 14, pg. 30).

Reflection Section

- The scientist found that the populations of bird species that nest in urban areas were declining. He was surprised, considering that the number of urban areas is increasing. What might be some of the reasons those populations seem to be declining?

Figure 4. Sage grouse is a bird species that lives on the ground in grasslands.



Figures 5-12. The populations of some wildlife species were predicted to go up, some were predicted to go down, and others were predicted to stay the same.

Figure 13. Areas of the United States with a high number of threatened and endangered species.

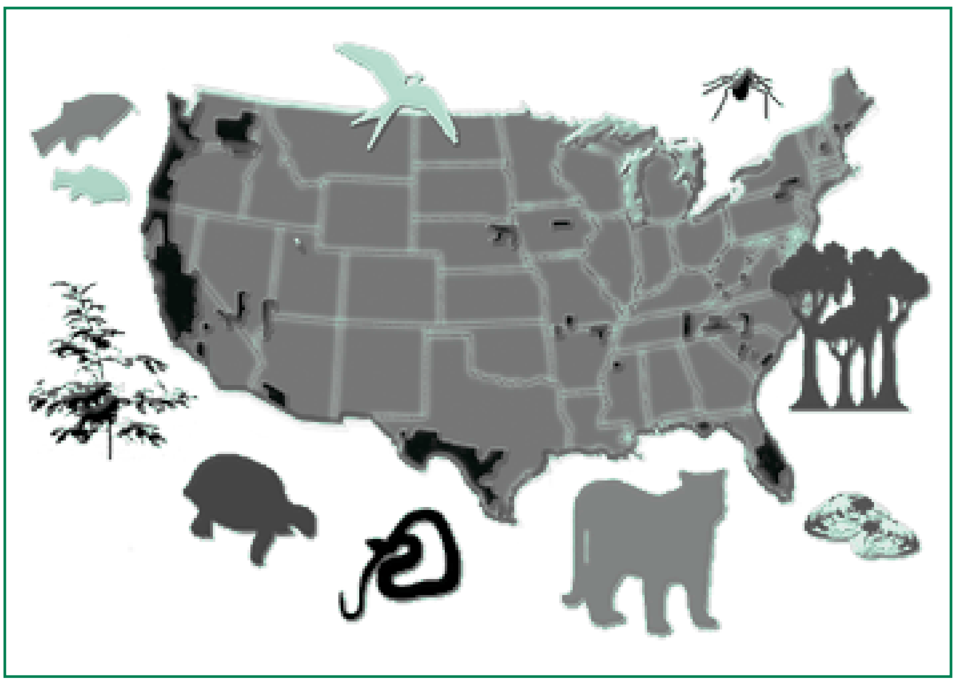


Figure 14. Areas predicted to have the greatest increases in the number of threatened and endangered species in 2020.

- The number of ducks seems to be related to the amount of rainfall received each year. Think about whether the rainfall amount in your area this year is about normal, greater, or less than normal. Go back and review the list of wildlife that you made for the first Reflection Section. Do you think that the amount of rainfall is affecting the wildlife in your area? Why or why not? If you think that the amount of rainfall is affecting the wildlife, how is the wildlife being affected?

Implications

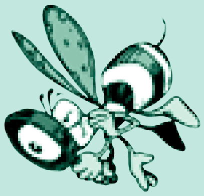
Many wildlife species are staying the same or are gaining in numbers. Others are losing numbers, and the existence of some of those species is threatened or endangered. In some areas, the natural environment is healthy enough to support wildlife.

In other areas, changes in how we use the land are placing some wildlife in danger. When humans make changes to the land, we always affect the wildlife that lives there. Sometimes we make changes that improve the land for wildlife, and sometimes we make changes that damage the land for wildlife.

Reflection Section

- When we make changes in the land that damage it for wildlife, do you think that we are making the land more healthy or less healthy? Why or why not?
- Do you think that people should consider the needs of wildlife when they make changes to the land? Why or why not?

From: Flather, Curis H.; Brady, Stephen J.; Knowles, Michael S. 1999. *Wildlife resource trends in the United Satates: A technical document supporting the 2000 USDA Forest Service RPA Assessment.* Gen. Tech. Rep. RMRS-GTR-33. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station.



FACTivity

The scientists in this study identified areas of the United States that may have a high number of threatened and endangered animal species in the future. When an animal species becomes endangered, it could die out and be lost forever. Some animal species, such as the Passenger Pigeon, are already lost. The question you will answer in the FACTivity is: What are the advantages and disadvantages of different ways to protect an endangered animal species from dying out?

The method you will use to answer this question is: Divide your class into three equal groups. Each of the groups will take a suggested solution on the best way to protect an animal species from dying out. The three possible solutions are:

1. We should put some of the individuals from an endangered species in a zoo where they will be protected. They can breed and live in the zoo. Then we will not have to worry about them dying out in the natural environment.
2. Whenever a wildlife species becomes endangered, we should catch some of the animals. Using the latest technology, we should clone the animals, then release all of the animals into the natural environment. Then we will not have to worry about the species dying out in the natural environment.
3. We should protect the existing *habitat* of endangered species from damaging human activity so that the endangered animals can live on their own in the natural environment.

Members of each group should discuss the solution as a group. Some of the questions each group should consider are:

Group 1
1. Are animals that live in a zoo still wild animals?
2. Do you think that the land where the endangered species used to live will become more or less healthy if the endangered species living there is gone?
3. Do people have the right to put wild animals in a zoo, even if one of their purposes is to protect the animals?

Group 2
1. Would cloning individuals from an endangered species make that species healthier or less healthy?
2. What might be some of the effects of cloning individuals from an endangered species?
3. Do people have the right to clone animals?

Group 3
1. Who will pay for protecting the habitat of endangered species? Should we spend tax money to protect the habitat?
2. What about people who want to build homes and businesses where endangered species live? What should they do? Do they have a right to live in those areas, even if by building there an animal species might die out?
3. Do animals have a right to live in the natural environment, even if their habitat is wanted by people for human purposes?

Spend about 15 minutes discussing your solution. Some group members might decide to support the solution, while others might decide that they cannot support the solution. Each of the three groups should divide in two, based on whether they support or do not support that solution.

Your class will now be separated into up to six groups. Each group should appoint a spokesperson. The spokesperson of each group will tell the group why the group supports or does not support the solution.

Made in the Shade:

The Current Situation and Possible Future of U.S. Urban Forests

Meet Dr. Dwyer:

I like being a scientist because I like learning new things and sharing them with people who can use them.

Dr. Dwyer

Meet Dr. Nowak:

I like being a scientist because it allows me to answer questions that have never been answered before.

Dr. Nowak

Meet Ms. Noble:

I like being a scientist because it allows me to understand, appreciate, and take an active role in protecting our beautiful natural environment.

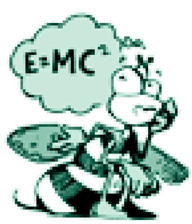
Ms. Noble

Meet Ms. Sisinni:

I like being a scientist because my job is defined by my imagination. This means I get to explore the world and sometimes learn things that no one else knew before.

Ms. Sisinni

Thinking About Science



One of the goals of science is to be able to predict what might happen in the future. No one really knows for sure what will happen in the future, even with scientific information. With accurate scientific information, however, scientists can make a fairly good guess.

One of the ways that scientists predict what will happen in the future is to examine what has happened over time. Let's say, for example, that a scientist has observed that the number of frogs living in an

Glossary

mammals (**mam** ulz): Warm-blooded animals that have a backbone; Females have glands to produce milk for feeding their young.

absorbing (ab **zôrb** *ing*): Attracting and taking in another substance.

carbon dioxide (**kär** bun di **ox** id): A gas made up of carbon and oxygen with no color or smell.

natural resources (**nach** ur ul **re** sôr sez): Things in nature that take care of a human need, such as oil.

status (**stat** us): The state or condition of something.

estimate (**es** tuh mat): To make a general but careful guess about the size, quality, value, or cost of something.

census (**sen** sus): An official count of all the people in a country, including other information such as their sex, age, and occupation.

crowns (krownz): The top parts of things.

average (**av** rij): The number gotten by dividing the sum of two or more quantities by the number of quantities added.

analyze (**an** uh liz): To separate something into its parts in order to examine them.

data (**dat** uh): Facts or figures studied in order to make a conclusion.

analysis (uh **nowl** uh sis): Separating something into its parts to examine it.

radiation (ra de **a** shun): The process of sending energy out in rays from atoms and molecules.

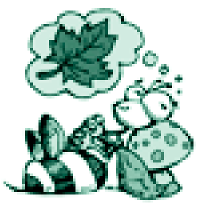
Pronunciation Guide

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**.

area between 1981 and 2003 went down every year. If you were the scientist, would you predict that the number of frogs will go down over the next 5 years or stay the same?

You can see that if scientists are going to make useful predictions concerning the future, they need to know what has happened in the past over a period of time.



Thinking About the Environment

The scientists in this study examined a special kind of forest. This kind of forest is probably familiar to you, but you never guessed that it is called a forest!

This special forest is called an urban forest, and it is defined as the trees and other plants that grow where people live, work, and play. An urban forest includes trees that grow along the street, in your schoolyard, in parks, and anywhere else in the community (figure 1).

An urban forest, like a rural forest, provides homes for animals, such as birds, small *mammals*, and insects. They make places more beautiful, reduce noise, and provide shade. They also reduce flooding by slowing or stopping some rain from hitting the ground and by *absorbing* rainwater. Urban forests keep the air cleaner by absorbing *carbon dioxide*. They also provide places for people to play and learn about the natural

Figures 1a, 1b, and 1c. Examples of urban forests.

environment. People don't always think of the trees and other plants near their homes as *natural resources*, but they are!

Introduction

The scientists in this study were asked to determine the current *status* of urban forests in the United States. The scientists decided to find out how much land is covered by trees in cities, towns, villages, and other areas. The scientists were also asked to predict the future of urban forests, so they tried to answer this question: "Will there be more or less urban forests in the future?"

Reflection Section

- Do you think that the scientists visited every city, town, and village where people live across the United States to count the number of trees within urban forests? Why or why not?
- If you were the scientist, how would you *estimate* the current status of urban forests across the United States?

Method

The scientists could not visit every city, town, village, and suburban area in the United States and count the trees. That would have taken them years and years! Instead, they used information collected by other scientists.

First, they used information from the United States *census* to identify the areas of the country where most people live (figure 2). Then they used maps created by USDA Forest Service scientists that show how much of the land area where people live is covered by the *crowns* of trees (figure 3).

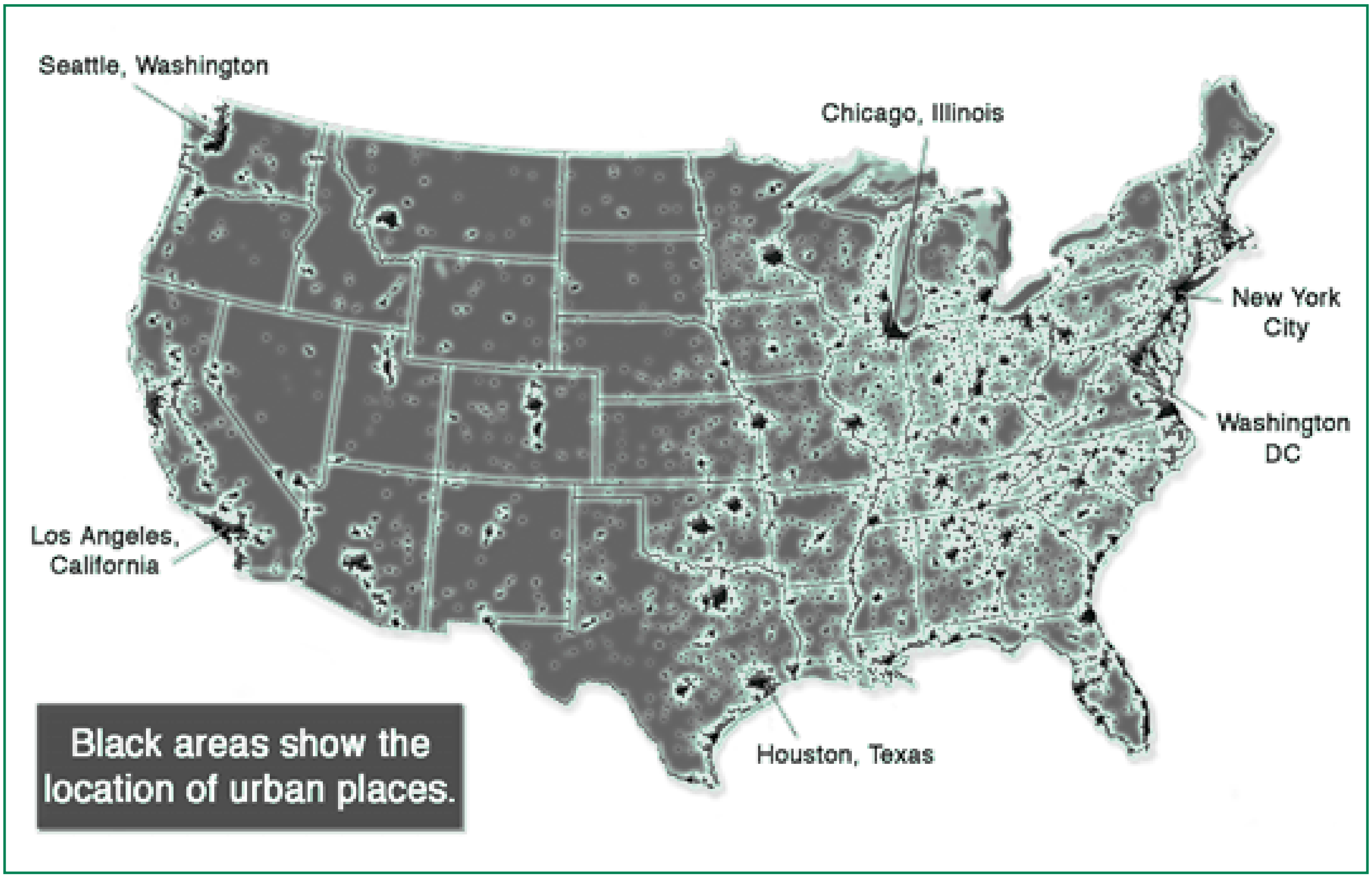


Figure 2. Location of urban places. This map of the United States was drawn from a photograph taken from space at night.

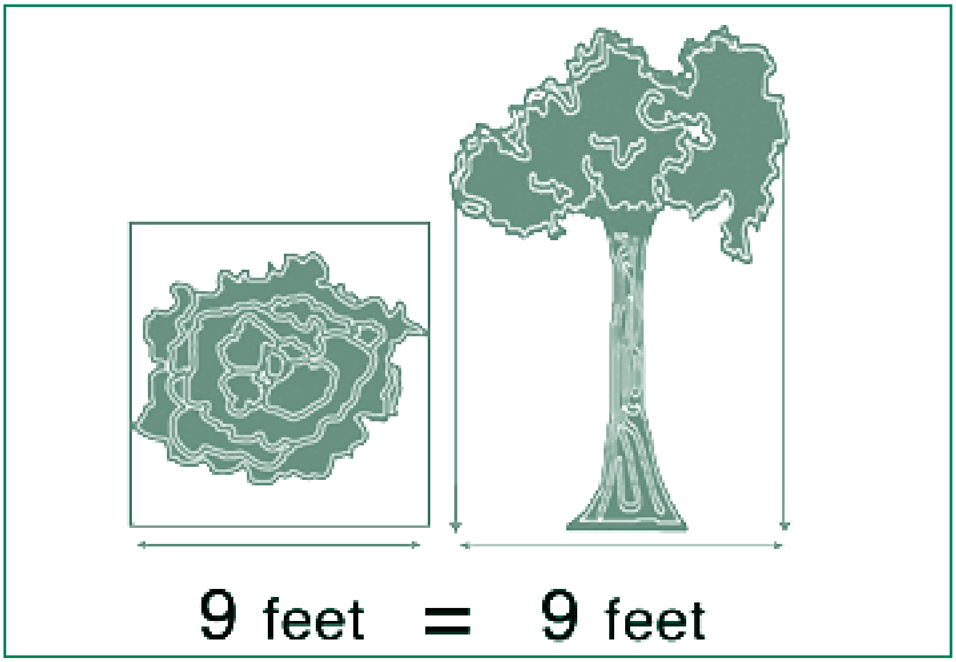


Figure 3. Tree crown and its relationship to the measurement of tree cover.

Reflection Section

- Do you think that the scientists will be able to predict what might happen in the future, based on the information that they collected? Why or why not?

Results

The scientists found that 8 out of every 10 Americans live in cities, towns, villages, or suburban areas. (What percentage is that? Divide 8 by 10 to find out.) The scientists found that these areas where people live have about 27 percent tree cover (figure 4, pg. 37). This means that a little over one- quarter of the land where people live is covered by tree crowns. Surprisingly, this is not much less than for all lands in the United States, which is almost 33 percent. There is more tree cover in cities, towns, and suburban areas in the Eastern United States, as compared with the midwestern, western, and southwestern areas of the country.

The scientists discovered that the amount of land across the United States that is taken up by buildings, roads, and parking lots has tripled during the past 20 years. The rural forests are being replaced by buildings, roads, parking lots, grassy areas, and trees and other plants that are planted around or near the built structures. If the amount of land taken up by buildings, roads, and parking lots continues to increase in the future, there will be less rural forests and more urban forests across the United States.

Reflection Section

- Why do you think there is more tree cover in the Eastern United States than in the midwestern, western, and southwestern areas of the country?
- Do you think that in the future, more or less rural forests will be replaced by buildings, roads, parking lots, and urban forests? Why?

Implications

Urban forests are an important part of the places where people live. The scientists believe that urban forests will become even more important in the future. More land is being used for buildings, streets, and parking lots. People will need to have urban forests around them to provide the benefits listed in "Thinking About the Environment." (Can you name some of those benefits?)

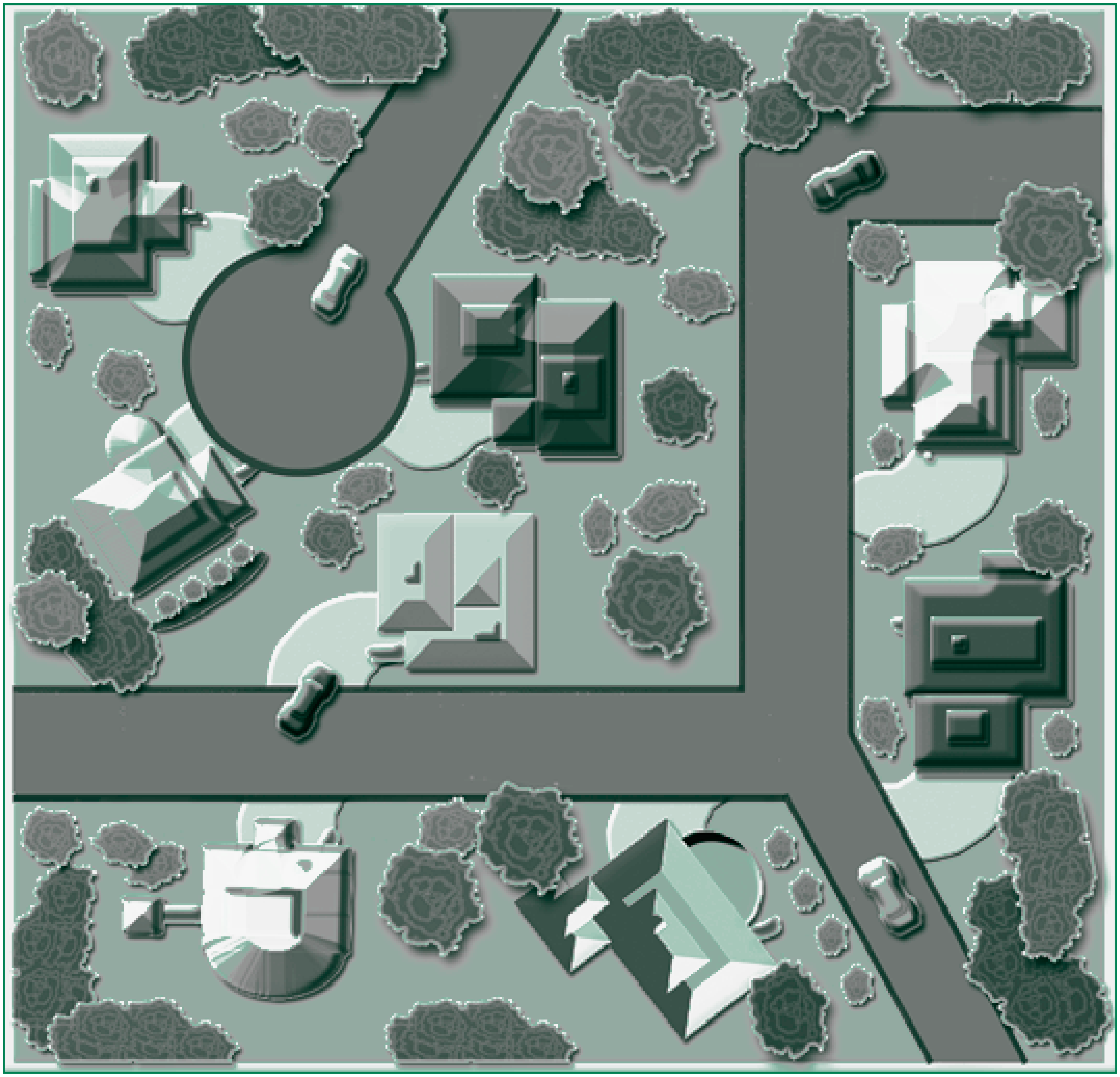
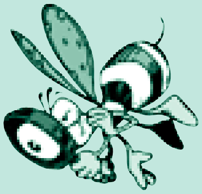


Figure 4: On the average *across the United States, 27 percent of the areas where people live are covered in trees.*

Reflection Section

- Would you consider your schoolyard or local park area an urban forest? Why or why not?
- Think about your own use of urban forests. What are some of the benefits you get from having an urban forest near where you live or play?

From: Dwyer, John F.; Nowak, David J.; Noble, Mary Heather; and Sisinni, Susan M. 2000. *Connecting people with ecosystems in the 21st century: An assessment of our nation's urban forests.* Gen. Tech. Rep. PNW-GTR-490. Portland, OR: USDA Forest Service, Pacific Northwest Research Station. 483 p.



FACTivity

Sometimes, the temperature is too hot for people to feel comfortable outside. Urban forests might have an impact on how hot or cool you feel in the warmer months. The question you will answer in this FACTivity is: How does being in the shade affect how hot you feel?

The method you will use to answer this question is:

1. Get two thermometers. Place one thermometer outside under some shade, such as among tree branches. If there are no trees near you, place one thermometer outside under a bush or other vegetation where it will receive shade.

2. Place the second thermometer as close as possible to the first, but in a place where it will receive full sun. Leave the thermometers in place for at least 30 minutes before making your first observation.

3. Record the temperature registered by each of the thermometers.

4. Have one person in your class observe and record the temperatures at the beginning of the class period, another person observe and record the temperatures during the middle of class, and a third person observe and record the temperatures at the end of the class period.

5. Also observe and record the cloud conditions at the time each observation is made. Use the chart below as a guide for your recording.

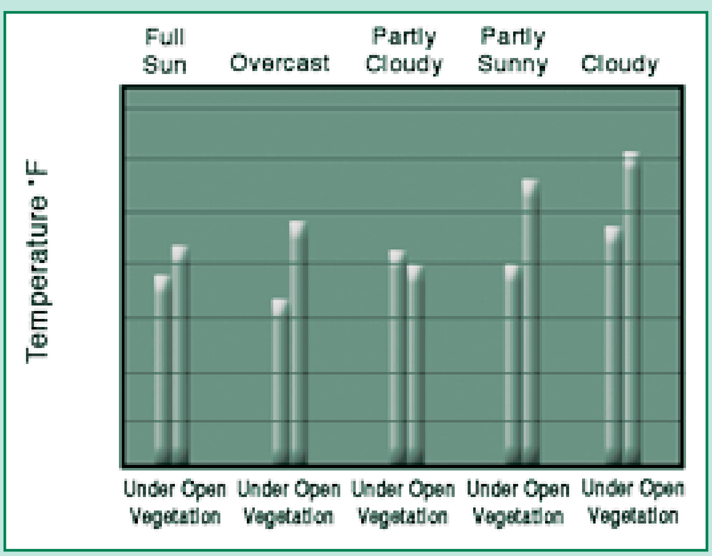
Date and time	Temperature–In the shade (°F or °C)	Temperature–In the open (°F or °C)	Cloud conditions (1-5)

❻ Observe and record the temperature and cloud conditions for at least 9 school days (or almost 2 weeks). (How many observations will you have? Multiply 3 X 9.) On the 10th day, you will *analyze* your *data*. Use the following to observe and record cloud conditions:

Cloud conditions:
1 = Clear (full sunshine, sharp shadows, no clouds)
2 = Overcast (Hazy sunshine, fuzzy shadows)
3 = Partly cloudy (Mostly full sunshine, some clouds over the sun at times)
4 = Partly sunny (Mostly cloudy, some periods of full sun)
5 = Cloudy (No periods of sunshine)

❼ Separate your recorded data into categories based on cloud conditions. For example, place all of the 1's (full sun) together, all of the 2's together, all of the 3's together, and so forth.

❽ Create a bar chart for each cloud condition that occurred during your observation and recording. Bar charts are also called histograms. See the example below.



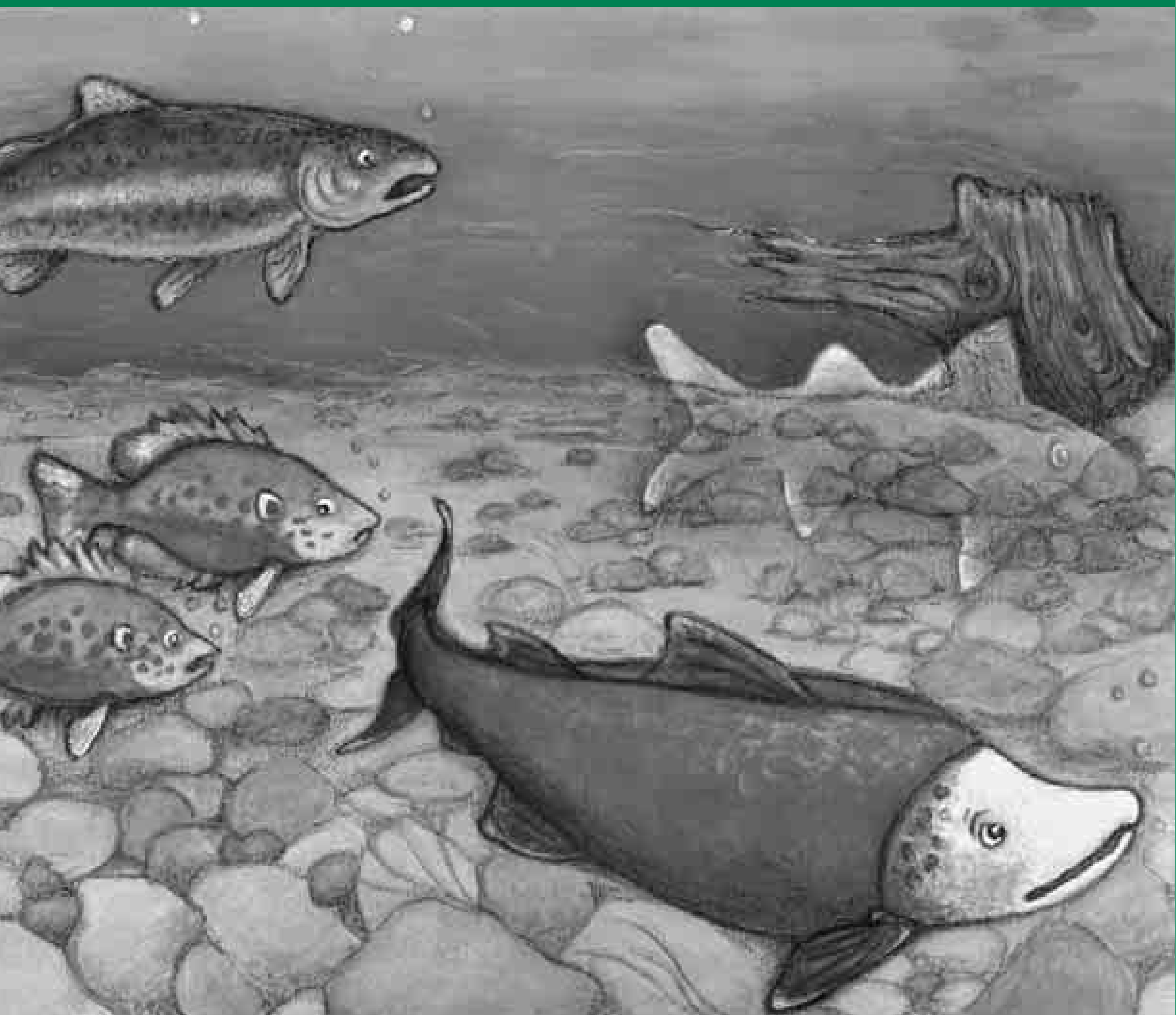
❾ After you have created all of your bar charts, compare the charts with one another. Is each cloud condition different? If so, how?

❿ Now compute the average of all of the temperature recordings taken in open conditions, and the average of all of the temperature recordings taken under vegetation. To calculate the average, add all of the temperature recordings and divide the total by the number of observations. Compare the two averages. From your *analysis*, answer the question posed at the beginning of this FACTivity.

Your results probably show a difference between the temperature recorded in the sun as compared with the temperature recorded in the shade. Were you surprised? Probably not, as you know that you feel hotter in the sun than you do in the shade. Did you know that in both cases the air temperature is actually the same? You feel hotter in full sun because the sun's *radiation* falls on your skin and heats it. The sun does the same thing with the thermometer. It feels cooler under trees because the shade keeps the sun's radiation from heating your skin.

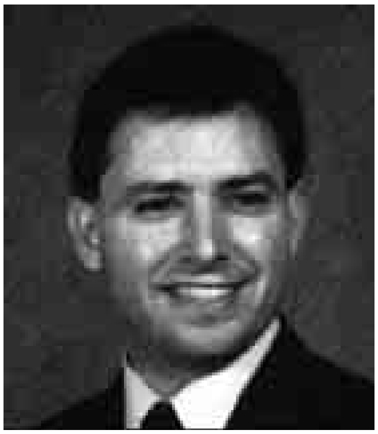
One Fish, Two Fish, Red Fish—No Fish?

The Current Situation and Possible Future of Aquatic Animals in the United States



Meet Mr. Loftus:

I like being a scientist because it gives me a chance to explore new things and use what I discover to change the way we *manage* the environment.



Mr. Loftus

Meet Dr. Flather:

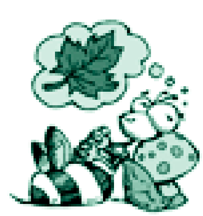
I like being a scientist because it is essentially problem solving—and in my case, the problems deal with the *conservation* of *wildlife*. Working on wildlife conservation problems can be very satisfying when their solution leads to better management of the *habitats* where wildlife live.

Dr. Flather

Thinking About Science

Scientists try to solve problems or answer questions by collecting information and doing an *analysis* of the information they have collected. If they have enough time and money, scientists usually collect their own *data*. If they do not have enough time or money, or if the kind of data they need are already available, they will analyze (**an** uh liz) data already collected by other scientists.

In this study, the scientists did not have enough time or money to collect their own data. Instead, they used data already collected by other scientists to help them answer their questions. You do the same thing when you write a school paper on a topic not familiar to you. You collect information from other sources, such as the Internet, the library, or encyclopedias. When you collect information to write a paper, you are like the scientists in this study!



Thinking About the Environment

Since the pilgrims landed in Massachusetts in 1620, more

Glossary

manage (**man** ij): To have charge of or direct the work of.

conservation (kän sür **va** shun): The care and protection of natural resources such as forests and water.

wildlife (**wild** lif): Animals that live in the wild.

habitats (**hab** uh tats): Environments where a plant or animal naturally grows and lives.

analysis (uh **nowl** uh sis): Separating something into its parts to examine it.

data (**dat** uh): Facts or figures studied in order to make a conclusion.

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

extinct (ek **stinkt**): No longer living.

populations (päp yoo **la** shunz): The total number of individuals of separate types of plants or animals occupying an area.

classify (**klas** uh fi): To arrange by putting into groups according to some system.

status (**staht** us): The state or condition of something.

trends (trendz): The directions or courses that some things take.

aquatic (uh **kwat** ik): Growing or living in or upon water.

freshwater (fresh **wat** ür): Having to do with or living in water that is not salty.

assumption (uh **sump** shun): Anything taken for granted.

native (**nat** iv): Naturally occurring in an area.

eroding (e **rod** *ing*): Wearing away.

emissions (e **mish** ens): Something discharged or sent out.

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**.

than 500 plant and animal *species* have become *extinct* in the United States. The U.S. Fish and Wildlife Service is charged with protecting species from extinction (eks **tink** shun). To do this, the U.S. Fish and Wildlife Service studies the *populations* of animals and plants. When they find a plant or animal species that is in immediate danger of becoming extinct, they *classify* it as endangered (en **danj** ürd).

When the U.S. Fish and Wildlife Service finds a plant or animal species that is likely to become endangered, it is classified as threatened. Being classified as threatened or endangered provides the plant or animal species with special consideration that protects it from human activities that would further threaten or endanger it.

Introduction

The scientists in this study were asked to develop information about the *status* of and *trends* in *aquatic* animal species populations across the United States. They already knew that there are about 800 *freshwater* fish species in the United States (figure 1).

However, the scientists found that there were few measurements already available that would help them to determine the status of and trends in the populations of these 800 freshwater fish and other freshwater aquatic species. The only data they could find were collected in a few separate areas of the country.

In addition, the information was not the same from location to location. Still, the scientists collected information that might show general trends. From these separate pieces of information, the scientists made an informed guess about the status of and potential trends in populations of freshwater aquatic species.

Reflection Section

- One of the purposes of science is to use current data or information to predict what might happen in the future. Scientists predict what might happen in the future by studying trends from the past and into the present. Why it is important to be able to make scientific predictions about what might happen in the future? (Hint: Think about the future path of a hurricane or about global

Figure 1. Trout are a freshwater aquatic species.

climate change. Is it important to be able to predict these events? Why or why not?)

Methods

The scientists used two types of information. To determine the status of aquatic species populations, they gathered data that had been collected by other scientists. Even though they did not have all of the data that they needed, they made an educated guess about the current status of aquatic animal species populations.

To determine the trends in populations, the scientists studied examples of things that people have done that affected the trends in species. If the things people do increase the populations of aquatic species in a particular stream, river, or lake, this is an example of conservation (**kän** sür **va** shun). Conservation means taking care of the natural environment so that it will be both useful and protected now and in the future.

Reflection Section

• To guess what might happen in the future to some populations of aquatic species, the scientists made an *assumption* that more and more people will practice conservation. What does conservation mean? Think of an example of a conservation activity.

Remember that conservation activities can benefit land, water, air, plants, animals, or any part of the natural environment. How many conservation activities can you and your class think of?

Results

The scientists found that there are more threatened and endangered aquatic species than any other type of animal species, including those that live on land. Of the 297 freshwater mussel species naturally living in North America, 213 are considered threatened, endangered, or of special concern (figure 2). (What percentage is that? Divide 213 by 297 to find out!)

Other species are declining but are not yet considered threatened or endangered. In the Chesapeake Bay, for example, there are 99 percent fewer oysters living there than were living there over 100 years ago (figure 3).

In the Pacific Northwest, some types of salmon (**sam** un) are threatened or endangered, but the population of salmon as a whole is not considered threatened. In the Northeast, the number of Atlantic salmon is declining. In the Southern Appalachian mountains of Tennessee, the number of miles of streams and rivers where *native* trout can be found is only about 30 percent of what it used to be.

These are just a few of the examples that the scientists discovered. There are many reasons for the decline in the numbers of fish and other

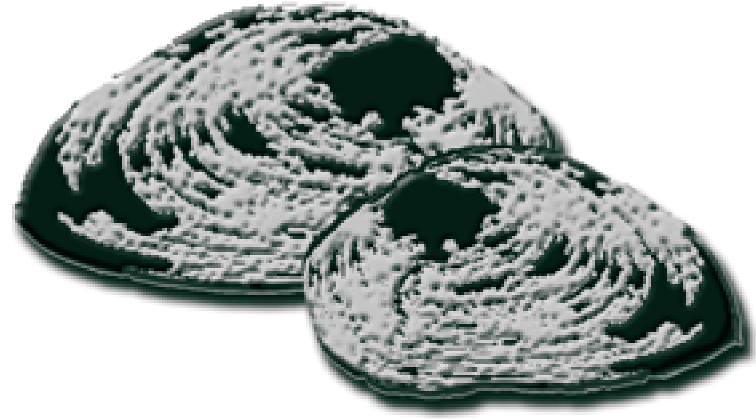


Figure 2. Freshwater mussel.

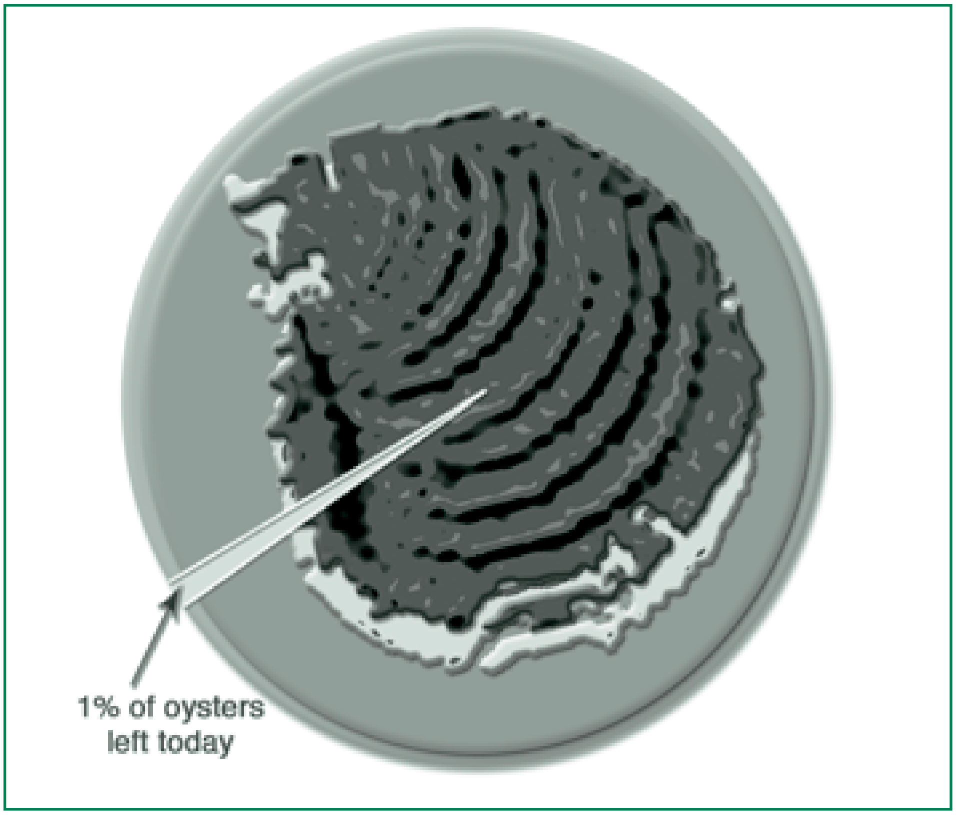


Figure 3. There are 99 percent fewer oysters living in the Chesapeake Bay now compared to 100 years ago.

aquatic animals (figure 4). Most of the decline is caused by human activities.

The scientists found that people living in different areas of the country have been doing things to reduce the decline in the populations of aquatic animal species. In some cases, people have been able to improve the quality of streams, rivers, and lakes so that the populations of aquatic animals are actually increasing. For example, a group of people living in the States surrounding the Chesapeake Bay (figure 5) have agreed to work together

Agriculture—*Eroding* soil and washing fertilizers into waterways. This is called siltation. Silt is the number one pollutant threatening our Nation's waters.

Dams—Stopping the free flow of water in a stream or river.

Over-fishing—Taking more fish out of the water than the species can handle to keep their numbers at a healthy level.

Buildings and other human development—Causing erosion and pollution.

Gravel mining—Taking gravel from stream beds for human use.

Water supply—Taking water out of streams and rivers for irrigation of agricultural land and water supply.

Nonnative fish species—Competing with native fish species for food and habitat.

Pollution—Coming from a range of human actions, such as industrial waste products, poor farming practices, runoff from city streets, *emissions* from cars, etc.

Cattle grazing near streams and lakes—Eroding soil into waterways.

Poor forestry practices—Washing soil from unpaved forest roads into waterways.

Mining—Washing heavy metals into waterways.

Figure 4. Some causes of the decline in the number of fish and other aquatic species.

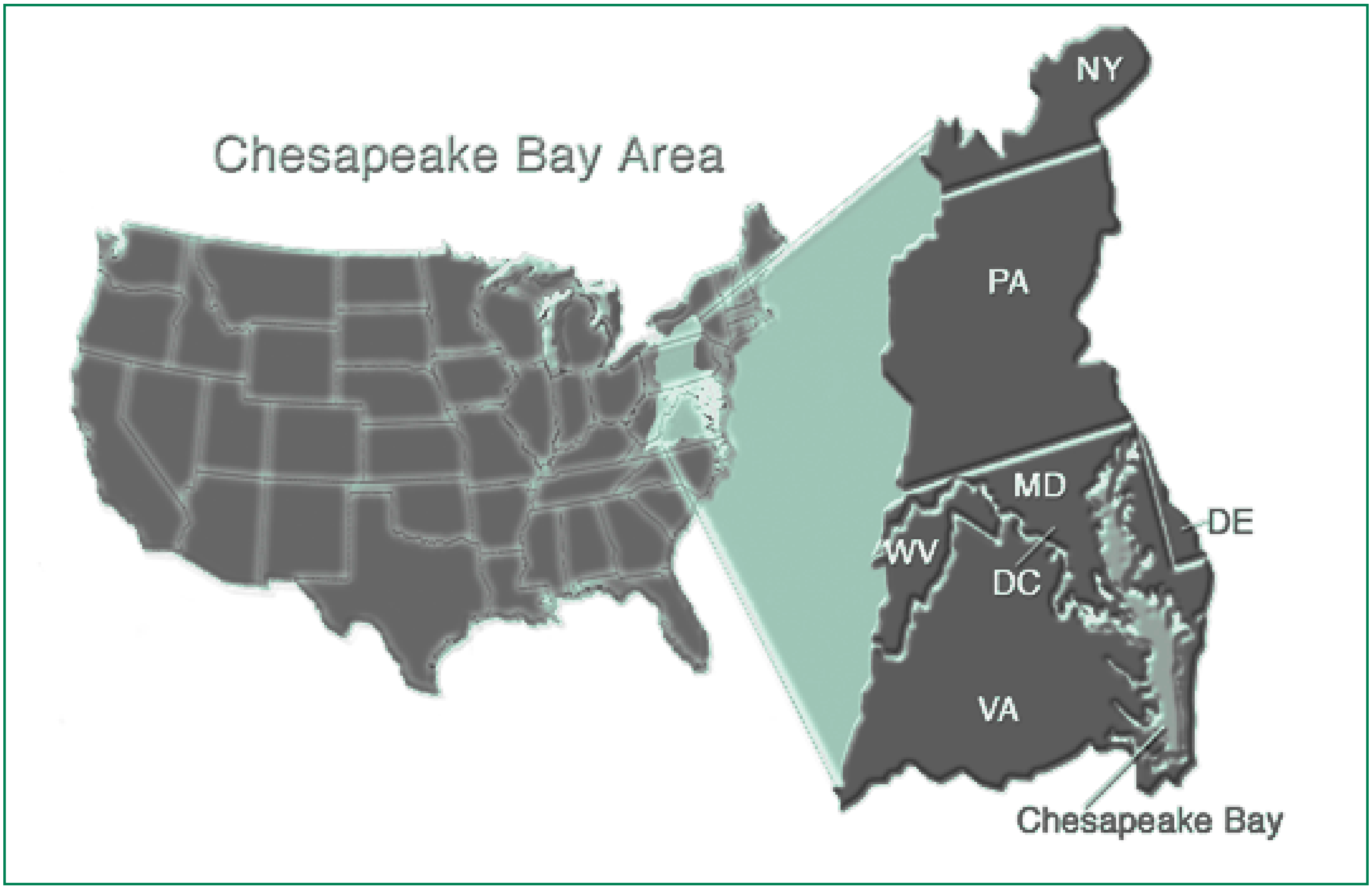


Figure 5. The States surrounding the Chesapeake Bay.

to clean up the bay. Some of the things they are doing are:

1. Cleaning up the water and the land surrounding the bay.
2. Reducing the amount of pollution entering the bay.
3. Educating citizens about what they can do to protect the bay.
4. Encouraging citizens to help make decisions about the bay.
5. Agreeing to continue to work together on solving the problems of the bay.

In another example, a group of people from Arizona wanted to improve Canyon Creek for trout. One of the problems was the rising water temperature, caused by the loss of green plants along the stream's edge. The plants had provided shade for the stream, keeping it cooler. The plants had been killed by cattle that were allowed to graze by the streambank. The people moved the cattle away from the stream and planted native plants along the stream's edge. Within 8 years, the water temperature dropped from an average of 21.7 °Celsius to 12.3 °Celsius (figure 6). (To determine the temperatures in Fahrenheit, multiply the temperature in Celsius by 9/5 and then add 32.) Because of the cooler water, native trout are once again living and reproducing in Canyon Creek.

Reflection Section

- Do you think that the water in creeks or rivers near your home or

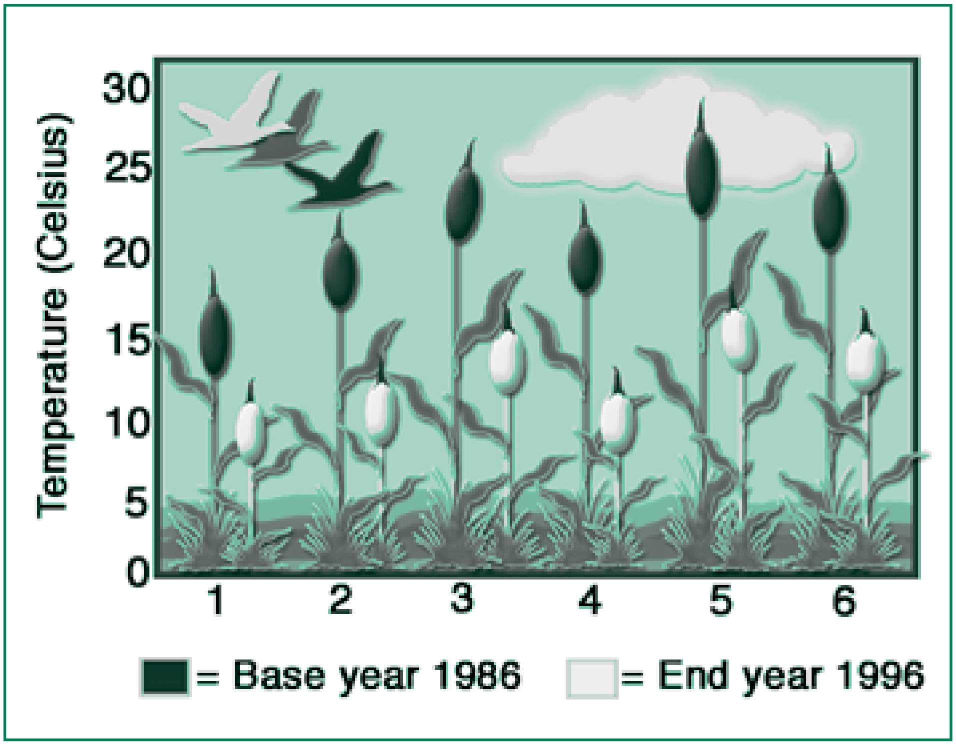


Figure 6. Water temperature changes in six areas of Canyon Creek.

school is clean and healthy? Why or why not?

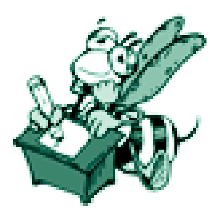
- What do you think will happen to the populations of aquatic animals if conservation is not practiced? Why? What do you think will happen to the populations of aquatic animals if conservation is practiced? Why?

Implications

Although the scientists were able to determine that the populations of fish and other aquatic animals have been declining across the United States, they do not know exactly what the status of these animals is nationwide.

So that better information is available in the future, the scientists are trying something new. They are working with people from six States to develop a way to share information about fish and other aquatic animals. They have agreed to share the same information, such as water temperature; the number of aquatic species and animals found in streams, rivers, and lakes; and the chemical content of the water. They are using the Internet to share the information.

Using this system, the scientists will know whether populations of aquatic species are continuing to decline, or whether conservation activities are helping aquatic animals to survive and reproduce. The scientists will be able to compare the status of one river with another river. They hope that more States will join the effort. Using this system, one day scientists will know a lot more about the status of and trends in the Nation's aquatic species.



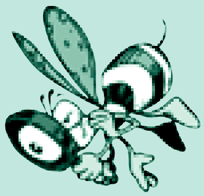
Reflection Section

- Why do you think that it is important to determine the status and possible future of the Nation's fish and other aquatic species?

For water-related activities, visit:

www.epa.gov/ow/citizen/thingstodo.html
www.epa.gov/ow/kids.html
www.projectwet.org

From: Loftus, Andrew J. and Flather, Curtis H. 2000. *Fish and other aquatic resource trends in the United States: A technical document supporting the 2000 USDA Forest Service RPA Assessment.* Gen. Tech. Rep. RMRS-GTR-53. Ft. Collins, CO: USDA Forest Service, Rocky Mountain Research Station. 50 p.



FACTivity

The question you will answer by doing this FACTivity is: What is the status and probable future of a current environmental condition or event? The method you will use to answer the question will be to analyze news articles describing the environmental condition or event. This is similar to how the scientists in this study determined the status and probable future of aquatic animal species.

As a class, decide on a current environmental condition or issue that will likely be reported in the newspaper, TV, and in magazines for at least a few days. You may select any environmental condition or event, such as a recent hurricane, flood, wildland fire, or chemical spill. You may select stories about whether, as a society, we should drill for oil in a national wildlife area, for example. You may select a local, national, or international condition or event.

Once you have selected your topic, each student should search for current printed news on the topic. The stories can come from a newspaper, magazine, the internet, or other printed source. If the issue is national or international, be sure to check news magazines. Each student should bring his or her printed news article to class.

You will need to have at least five different stories on the same topic. They may be stories about similar conditions or events happening in different places, such as wildland fires occurring in different States or countries. Eliminate any duplicate articles.

Divide the class into groups of five students each. Each group should get one copy of each of the articles. Assign one news story to each student in the group. Each student should study his or her article and answer the four questions below. Then, the entire group of five students should discuss the issue and develop a group answer to the following questions.

1. What caused the condition or event? For example, if you studied a wildland fire, did dry weather and lightening likely cause the fire? If you studied a debate over drilling for oil, what are the conditions that caused the debate?
2. What is the current environmental status of the condition or event?
3. Based on the evidence that you have, what do you think will happen to the environment within the next 3 days? Within the next week? Can you guess what might happen in a month, based on the information that you currently have? What might happen within the year?
4. What are the possible implications of the condition or event? The implications may be environmental, personal, social, or economic.

Each group should present its analysis of the news articles to the class. As a class, identify which groups reported similar answers, and which groups reported different answers. What do you think caused the analyses to be the same? Why do you think some of the analyses are different?

By analyzing different news stories, you are using a similar method as the scientists in this study. What are the advantages of using this method? What are the disadvantages?

Alternative: Your teacher may identify an event or condition or even supply the articles. Also, each group can address a different current environmental condition or event.

Stress Test:

The Current and Probable Future of Forests and Rangelands in the United States

Meet Dr. Hof:

I like being a scientist because I enjoy using both math and science to solve problems.

Dr. Hof

Meet Dr. Flather:

I like being a scientist because it is essentially problem solving—and in my case, the problems deal with the *conservation* of wildlife. Working on wildlife conservation problems can be very satisfying when their solution leads to better management of the *habitats* where *wildlife* live.

Dr. Flather

Thinking About Science

Scientists often work with things called *variables*. A variable can be anything, as long as it can be measured or placed into a category. Length of hair is a variable. The number of students in a class is a variable. Age, heart rate, and eye color are variables too! When scientists do their research, they often look for *relationships* between variables. Scientists find a relationship between variables when they discover a pattern of change between them.

For example, there is a general relationship between the height and weight of middle school students. As students get taller, they usually weigh more.

Scientists typically focus on the measurement of a special kind of variable, called a dependent variable. Dependent variables are called this because their value depends on the values of one or more other variables. The other variables are called independent variables. When you write a paper, you earn a particular grade (the dependent variable). Your grade depends on the values of many other independent variables, such as the accuracy of what you write, your grammar, sentence structure, spelling, neatness, and whether you turned your paper in on time.

Glossary

conservation (kän sür **va** shun): The care and protection of natural resources such as forests and water.

habitats (**hab** uh tats): Environments where a plant or animal naturally grow and live.

wildlife (**wild** li̱f): Animals that live in the wild.

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

variables (**ver** e̱ uh bulz): Things that can vary in number or amount.

relationships (re̱ **la** shun ships): Connections in some fashion of two or more things.

rangelands (**ranj** lands): Open lands which are mostly covered with grasses or shrubs.

stressed (stresd): Strained, pressured, or placed under tension.

indicate (**in** di ka̱t): To point out or point to.

native (**na** tiv): Naturally occurring in an area.

threatened and endangered species (**threh** tend and en **dan** jürd **spe** she̱z): *Species* whose numbers are so low as to threaten or endanger its existence in the future.

cubic feet (**kyoo** bik fe̱t): The summed volume of many cubes that are each 1 foot long, 1 foot high, and 1 foot wide.

sediment (**sed** uh ment): Matter set down by wind or water, such as sand or soil.

ratio (**ra** she̱ o̱): The relation of one thing to another in size, amount, etc. Proportion.

breeding birds (**bred** ing bürds): Birds who are also breeding and raising their young in the area they are living.

climate (**kli** met): Average weather conditions of a place over a number of years.

elevation (el uh **va** shun): The height above sea level.

population (pop yo̱o̱ **la** shun): The total number of individuals of separate types of plants or animals occupying an area.

publicly (**pub** lik le̱): By the government, on behalf of all citizens.

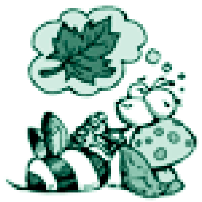
analysis (uh **now** luh sis): Separating something into its parts to examine it.

represent (rep re̱ **zent**): To be an example of.

Pronunciation Guide

a̱	as in ape	ô	as in for
ä	as in car	u̱	as in use
e̱	as in me	ü	as in fur
i̱	as in ice	o̱o̱	as in tool
o̱	as in go	*ng*	as in sing

Accented syllables are in **bold**.



Thinking About the Environment

The scientists in this study were interested in identifying forest and *rangeland* areas of the United States where the natural environment might become more *stressed* in the future. They picked seven conditions that *indicate* how stressed the natural environment is. These conditions included things like the number of *native* birds living in an area and how much water was flowing in streams.

The scientists considered many changes that might affect these conditions. They assumed that the changes that would place the most stress on the environment are the ones caused by human activity. This included things like how many people are living in an area, how much of the land is built up with homes and businesses, and how much of the land is used for cattle grazing.

Change is a normal part of the natural environment, but natural change usually takes a long time to occur, and the environment has time to adapt to the changes. When people make changes to the natural environment, the change is usually faster. If the environment does not have time to adapt to changes, it might become more stressed.

Introduction

It is important to understand the condition of our forests and rangelands, now and into the future. Ideal forests and rangelands have clean water in their streams, a variety of native animals, and few *threatened and endangered species* (figure 1).

The scientists in this study were asked to identify which areas of forest and rangeland in the United States might become more stressed in the future. To do this, they decided to identify areas across the United States where human activity might cause stress on forests and rangelands.

Examples of human activities that might cause stress on forest and rangelands include using trees for wood products and mining the earth for minerals. These activities can affect the types and amount of wildlife, the cleanliness of the water, and whether there are a lot of different types of plants growing in an area.

Figure 1. The Mexican wolf is an endangered species.

Reflection Section

- What is the question the scientists were asked to answer?
- To determine what might happen in the future, what will they need to know about the human activities that might cause stress to the natural environment?

Method

The scientists identified seven dependent variables, which they called indicators. The scientists called these dependent variables indicators because they believed these variables would indicate how much stress a forest or rangeland was experiencing. The seven indicators were:

1. The number of threatened and endangered plant species per acre.
2. The number of threatened and endangered animal species per acre.
3. The amount of water flowing in streams, measured in *cubic feet* per second.
4. The amount of *sediment* flowing down waterways, measured in tons per day.
5. The *ratio* of the number of acres of undisturbed land to total number of acres.
6. The number of native *breeding birds* per acre.
7. The ratio of the number of nonnative breeding birds to the total number of birds (figure 2).

Figure 2. The European starling is a nonnative breeding bird that can be found across the United States.

The independent variables included measures of the *climate* of an area, its *elevation*, its *population*, how much money had been paid for trees to be used for wood products, how many cows were grazing on the land, how many mining sites were in the area, and whether the land was privately or *publicly* owned.

Using a computer program, the scientists did their *analysis* using two steps. First, they looked for current relationships between the indicators and the independent variables. For example, when human population grows in an area, is there a greater or lesser number of threatened and endangered plant species in that area? What happens to the amount of sediment flowing in streams when more cows are allowed to graze in an area?

The scientists entered numbers into the computer program that *represent* what might happen to the independent variables in the future. For example, is the climate expected to change? If so, how? Is the number of cows grazing on land expected to increase, decrease, or stay the same in the future?

Remember that the scientists already knew the relationship between the indicators and the independent variables. From the expected future changes in the independent variables, the scientists were able to predict how the indicators might change in the future.

Reflection Section

- Why were the scientists able to predict what might happen to the indicators in the future? Taken together, what do the indicators represent?
- You probably know the relationship between your grade on a school paper and how accurate your information was, the number of words you incorrectly spelled, your neatness, and whether you turned your paper in on time.

  If the number of incorrectly spelled words went down, your writing or typing got neater, and you turned your paper in early, how would you expect your grade to change from grades in the past? What if the number of incorrectly spelled words went up, your writing or typing got sloppier, and you turned your paper in late? How would you expect your grade to change? How is your experience with grades in school like this study?

Findings

The scientists developed maps that show areas of the United States where by the year 2020 there is likely to be the greatest concern for each of the seven indicators of forest and rangeland stress (figures 3-9, pgs. 52-54). Then, they combined the seven maps and created another map that shows areas where by the year 2020 there is likely to be the greatest concern for stress on forests and rangelands overall (figure 10, pg. 54).

The scientists predicted that by the year 2020, almost 24.6 percent of the United States will experience a high level of stress for at least one of the seven indicators. The scientists caution that this is only a prediction. What will actually happen in the future could be different. Their conclusions are similar to another study that showed the same general locations across the United States where stress on forests and rangelands may be the greatest.

Figure 3. Areas of the United States where there is likely to be the greatest increase in threatened and endangered plant species by the year 2020.

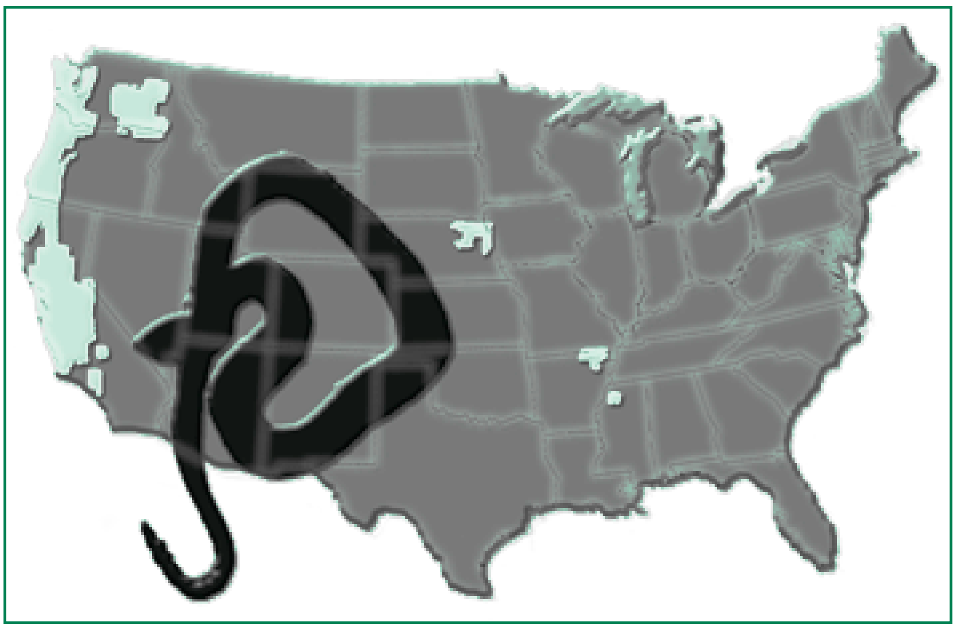


Figure 4. Areas of the United States where there is likely to be the greatest increase in threatened and endangered animal species by the year 2020.

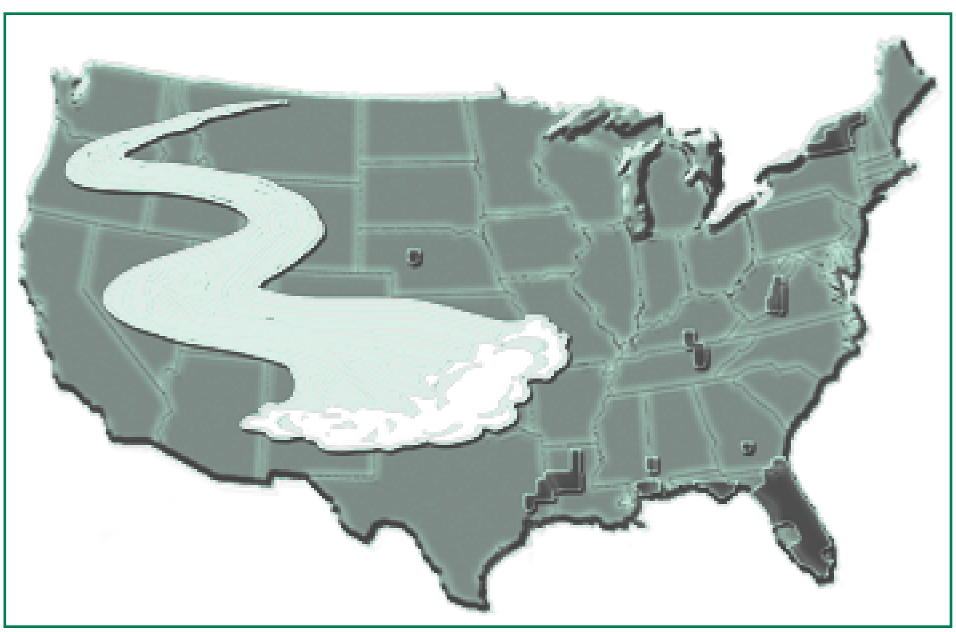


Figure 5. Areas of the United States where there is likely to be the greatest decrease in stream flow by the year 2020.

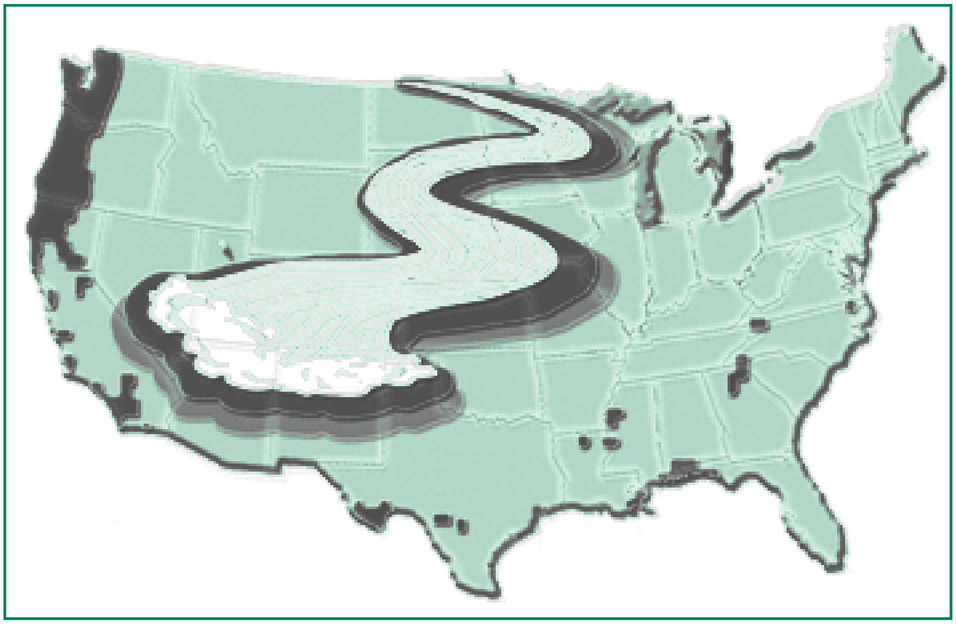


Figure 6. Areas of the United States where there is likely to be the greatest increase in sediment discharge by the year 2020.

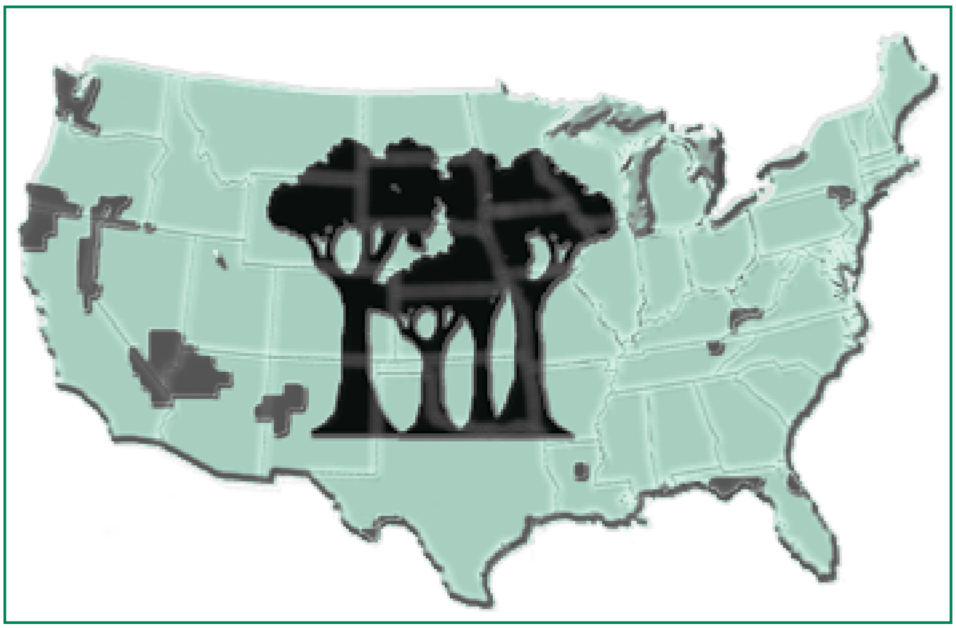


Figure 7. Areas of the United States where there is likely to be the greatest decrease in undisturbed natural land by the year 2020.

Figure 8. Areas of the United States where there is likely to be the greatest decrease in native breeding birds by the year 2020.

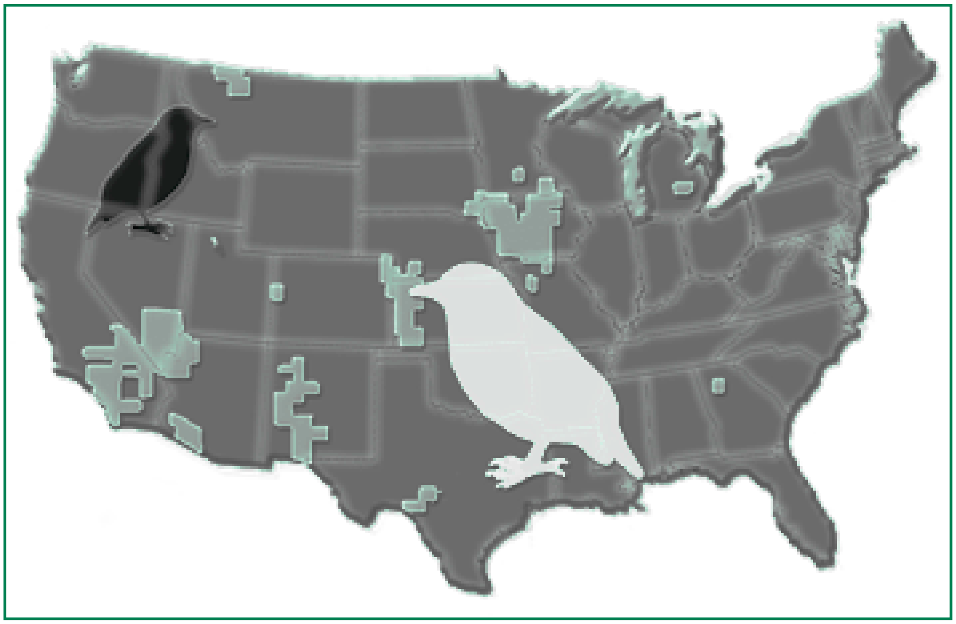


Figure 9. Areas of the United States where there is likely to be the greatest increase in nonnative birds by the year 2020.

Reflection Section

- Look at figures 3-9. Do you see any similarities in the location of the seven indicators? What are some of the areas across the United States where the most stress is predicted to occur?
- The scientists reported that the areas of the United States where they predicted a greater level of stress in forests and rangelands are similar to the results of another study. Does this give you more or less confidence in their results? Why?

Figure 10. Areas of the United States where there is likely to be the greatest increase in environmental stress by the year 2020.

Implications

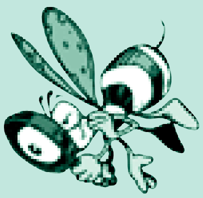
Although this study identified areas in the United States where forests and rangelands may experience more stress by the year 2020, this is only a prediction. Scientific predictions are based on the best information that scientists have today. What happens in the future might be different. This study helps us to think ahead into the future, and to pay special attention to the areas that need it the most. By doing that, we might be able to keep those areas healthier, and possibly change what will happen in the future.

Reflection Section

- How old will you be in the year 2020? What kind of impact might a decline in stream flow have on your life in the year 2020? What kind of impact might an increase in the number of threatened and endangered animal species have on your life?
- Do you think that people should pay attention to the predictions made in this study? Why or why not?

From: Hof, John; Flather, Curtis; Baltic, Tony; Davies, Stephen. 1999. *National projections of forest and rangeland condition indicators: A supporting technical document for the 1999 RPA assessment.* Gen. Tech. Rep. PNW-GTR-442. Portland, OR: USDA Forest Service, Pacific Northwest Research Station. 57 p.

FACTivity



The question you will answer in this FACTivity is: What is the environmental condition of the land around your school? The method you will use to answer this question is: First, you have to decide what the best indicators are of the environmental condition of the land around your school. You also have to decide what the indicators mean. To do this, divide your class into groups of 4-5 students. Each group will hold a discussion and submit one indicator to the class. It is okay for more than one group to suggest the same indicator, but if your class does not have at least 5 indicators, assign the groups to develop more. Examples of indicators that you might use are:

1. The number of trees per acre. More trees indicate a better environmental condition.
2. Whether you have a bird bath, pond, or stream on the land surrounding your school. A source of water for birds and other animals indicates a better environmental condition.
3. The number of bird nests on the land surrounding your school. More bird nests indicate a better environmental condition.

After your class has developed five indicators, the class should determine the values of each of the indicators and what the values represent. Here are examples of the values and what they represent for the examples given above.

1. The number of trees per acre. (You will have to find out how many acres of land surround your school.) Less than 5 (<5) trees per acre = poor condition; 6-10 trees per acre = good condition; more than 10 (>10) trees per acre = very good condition.
2. A source of water available to birds and other animals. No = poor condition; Yes, we have a bird bath that is cleaned and filled daily = good condition; Yes, we have a pond or a stream on our school grounds = very good condition.
3. The number of bird nests on the land surrounding your school. None = poor condition; 1-5 = good condition; >5 = very good condition.

Select a student to write the indicators and their values on the board. Hold a class discussion over what the indicators indicate about the condition of the land surrounding your school. Do the indicators tell you clearly whether the condition of your school's land is good or poor? Why or why not? Hold a class discussion about how this FACTivity is similar to the method used by the scientist in this study. In what ways is it different?

Sample *Natural Inquirer* Lesson Plan

Article: Do What You Water

Subjects Covered:
- **Science**-water use, fresh water
- **Math**- multiplication, addition, estimation
- **Reading**- comprehension

Recommended Web Site:
U.S. Geological Survey Water Science for Schools at http://ga.water.usgs.gov/edu/index.html

Objectives:
1. Students will be able to analyze and discuss the problems with fresh water use on Earth.
2. Students will be able to formulate solutions for problems with fresh water use.
3. Students will be able to synthesize information from a scientific magazine and discuss the information with peers.
4. Students will be able to estimate personal water use and compare with the class.

Estimated Time for Lesson:
3-4 class periods

Materials:
Day 1
- Large glass jar
- Measuring cup
- Water
- Teaspoon
- Small glass jar
- Copies of the Facts to the Future *Natural Inquirer*
- Student science journals or notebook paper
- Pencils

Day 2
- Paper
- Pencils

Day 3
- Factivity questions
- Water estimation guidelines from Factivity
- Poster board or colored construction paper
- Markers, crayons, colored pencils
- Old magazines
- Scissors
- Glue

Procedure:

Day 1
1. Introduce topic by setting out a jar filled with approximately 100 teaspoons (approximately 16.7 ounces or a little over 2 cups) of water.
2. Take a teaspoon and fill it up with water from the jar.
3. Pour the teaspoon into the smaller jar.
4. Ask students what they think the teaspoon of water represents.
5. Once students have started making a few suggestions, discuss with students some of the following facts about water.
   - 5.1. Approximately 70 percent of the Earth's surface is covered with water.
   - 5.2. Out of all the water on Earth, only 1 percent is useable by humans. (The jar with 100 teaspoons (16.7 ounces a little over 2 cups) of water represents all the water on Earth and the single teaspoon of water in the small jar represents how much water is useable by humans. This is only a visual aid. It is a loose approximation.)
   - 5.3. Out of this 1 percent that is useable by humans, some of the water is difficult to access because of where it is located.

6. As a class, begin reading *Do What You Water.* The teachers or student volunteers can read aloud, the following sections: Meet the Scientists, Thinking About Science, and Thinking About the Environment.
7. After reading the Thinking About the Environment section have students break into pairs to read the article *Do What You Water.*
8. While students are reading in pairs, they should write down answers to the reflection questions in their science journal.

Day 2

1. At the beginning of class, have each student pair up with his/her reading buddy from the previous class.
2. Tell students that they are going to compete in a "Quick Jot."
3. In order to compete in the "Quick Jot," students need to brainstorm a list of as many terms, phrases, and ideas as they can remember from the article *Do What You Water* during a 2-minute time period.
4. When the 2 minutes are up, have the students share some of the terms they came up with.
5. Make a list on the board of their responses.
6. Now that students are thinking about the article and what they learned from it, conduct a class discussion using some of the reflection questions.

Day 3- Day 4

1. As students come into the classroom, hand them a slip of paper with the questions from the Factivity and the estimation procedure listed.
2. Students should answer the questions and then estimate their water use.
3. Once all students have finished, create a class water use graph.
4. Discuss the results and have students think of ways to reduce water use.
5. Create "Water Wise" posters using the students' suggestions and post them in the school hallways.

Assessment:

Students can be assessed formally and informally during this lesson. Formal assessment can be done by creating a rubric for the posters. For example you might require students to have some of the following: two pictures on the poster, four ideas for reducing personal water use, correct spelling and punctuation, and a sentence or phrase about why water conservation is necessary.

Informal assessment can be done through class discussions, observations of group interactions, and participation.

Modifications:

- Students that have difficulty reading can be paired with a partner or the teacher may want to assist while the student reads.
- Students that need an extra challenge can work on a PowerPoint® presentation for the class that uses the *Natural Inquirer,* as well as other sources to create an informational slideshow on water use and the water cycle.

TEACHERS, PLEASE COPY THIS FORM BEFORE DISTRIBUTING.

STUDENTS,
Tell Us What You Think About *The Natural Inquirer*

1. The article I read was entitled:

- n Where in the World Is Carbon Dioxide?
- n Do What You Water
- n Born To Be Wild
- n Made in the Shade
- n One Fish, Two Fish, Red Fish – No Fish?
- n Stress Test

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? n Yes n No

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

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

6. Would you like to read another article?

   n Yes n No

7. How old are you? *(Circle)*

   9 10 11 12 13 other age: _____

8. What grade are you in? *(Circle)*

   4th 5th 6th 7th 8th 9th

9. Are you a girl or a boy?

   n Girl n 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
USDA Forest Service
320 Green St.
Athens, GA 30602-2044

Thank you!

PLEASE COPY THIS FORM BEFORE COMPLETING.

The Natural Inquirer—Teacher 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.

	Not useful				Very useful
Sidebars	1	2	3	4	5
Glossary	1	2	3	4	5
Introduction	1	2	3	4	5
Methods	1	2	3	4	5
Findings	1	2	3	4	5
Graphs, figures, photos	1	2	3	4	5
Reflection Questions	1	2	3	4	5
FACTivity	1	2	3	4	5

6. 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:

Sidebars

____

____

Glossary

____

____

Introduction

____

____

Methods

____

____

PLEASE CONTINUE THIS EVALUATION ON THE NEXT PAGE +

Findings

Graphs, figures, photos

Reflection Questions

FACTivity

7. Was the "Note to the Teacher" useful to you?

n Yes n No n Somewhat

8. What grade(s) do you teach? ______

9. What subject(s) do you teach?

10. Other comments or suggestions:

Please send this evaluation, along with your students' evaluations, to:

Dr. Barbara McDonald
USDA Forest Service
320 Green St.
Athens, GA 30602-2044

Thank you! Your evaluations will help us to continually improve the *Natural Inquirer.*

Which National Science Education Standards* Can Be Addressed by the *Natural Inquirer?*

Science Education Standards* / Articles →	Where in the World Is Carbon Dioxide?	One Fish, Two Fish, Red Fish – No Fish?	Do What You Water	Made in the Shade	Born To Be Wild	Stress Test
Science as Inquiry						
Abilities necessary to do scientific inquiry	X	X	X	X	X	X
Understandings about scientific inquiry	X	X	X	X	X	X
Physical science						
Properties and changes in properties in matter	X					
Motions and forces						
Transfer of energy						
Life science						
Structure and function in living systems	X			X		
Reproduction and heredity		X				
Regulation and behavior		X				
Populations and ecosystems		X			X	X
Diversity and adaptations of organisms	X				X	
Earth and space science						
Structure of the Earth system	X		X			
Science in personal and social perspectives						
Personal health			X	X		
Populations, resources, and environments	X	X	X	X	X	X
Natural hazards						
Risks and benefits	X	X	X	X		X
Science and technology in society	X	X	X		X	X
History and nature of science						
Science as a human endeavor	X	X	X	X	X	X
Nature of science	X	X	X	X	X	X
History of science						

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

What Is the Forest Service?

The U.S. Department of Agriculture (USDA) Forest Service is part of the Federal Government. It is made up of thousands of people who care for the Nation's forest land. The USDA 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 national forests and national parks provide clean water, homes for 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 USDA Forest Service are scientists, whose work is presented in this journal. USDA 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.

United States Department of Agriculture

Forest Service

FS-798 • March 2004

Visit these Web sites for more information:

USDA Forest Service:
www.fs.fed.us

The Natural Inquirer:
www.naturalinquirer.usda.gov

Conservation Education:
www.fs.fed.us/outdoors/nrce/

USDA Kid's Page:
www.usda.gov/news/usdakids/index.html

Agriculture in the Classroom:
www.agclassroom.org

NatureWatch:
www.fs.fed.us/outdoors/naturewatch/default.htm

Woodsy Owl:
www.fs.fed.us/spf/woodsy

National Forest Information:
www.fs.fed.us/links/forests/shtml

National Forest Recreation:
www.fs.fed.us/recreation/recreation.shtml