PROJECT 2
Getting to the Roots about Roots

Areas of Focus

- Biology: Community ecology, competition, adaptation, form and function
- Science (general): Experimental design, data gathering, calculating averages, preparing graphs
- Language arts: Preparing a journal and report of findings

Target Grade Level: 6 - 8

The Science Behind the Project

When you think of a plant, what first comes to mind is the leaves, stems, and flowers. In other words, the parts of the plant that are above ground. It's true that it's the leaves that perform the photosynthesis and the flowers that attract the pollinating animal and eventually produce the fruit - but what about those roots? So much of what makes a plant a plant is what occurs underground. Whether you are attempting to grow a vegetable garden in your own backyard, or introducing native plant seeds to bare slopes in the Baldwin Hills, it's the roots that will determine if you have any chance of success. In other words, without the roots, there will be no stems, leaves, or flowers.

Roots provide that lifeline between the plants, water, and nutrients in the soil. The roots also provide the means to keep soil in place on steeper slopes or rain-drenched hillsides, as we will see later. Roots come in several distinct configurations that are related to the kinds of environments in which they grow. For many plants on Earth, roots form close relationships with other organisms such as beneficial bacteria or fungi that can improve plant growth and the overall nutritional value of the soil. So let's take a closer look at those underground - and underappreciated - plant roots.

Activity Overview

In this next set of activities, you will be exploring the diversity seen in plant roots. You will also stage a contest between plant roots for the control of the soil. Finally, you will test the ability of roots to keep soil in its place.

Activity 1: So Exactly What's Going on Down There Underground?

In this simple activity, you will be growing plants from seeds in order to observe their root systems. The chosen plants produce very different kinds of roots, so you will get an opportunity to make connections between what grows underground and aboveground. Later in this project, you will see how root design helps keep hillsides from sliding down.

Materials – What You Need

- Corn, bean, and carrot seeds
- Pots or similar containers in which to grow seeds (milk cartons with the top cut off and holes punched in the bottom for drainage work well)
- Potting soil
- Newspaper or paper towels
- Flat board, cookie sheet, or similar flat surface
- Small ruler
- A copy machine (if available, but certainly not necessary)

Procedures – What You Do

1. Prepare at least one pot for each type of plant (2 or 3 would be better in the event you are not as good a gardener as you thought you were). To do this, place prepared potting soil to within 1 centimeter (cm) of the top of each container.
2. Now plant one seed in each of the pots, one plant type per pot. Follow the directions on the seed packet when preparing your seeds for planting (some plant seeds need to be soaked in water for some time before planting).
3. Place your pots in a location where they get some warmth and sunlight.
4. Monitor the dampness of the soil in each pot daily, and add water as needed to keep the soil slightly damp.
5. Keep a journal of your observations on each pot, noting daily soil dampness, and the time when the first seedling appears.
6. When each of the plants is at least 15 cm high, very carefully remove the soil from its roots. This takes lots of skill and patience as you may tear the fragile roots apart. Begin by flushing water into each pot with a garden hose or watering can (best done outside) to loosen and wash away the soil. With different types of plants, you will likely find each plant will grow at different rates.
7. Now take the roots (plant stem still attached) and gently soak up the excess water with newspaper or a paper towel.
8. Lay the root system between layers of newspaper or paper towels and place it on the flat surface (board, cookie sheet). You will need at least 5 layers of paper above and below the plant. Spread out the roots on the paper so they are not clumped. Why aren't the roots green, like the rest of the plant?
9. Now place a heavy flat object on each plant. Phone books work well. You are creating a plant press to dry and preserve your roots, so some form of weight is needed on top to press the samples.
10. Let the samples sits undisturbed in a dry place for up to one week.
11. When one week has passed, carefully remove the plant from the layers of paper. The root system should be dry and stiff by now. If not, let the plant press sit for several more days up to a week.
12. Compare the root systems of your plants. Are they different? If so, in what way? How hard would it be to measure the total length of each root system? Try and see how far you get with a small ruler.
13. Draw each root system in your journal. If one is available, you should try to make a photocopy of each root system (since they are now flat, they should photocopy well. Alternatively, you may try to use sun-sensitive paper to make an image of each root system, or photograph each root system, preferably on a black background.
14. Go to the library or search the Internet for information on plant root types. See if you come across the following terms: root hairs, tap roots, and root balls. Can you come up with reasons why the roots systems of these three types of plans would be so different?

Going Further

- Next time you take a walk through the produce section of a supermarket or the farmer's market, take note of all the foods that are all or part of a plant's root system (referred to as root vegetables). Before you go, look up the following terms: *tubers*, *corms*, *rhizomes*, and *bulbs*. These represent some of the types of root vegetables available. What is an onion? A potato? Garlic?

Activity 2: The War of the Roots

When plants grow next to each other, competition for sunlight may ensue as one grows over and attempts to overshadow the other. But the real battle lies underground in the game of root versus root. In this activity, you will set the stage for the war of the roots, and demonstrate that in regards to plant growth, it is best to go it alone.

Materials – What You Need

- 3-6" planter pots (1-gallon milk cartons with the tops cut off and drainage holes in the bottom work just as well)
- Corn seeds (at least 20)
- Potting soil (enough to fill the 3 pots)
- Ruler

Procedures – What You Do

1. Fill each of the 3 pots to within 1 cm of the top. For more significant results, you may want to increase the number of pots for each experimental treatment. In other words, set up multiples of each pot.
2. In one pot (or set of pots), plant 1 corn kernel; in the second pot, plant 3 corn kernels; and finally in the last pot, plant 5 corn kernels (if you like, you can really pack them in with another pot containing 10 kernels). Try and place the seeds an equal distance from each other in the pots.
3. Treat all the pots equally in terms of watering schedule and exposure to light.
4. When the young seedlings emerge, measure and record their heights in your log or datasheet.
5. Continue to monitor the plant growth in each pot at regular sampling intervals, such as weekly - it may take a month or more before you may want to call it quits.
6. Along with changes in height of each plant, you may want to also compare leaf number and size, color, and other measures of overall plant health. You may find the plants differ in their final height - the point when they seem to stop growing, and perhaps even fall over!
7. The growth data would be best presented on a line graph, with the x-axis showing the dates of height measurement and the y-axis assigned to the height. For multi-plant pots, you should take an average of the heights of each plant.
8. When you finish your sampling, you may want to try and carefully remove the plants from the pots to expose the root systems. For the multi-pot plants, how tangled up are the plant's root systems? Do you see any other differences in the root systems of the single plant versus the multi-pot plants?
9. You may want to save some of your corn plants for the activity that follows.

Going Further

- To observe the absorptive ability of plant roots, you can immerse the exposed roots of your plants in a glass of food dye and water. You need to do this quickly following the roots being removed from the soil - keep them damp until you place them in the dyed water. Make sure the water is strongly colored enough to see it move up the roots and into the stem and leaves of the plant.
- Plant a small vegetable garden. For many garden vegetables grown from seed, such as radish, green onions, arugula, and lettuce, there will be a time when you will need to thin the plants out by removing some of the plants from the garden bed. This permits the remaining plants to grow to their maximum size and produce the most food.

Activity 3: That Other Job of the Plant's Roots: Keeping Soil in its Place

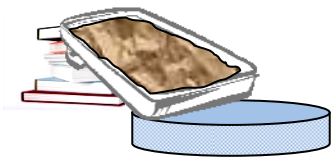
If it weren't for the plants that currently cover the Baldwin Hills, much of the soil that makes up those hills would be in someone's backyard or parking lot as mud. In fact, the world would be a lot muddier if it weren't for the ability of plants to help keep the soil in its place. Part of the role of plants is to break up hard rainfall with their leaves and stems so that it does not heavily impact the soil below. In other words, the green parts of plants help to take the punch out of heavy rains that would otherwise dislodge and wash away soil. But even without much of the above-ground parts of a plant, the roots cling to soil like Velcro. In this next activity, you will see just how important plants and especially roots are in keeping hillsides in their place.

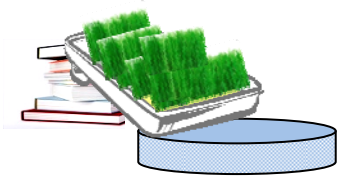
Materials – What You Need

- 2 wallpaper hanging trays (easy to find and inexpensive in home improvement stores)
- Plastic basin big enough to fit the end of the wallpaper hanging trays (you can simply use a sink, if necessary)
- Block of wood, phone books, or bricks to prop up one side of the wallpaper hanging tray to about a 45° angle (see diagram)
- 2 clear glass bottles or jars
- A watering can
- Potting soil
- Grass seed

Procedures – What You Do

1. Fill each of the trays with potting soil to within 1cm of the lip.
2. Plant grass seed in one of the trays and tend it as you would a lawn in your yard (place outside in a sunny location and water as needed - follow the directions on the seed bag). It will take several weeks to get good growth, so plan your schedule accordingly.
3. Once you have a good growth of grass in you tray, you are now going to recreate your simulated hillside. Refer to the diagram below to set up the apparatus.
4. Using the watering can, simulate rainfall on your grassy slope. Use one filled watering can to standardize the amount of rain that falls in your experiment.
5. Collect the water from the basin and examine it. How clear is the water? How much debris has ended up in the basin? Record your observations in your journal. Hold onto the first sample for comparison later.
6. Now repeat the procedure with your barren hillside tray (no grass). Use precisely the same amount of water with the tilt of the tray the same as the other tray.
7. Collect another sample of the water in the basin. Describe what you see and compare this water sample with the first. How successful was the grass at keeping the soil in its place?





Going Further

- Try repeating the experiment (after the soils have dried a bit) but this time mow the lawn by trimming the grass with garden snips or clippers. Does removing part of the grass change the results?
- Alter the angle of tilt of your hillsides. How much tilt is too much even for the grass? (Warning: this may result in a bit of a mess).
- Next time you are taking a drive in places with roads have been cut through hilly areas, look at the road cuts and see if you can see what has been done to keep the road cuts stable.

Wrap It Up

The roots systems of plants have the task of accessing and controlling the local resources of the soil. This can become a critical task in areas where water and nutrients are of limited supply, like the drier conditions of southern California. Habitat specialists working on the Baldwin Hills are well aware of just how native plants can be placed in order for each plant to have the best chance for survival and maximum growth. Now, there occurs in nature a sort of 'survival of the fittest' in which plant seeds fall in such density that not all of them will be able to survive over time due to overcrowding. Many will eventually die, but a few seeds will succeed in the competition for sunlight and nutrients and dominate the landscape.

Examples of cool root systems

Plant spacing in natural areas

Coastal Sage Scrub Habitat