



Fill Those Potholes

Identifying Ecosystem services of
small wetlands on the American Prairie

Meet the Scientists

> **Dr. Robert Gleason**, Research Wildlife Biologist: As a wildlife biologist I have had many memorable experiences conducting field work in **wetlands**, including studying soils, plants, **aquatic** insects and other animals, and especially **waterfowl**. The most rewarding aspect of my job, however, is when research results provide the scientific basis for sound **management** and **conservation** of wetland **ecosystems**.



< **Mr. Murray Laubhan**, Ecologist: My favorite science experience is learning something new that helps land managers successfully restore wetlands.



^ **Mr. Brian Tangen**, Biologist: My favorite science experience involved canoeing and back-country camping in the boundary waters wilderness area in northern Minnesota. I did this to conduct research on bald eagle **habitat**.



< **Dr. Chip Euliss**, Research Wildlife Biologist: I am a pretty lucky fellow because I've had many favorite science experiences over my career. Writing this to you is one of my favorites. This is because what I enjoy most about my job is helping teach people about science and how it can improve our lives. The information in this article will teach you about the important services that ecosystems provide to our society.

Glossary

wetlands (**wet** lendz): Areas of land with a lot of soil moisture.

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

waterfowl (wä tür fowl): Birds that spend part or most of their life around or on water.

management (**man** ij ment): The conducting or supervising of something.

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

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

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

agency (**a** jen se): A separate unit of a government.

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

natural resources (**na** cha rôl **re** sôrs es): A supply of something in nature that takes care of a human need, such as oil, forests, or water.

economic (**e** kō **nom** ik): Having to do with the management of money in a home, business, or government.

migratory (**mi** gruh tôr **e**): Having a characteristic of moving from one place to another.

breeding habitat (**bre** ding **hab** uh tat): Environment where an animal nests and reproduces as opposed to where it lives during the rest of the year.

diversity (di **vür** suh te): A measure of the differences between the types and numbers of living things in a natural area.

restore (**re** stôr): To put or to bring back into a past or original state.

policy (**päl** uh **se**): Overall plan with rules that must be followed, generally made by a government.

variable (**ver** e uh bul): A thing that can vary in number or amount.

nutrient (**noo** tre ent): Any of the substances found in food that are needed for the life and growth of plants and animals.

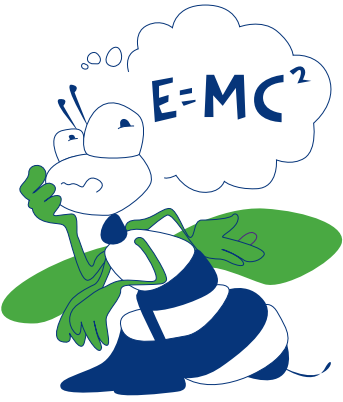
erosion (**e** rô zhen) The process or state of wearing or washing away.

Pronunciation Guide

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

Accented syllables are in bold.





Thinking About Science

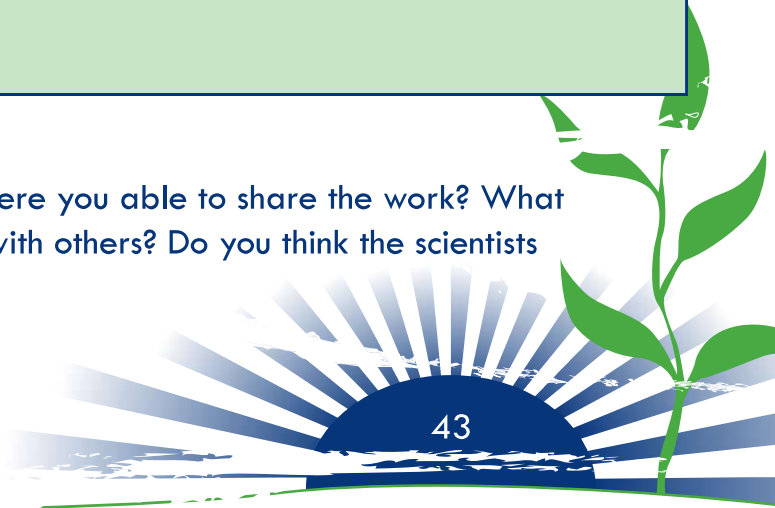
Most scientists, like most people, work as members of an organization. All organizations have a mission. A mission is similar to a goal. Everyone in the organization does their own job to fulfill the mission. Sometimes people in different organizations work with each other. They do this when what they are doing together helps each organization to fulfill its mission.

In this study, the scientists worked for different United States **agencies** (figure 1). These agencies all work to use and **sustain** the Nation's **natural resources**. Even though the agencies all work with natural resources, their missions are different. When scientists work with scientists from other organizations, they can still help their own agencies fulfill their mission. They also save time and money by sharing the work. Whether or not you are a scientist, it makes sense to work with others when you can all achieve your goals by working together. As you read figure 1, compare each agency's mission. How are the missions alike? How are they different?

Agency	Mission
U.S. Department of the Interior, U.S. Geological Survey (USGS)	Serves the Nation by providing scientific information to: <ol style="list-style-type: none"> 1. Describe and understand Earth 2. Minimize loss of life and property from natural disasters 3. Manage water, biological, energy, and mineral resources 4. Enhance and protect the quality of life
U.S. Department of Agriculture, Farm Services Agency (FSA)	Handles farm, conservation, disaster, and loan programs to help farmers manage their land for economic health now and in the future.
U.S. Department of the Interior, U.S. Fish and Wildlife Service (FWS)	Works with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people.
U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS)	Helps people help the land through conservation programs.

Figure 1. The U. S. agencies involved in this research.

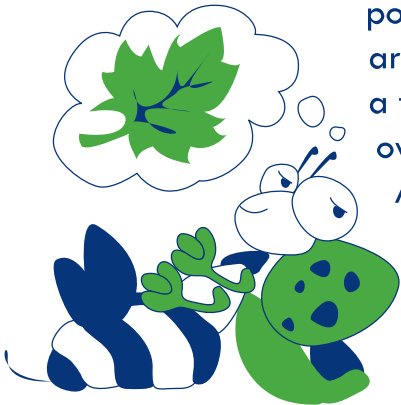
Think of a time when you worked with others. Were you able to share the work? What qualities does a person need to work successfully with others? Do you think the scientists in this study had these qualities? Why or why not?



Thinking About the Environment

The Prairie Pothole Region of North America is an area of the northern Great Plains (figure 2). This area was once mostly made up of mixed grass and tallgrass prairies (figures 3 and 4). When the glaciers receded 10,000 years ago in this area, they left millions of shallow depressions. These depressions filled with water and are now known as prairie potholes. These depressions filled with water and are now known as prairie

potholes. These potholes are wetlands which provide a temporary home to over 50 percent of North America's **migratory** waterfowl. Most of the water found in prairie potholes comes from melting winter snow.



In this area of the United States, the soil is good for growing agricultural crops. In the past, farmers drained the potholes to increase the amount of land available to grow crops. Over half of the prairie potholes have been drained. This was not good for the waterfowl who depend on the potholes for **breeding habitat**, food, and shelter. Government programs now help farmers and landowners restore the prairie potholes to their wetland condition. As wetlands, the potholes do more than provide habitat for waterfowl. In this research, you will learn about other services provided to humans by prairie potholes. These services are known as ecosystem services.



Figure 2. The Prairie Pothole Region of North America. Notice how this region goes into Canada.



Figure 3. A mixed grass prairie.



Figure 4. A tallgrass prairie.

Introduction

Ecosystem services are environmental benefits provided by natural areas. Ecosystem services are important to humans. Ecosystem services include things such as providing clean water, clean air, habitat for animals, a variety of plants, and healthy soil. It is believed that prairie potholes provide many important ecosystem services.

Prairie potholes are small wetlands formed when melting snow runs into small depressions in the land (**figures 5 and 6**). In the past, many of these potholes were drained by farmers. The potholes were drained to increase the amount of land available to grow crops. The benefits of having more crops were thought to be more important than the benefits of having prairie potholes.

In 1985, the United States Department of Agriculture (USDA) started two nationwide programs to restore some types of land to their natural state. These programs help landowners and farmers in the Prairie Pothole Region restore the prairie potholes that were drained. The goal of these programs is to restore the ecosystem services that were lost when the potholes were drained.



Figure 5. Prairie pothole.



Figure 6. Prairie pothole.

Number Crunches

How many years have the two government programs been in operation?

The Two Government Programs

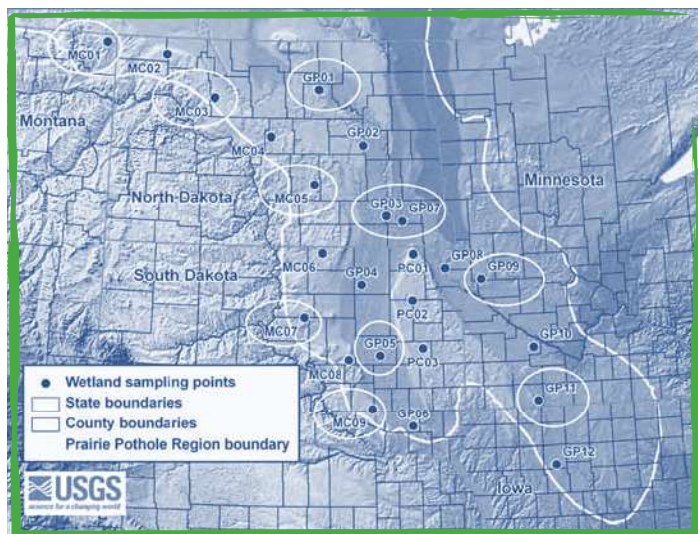
The Conservation Reserve Program (CRP) and the Wetlands Reserve Program (WRP) were established in the 1985 Farm Bill. The Farm Bill is the primary way that agricultural policies are determined by the Federal Government. The CRP encourages landowners to take cropland that is in environmentally sensitive acres and plant grasses or trees instead of crops. The WRP encourages landowners to restore wetlands in areas that had been drained and planted in crops. Landowners receive an annual rental payment for 10 to 15 years. This payment makes up for the money they would have made from selling crops grown on that land. These programs are run by the Natural Resources Conservation Service, or NRCS. (See figure 1 to learn about NRCS's mission.)

Now that the programs have been in operation for many years, it was time to find out whether the programs are achieving their goal. The scientists in this study wanted to know whether some of the ecosystem services provided by prairie potholes are restored when the potholes are restored. They wanted to know how much benefit the restored prairie potholes provide to people, compared to the natural prairie potholes that had never been drained for crops. They also compared the restored potholes with nearby crop land.

Method

The scientists wanted to know about prairie potholes that had been restored. To restore prairie potholes, farmers and landowners removed unnatural drains and planted grasses and other plants in and around the potholes. The scientists studied 204 potholes in 1997 and 270 pothole areas in 2004 (**figure 7**). The pothole areas included more than the pothole or wetland itself. The areas included the land around the pothole, which drained water into the pothole (**figures 8 and 9**). The restored potholes were surrounded by crop land (**figure 10**).

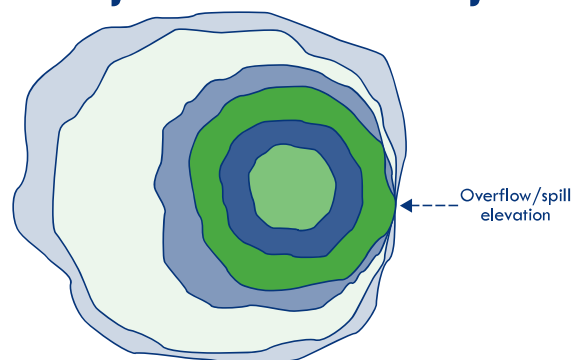
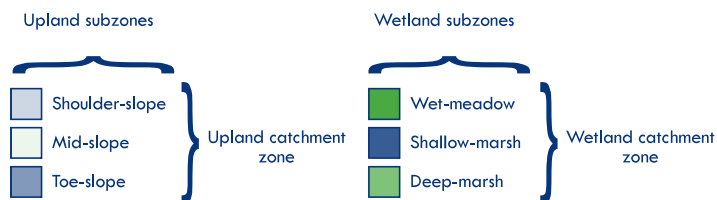
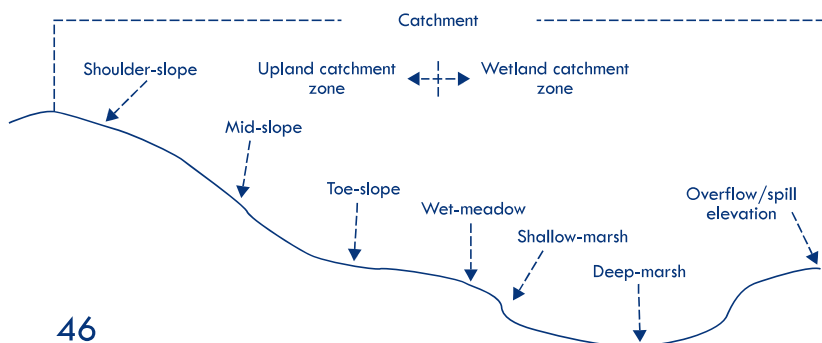
Figure 7. Areas studied in 1997 and 2004. The dots show the pothole areas that were studied.



Reflection section

- The United States Congress created two programs to help restore land to its natural state. By creating these programs, Congress recognized that some ecosystem services are at least as important as the services provided by agricultural crops or other uses of land. Review the list of ecosystem services in the first paragraph of the “Introduction.” You may also review “Thinking About the Environment” to learn about an important ecosystem service provided by prairie potholes. Do you agree that some of these services are as important as agricultural crops? Why or why not?
- What are the questions the scientists wanted to answer?

Figure 8. Profile of a prairie pothole area.



The catchment area is the land area where water from rain or snow runs downhill into a body of water. The catchment area surrounds the prairie pothole. Compare this photo to figure 8.

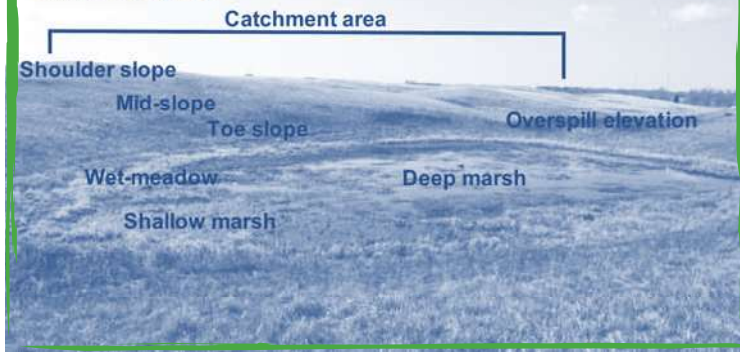


Figure 9. The profile of a prairie pothole using a photograph. Compare this to figure 8.



Figure 10. This restored prairie pothole is surrounded by crop land. Compare this prairie pothole with those in figures 5 & 6.

Variable	Measurement
Soils	Nutrients (Carbon, Nitrogen, Phosphorus)
	pH (A measure of how acidic or basic the soil is)
	Type of soils in the area
Plants (vegetation)	Soil texture
	Types and number of plants in the area
	How much of the ground is covered by plants
	The depth of the dead plant material on the ground
Three-dimensional shape	How much living and once-living plant material is found in the area
	How thick the plants are from the ground to 2 meters high
	How wide each of the zones are (see figure 8)
	The size of the area in hectares
	The physical shape and unevenness of the area
	The volume of water in the pothole wetland

Figure 11. Some of the **variables** measured at each restored and natural prairie pothole or prairie pothole area. The scientists also measured some of these variables on nearby crop land.

When a restored pothole or a restored pothole area was identified, the scientists located the closest natural pothole to it. For each restored and nearby natural pothole area, scientists collected information about its soil, plants, and three-dimensional shape (**figure 11**). They also collected the most of the same information from nearby crop land.

The scientists then compared the information they collected at restored and natural potholes and pothole areas. They also compared this information with information collected at nearby crop land.

Number Crunches

How many yards high is 2 meters? Multiply 1.09 by 2 to find out. How many feet high is 2 meters? (Note: This measure told the scientists how much protection from plants was available for wildlife around the prairie pothole.)

Reflection section

- Look at figures 7, 8, and 9. In 1997, the scientists collected information about potholes only. In 2004, they collected information about potholes and the land surrounding the pothole. Why do you think they expanded the study area around each pothole?
- Why did the scientists compare restored prairie potholes to natural prairie potholes?



Findings

The scientists reported on four ecosystem services. These services were (1) Providing a variety of plant **species**; (2) Helping to address climate change by holding carbon in the soil; (3) Holding rain and storm water in the potholes, thereby reducing the threat of flooding; and (4) Reducing soil **erosion**.

The scientists discovered that the variety of plants in restored potholes and pothole areas was not as great as the variety of plants in natural potholes and pothole areas. They found, however, that the variety of plants in restored potholes was greater than in nearby areas with crops.

The scientists were interested in how much carbon was being held in the soil of prairie potholes and pothole areas. When the soil holds carbon in the form of dead and decaying plant and animal matter, it prevents more carbon from going into the atmosphere. Carbon in the atmosphere contributes to global climate change. When soil holds carbon, therefore, it is considered an ecosystem service.

The scientists found that natural prairie potholes and pothole areas hold more carbon than either restored potholes or areas with crops. The scientists expected the soil of restored potholes to contain more carbon than areas with crops, but they did not find this to be the case.

The scientists were also interested in how well the potholes could prevent flooding in nearby areas. They estimated that all of the restored and natural prairie potholes in the United States could hold an amount of water equal to 56,500 hectares 1 meter deep. This equals 458,000 acres of water 1 foot deep (**figure 12**). The scientists concluded that prairie potholes provide a service to people because they can help protect people from floods.

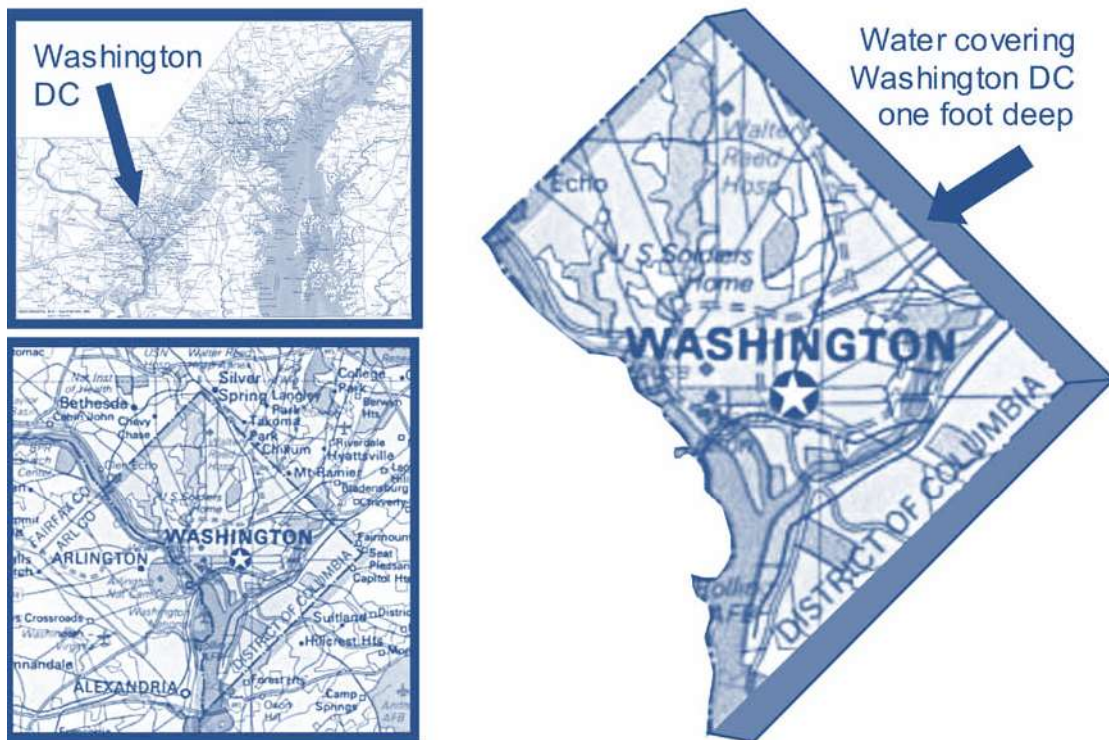


Figure 12. An area of water covering 458,000 acres and 1 foot deep. This is a little less than the area of the District of Columbia.

The scientists also discovered that soil erosion was reduced in the restored prairie potholes as compared to land with crops. One of the greatest benefits of reduced soil erosion is that the pothole wetlands do not fill with soil. They can, therefore, remain pothole wetlands and continue to provide all of the services listed above (figure 13).

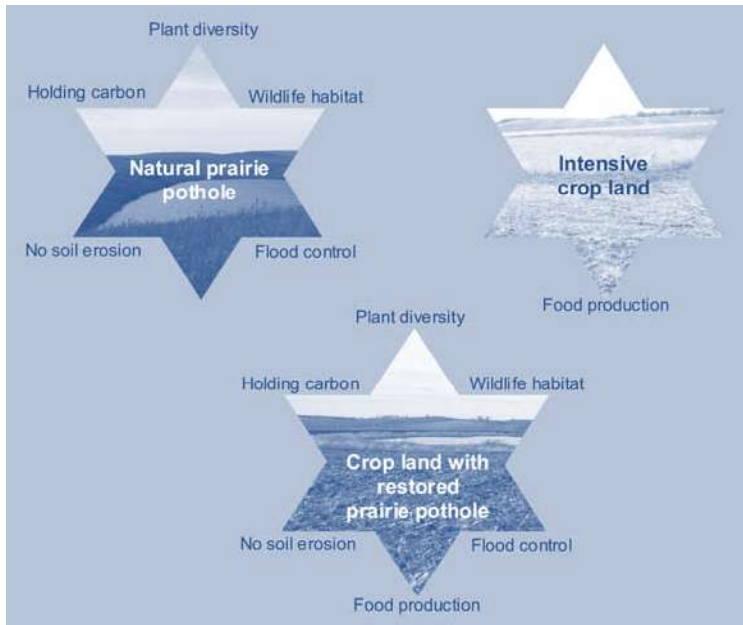


Figure 13. A comparison of the ecosystem services provided by natural prairie potholes, intensive crop land, and crop land with restored prairie potholes. Adapted from rs.resalliance.org/wp-content/tradeOff.jpg.

Discussion

The scientists believe that much more research has to happen before they can identify and measure all of the ecosystem services provided by prairie potholes. They also believe that the CRP and the WRP have helped to provide ecosystem services to people. The programs have done this by encouraging farmers and landowners to restore some of their cropland back to prairie potholes and pothole areas.

Reflection section

- Based on the findings of this research, what is another research question the scientists could ask about prairie potholes and prairie pothole areas? (Hint: Reread the findings having to do with carbon and climate change.)
- Do you agree that the CRP and the WRP have helped to provide ecosystem services? Why or why not?

Reflection section

- Based on the findings reported by the scientists, do you think prairie potholes provide valuable ecosystem services to people? Why or why not?
- The scientists reported on four ecosystem services. Based on your reading of this article, what is one other ecosystem service provided by prairie potholes and pothole areas?

Adapted from: Gleason, R.A.; Laubhan, M.K.; and Euliss, N.H. Jr.; eds., 2008. *Ecosystem services derived from wetland conservation practices in the United States Prairie Pothole Region with an emphasis on the U.S. Department of Agriculture Conservation Research and Wetlands Reserve Programs*. U.S. Geological Professional Paper 1745, 58 p. <http://pubs.usgs.gov/pp/1745/pdf/pp1745web.pdf>.



FACTivity

Time Needed: One class period

Materials Needed:

Visit <http://www.naturalinquirer.org> and print one each of the following articles:

Urban Forest Edition: (1) What you see is not what you get, (2) I've got you covered, (3) Good to the last drip, (4) Yard sale!, (5) Social groupies, (6) Balancing act.

Wilderness Benefits Edition: (1) Wilderness makes sense, (2) Elemental, my dear! (3) Can you hear me now? (4) Speakological, (5) As the frog hops.

Students will divide into pairs.

(These 11 articles should be enough for each pair of students to have their own article. If all of these articles cannot be printed, select enough so that the class is in groups of three to four and each group has its own article. More than one pair of students can read the same article.)

Each pair (or group) should have a blank piece of lined paper and a pencil.

The question you will answer in this FACTivity is: What are other ecosystem services provided by the Nation's natural resources? The method you will use to answer the question is:

5 minutes:

As a class, discuss the term "ecosystem services" and what it means. If you have not done so before, read "Welcome to the Ecosystem Services Edition of the *Natural Inquirer*" on page 6. Before continuing, students should understand what ecosystem services are in a broad sense. In other words, students should understand that all natural areas provide at least one ecosystem service, or environmental benefit, to humans. Some of them provide many ecosystem services.

15 minutes:

Each pair (or group) of students will have an article and a blank piece of lined paper and a pencil. The pair (or group) should write their names and the article title on the top of the paper. Each pair will read only the following article sections: Thinking About the Environment, Introduction, Method, Findings, Discussion. Students should read the article aloud, rotating paragraph by paragraph.

10 minutes:

Each group will identify as many ecosystem services as possible found in their article. Note that these services may not be identified as such in the article. Students should use their imagination to identify more than one ecosystem service. One student will write these ecosystem services in a list, using this example format:

1. When fruit bats eat fruit, they later defecate the seeds at a place far away from where they ate the fruit. A new fruit tree may then grow. This is an ecosystem service because fruit bats help to spread the seeds of fruit trees and, therefore, enable new fruit trees to grow in new places.

10 minutes:

Students will share their list of ecosystem services with the class. Hold a class discussion about the types of services provided by the natural environment. Do the services identified provide important benefits? Why or why not?

Students should turn in their sheets to the teacher. The sheets can be used for assessment.



If you are a Project Learning Tree-trained educator, you may use #71, "Watch on Wetlands" as an additional resource.

FACTivity Extension



For homework, students will observe the natural land (and water) around them and identify as many ecosystem services as possible. Students can start with the schoolyard, looking out of the bus or car window, observe while they are walking, or explore the area around their home. The ecosystem services should be identified in written form, using the format given above. In class, using a rapid-fire format, students will share their observations. Students should consider all they have learned about the environment to identify ecosystem services. Students may be assessed on the number of ecosystem services identified, and the clarity and correctness of written expression.

Additional Web Resources:

Scientific American podcast on ecosystem services, 60-second Earth:
<http://www.sciam.com/podcast/episode.cfm?id=why-ecosystem-services-matter-09-02-05>

Ecological Society of America: Ecosystem Services: A Primer:
<http://www.esa.org/ecoservices/comm/body.com.fact.ecos.html>

Forest Service Ecosystem Services:
<http://www.fs.fed.us/ecosystems-services/>

