Can We Grow Now?

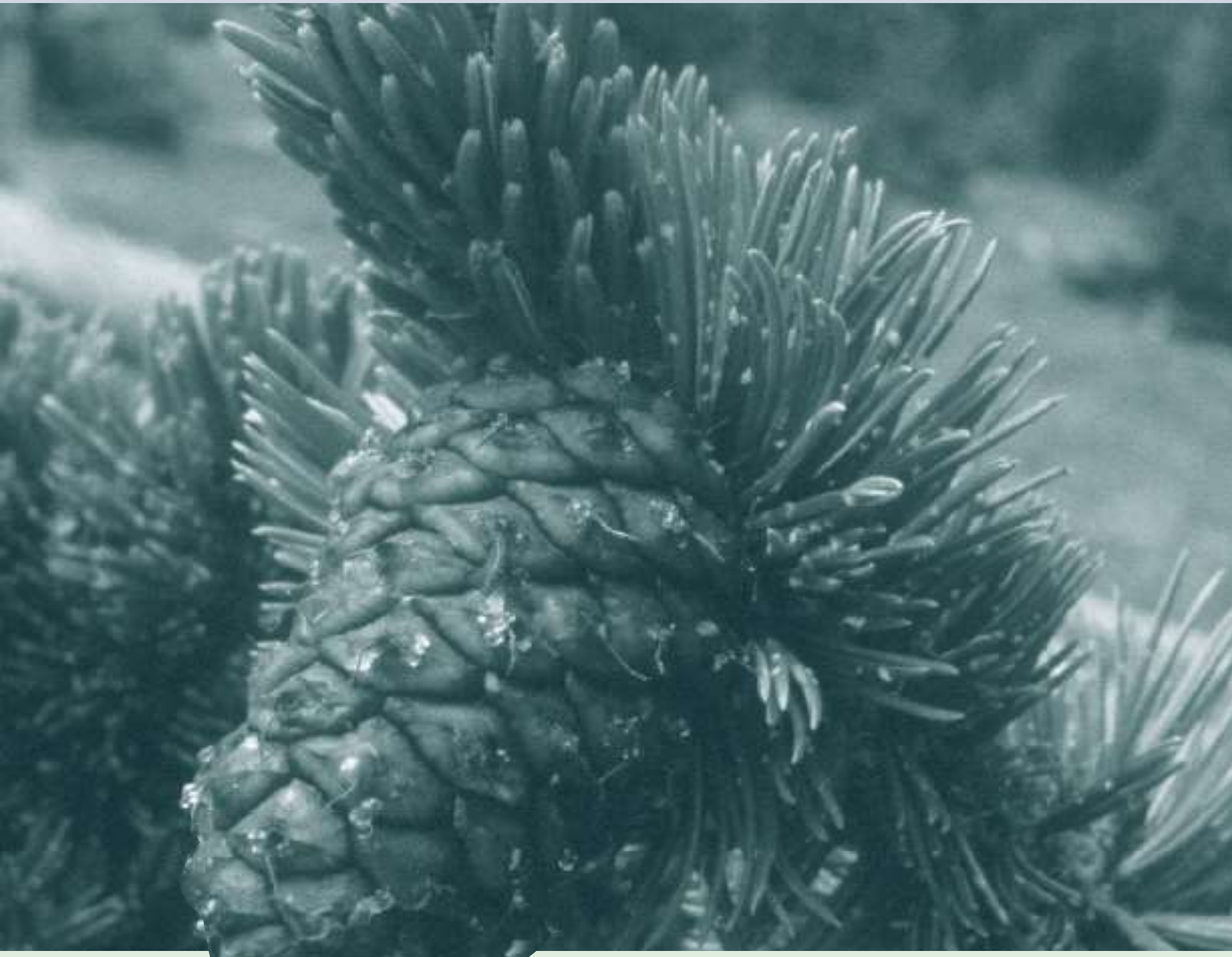


Photo by Dave Powell, Forest Service, http://www.Bugwood.org.

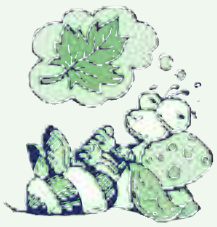
Helping Bristlecone Pine Trees To Take Root and Grow

Thinking About Science

When scientists complete their research, they communicate their results to other scientists. One way they do this is by writing a scientific paper. Within a scientific paper, scientists almost always use many ways to communicate. These ways include words, photographs, maps, drawings, tables, charts, and graphs. As you read *Natural Inquirer* articles or other scientific material, look carefully at the many ways scientists communicate their findings.

In this article, you will see photographs, charts, and maps that help you understand the research. In your own life, how do photographs, charts, and maps help you understand in a way that words do not? Have you recently looked at an hour-by-hour forecast of the temperature? How does that graph help you understand the coming weather in ways that words do not?

Thinking About the Environment



Bristlecone pine trees are special. They are special because they can live for long periods of time, some up to 4,500 years. This makes them the oldest living **species** on Earth. In the Ancient Bristlecone Forest in California, the oldest of these trees is named Methuselah (mə-'**thü**-zə-lə). This tree was named for the oldest person named in the Bible. Methuselah is a Great Basin bristlecone pine. The scientists in this study examined Rocky Mountain bristlecone pine trees. Bristlecone pines can live in harsh environments, such as cold, windswept, rocky slopes **(figure 1)**. They can also live in more favorable **habitats**, where they form **closed-canopy** forests **(figure 2)**.

Rocky Mountain bristlecone pine trees are found in Colorado. Bristlecone pine trees provide a lot of benefits to the areas in which they grow. They provide seeds for birds and other wildlife. They hold carbon in their wood, which helps to reduce climate change. They contribute to the water cycle by pulling in water through their roots and **transpiring** it through their needles. They provide a special benefit to people who visit the old trees, or maybe just look at photographs of them. Can you name this benefit? The benefits provided by nature are called **ecosystem** services.

Figure 1. Rocky Mountain bristlecone pine.

Figure 2. Closed-canopy bristlecone pine forest.

Meet the Scientists

Dr. Jonathan Coop, Plant Ecologist: My favorite science experiences are learning something new about how nature works and sharing what I know with students, especially on top of a mountain. ▼

▲

Dr. Anna Schoettle, Plant Ecophysiologist (ē-kō-ˌfi-zē-'ä-lə-jist): My favorite science experience is exploring the relationships between plants and their environments. I also enjoy providing scientific information that helps **forest managers** take care of our beautiful public lands..

For more information on ecosystem services, see the Ecosystem Services edition of the *Natural Inquirer* at http://www.naturalinquirer.org. Click on "Search and order issues."

Introduction

Bristlecone pines have an interesting relationship with fire. When a fire occurs, it may open a once-closed area to sunlight. When this happens, bristlecone pine seedlings get a chance to grow. These trees grow slowly, however, and can take between 50 and 100 years to mature. A tree is considered mature when it begins to produce seeds. The seeds of a bristlecone pine have wings **(figures 3 and 4)**. When wind blows, the seeds travel away from the parent tree. Most of the seeds land within 10 to 100 meters of the parent tree.

In the early 1900s, a fungus from Asia was brought by accident to the United States. This fungus is deadly to many pines, including bristlecone pine trees. This fungus is called white pine blister rust **(figure 5)**. If white pine blister rust spreads across Colorado, the bristlecone pine trees could be in danger.

Figure 3. Bristlecone pine seeds.

Figure 4. Bristlecone pine cone. Why do you think these trees are called bristlecone pine trees?

Number Crunches

- How many yards away from the parent tree do most bristlecone pine seeds land? Multiply the number of meters by 1.09 to find out. How many feet away from the parent tree do most of these seeds land?

The scientists in this study wanted to know more about the best conditions for bristlecone pine tree seeds to take root and grow. If they better understood this, forest managers could do things to improve the conditions for seeds to take root and grow. One way to save bristlecone pine trees from white pine blister rust is to find trees that are not as easily affected by white pine blister rust. When scientists and forest managers find bristlecone pines that are resistant to this disease, they can plant those trees' seeds in the best locations.

Figure 5. A bristlecone pine infected by white pine blister rust.

Reflection Section

- In the form of a question, state what the scientists wanted to discover.
- Name two things that make it hard for Rocky Mountain bristlecone pine trees to survive.

Methods

The scientists identified two areas in Colorado that experienced a severe wildfire in 1978 **(figure 6)**. These areas were in the Pike-San Isabel National Forest.

The areas were too large to examine entirely. The scientists developed a system to randomly select smaller areas within the larger areas. The scientists made sure that they studied areas that had experienced different levels of fire. They selected areas 15, 45, and 100 meters into each burned area. They also studied areas of forest at the edge of the burned area. The scientists placed each area they studied into one of three categories: (1) completely burned, (2) partly burned, and (3) unburned **(figure 7)**.

Within each area they studied, the scientists counted the number of trees. They measured the size and height of each tree **(figure 8)**. They also counted the number of saplings and seedlings. Saplings are young trees, and seedlings are even younger trees. They did this for every tree species in the area.

Number Crunches

- How many years have passed since the severe wildfires in Colorado?

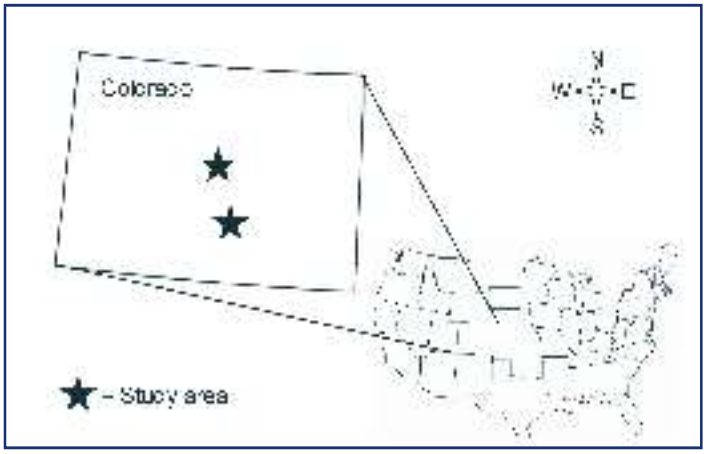


Figure 6. The areas studied by the scientists.

For every bristlecone pine seedling found, the scientists did something extra. They identified the three other objects nearest to each seedling. These other objects included boulders, stones, fallen wood, and standing tree trunks. They measured the distance from the seedling to each of the objects they found.

The scientists also randomly identified other points in each area. They measured the distance from each point to the nearest three objects found. **(figures 9a and 9b)**.

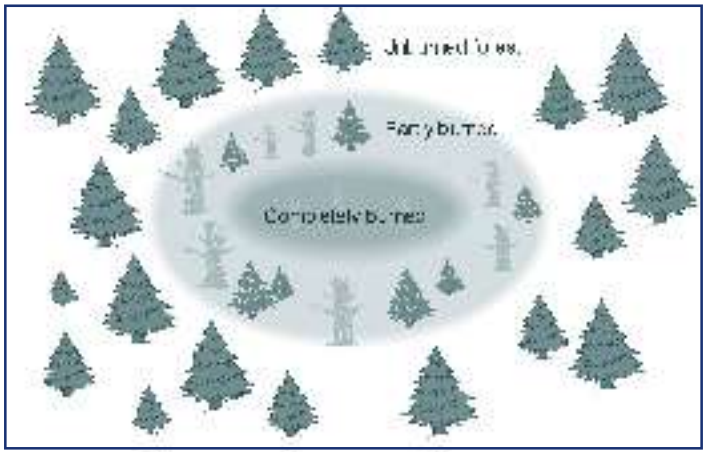


Figure 7. The scientists studied three different kinds of areas.

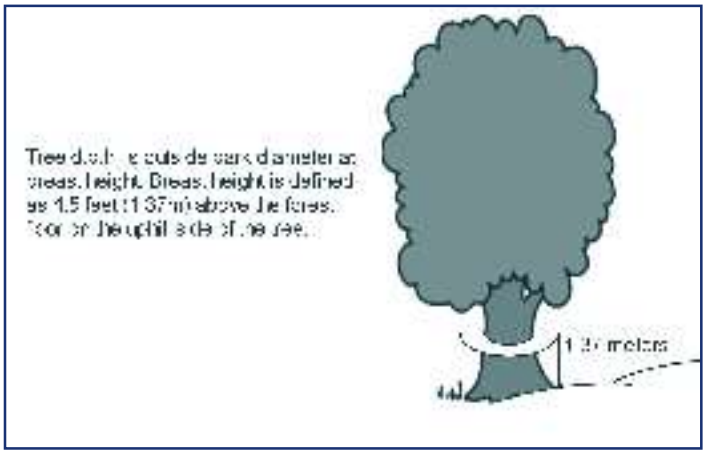


Figure 8. Scientists and foresters determine the size of a tree by measuring the diameter at breast height (d.b.h.).

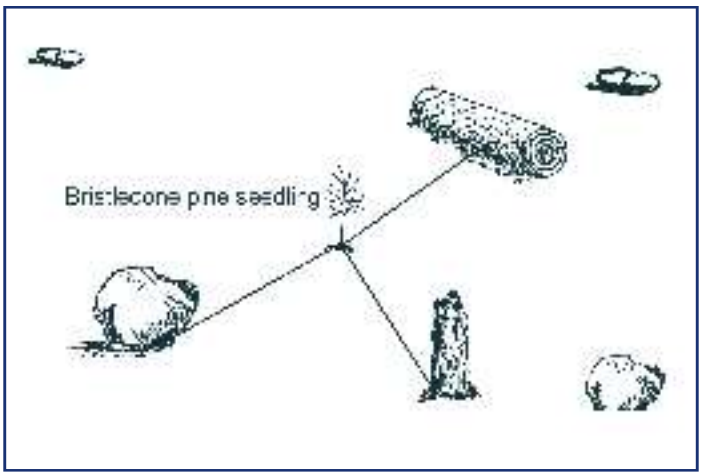


Figure 9a. The scientists measured the distance from each seedling to the three nearest objects.

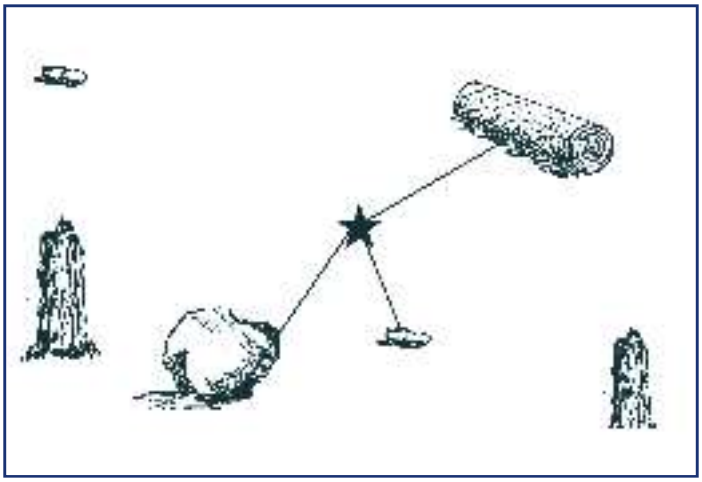


Figure 9b. The scientists measured the distance from randomly selected points to the three nearest objects to each point.

Reflection Section

- Why did the scientists select their study sites randomly?
- Why do you think the scientists measured the distance from each seedling to other objects?
- Why do you think the scientists measured the distance from randomly selected points to nearby objects?

Findings

The scientists found more bristlecone pine trees growing in partly burned areas than unburned and completely burned areas **(figure 10)**.

Younger trees were found more often closer to mature trees. As the distance from a mature tree increased, fewer young trees were found.

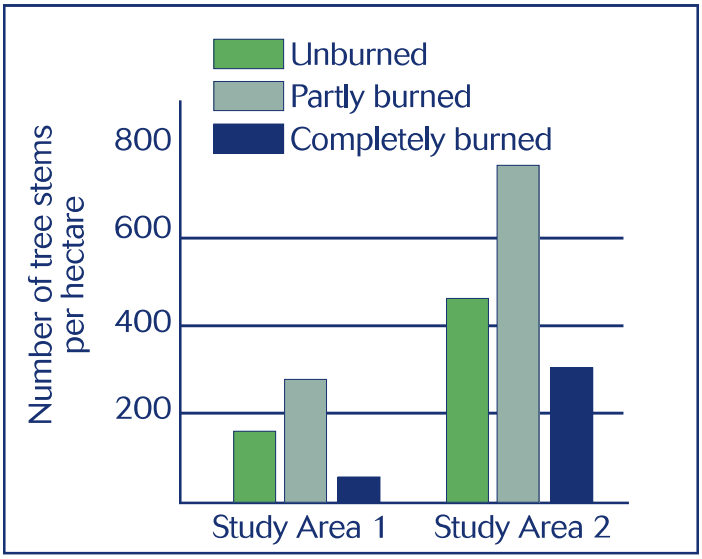


Figure 10. Partly burned areas had the most bristlecone pines. What do you notice about the two study areas?

Figure 11. You can see the seedling growing near the downed tree. The scientists call these other objects nurse objects because they appear to help the young trees grow.

The scientists found that seedlings were often growing near other objects, such as boulders, stones, fallen wood, and standing tree trunks **(figure 11)**. They also found that, when compared with a randomly selected point, the seedlings were closer to these objects **(figure 12)**.

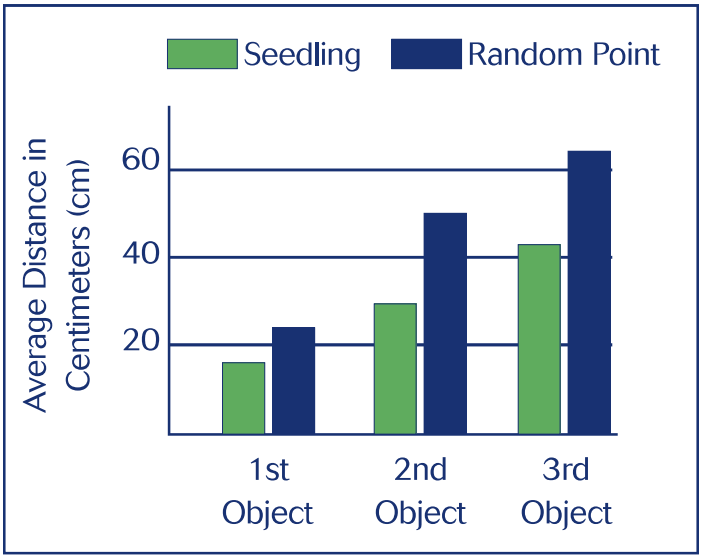


Figure 12. When compared with the distance from an imaginary point, seedlings were found growing closer to other objects than they would have been by chance.

Reflection Section

- Look at figure 10. You can see that more bristlecone pine trees were found growing in partly burned areas. What else does that chart tell you?.
- Explain the evidence for calling boulders, stones, fallen wood, and standing tree trunks nurse objects.

Discussion

The scientists found that a partly burned area was more favorable for bristlecone pine tree growth than either unburned or completely burned areas. They concluded that partly burned areas are important for bristlecone pine trees.

The scientists also concluded that objects such as boulders, stones, fallen wood, and standing tree trunks helped seeds to sprout and young trees to grow. They believe that these objects protect the seeds and young trees from wind, ice, the hot sun, and animals that might eat the seeds.

The scientists suggested that forest managers could set controlled fires that create small openings. These small openings would be favorable places for bristlecone pine seeds to take root. In addition, forest managers could make sure these openings have nurse objects in them. Forest managers can create favorable areas on purpose. These areas will help more bristlecone pine trees to grow. When scientists find bristlecone pine trees that are more resistant to white pine blister rust, they can purposely plant seeds from those trees in these kinds of areas. By doing these things, scientists and forest managers can help to save the bristlecone pine.

Reflection Section

- Do you think forest managers should use fire as a tool to help save the bristlecone pine? Why or why not?
- Name other ways that objects such as boulders, stones, fallen trees, and standing tree trunks provide benefits to the natural environment, anywhere they are found.

Glossary

Closed canopy ('**klōzd** '**ka**-nə-pē): A forest in which the leaves of trees are touching, providing a mostly shaded area beneath.

Ecosystem (ē-kō-**sis**-təm) Community of plant and animal species interacting with one another and with the nonliving environment.

Forest manager ('**fȯr**-əst 'ma-ni-jər) Skilled individual who takes care of natural resources.

Habitat ('**ha**-bə-ˌtat): Environment where a plant or animal naturally grows and lives.

Randomly ('**ran**-dəm-lē): A way of selecting a smaller number from a group in such a way that all members of the group have the same chance of being selected.

Species ('**spē**-(ˌ)shēz): Groups of organisms that resemble one another in appearance, behavior, chemical processes, and genetic structure.

Transpiring (tran(t)-'**spī(-ə)r** iŋ): The act of passing off in the form of a vapor. Trees give off water vapor through pores in their leaves.

Accented syllables are in **bold.** Marks taken from Merriam-Webster Pronunciation Guide.

Adapted from Coop, J.D. and Schoettle, A.W. 2009. Regeneration of Rocky Mountain bristlecone pine *(Pinus aristata)* and limber pine *(Pinus flexilis)* three decades after stand-replacing fires. *Forest Ecology and Management*. 257: 893–903, http://www.fs.fed.us/rm/pubs-other/rmrs_2009_coop_j001.pdf.

FACTivity

You will answer the following questions in the FACTivity: What are the ways different seeds move away from the parent plant? What are the characteristics that enable seeds to travel from the parent plant?

Time needed:

One class period (With prework in addition)

Materials needed:

Variety of seeds
- For prework, collect three or more seeds from areas around your home, schoolyard, unmowed area, or wooded area. You may also collect seeds from fruits, such as from a tomato, apple, watermelon, or pumpkin. The entire fruit may be brought in as well.

Magnifying glasses or microscopes
Rulers
Blank paper
Pencil

For extension:

Fan
One small dry bean or seed (one for each student)
Paper
Scissors
Masking tape
Glue
Tape measure

The procedure to be used to answer the question is:

Using this article as a starting point, the teacher will explain that all seeds have a way to travel from the parent tree. This is called seed dispersal. Examples include wind, water, animals (either by purposely carrying seeds, eating fruits and later defecating the seeds, or having seed burrs stick in their fur), and mechanics (such as "explosions"). Bristlecone pine seeds are winged seeds and use wind as a way to travel. (Note that some seeds use more than one dispersal mechanism.)

Your teacher will create a station for each type of seed dispersal. Place your seeds at the station you think is the right one for each seed. A magnifying glass or microscope and ruler should be available at each station. (Multiple stations for each type of seed could be established if there is enough room.)

You will then move from station to station, observing the seeds at each station. On your piece of paper, draw an example of the seeds and make notes about how the seed's physical characteristics enable it to travel.

After all students have visited all stations, your teacher will hold a class discussion about what was discovered. How do you think each of the seeds is dispersed from the parent plant? What are the physical characteristics that make dispersal possible for each type of seed? Be sure to answer the questions posed at the beginning of this FACTivity.

Compare whatever winged seeds you collected with the photograph of the bristlecone pine seeds (figure 3 in the article). How are the seeds similar? How are they different?

FACTivity Extension

Get a dry seed or bean, a piece of paper, scissors, and have access to the tape and glue. Design a wind-dispersed seed mechanism for your seed. Be creative in your design. After the seeds have been designed, each student will drop their seed from the same height, in front of the fan. Each student will get three tries. Calculate the average distance. Determine which design traveled the farthest.

Hold a class discussion about why the seed that traveled the farthest did so. What design was used and what made it successful?

Teachers: If you are a trained PLT teacher, you may use Activity # 43, "Have Seeds, Will Travel," as an additional resource.

This FACTivity was adapted from Discovery Education: http://school.discoveryeducation.com/lessonplans/programs/scatteringseeds/

National Science Education Standards

Science as Inquiry:

Abilities Necessary To Do Scientific Inquiry;
Understanding About Scientific Inquiry

Life Science:

Structure and Function in Living Systems;
Populations and Ecosystems;
Diversity and Adaptations of Organisms;
Reproduction and Heredity

Science in Personal and Social Perspectives:

Populations, Resources, and Environments;
Natural Hazards;
Risk and Benefits

History and Nature of Science:

Science as a Human Endeavor;
Nature of Science

Additional Web Resources

The High Elevation White Pine Educational Web site
http://www.fs.fed.us/rm/highelevationwhitepines/

NOVA: Explore the Methuselah Grove
http://www.pbs.org/wgbh/nova/methuselah/expl_grove.html