

# Natural Inquirer

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Number 18

The *Natural Inquirer* Monograph Series: Carbon 1

## LOGJAMS and BEAVER DAMS

How Different Landforms Affect the Amount of Carbon in an Ecosystem







# Natural Inquirer

Monograph Series: Carbon 1

## Logjams and Beaver Dams: How Different Landforms Affect the Amount of Carbon in an Ecosystem

### Produced by

*U.S. Department of Agriculture, Forest Service  
Cradle of Forestry in America Interpretive Association*

### Production Staff

*Babs McDonald, Forest Service  
Jessica Nickelsen, Cradle of Forestry in America  
Interpretive Association  
Brian Cooke, Cradle of Forestry in America Interpretive  
Association  
Michelle Andrews, University of Georgia  
Carey Burda, Cartographer  
Stephanie Pfeiffer, SMP Illustration  
Leslie Shaw, Leslie Shaw Design*

### Forest Service Scientists Highlighted in the Journal

*Kate Dwire, Rocky Mountain Research Station*

### Collaborating Scientists

*Ellen Wohl, Colorado State University  
Nicholas Sutfin, Los Alamos National Laboratory  
Roberto Bazan, Post Oak Savannah Groundwater  
Conservation District*

### Forest Service

*Victoria Christiansen, Chief  
Alex L. Friend, Deputy Chief,  
Research and Development  
John Phillips, Deputy Chief,  
State and Private Forestry  
Michiko Martin, Director, Recreation,  
Heritage & Volunteer Resources  
Tracy Hancock, Staff Director,  
Knowledge Management & Communications  
Tinelle Bustam, Acting Director, Conservation Education*

### Cradle of Forestry in America Interpretive Association

*Susan Moore, Chairperson  
Carlton Murrey, Executive Director  
Adam DeWitte, Director of Education*

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# CONTENTS

Page 10

FEATURE:

## LOGJAMS and BEAVER DAMS:

How Different Landforms Affect the  
Amount of Carbon in an Ecosystem

- 4 Editorial Review Board
- 5 About *Natural Inquirer* Monographs!
- 6 Who Are Scientists?
- 7 Welcome to the *Natural Inquirer* Monograph—  
Carbon Series!
- 10 **FEATURE:**  
Logjams and Beaver Dams: How Different  
Landforms Affect the Amount of Carbon  
in an Ecosystem
- 30 Logjams and Beaver Dams Glossary
- 31 FACTivity
- 36 Logjams and Beaver Dams  
Illustrated Glossary Challenge
- 37 Logjams and Beaver Dams  
eyeChallenge
- 38 National Education Standards

### Inside back cover

What Is the Forest Service?  
What Is the Cradle of Forestry in America  
Interpretive Association?

### Back cover

Websites

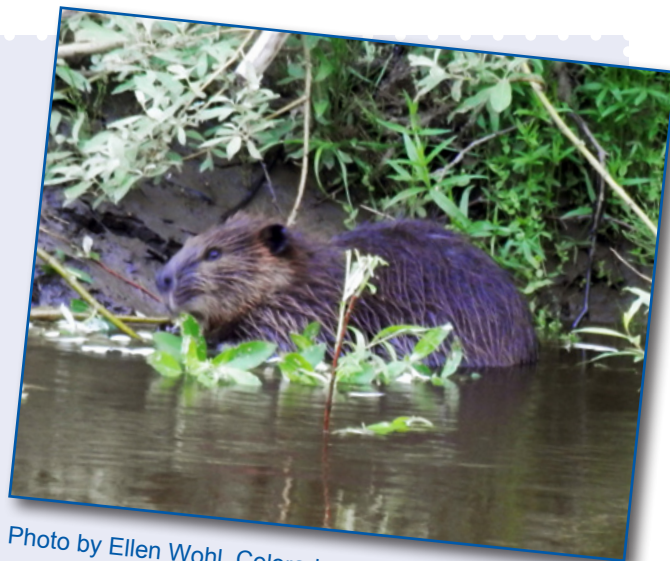


Photo by Ellen Wohl, Colorado State University.

**Join us in  
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The following educator resources  
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These resources can be found with  
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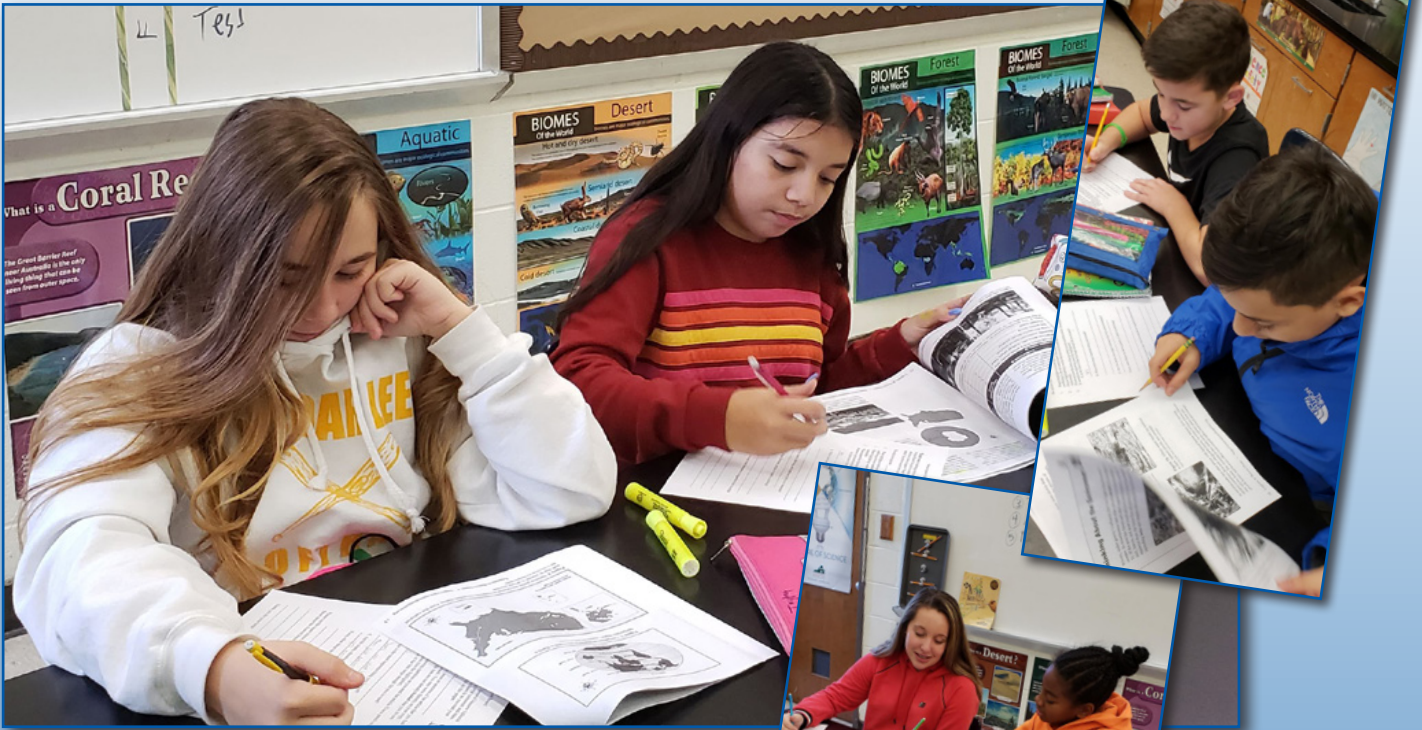
- **Note to Educators**
- **Lesson Plan**
- **Reflection Section Answer  
Guide**
- **National Education Standards  
(specific to each article),  
including:**
  - National Science Education  
Standards
  - National Curriculum Standards for  
Social Studies
  - Common Core State Standards
  - Next Generation  
Science Standards

# *Natural Inquirer*

## Editorial Review Board Hard at Work

Cedar Lee Middle School  
Bealeton, VA

Ms. Bryant's 7th Grade Academic Seminar Students



**"Make the book more fun by giving more fun facts and questions."**

**"I enjoy working in this because I like to talk about the forest."**

**"I didn't know there were many types of scientists."**

**"I think this book is amazing. I could understand everything perfectly."**

**"The most important thing I learned is that every single living animal and plant has carbon in it."**



# About *Natural Inquirer* Monographs!



Scientists report their research in a variety of special books called journals. Although journals have been produced in hard copy, they are increasingly also produced online. Journals usually contain between 4 and 7 scientific papers. Journals enable scientists to share their research with one another. A monograph is a type of journal about research that focuses on a single scientific paper.

This monograph of a *Natural Inquirer* article was created to give scientists the opportunity to share their research with you and other students. The monograph presents scientific research conducted by Forest Service scientists and other scientists. If you want to learn more about the Forest Service, you can read about it on the inside back cover of this monograph, or you can visit the *Natural Inquirer* website at <http://www.naturalinquirer.org>.

All of the research in this *Natural Inquirer* monograph is concerned with the natural environment, such as trees, forests, soils, animals, insects, outdoor activities, and water. First, you will “meet the scientists” who conducted the research. Then you will read about one of the many interesting aspects of science and about the natural environment. You will also read about a specific research project. The research article is written in the format that scientists use when they publish research in scientific journals. Then YOU become the scientist as you go through the FACTivity associated with the article. Don’t forget to look at

the glossary and the special sections highlighted in the article. These sections give you extra information that is educational and interesting.

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 will help you think like a scientist. They will help you think about how research is conducted. Your teacher may use these questions in a class discussion, or you may discuss these questions in a small group.

Each *Natural Inquirer* monograph will help you explore the exciting world of science and prepare you to become a young scientist. You will learn about the scientific process, how to conduct scientific research, and how to share your own research with others.

Visit <http://www.naturalinquirer.org> for more information, articles, and resources.

Be sure to try the Logjams and Beaver Dams Illustrated Glossary Challenge and eyeChallenge on pages 36 and 37!







# WHO ARE SCIENTISTS?



Scientists collect and evaluate information about a wide range of topics. Some scientists study the natural environment.

**To be a successful scientist, you must:**

**Be curious:**  
Are you interested in learning?

**Be enthusiastic:**  
Are you excited about a particular topic?

**Be careful:**  
Are you accurate in everything you do?

**Be open-minded:**  
Are you willing to listen to new ideas?

**Question everything:**

Do you think about what you read and observe?



Photo courtesy of Rachel Arango, USDA Forest Service.



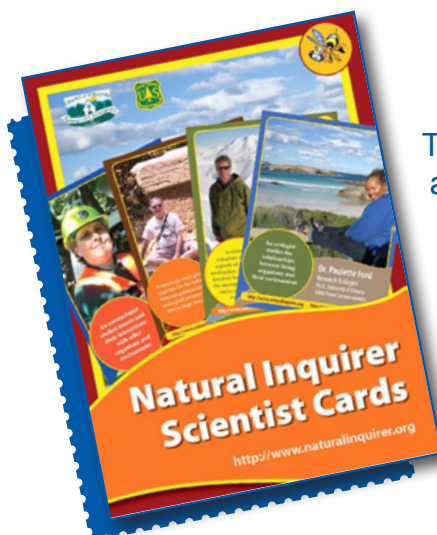
Photo courtesy of Yongqiang Liu, USDA Forest Service.



Photo courtesy of Melody Keena, USDA Forest Service.



Photo courtesy of Dexter Strother, USDA Forest Service.



To learn more about scientists and their work, you can find *Natural Inquirer* scientist cards and posters online at <http://www.naturalinquirer.org>.



# Welcome to the *Natural Inquirer* Monographs— **CARBON SERIES!**

Glossary words are in **bold**  
and are defined on page 30.

Welcome to the *Natural Inquirer* Monographs—Carbon Series! A monograph is a single research article organized into a booklet. This monograph series will focus on carbon. Carbon is an important part of our world. Carbon is an element that can be found in water, soil, plants, animals, and the atmosphere. In fact, about 18 percent of the human body is carbon!

Humans and other animals get carbon from eating plants and from eating

animals that eat plants. A plant contains carbon as long as it lives and until it completely decays or is burned. Plants get carbon by taking in carbon dioxide (CO<sub>2</sub>). When the plant takes in CO<sub>2</sub>, it keeps the carbon and releases the oxygen. Another place that carbon is held is in the water. For example, carbon that is held in ocean water and coastal forests is known as blue carbon. This blue carbon is held in areas such as salt marshes, sea grasses, and mangroves (figure 1).

To learn more about monographs, read  
“*About Natural Inquirer Monographs!*” on page 5.



All places that hold carbon on Earth are known as carbon sinks. Carbon sinks are important to understand because too much carbon in the atmosphere contributes to climate change. Therefore, understanding how carbon sinks work and where they are located can help with **adaptation** and **mitigation** strategies for a changing climate.

With all this discussion about where and how carbon is stored, you may be wondering how carbon gets released back into the atmosphere. A natural release of carbon into the atmosphere comes from wildland fires (figure 2). Another way carbon is released back to

the atmosphere is through the burning of fossil fuels. Fossil fuels are oil, coal, and natural gas. Fossil fuels are made from the chemical remains of dead plants and animals. When fossil fuels are burned, they release mainly heat, water, and carbon dioxide. This process of carbon cycling through different locations on Earth and in the atmosphere is called the carbon cycle (figure 3).

Because carbon is so **pervasive** and important in the environment, many scientific studies are conducted to help understand the role that carbon plays in our world. For example, some studies have been done on carbon



**Figure 1.** Sea grasses store blue carbon. Photo by Babs McDonald, used with permission.



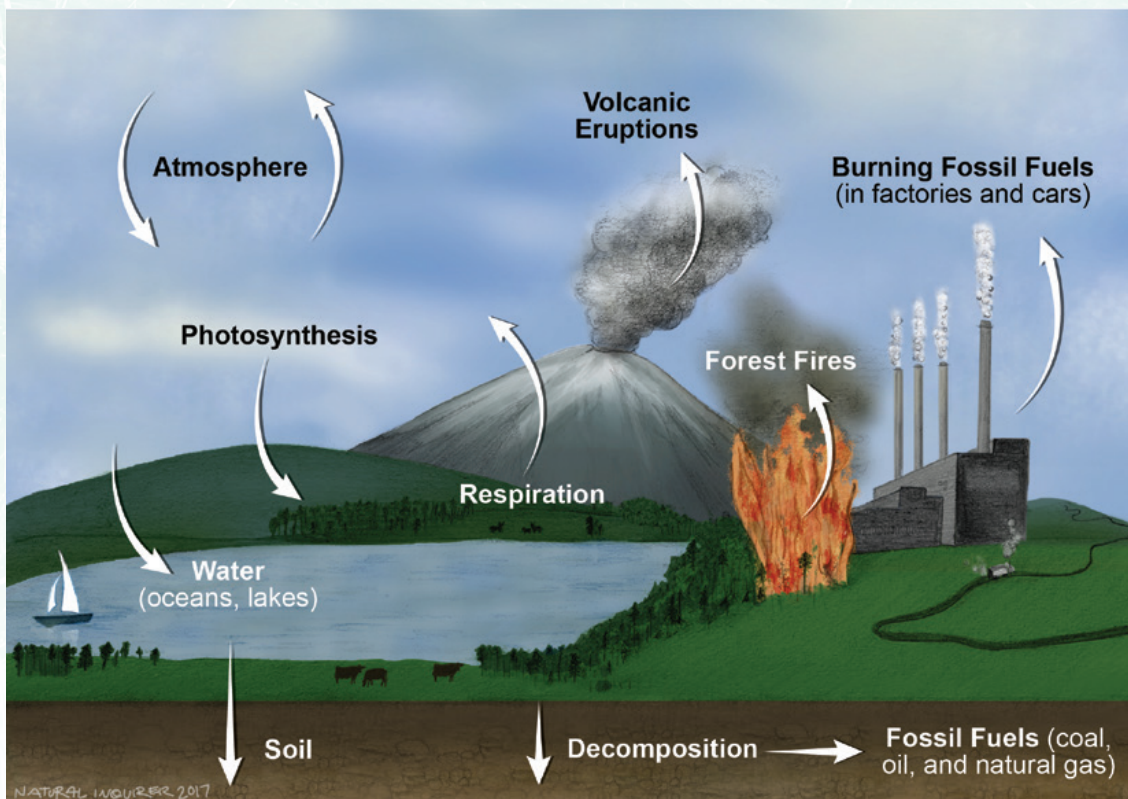
sequestration (sē kwə **strā** shən). Carbon sequestration refers to the ability of some areas to keep carbon in a solid or liquid form instead of releasing the carbon back into the atmosphere. As noted earlier, these areas that hold carbon are called carbon sinks.

In this first monograph of the Carbon Series, you will learn about research that examines how landforms beside rivers affect how much carbon is stored. You will learn how beavers play a role in the carbon cycle. You will also learn what natural processes affect the location and the amount of carbon in these ecosystems.



**Figure 2.** Carbon is naturally released into the atmosphere when wildland fires occur.

USDA Forest Service photo.



**Figure 3.** The carbon cycle.

Illustration by Stephanie Pfeiffer.



# Logjams and BEAVER DAMS

## How Different Landforms Affect the Amount of Carbon in an Ecosystem

Photo by Ellen Wohl,  
Colorado State University.

### MEET THE SCIENTISTS!



Photo courtesy of Ellen Wohl (on right), used with permission.

#### ◀ ELLEN WOHL, Geologist

My favorite science experience was hiking into a remote area of the Nepalese (ne pə lēz) Himalaya to look for **flood deposits**. Few outsiders had ever visited the area. The local people were fascinated by things I take for granted, such as being able to write rapidly by hand in a field notebook.

The Himalaya Mountain range has some of Earth's highest peaks. The Himalaya Mountains are spread across five countries in Asia. The mountains lie between China to the north and India to the south. In this photo, I am with a university graduate student, Katherine Lininger, who is on the left. In this photo, we are canoeing while doing research for this article.





Photo courtesy of Nicholas Sutfin, used with permission.

## ◀ **NICHOLAS SUTFIN,** **Geomorphologist**

One of my favorite science experiences was taking a whitewater rafting trip with other scientists. We rafted on the Middle Fork of the Salmon River in Idaho's Frank Church—River of No Return Wilderness. I was a member of a research team made up of different types of scientists. Our team included geologists, geomorphologists, hydrologists, fish biologists, ecologists, and entomologists.

The team spent several days rafting and camping along the deep canyons and beautiful waterfalls. These canyons and waterfalls were created over thousands of years by the river's flow. We shared past research, talked about future research, soaked in hot springs, snorkeled in the river to look at fish, and learned more about rivers from one another.

On that trip, I shared observations I made on another rafting trip along the same river. In that other rafting trip, I did a lot of digging to help collect buried charcoal pieces from burned trees. As a natural resource scientist, I have many outdoor adventures. In this photo, I am snowshoeing out of a study site along the East River near Crested Butte, Colorado.



## ROBERTO “BOBBY” BAZAN, ► Hydrologist

My favorite science experience was when I was with a crew studying the vegetation in Beaver Creek Meadow in Rocky Mountain National Park. The wildlife we saw and experienced made this area memorable. While driving, our crew witnessed a coyote trotting alongside the road carrying what appeared to be a whole elk leg in its mouth. Later that day, however, our experience was more **majestic**. The crew got up close and personal with a large bull elk while collecting vegetation samples. The bull elk was bugling as he walked past us. The sight, sound, and smell of being so close to such a powerful creature was exciting to experience and a moment I'll always remember.

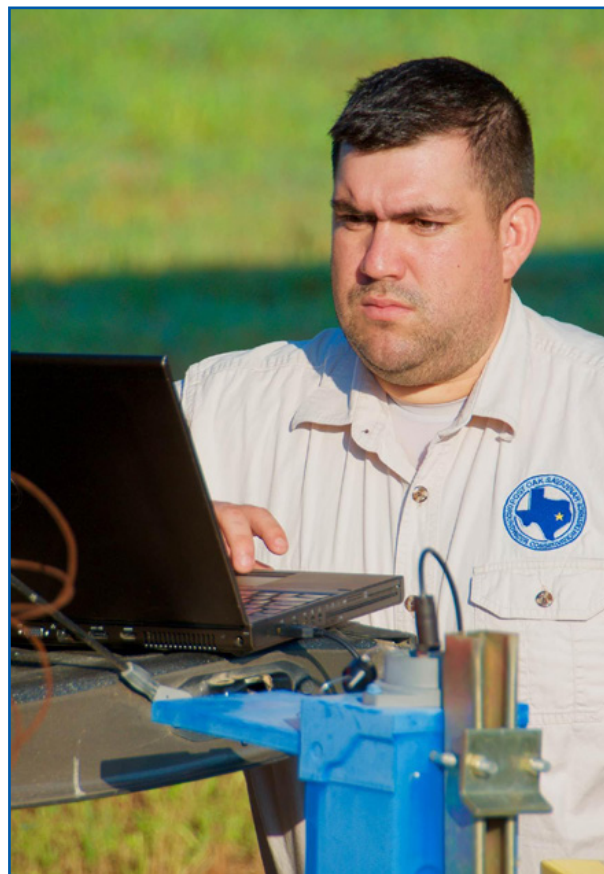


Photo courtesy of Roberto Bazan, used with permission.



Photo courtesy of Kate Dwire, used with permission.

## ◀ KATE DWIRE, Riparian Ecologist

One of my favorite science experiences has been exploring fens in the Rocky Mountains. Fens are special wetlands that have developed over thousands of years through the accumulation of peat (organic soils). They are usually water saturated, so organic matter from wetland vegetation does not decompose but is transformed into peat over time.



## Dwire *continued*

In this photo, I am using an auger to core a soil sample to determine the depth of peat in a side-slope fen in the Colorado Rocky Mountains. Fens are ancient wetland ecosystems, can support unusual rare plants, and may be particularly vulnerable to changing climate. From these peat cores, I can learn about the types of plants that formed the peat and gain insights into the age of the fen and how it formed.

### What Kinds of Scientists Did This Research?

**geologist:** This scientist studies Earth's processes, such as landslides and volcanoes; Earth's materials, such as metals and rocks; and the how these processes and materials change over time.

**geomorphologist:** This scientist studies the origin, development, and characteristics of Earth's natural features, called **landforms**.

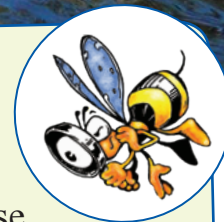
**hydrologist:** This scientist studies the distribution, movement, and quality of Earth's waters.

**riparian ecologist:** This scientist studies the relationship of living things with their living and nonliving environment in riparian areas. Riparian areas are areas along streams and rivers.

Glossary words are in **bold** and are defined on page 30.



## Thinking About Science

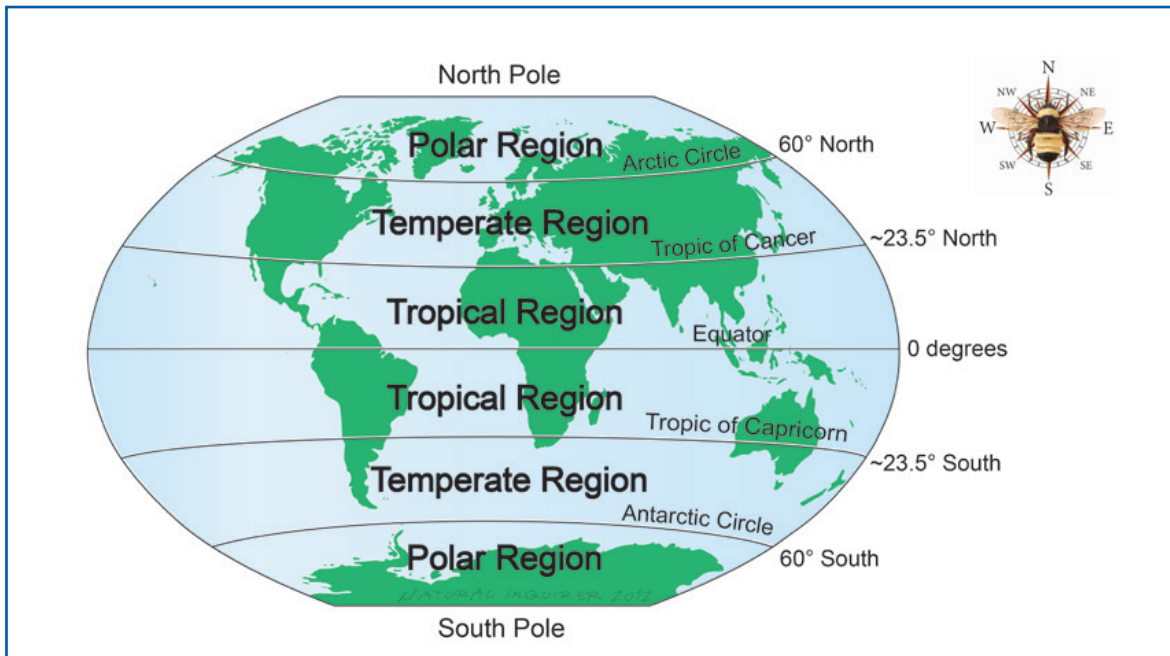


Natural resource scientists sometimes face a special challenge. If these scientists want to understand natural processes, they must find ecosystems that have not been changed much by human activities. In the world today, many ecosystems have been changed by human activities.

The scientists in this study wanted to understand a particular process that happens in temperate mountainous forest and river ecosystems. Temperate ecosystems are those that lie between Earth's tropical and polar regions (figure 1). Temperate ecosystems are not extremely hot or extremely cold, and they have four seasons every year.

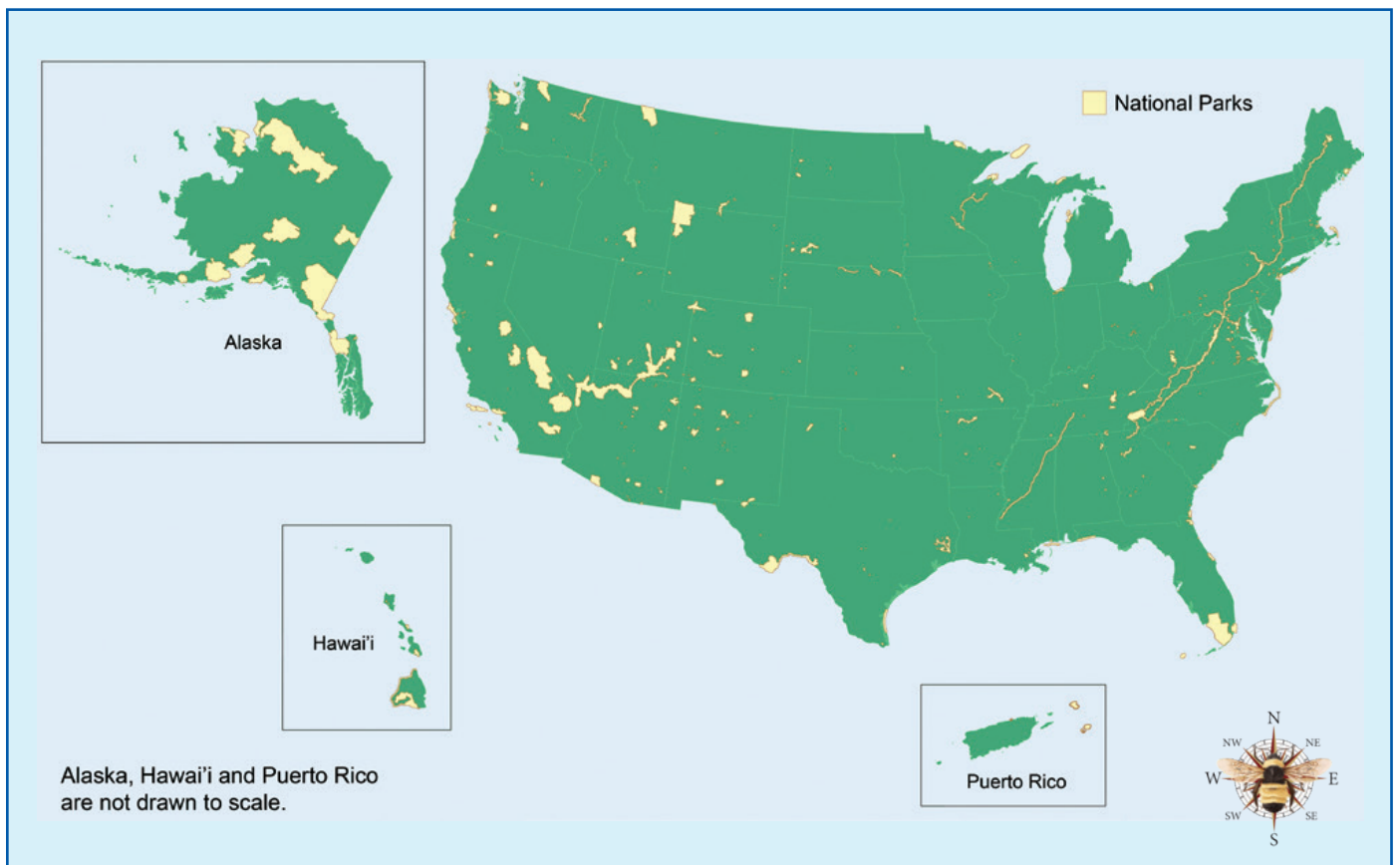
The scientists identified a temperate mountainous forest and river ecosystem that had not been greatly affected by humans. This ecosystem was in Rocky Mountain National Park. National parks are established by the U.S. Congress and are protected by law. National parks often include lands and waters kept in their natural condition, making them good places to study natural processes (figure 2). When an ecosystem is left in its natural condition, scientists can study what happens in an ecosystem that has not had much human impact.





**Figure 1.** Temperate ecosystems are found in Earth's temperate region.

Illustration by Stephanie Pfeiffer.



**Figure 2.** National parks are located throughout the United States. Find the national park that is closest to where you live.

Map by Carey Burda and Stephanie Pfeiffer.



# Thinking About the Environment



Rivers, under gravity's influence, flow from higher land areas towards the oceans. In mountainous land areas, rain and **snowmelt** flow into rivers (figure 3). If the area has forests and other vegetation, the rain and snowmelt carry soil, leaves, and dead wood into rivers and downstream. Leaves and other material from the forest floor are called litter. Dead wood includes dead trees, including **boles** and branches that have fallen to the forest floor. Rivers in

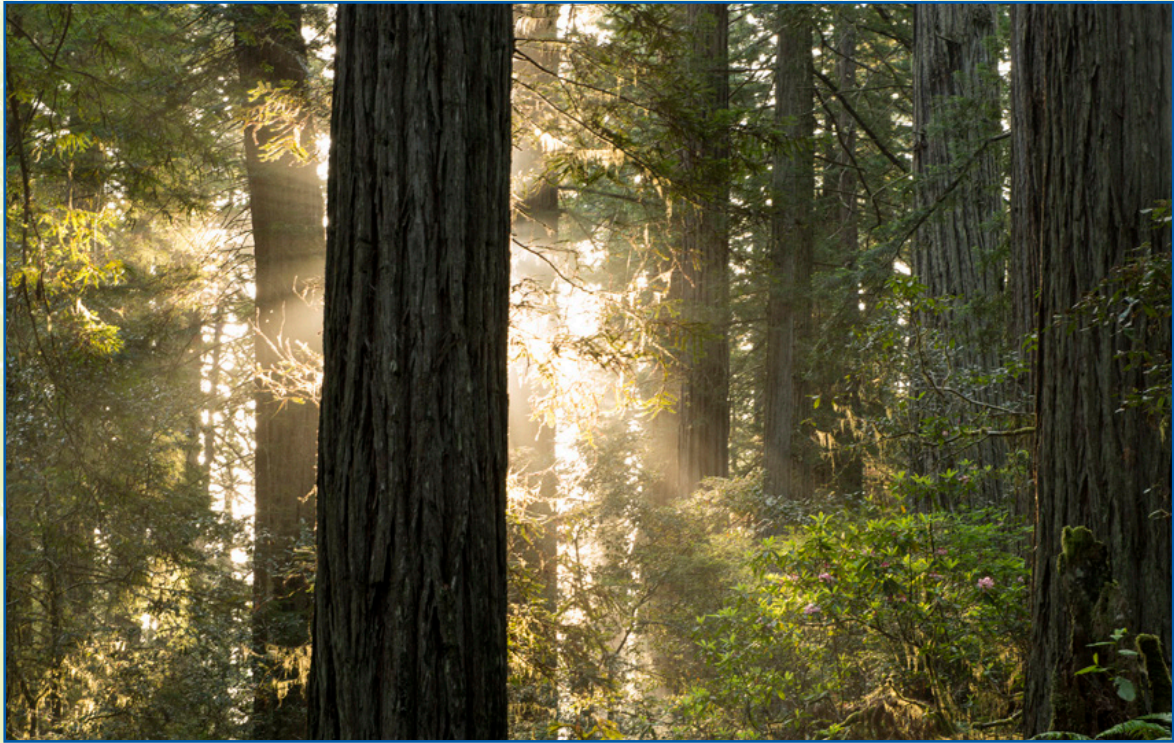


**Figure 3.** This river rushes through a mountainous environment.

Photo by Babs McDonald, used with permission.

mountainous areas also flow through places that are not steep. In these places, the land beside the rivers is flatter, and the rivers flow more slowly. **Old-growth** forests are found in many of these places, and particularly in national parks (figure 4). When large trees fall, they may become **lodged** in the river, causing the water to overflow the river's banks and create multiple **channels** (figure 5).





**Figure 4.** Old-growth forests are often found in national parks.

Photo by Hadel Productions, via <http://www.istockphoto.com>.



**Figure 5.** Old-growth forests are a source for logs that may fall across stream or river channels. When logs fall across a channel, the water may overflow and additional channels may form.

Photo by Ellen Wohl, Colorado State University.



Recall that streams flowing through flatter places move more slowly than streams flowing down steep hillsides. Beavers build dams in the streams of these flatter areas (figure 6). Beaver dams back up water in the stream channels, creating beaver ponds (figure 7a and 7b).



**Figure 6.** Beavers build dams to create habitat for themselves.

Photo by shaunl, via <http://www.istockphoto.com>.

**Figure 7a.** Beavers are mammals that are closely related to rodents, like mice, rats, squirrels, and hamsters. Beavers are **nocturnal**, and they spend most of their time in or near the water.

Photo by Ellen Wohl, Colorado State University.



**Figure 7b.** When water backs up behind a dam, beaver ponds are created.

Photo by Ellen Wohl, Colorado State University.



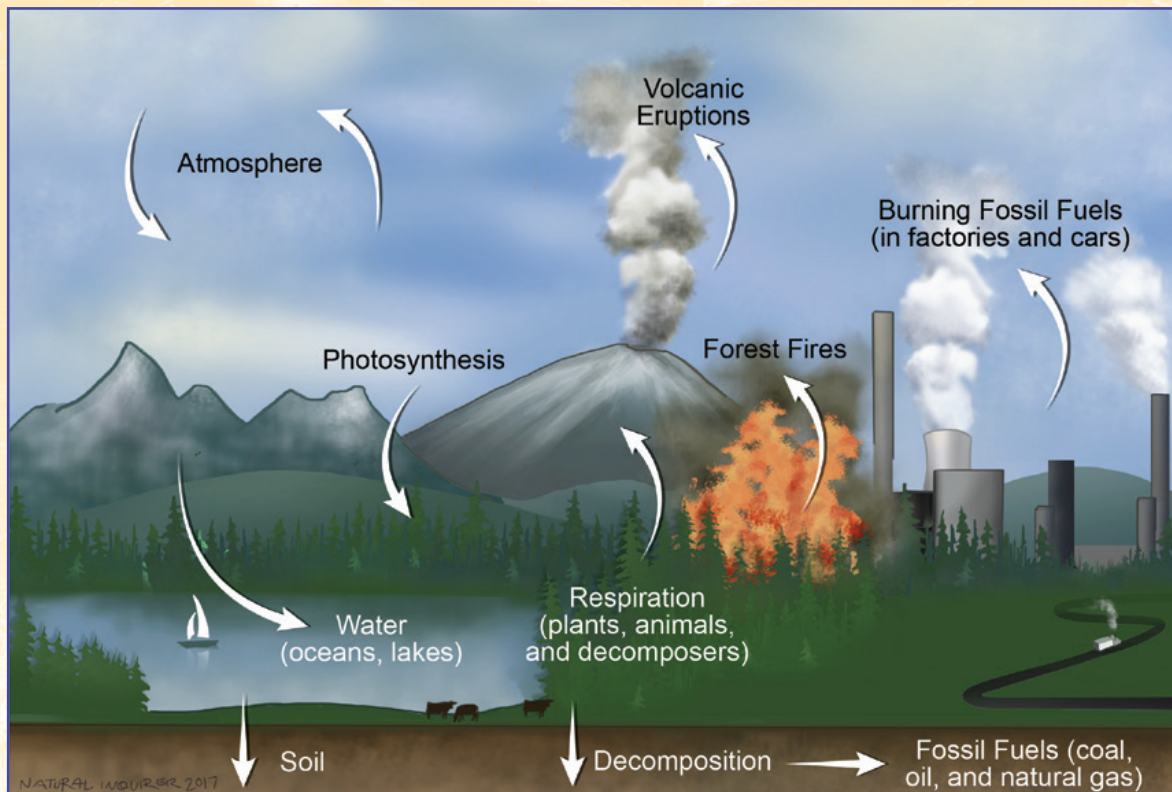
In national parks and other places with limited human impact, slow-moving streams sometimes flow past old-growth forests. In some of these places, beavers may still be found. The scientists in this study were curious about how old-growth forests and beavers affect river-related carbon movement and storage.



# Introduction

All living and once-living things contain the element carbon. Much of Earth's carbon is found in forest plants, trees, and soils. When animals, plants, and trees die, the carbon remains. As these

once-living organisms decay, the carbon that they contained goes into the ecosystem. Some scientists are interested in how carbon moves throughout and is stored in ecosystems (figure 8).



**Figure 8.** Carbon moves across Earth's surface, underground, and into its atmosphere in a cycle. As a part of the cycle, carbon is often stored for a period of time in various ecosystems. For example, carbon is stored in trees and other vegetation, as well as in the soil and in waterways and oceans. Carbon is also stored in dead wood and litter. Carbon may be stored in ecosystems for many years, even for centuries or over millions of years.

Illustration by Stephanie Pfeiffer.



Scientists know little about the movement of litter and dead wood from forests to rivers in mountainous temperate ecosystems (figure 9). Studying this movement is one way that scientists can better understand the carbon cycle.

The scientists in this study asked three questions about mountainous

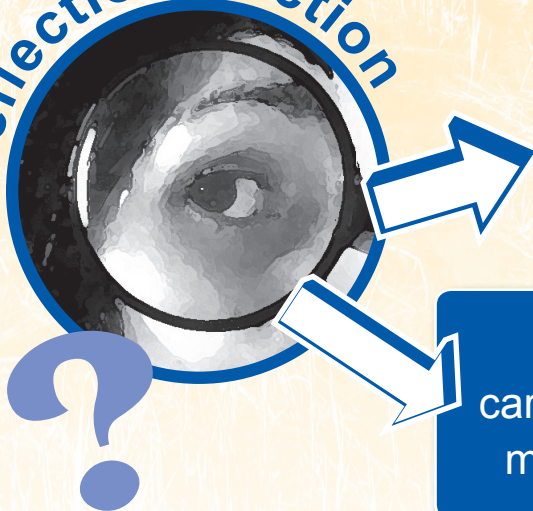
temperate forest and river ecosystems: (1) Where is carbon found in these ecosystems? (2) How do the landforms beside rivers affect how much carbon is stored in or moved out of these ecosystems? (3) What natural processes affect the location and amount of carbon in these ecosystems?



**Figure 9.** A mountainous temperate forest and river ecosystem in the Western United States.

Photo by Ellen Wohl, Colorado State University.

Reflection Section



Does your body contain carbon?  
How do you know?

What might happen to the  
carbon found in a log lodged in a  
mountainous temperate river?



# Methods

Many of the valleys in the mountainous Western United States have been forested at some point in history. Before many of the trees were harvested, most of the forests were old-growth forests. The scientists identified six types of areas along rivers in Rocky Mountain National

Park (table 1). They wanted to compare old-growth forests with younger forests (figures 10a and 10b). As discussed in “Thinking About Science,” Rocky Mountain National Park was a good place to study because some of the old-growth forests still remain.

LANDFORM ► VEGETATION TYPE ▼	Unconfined Valley	Confined Valley
Old-growth forest with a single stream flow	X	
Old-growth forest with multiple stream flows	X	
Recently abandoned beaver meadow	X	
Long abandoned beaver meadow	X	
Old-growth forest		X
Younger forest		X

**Table 1.** The scientists studied six different types of valley ecosystems. Each of the boxes with an “X” represents a different kind of valley ecosystem.



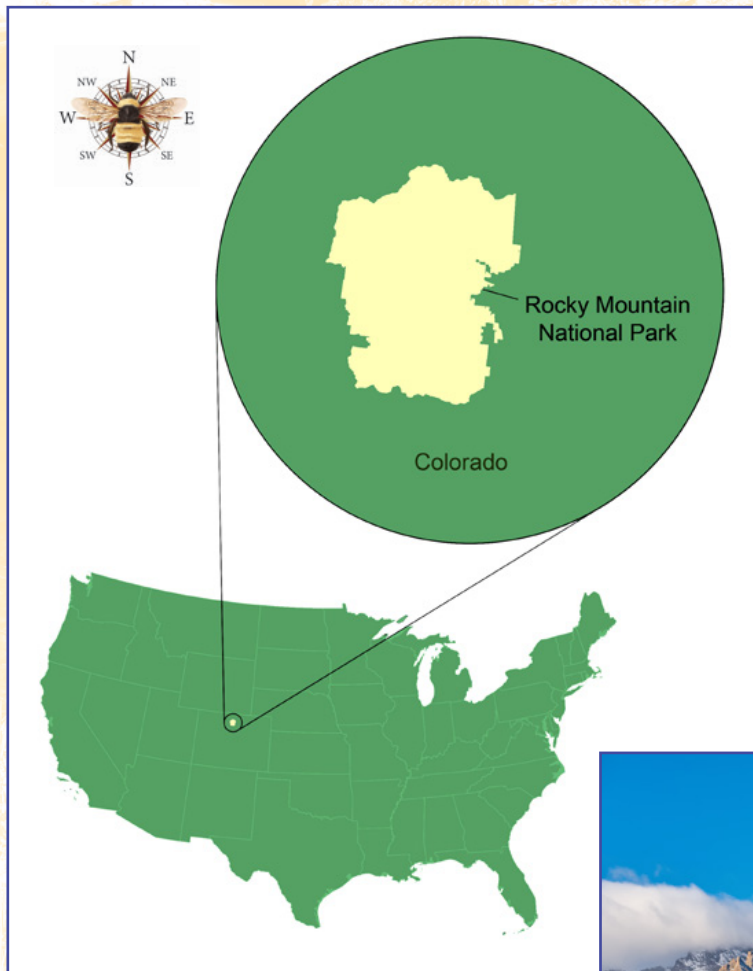
**Figure 10a and 10b.** Young forest and old-growth forest.

Illustration by Stephanie Pfeiffer.



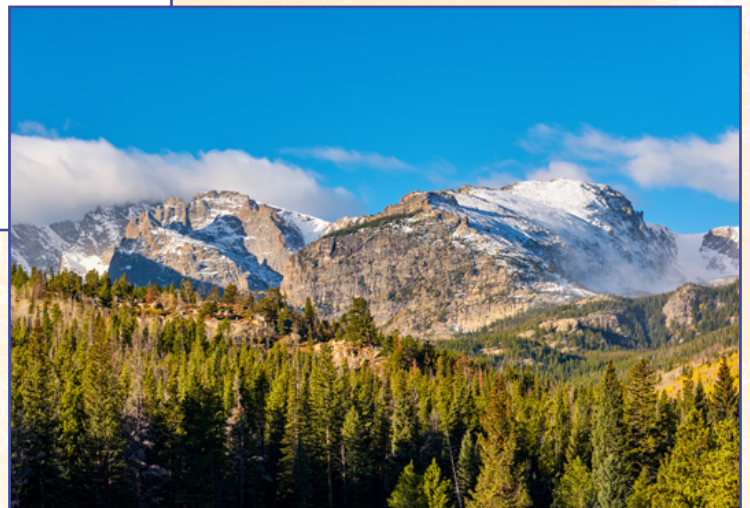
The scientists also studied two types of valleys along rivers in Rocky Mountain National Park (figures 11a and 11b). Confined valleys have steep slopes and often have little vegetation (figure 12). Unconfined valleys, which were flatter places, might have young or old

forests. Unconfined valleys might also have been areas where beavers had built beaver dams (figure 13). After beaver dams are abandoned, the beaver ponds created by the dams slowly fill in with **sediment** and become beaver meadows (figure 14).



**Figure 11a.** Rocky Mountain National Park is located in Colorado.

Map by Carey Burda.



**Figure 11b.** Rocky Mountain National Park is a popular national park for hiking, camping, rock climbing, and wildlife viewing.

Photo by haveeseen, via <http://www.istockphoto.com>.



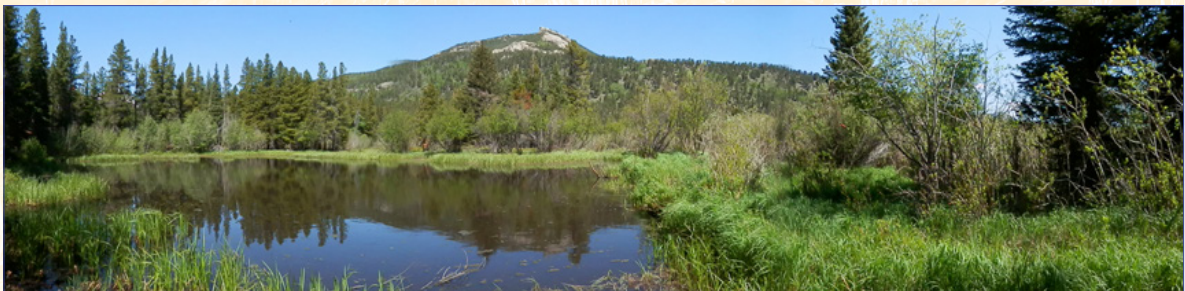


**Figure 12.** Confined river valleys are steep on both sides of the river. The steep sides are often exposed rock with little vegetation.

Photo by Babs McDonald, used with permission.



**Figure 13.** Unconfined valleys are relatively flat on both sides of the river. Photo by Ellen Wohl, Colorado State University.



**Figure 14.** As beaver ponds began to fill with sediment, they became meadows.

Photo by Ellen Wohl, Colorado State University.





**Figure 15.** Animals such as moose can benefit from the beaver ponds created by beaver dams.

Photo courtesy of Ellen Wohl, Colorado State University.

## **Why Are Beaver Dams Abandoned?**

European colonists in North America hunted beavers for their pelts, or skins. All over North America, beavers were hunted almost to **extinction**. People did not understand the vital role that beavers play in supporting a diversity of wildlife habitat, promoting water quality, and increasing ecological health. As a result, beaver dams were abandoned over time in the Western United States. Today, beavers are now recognized for their ecological contributions and are returning to areas where they once lived (figure 15).

Beavers also abandon dams for other reasons. Beaver dams may fail and be too complicated to fix. Dams may also be abandoned if a beaver pond fills in with sediment or a beaver's food source is lost.



The scientists collected samples of the vegetation, sediment, litter, and dead wood found in each of the six types of

areas they studied (see table 1, page 21). Each sample was analyzed for **organic carbon** (figures 16a and 16b).



**Figure 16a.** Dr. Wohl kayaks under a log in Yukon Flats National Wildlife Refuge in Alaska.

Photo courtesy of Ellen Wohl, Colorado State University.

**Figure 16b.** The scientists used a LECO TruSpec® CN Furnace to measure the amount of organic carbon in the collected samples.

Image by LECO Corporation.



Reflection Section

Why do you think the scientists studied young forests and old forests?

In your own words, describe what kind of valleys the scientists compared in this research.



# Findings

Less carbon is stored in confined valleys than in unconfined valleys. Confined valleys with steep sides carried carbon into waterways and downstream.

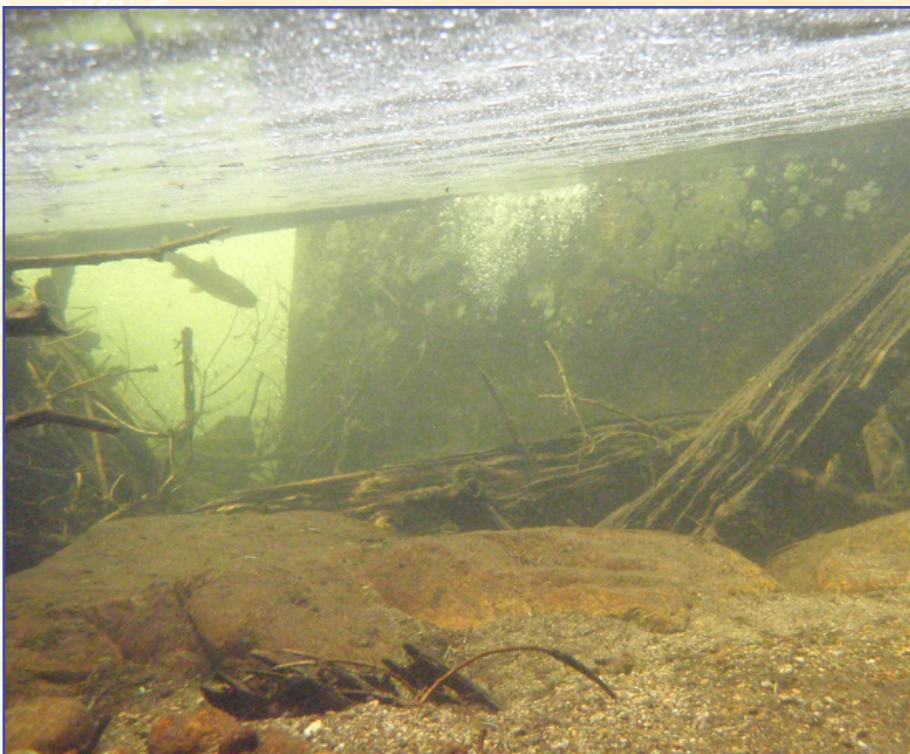
Unconfined valleys with old-growth forest held most of their carbon in large pieces of wood, like logs and tree boles. When trees fell in the stream or river, or

were otherwise pushed into the channel by the water current, the logs sometimes created logjams. The logjams caused the river to overflow its banks and split into multiple channels (figures 17a and 17b). Many of the unconfined valleys had abandoned beaver dams. These unconfined valleys held most of their



**Figure 17a.** Logjams in unconfined valleys may cause the stream to overflow and to split into multiple channels.

Photo by Ellen Wohl, Colorado State University.



**Figure 17b.** The logjams also block areas below the surface of the water.

Photo by Ellen Wohl, Colorado State University.

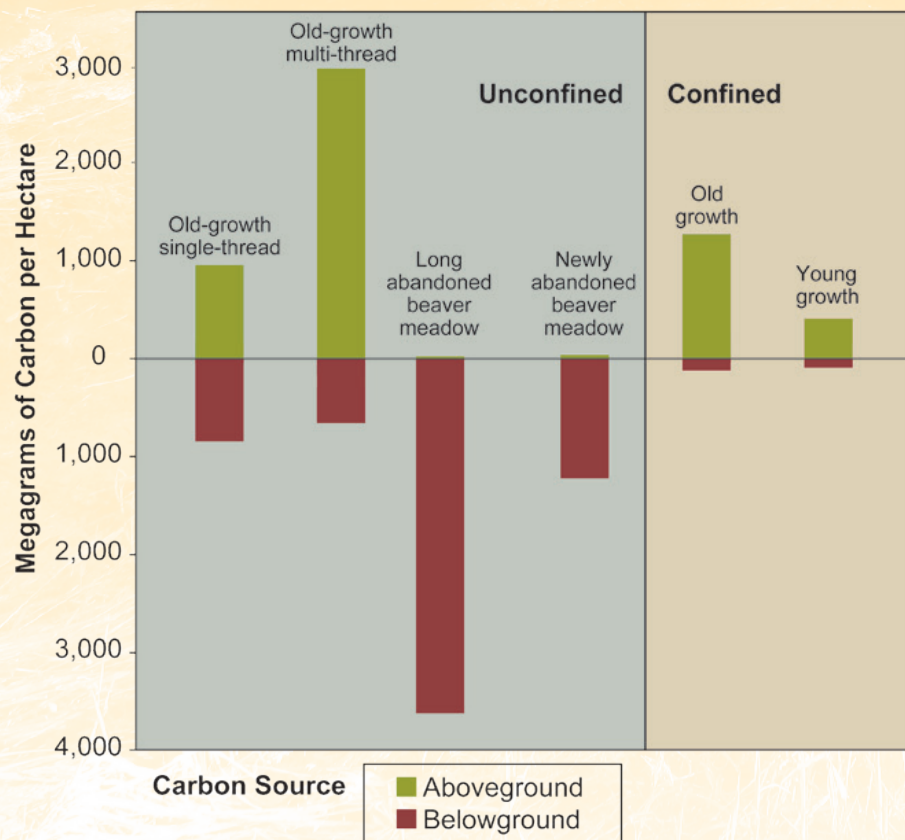


carbon in sediment that was carried onto them when rivers overflowed. The scientists found that these unconfined valleys with beaver dams covered less than 25 percent of the river's total length. However, these valleys held about 75 percent of the total carbon found along the entire river ecosystem (figure 18).

The scientists identified four places where carbon is stored in temperate mountain and river valleys. Carbon is stored in old-growth single-thread, old-growth multi-thread, old-growth forests, and young-growth forests (see figure 18). Carbon is also stored in logjams or deposited on the floodplain.

Carbon is stored in small pieces of matter, such as soil particles, and in living vegetation.

The scientists found that three natural processes supported carbon storage in these floodplain ecosystems. (1) Beaver dams and logjams force water onto the floodplain, where soil particles with carbon content are deposited. (2) When water is held on floodplains by logjams or beaver dams, the decay of the soil particles is slowed, because the soil is saturated with water. (3) Logjams decay slowly and therefore hold a lot of carbon in the waterways and on the floodplain.



**Figure 18.** Average amount of aboveground and belowground carbon per hectare for each of the six valley types.

Illustration by Stephanie Pfeiffer.



## Reflection Section



Examine figure 18.  
Why do you think that  
old beaver meadows  
contained so much  
belowground carbon?

The scientists asked three  
questions in this research.  
The questions are found at  
the end of the “Introduction”  
on page 20. What answers  
did the scientists find to  
these questions?

Photo by Ellen Wohl,  
Colorado State University.



## Discussion

The scientists found that old-growth forests, logjams, and beaver dams contribute to holding carbon within mountainous temperate forest and river ecosystems. Old-growth forests, logjams, and beaver dams may be found

in unconfined valleys, which make up just a small proportion of a mountain river's length. These landforms and ecological processes play an important role, however, in holding carbon within mountainous Western U.S. ecosystems.

Reflection Section

Based on this research, would you say that people can influence the storage of carbon in mountainous temperate river ecosystems? Why or why not?

The Pareto (pə rā tō) Principle states that about 80 percent of the effects of something come from about 20 percent of the causes. Although one can find examples of the Pareto Principle online, not all of the information fits what is also called the "80/20 rule." In the "Findings" section, you will see a finding that comes close to fitting the Pareto Principle. What is that finding? What more general conclusion could you make about the Pareto Principle?

Adapted from Wohl, E.; Dwire, K.; Sutfin, N.; Polvi, L.; Bazan, R. 2012. Mechanisms of carbon storage in mountainous headwater rivers. *Nature Communications*. 3(1263): 1–8, doi: 10.1038. <http://www.nature.com/ncomms/journal/v3/n12/full/ncomms2274.html>.



# Logjams and Beaver Dams

## Glossary

**bole** (bōl): Trunk or stem of a tree.

**dead wood** (ded wud): A branch or part of a tree that is dead.

**flood deposit** (fləd di pä zət): Particles that come from a stream or river and can consist of clay, gravel, sand, and silt.

**floodplain** (fləd plān): Flat land area next to a stream or river.

**lodge** (lāj): To become stuck or fixed in a place or position.

**logjam** (läg jam): A situation in which a large number of logs floating down a river become tangled with each other so that further movement is not possible.

**majestic** (mə jes tik): Being stately and dignified.

**nocturnal** (nök tûr nəl): Relating to, occurring in, or active at night.

**organic carbon** (ör ga nik kär bən): Carbon is an element with the symbol C. Organic carbon is carbon that comes from a living or once-living organism.

**riparian** (rə per ē ən): Areas along streams and rivers.

**sediment** (se də mənt): Matter set down by wind or water, such as sand or soil.

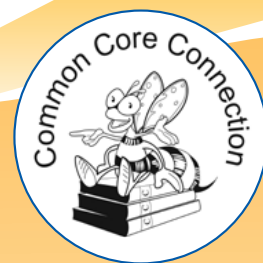
**snowmelt** (snō melt): Water from melting snow that flows over the surface of the ground into streams and rivers.

**topography** (tə pä grə fē): Physical features that make up the topography of an area including mountains, valleys, plains, and bodies of water.

Accented syllables are in **bold**.  
Marks and definitions are from <http://merriam-webster.com>. Definitions are limited to the word's meaning in the article.



# FACTivity



## Time Needed

One class period

## Materials (for each student or group of students)

- Large disposable aluminum pan (approximately 10"x12"x2.5")
- Enough dirt to cover the pan's bottom to about 1"
- A bucket of extra dirt with water, mixed into a thick mud
- Scissors (for the educator's use)
- Plastic gallon jug filled with water
- Source of more water if needed
- Sticks of various sizes, from about pencil-sized to about  $\frac{3}{4}$ " in diameter, between 3" and 5" long
- Other natural materials, such as gravel or small rocks, leaves, bark, and grass

## Some of the questions you will answer in this FACTivity are:

How can you successfully build a model of a beaver dam? What are the similarities and differences between a beaver dam and a logjam?

A model is a representation of something. It can be a mathematical model, a map, a drawing, or a physical representation. A model car, for example, is a physical representation of an automobile. In this FACTivity, you will build a physical representation, or a model, of a beaver dam.

Beavers build dams using mud, logs, leaves, grass, stones, and just about anything they can find in the environment. To begin their dam, beavers use mud to help support the first logs.

For additional information, view this short video on how beavers build dams. Visit <http://www.pbs.org/wnet/nature/leave-it-to-beavers-video-how-beavers-build-dams/8847/>.





Photo by Ellen Wohl, Colorado State University.

## FACTivity **Methods**

Your teacher will cut a 0.5" diameter hole in one end of the aluminum pan, about 0.5" from the bottom of the pan. This hole will be on one of the 10" sides.

Fill the bottom of the pan with a layer of dirt about 1" thick. The dirt should slope gently downwards toward the hole. Therefore, the surface of the dirt should be slightly higher than 1" on the side opposite from the hole and a little under 1" on the side with the hole. Keep the hole clear of dirt. Gently pack down and smooth the dirt.

Create a stream channel from one side of the pan to the other side along the pan's length, with one end of the channel ending at the hole. The channel should be about 1" wide and 0.75" deep.

If you do this FACTivity outside, place the pan outside in the grass, making sure that it is level so that the dirt surface is still sloping downward toward the hole. If you do this FACTivity indoors, make sure the water drains into a sink or into a bucket.

Slowly pour 1 cup of water into the channel at its higher end. What happens to the water?



Begin building your dam about 3" from the end of the pan with the hole. Use the natural materials that you have collected, along with the sticks and the mud, to build your dam. When you have finished, your beaver dam should be between 6 and 7 inches wide.

Test your dam by slowly pouring water into the channel at the channel's higher end. Make adaptations to the dam as needed.

When you have finished your dam, slowly pour water into the stream channel on the upward side of the pan. What happened to the water? Were you successful at building a beaver dam model? A successful beaver dam holds water in one area, letting only small amounts of water pass through.

If the dam was not successful, continue to make adaptations to your dam and test it by slowly pouring a jug of water into the tray.

Write a paragraph about the beaver dam model. How did you build the beaver dam? What adaptations did you need to make while building the beaver dam? What happened when you slowly poured water into the stream channel? Were you ultimately successful at building a beaver dam model? Why or why not?

Now, build a model of a logjam about 2" from the other end of the pan. Drop a few of your larger sticks across the channel. Then drop a few smaller sticks and other natural materials on the higher side of the channel-spanning sticks. Look at the photos of logjams in the article to help you build your logjam. Pour water into the channel and observe what happens.

Write a paragraph about how you built your logjam model and what happened when you poured water into the channel. Write about any modifications you had to make. Were you successful at building a logjam model?



# Logjams and Beaver Dams Graphic Organizer

**Group Names:** \_\_\_\_\_

**Observations and notes:**

**What made your beaver dam successful or unsuccessful?**

**Name three similarities and three differences between beaver dams and logjams.**

**Where is the carbon located in your models?**

**How could you improve the model-building activity?**



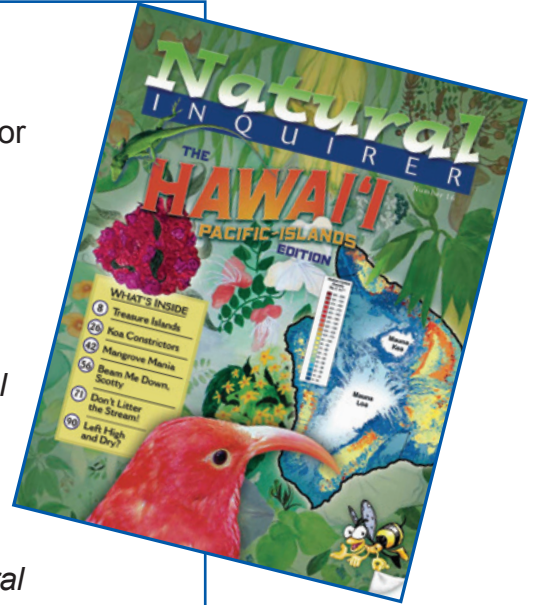
## Natural Inquirer Connections

You may want to reference these *Natural Inquirer* articles for additional information:

- For more information on the movement of organic matter in rivers, read “Caribbean Cruise: Examining the Movement and Quality of Organic Matter Over Time From Two Caribbean Watersheds” in the *Natural Inquirer* Freshwater edition.
- For more information on invasive species movement in rivers, read “Don’t Litter the Stream: An Invasive Tree Species and a Hawaiian Food Web” in the *Natural Inquirer* Hawai’i—Pacific Islands edition.

This article, along with others, can be found at:

<http://www.naturalinquirer.org/all-issues.html>.



If you are a trained Project Learning Tree educator, you may use “A Forest of Many Uses” and “Loving It Too Much” as additional resources.

## Web Resources



### Beaver Ponds, GPB Public Broadcasting System Videos:

<https://gpb.pbslearningmedia.org/resource/nat14.sci.lifsci.benefits/benefits-of-beaver-ponds-and-lodges/#.WUp8HTLyupo> and <https://gpb.pbslearningmedia.org/resource/nat14.sci.lifsci.builders/hardworking-builders/#.WUp9ejLyupo>.

### Graduate Student Research on Stream Carbon from Colorado State University:

<https://sites.warnercnr.colostate.edu/carbon/completed-projects/>.

### National Aeronautics and Space Administration: The Slow Carbon Cycle

<https://earthobservatory.nasa.gov/Features/CarbonCycle/page2.php>.

### Historic England: How Does Wood Survive Underground for Thousands of Years?

<https://historicengland.org.uk/listing/what-is-designation/heritage-highlights/wood-survive-underground-for-thousands-of-years>.



# Logjams and Beaver Dams

## Illustrated Glossary Challenge



Pick four words from the glossary (page 30) to illustrate below.  
Pretend that you are making these drawings for a younger child to help him or her understand what the word means.

Word and Definition	Illustration of Word



# Logjams and Beaver Dams

## eyeChallenge



Each of the following images represents something from the article. Explain what each of these images represents. You may write your explanation or hold a class discussion. If you write your explanation, use complete sentences, proper spelling and grammar, and appropriate punctuation.

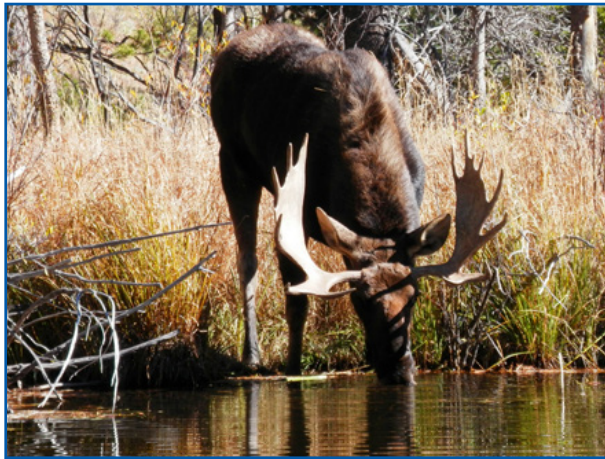


Photo by Ellen Wohl, Colorado State University.



Photo by Ellen Wohl, Colorado State University.



Photo by Ellen Wohl, Colorado State University.

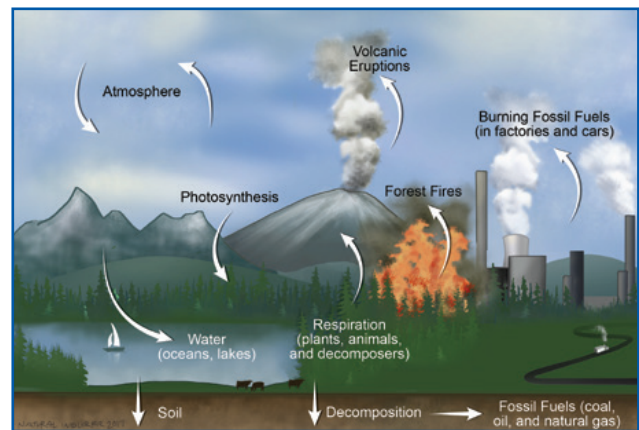


Illustration by Stephanie Pfeiffer.



Photo by Ellen Wohl, Colorado State University.



## National Education Standards

For more detailed correlations of this *Natural Inquirer* Monograph to National Education Standards, visit the *Natural Inquirer* website (<http://www.naturalinquirer.org>).

### • National Science Education Standards Addressed In This Article

- Abilities Necessary To Do Scientific Inquiry
- Understandings About Scientific Inquiry
- Structure of the Earth System
- Understandings About Science and Technology
- Science and Technology in Society
- Science as a Human Endeavor
- Nature of Science
- History of Science
- Social Studies Education Standards Addressed in This Article
- People, Places, and Environments
- Science, Technology, and Society

### • Common Core Education Standards Addressed In This Article

#### English and Language Arts

- Key Ideas and Details
  - CCSS.ELA-Literacy.RI.6-8.1
  - CCSS.ELA-Literacy. RI.6-8.2
  - CCSS.ELA-Literacy. RI.6-8.3
- Craft and Structure
  - CCSS.ELA-Literacy. RI.6-8.4
  - CCSS.ELA-Literacy. RI.6-8.5
- Integration of Knowledge and Ideas
  - CCSS.ELA-Literacy. RI.6.7
  - CCSS.ELA-Literacy. RI.6-8.8
  - CCSS.ELA-Literacy. RI.6-8.9

#### Science and Technical Subjects

- Key Ideas and Details
  - CCSS.ELA-Literacy.RST.6-8.1
  - CCSS.ELA-Literacy.RST.6-8.2
  - CCSS.ELA-Literacy.RST.6-8.3
- Craft and Structure
  - CCSS.ELA-Literacy.RST.6-8.4
  - CCSS.ELA-Literacy.RST.6-8.5
  - CCSS.ELA-Literacy.RST.6-8.6
- Integration of Knowledge and Ideas
  - CCSS.ELA-Literacy.RST.6-8.7
  - CCSS.ELA-Literacy.RST.6-8.8
  - CCSS.ELA-Literacy.RST.6-8.9

### Next Generation Science Standards Addressed In This Article

- Science and Engineering Practices
  - Asking Questions and Defining Problems
  - Planning and Carrying Out Investigations
  - Analyzing and Interpreting Data
  - Constructing Explanations and Designing Solutions
  - Obtaining, Evaluating, and Communicating Information
- Disciplinary Core Ideas
  - Life Science: LS2.B Cycle of Matter and Energy Transfer in Ecosystems; LS2.C Ecosystem Dynamics, Functioning, and Resilience
  - Earth and Space Science: ESS2.C The Roles of Water in Earth's Surface Processes; ESS3.A Natural Resources; ESS3.C Human Impacts on Earth Systems; ES3D Global Climate Change
- Crosscutting Concepts
  - Patterns
  - Cause and Effect: Mechanism and Prediction
  - Scale, Proportion, and Quantity
  - Systems and Systems Models
  - Stability and Change
  - Connections to the Nature of Science
  - Connection to Engineering, Technology, and Applications of Science
  - Stability and Change
  - Connections to Nature of Science
  - Connection to Engineering, Technology, and Applications of Science





## What Is the Forest Service?

The Forest Service is part of the United States Department of Agriculture (USDA). The Forest Service is made up of thousands of people who care for the Nation's forest land. The Forest Service manages 154 national forests and 20 national grasslands. These are large areas of trees, streams, and grasslands. National forests are similar in some ways to national parks. Both are public lands, meaning they are owned by the public and managed for the public's use and benefit. Both national forests and national parks provide clean water, homes for the animals that live in the wild, and places for people to do fun things in the outdoors. National forests also provide resources for people to use, such as trees for lumber, minerals, and plants used for medicines. Some people in the Forest Service are scientists whose work is presented in the journal. Forest Service scientists work to solve problems and provide new information about natural resources so that we can make sure our natural environment is healthy, now and into the future.

For more information, visit <https://www.fs.fed.us>.

## What Is the Cradle of Forestry in America Interpretive Association?

The Cradle of Forestry in America Interpretive Association is a 501(c)3 nonprofit organization based in Pisgah Forest, North Carolina. The interpretive association strives to help people better understand ecology through recreation and education opportunities. Their projects include the following:



- Campground and recreation area management
- Educational programs and services, including *Natural Inquirer*, *Investi-gator*, *Natural Inquirer* Reader Series, *NSI: Nature Science Investigator*, scientist cards, and *Leaf Prints* (formerly *Nature-Oriented Parenting*)
- Sales of forest-related gifts and educational materials
- Workshops, newsletters, and publications
- Partnership with the Forest Service to provide programming at the Cradle of Forestry Historic Site

For more information, visit <https://www.cfaia.org>.

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To request a copy of the complaint form, call (866) 632-9992. Submit your completed form or letter to USDA by: (1) mail: U.S. Department of Agriculture, Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; (2) fax: (202) 690-7442; or (3) email: [program.intake@usda.gov](mailto:program.intake@usda.gov).

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