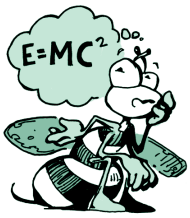
# Finding Ways to Soak Up the Rays

## *Lodgepole Pine Adaptation to Different Environmental Conditions*

### Meet Dr. Anna Schoettle (pronounced "shuttle"):

"I like being a scientist because it is fun to ask questions, solve problems, and discover new information about plants and ecosystems."




### Thinking About Science...

Scientists work in a variety of settings, and are employed by different organizations. Scientists work for universities, business and industry, hospitals, and the government. Scientists work in many different settings, such as laboratories, classrooms, factories, oceans, forests, in space, or on farms. The scientist in this study works for the USDA Forest Service, a Government agency that manages many of our Nation's forests. She collected branches from pine trees in the Rocky Mountain forests of Colorado. Then, she took the branches into a laboratory, took measurements of the branches and pine needles, and used a computer to compare her results. You can see that scientists work in a lot of different settings. What setting would you like to work in?

*Dr. Anna Schoettle*

### Thinking About the Environment...

Organisms must be able to live in a constantly changing environment. (Think about yourself. Don't you need to do that too?) If an organism is to survive, it will try to keep its internal environment stable, regardless of the external environment. This means that organisms will try to ***adapt*** over time to survive in changing environments. The scientist in this study wanted to know why lodgepole pines can survive at very different ***elevations*** in the Colorado Rocky Mountains. This shows that the pines can live in very different environ-

ments. The scientist was interested in discovering how lodgepole pines adapt to living in such different environments.

## Introduction

Sunlight is the source of energy for plants, which create food through *photosynthesis*. Photosynthesis occurs in the *foliage*, or green leaves (or needles) of a plant. The amount of food a plant can produce is partly dependent on the amount of its leaf or needle surface area.

Lodgepole pines grow in mountain forests at very different elevations. Dr. Schoettle, the scientist in this study, *hypothesized* that pines growing at higher elevations adapt to these harsher environmental conditions by growing needles that live for more years than needles growing at lower elevations. She also hypothesized that the shoots (branches) of higher-elevation pines would grow less each year than the shoots of pines growing in the lower elevations. *The interaction of growing less and the longer lifespan of the needles should equal out across elevations, maintaining the same amount of green needle area available for photosynthesis by the pines. Dr. Schoettle hypothesized that lodgepole pines have adapted in this way to live at different elevations.* She wanted to test this hypothesis.

## Reflection

- Why might it be important for plants to be able to adjust to different environments? (Hint—Can a plant move from place to place?)

- How does one test a hypothesis?

## Methods

When scientists study things, they usually study more than one example of it. The scientist therefore selected six forested areas at two elevations (three sites at each elevation). Four trees in each of the six areas were selected for study. (How many trees did the scientist study?) Then, the scientist selected an area in the lower third of each of the trees' *crown* from which she cut shoots. Dr. Schoettle measured four things: 1) the length of the shoot that had attached needles, 2) the age of the oldest pine needle on the shoot, 3) how much the shoot had grown each year, and 4) the total *biomass* of the needles on the shoot *(Figure 1)*. Biomass is measured by weight. The weight of the needles was measured by drying them in an oven and weighing them.

Dr. Schoettle then compared the four measurements using a computer program. The computer program helped her to determine if there were differences between the measurements of the shoots on trees growing at different elevations.

## Glossary:

*adapt:* (edapt') to adjust to new conditions

*biomass:* (bî'o mas) that part of a habitat consisting of living matter

*crown:* (kroun') the leaves and living branches of a tree

*data:* (dât'e) information

*elevation:* (el'e vâ'tion) the height above sea level

*foliage:* (fôl'ê ij) leaves of a plant or all plants

*hypothesize:* (hî poth'e sîz) to propose an explanation in light of known facts

*photosynthesis*: (fôtô sin'the sis) the process that plants use, with the aid of sunlight, to create food in the form of carbohydrates

| Characteristic | Site Elevation 2,800 meters | 3,200 meters |
|---|---|---|
| Average shoot length in centimeters (cm) | 19.9 | 20.7 |
| Average needle lifespan (years) | 9.5 | 13.1 |
| Average annual shoot growth $(cm)^2$ | 2.1 | 1.4 |
| Average needle biomass per shoot (grams) | 4.6 | 5.9 |

*Table 1. Effect of elevation on shoot characteristics of lodgepole pine.*

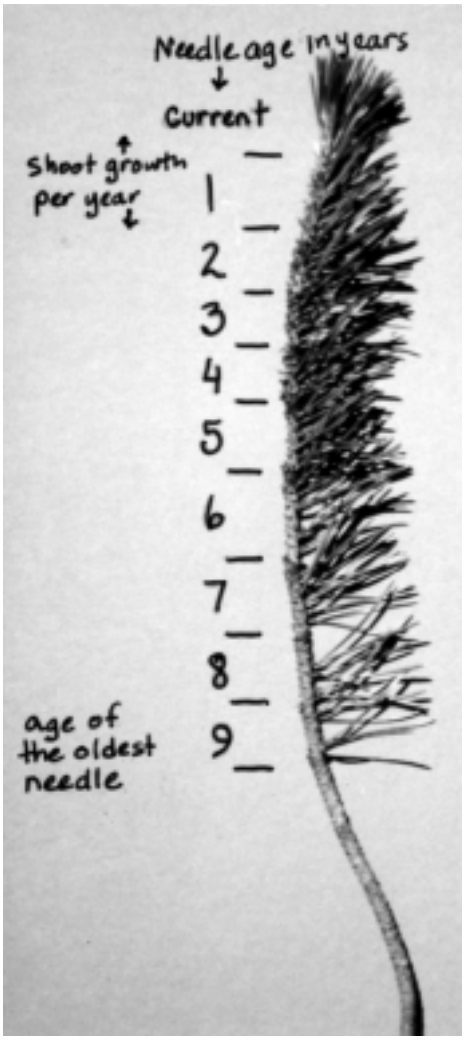



*Figure 1. Measurements taken on each pine shoot.*

### Reflection

- Why do you think scientists usually study more than one example of something? Do you think Dr. Schoettle should have studied only one tree at each elevation, rather than 12? Why or why not?

- Why did Dr. Schoettle want to know the total weight of the needles? (Hint—Weight is a measure of the amount of something, and Dr. Schoettle wanted to know the amount of green needle area available for photosynthesis.)

## Results

The results of the study are presented in Table 1. The needles growing on pines at higher elevations lived longer than the needles growing on pines at lower elevations. The shoots of these higher elevation pines, however, did not grow as much each year as the branches at lower elevations. The length and weight of the needles on all shoots were about the same, meaning that the same amount of green area was available for photosynthesis, regardless of where the trees grew.

### Reflection

- What conclusion would you draw from these results about the adaptation of lodgepole pine at higher elevations?

- Was Dr. Schoettle's hypothesis proved true or false by this study? How do you know whether it was true or false?

- What conditions do you think are different between locations at high and low elevations? How might temperature be different? Why should this affect how plants grow?

- How many years do leaves live on trees near your school?

## Implications

The scientist concluded that the lifespan of needles in lodgepole pine can vary, and may interact with the yearly growth of the shoot to produce the same amount of green area regardless of elevation. This may represent an adaptation of lodgepole pine, enabling it to live in a wide variety of environments.

## Reflection

- Can you think of other examples of adaptations in nature?

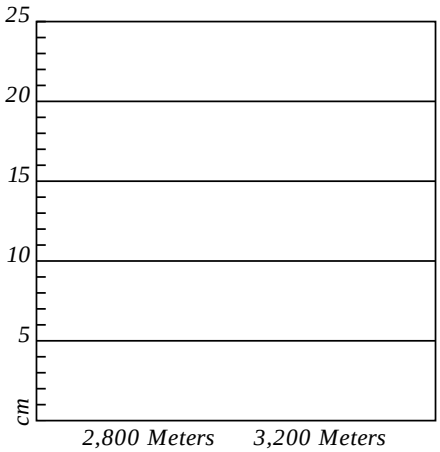
From: Schoettle, Anna W. (1990). The interaction between leaf longevity and shoot growth and foliar biomass per shoot in Pinus contorta at two elevations. *Tree Physiology, 7*, 209–214.

## Discovery FACTivity

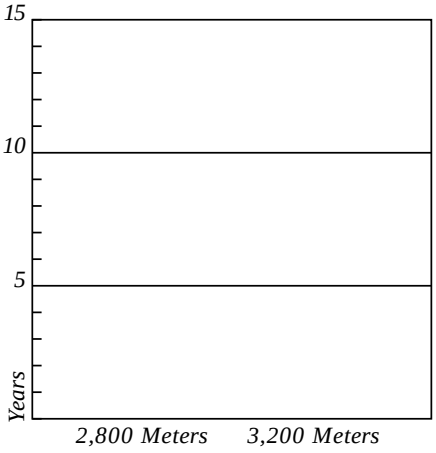
Bring in a cactus, a fern, and a plant that is native to your local environment. The cactus has adapted to a hot, dry, sunny environment. The fern has adapted to a shady, warm, wet environment. What kind of environment does your local plant live in? Carefully observe each of the plants. Compare them. How thick are each of the stems? Do the stems look different from one another? How are the leaves similar or different? Do the plants feel different to the touch? (Be careful with the cactus!) With the help of your teacher, explore how each plant has adapted to its native environment.

## Another FACTivity!

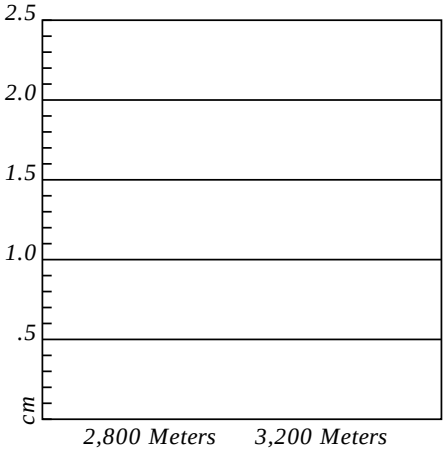
Using their numeric results, scientists often present their findings as charts or graphs. Using the data from Table 1, you will create your own bar charts. With the help of your teacher, complete the bar charts below. Turn to page 16 to see an example of a bar chart.



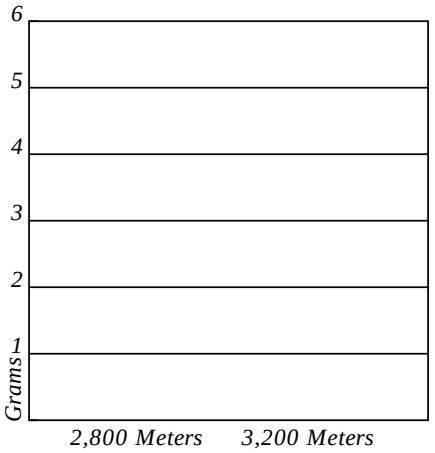

*Average Shoot Length in Centimeters (cm)*




*Average Needle Lifespan (Years)*




*Average Annual Shoot Growth (cm)²*




*Average Needle Biomass Per Shoot (Grams)*

The charts you have created present the same data as Table 1. Which kind of presentation do you prefer? Why? What are the advantages of using charts instead of tables to present data? What are the disadvantages?

For more information, see: www.xmission.com/~rmrs/staffs/labs/laramie/lar_rm4352.html