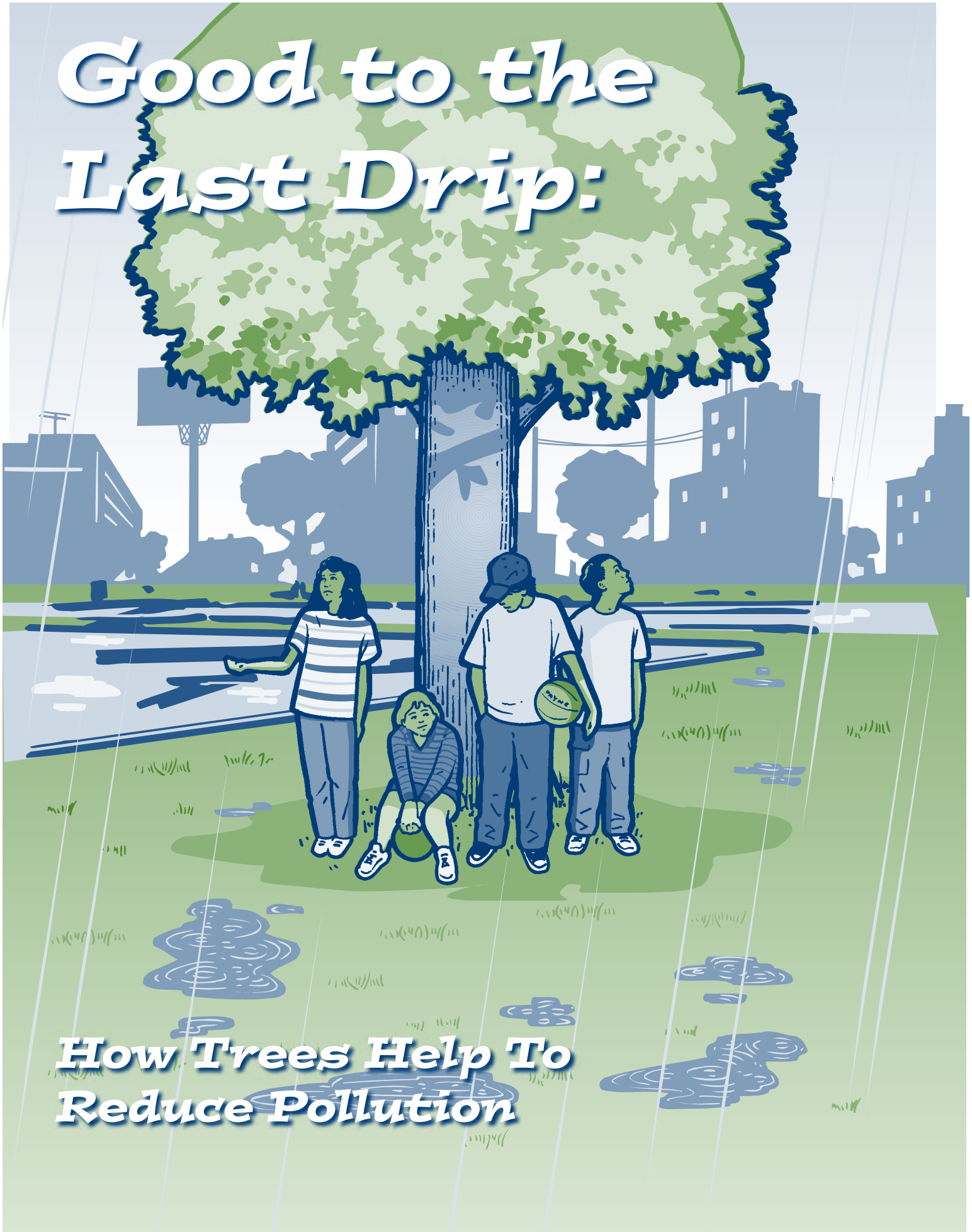
Good to the Last Drip:



How Trees Help To Reduce Pollution

Meet the Scientists

Dr. Xiao: ◄ I enjoy working to discover the secrets of the natural environment, such as the interactions between water and the surrounding environment. My favorite experiences in science are when I find these secrets and then use them to improve our environment. With these discoveries, we can improve the quality of our lives and care for our natural resources. Future generations will benefit from our work.

Dr. Ustin: ◄ I have always thought that it was important to preserve our natural *heritage* and wanted to work as an *ecologist*. Working with information collected from satellites has allowed me to view the environment from a large-scale perspective. It is a privilege to work on problems that have great benefit to society and to help improve the way we take care of our environment.

Dr. McPherson: ◄ My favorite science experience is seeing a paper finally in print or giving a presentation to a large group and sensing their interest and excitement. The process of planning and conducting research is long and painstaking. One has to be patient because results don't come quickly. However, the joy of seeing a project completed and knowing that it is valued by others is very gratifying.

Dr. Simpson: ◄ One of my favorite experiences in science was to participate in a *meteorological* field study in western Colorado. We camped out in the mountains. We flew on a helicopter to put some of our equipment on surrounding mountain ridges. We also had an opportunity to meet and work with other scientists from all over the United States.

Glossary:

heritage (**hair** uh tij): Something handed down from the past.

ecologist (e̲ **kol** uh jist): A scientist who studies the relationships between living things and their environment.

meteorological (**me̲** te̲ **or** o̲ **loj** uh kôl): Having to do with weather or climate.

intercepted (in tür **sep** ted): Stopped or interrupted.

erosion (e̲ **ro̲** shun): The process or state of wearing or washing away.

regulation (**reg** ya **la̲** shun): The act of controlling according to a system.

equation (e̲ **kwa̲** shun): A written statement that indicates the equality of two expressions.

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

aerial (**air** e̲ ul): Of or in the air.

deciduous (de̲ **sij** oo̲ us): Shedding its leaves every year; not evergreen.

Pronunciation Guide

a̲	as in ape	ô	as in for
ä	as in car	u̲	as in use
e̲	as in me	ü	as in fur
i̲	as in ice	oo̲	as in tool
o̲	as in go	ng	as in sing

Accented syllables are in **bold.**

Thinking About Science

One of the best things about science is that scientists will never learn everything. Even when scientists are pretty sure of something that they've learned, new information may cause them to revise their thinking. Scientists, therefore, will never run out of new things to study! In this research, the scientists wanted to know how much rainfall is *intercepted* by trees growing in urban areas. In the past, other scientists had estimated how much rainfall was intercepted by trees growing in rural areas. Since urban areas and rural areas are different, the scientists in this study felt that urban trees should be studied separately. When this study was finished, do you think that the scientists knew everything about rainfall interception by urban trees? Why or why not?

Thinking About the Environment

Natural systems are organized so that the environment will remain balanced. For example, when there is a lot of rainfall and few trees in an area, the rainfall can cause soil *erosion* and might cause flooding. When trees are growing in an area, the leaves, branches, trunk, and roots help to reduce soil erosion and flooding. Rain falls on the tree, where it is stopped or slowed down. Roots absorb water for the tree's use. The trees are a form of control that helps to protect the soil from erosion and the area from flooding. In natural areas that have a lot of rain, you will find a lot of trees. You can find this kind of *regulation* in all natural systems, including your own body! Can you think of one way that your body keeps your own amount of water balanced?

Introduction

Urban areas are different than rural areas. In urban areas, there are many more human structures and activities that are sources of pollution. When it rains, the rainfall washes the pollution from lawns, streets, sidewalks, and other surfaces. Water is carried from city streets through stormdrains and pipes that eventually lead to our streams and rivers (**figure 1**). If too much rain falls at one time, these pipes can get backed up and cause flooding.

Trees help to slow the amount of rainfall entering storm drains. The rainfall is stopped or slowed down by leaves, branches, and the trunk of trees. Some of the rain evaporates off of the leaves and branches before it can reach the ground (**figures 2 and 3**). The roots of trees also absorb some of the rain. This keeps even more of the water from going down the stormdrains.

In the past, scientists had estimated how much rainfall is intercepted by trees growing in rural areas. The scientists in this study wanted to know how much rainfall is intercepted by the trees that grow in an urban county in California.

Figure 1. Storm drains.

Figures 2 and 3. The leaves on trees intercept some of the rainfall.

Reflection Section

- What is the question that the scientists were trying to answer?
- Do you think that the amount of rainfall being intercepted by trees is different in urban areas than rural areas? Why or why not?

Method

The scientists developed two *equations*. The equations helped the scientists to identify what they needed to measure to find out how much rainfall is intercepted by a tree. Using symbols, the equations describe that when rain falls on a tree, it stays for a short time on the tree's leaves, branches, and trunk. Then, the rain water either runs down these surfaces, drips to the ground, or evaporates. Here are the two equations:

1. Rainfall Interception = L + E
2. Rainfall Interception = R–TH–F–D

Here is an explanation of the symbols.

L = The amount of rain that stays on leaves and branches.
E = The amount of rainfall that evaporates from leaves and branches.
R = The total amount of rain falling on the tree.
TH = The amount of rain that falls through the tree without hitting any leaves or branches.
F = The amount of rain that drips down the stems and trunk.
D = The amount of rain that drips from leaves and branches.

First, try to read these equations yourself using the explanation of the symbols.

This is how to read the equations:

Equation 1: The amount of rain that is intercepted by a tree is equal to the amount of rain that stays on the tree's leaves and branches plus the amount of rain that evaporates off of the leaves and branches.

Equation 2: The amount of rain that is intercepted by a tree is equal to the total amount of rain falling on the tree minus the amount of rain that falls through the tree without hitting any leaves or branches, minus the amount of rain that drips down the stems and trunk, minus the amount of rain that drips from leaves and branches.

In other words, any rain that reaches the ground underneath a tree has **not** been intercepted by the tree.

The scientists needed to determine how much rain is intercepted by various *species* of urban trees. They also needed to know how much rain is intercepted by different tree species during different weather conditions. For example, some rains are gentle and some are hard. Sometimes there is wind and sometimes the air is still. Rainfall can occur for a short period or a long period of time. Then, the scientists needed to determine two more things. They needed to know which tree species, and how many of each, were growing in the county. They discovered these two things using *aerial* photography and by walking around and actually looking at the trees.

The scientists calculated how much rainfall is intercepted by different tree species during different rainfall conditions. They knew how many trees of different species were growing in the county. They looked at weather records. This allowed them to determine what kinds of rain storms occurred in the past and in what season they occurred. With all of this information, they were able to estimate how much rain was intercepted by all of the trees growing within the county.

Reflection Section

- How did the equations help the scientists to answer their question?
- Why did the scientists need to know which tree *species* were growing in the county?

Findings

The scientists expressed the amount of rainfall interception in two ways. First, they calculated the percentage of rainfall that was intercepted only in the areas where trees were growing in the county (**figure 4, area A**). Then, they calculated the total percentage of rainfall that was intercepted by trees across all of the land in the county (**figure 4, areas A+B**). They reported the total amount of rain that was intercepted over the entire year. They found that 11 percent of the rain that fell directly on trees was intercepted (**figure 4, area A**). Across the entire county, including areas where there were no trees, 1 percent

Thinking About Ecology

Nature has a way of taking care of itself. For example, most systems in nature are self-regulating. This means that although things may fluctuate, the systems in nature keep things pretty even. This idea is demonstrated in this study by the idea of rain and trees. If there are few trees and a lot of rain in an area, the rain can wash soil into streams and rivers. In natural areas where there is a lot of rain, however, there are usually a lot of trees. The leaves on the trees help to slow the rainfall, and trees absorb the rain water, which protects the soil. Where there are a lot of trees (like in a forest), the leaves or needles that fall create a spongy forest floor that absorbs rain water. When nature is left undisturbed, things work together to keep the system stable. ■

of the rain that fell was intercepted by trees (**figure 4, area A+B**). *Deciduous* trees intercepted less rain than evergreen trees.

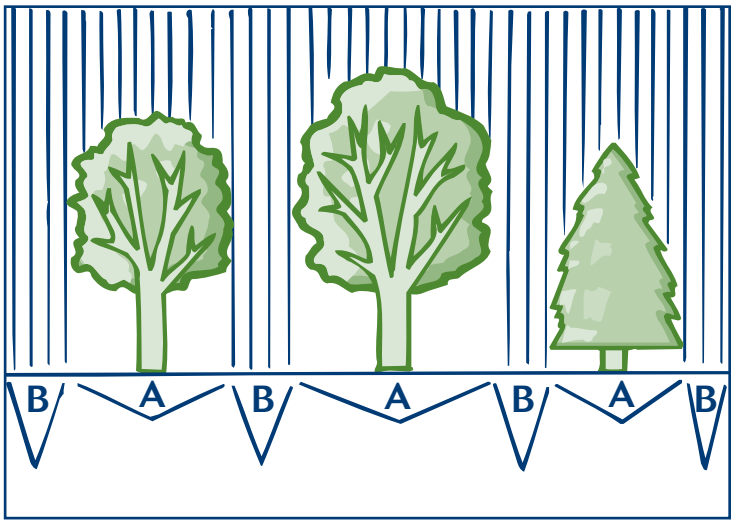


Figure 4. Areas that are under the tree canopies (A) and areas that are in the open (B).

Reflection Section

- Why do you think it is important to calculate the amount of rain intercepted over the entire county, and not just where trees were growing?
- Why do you think that deciduous trees intercepted less rain than evergreen trees? (Hint: The scientists collected information for an entire year.)

Implications

Evergreen trees intercepted more rain than deciduous trees. This was partly because most of the rainfall in that county occurs in the winter. In some areas of the country, most of the rainfall occurs in the summer. In those areas, deciduous trees would be much more important as rainfall interceptors. Urban trees are helpful in part because they reduce the amount of rain hitting the ground, so they help to reduce the amount of pollutants and the amount of soil being washed into streams and rivers. ■

Reflection Section

- We need to have a certain amount of rain hitting the ground, but how can too much rain hitting the ground at one time be a bad thing?
- What is one way that people living in urban areas can reduce the impact of rainfall on soil erosion?

From: Xiao, Q, McPherson, E. G., Simpson, J. R., and Ustin, S. L. Rainfall interception by Sacramento's urban forest. *Journal of Aboriculture* 24(4):235-244.

FACTivity

In this FACTivity, you will work with equations using symbols.

Write the statements below as equations using symbols, and then write what each of the symbols means. See the example below.

Example: The number of ears in a classroom is equal to the number of warm-blooded animals in the classroom times two.

E = A x 2

E = The number of ears in a classroom.

A = The number of warm-blooded animals in a classroom.

1. The area of sunshine reaching the roof of a house is equal to the total area of the roof, minus the area of the roof that is not receiving sunshine.

2. The total number of miles of streams in the United States is equal to the number of miles of streams in each State multiplied by the number of States.

3. The number of candybars in a middle school at 6 p.m. is equal to the number of candybars in the candy machine, plus the number of candybars brought to school by people, minus the number of candy bars eaten by 6 p.m.

As a class, see if you can develop more equations based on things that you see around you or topics that you are studying. You can get into small groups and hold a contest to see which group can come up with the most true equations within a time limit.

Use your imagination! Using the equation below, write out your own statement of what it might represent. You can do this in small groups and share your equation with the rest of the class.

$N = I + M1 + M2 - W - C$