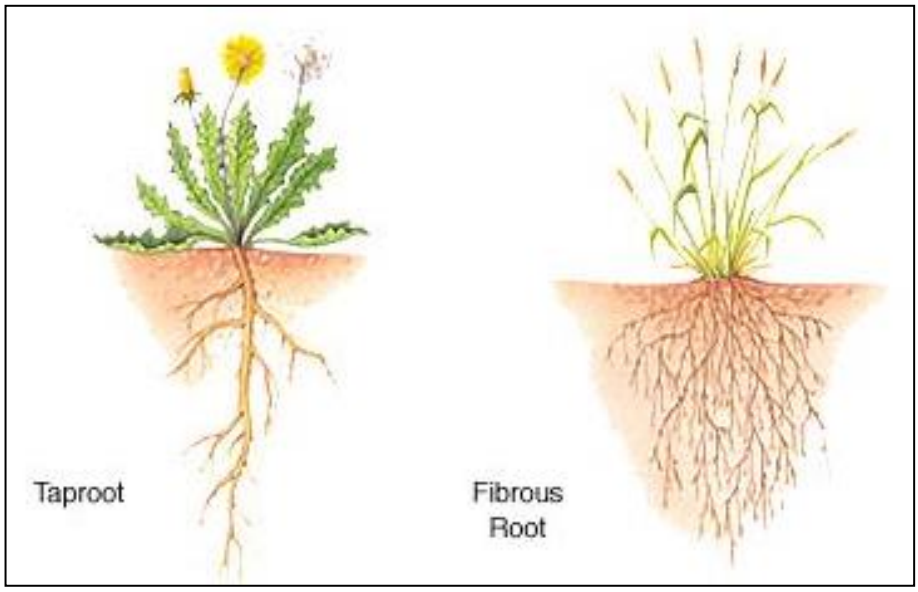
ROOTS AND SHOOTS



BACKGROUND

Plants are living things that are ferocious competitors. Like all living species, plants are in **competition** for resources (sunlight, and water and nutrients from the soil) to survive, and have adapted structures and characteristics to help them compete for survival.

The two primary structures of all plants are the roots and the shoots. The ***shoot*** of a plant is often the most visible. It is the above-ground part of the plant, which consists of stems, branches, leaves, flowers, and fruit. Shoots take in sunlight and carbon dioxide to create food.

The **roots** are usually hidden under the soil and often account for more than half of the plant. Diversity of root systems help plants survive and avoid competition of resources (nutrients, water, space) by allowing the roots to take in nutrients and water from different depths in the soil.
Roots perform several vital functions:

- Roots take in water and nutrients from the soil, providing nutrition for the plant.
- Roots anchor the plant in the soil so that it does not wash or blow away.
- Roots store food and water to keep the plant alive through harsh times such as winters or droughts.

Plants with a **fibrous root** system have small, string-like roots that look like a mop. Plants in the grass family, including, rice and corn, have fibrous roots.

Plants with a **taproot** have one or more thick main roots with smaller roots branching out from the larger ones. Dandelions, willow trees, and rose bushes have taproot systems, as do carrots, radishes, and beets.

In this activity students will investigate root systems by digging up plants, comparing roots, and explaining how different types of roots help plants; including how **invasive species**, avoid or create competition in order to survive.

Roots and Shoots was adapted from the Outdoor Biology Instructional Strategies Lessons (OBIS) produced by University of California Lawrence Hall of Science ©1982. Revisions made by Seattle Audubon, 2009, 2017

SEATTLE AUDUBON

Materials Each Group Guide will have a kit containing:

1 guide card
7 pencils
7 hand lenses
3 trowels (small shovels)
2 small brown paper bags
Resource Cards: 6 water cards (blue), 6 nutrients cards (orange), 6 sunlight cards (yellow),
7 invasive species cards

TIP The Group Guide needs to bring two mystery plants.

- Prior to the activity, find an example of each root system. A fibrous root system is found on grass-family plants. A taproot system is found on carrots and many weeds such as dandelions.
- Place the brown bags over the shoots of each plant. Verify that only the plant roots are exposed.

Key Learning Objectives

- Plants compete to survive in their habitats. They compete for limited resources: sunlight, and water and nutrients from the soil.
- The roots collect water and nutrients from the soil, the shoots collect sunlight.
- The diversity of root and shoot systems helps a variety of plant species survive in the same habitat while avoiding competition for resources.
- Invasive species are strong competitors and can outcompete native plants for resources; this is what enables them to invade (take over) a space.

Site The best site for this activity is a weedy lot, lawn, garden, or field with soft soil for easy digging. Be sure to obtain permission to dig up the plants in your activity site.

Vocabulary Throughout the activity be sure to use and reinforce the vocabulary words:

- ***competition*** – the fight for resources in order to survive
- ***shoot*** – the above-ground part of a plant (stems, branches, leaves, flowers, and fruit)
- ***fibrous root*** – the below-ground part of a plant with a large mass of string like roots
- ***taproot*** – the below-ground part of a plant with a long main root (which may have smaller roots growing from it)
- ***invasive species*** - A species that is non-native, able to succeed in many habitats, grows quickly, and spreads to the point of disrupting an ecosystem.

INTRODUCTION by TEAM LEADER (5 minutes)

The Team Leader will introduce the lesson to the entire class before dividing the students into their small field groups.

Introduce the activity to students

- Today we will observe plants – above the ground and below the ground.
- What is the part of the plant called above the ground? What is the part of the plant called below the ground?
- What is unique about plants?
- Discuss the general off-limit plants in your area.

ACTIVITY by GROUP GUIDE

The Group Guide will complete the activity with their small field group as described below.

TELL ME (5 minutes)

Gather the students into a circle and point out the study site boundaries

While not looking for any specific answers, facilitate the discussion by asking questions like:

- What do you know about plants?
- What do plants need in order to survive?
- How are plants different above and below the ground?
- What is the purpose of a root? (anchors the plant, take up water and minerals, store food and water)
- What is the purpose of a shoot? (to use sun and carbon dioxide (air/CO_2) to make food)
- How easy or hard is it for plants to get nutrients, water, and sunlight?
- Do you think plants compete for limited resources?

State the challenge Today we will investigate root systems to see how plants are adapted to compete for survival.

ACTION: Part I (5 minutes)

Resource competition game – reiterate the study area boundaries

1. Tell the students that they are going to pretend to be plants.

- Gather the group in a circle and review the resources plants need in order to survive (sunlight, air/CO_2, water and nutrients). Show them the resource cards and explain that yellow represents sunlight, blue represents water, and orange represents nutrients. There is no air/CO_2 card because air/CO_2 is not a limited resource; there is plenty to go around and plants do not need to compete for it.
- Have the students pretend to be seeds. Explain that when you begin to blow (representing wind) they will have 5 seconds to scatter and plant themselves somewhere in the study area boundaries. Have the students stop where they are when you say "plant."
- Tell them that their feet represent the roots of the plant and their arms represent the shoots of the plant. Remind them that the roots hold plants firmly in the ground so they cannot move from their spot.
- Scatter the resource cards on the ground within the study area boundary. Scatter the cards in a way that will make it difficult for *all* students to get *all* three limited resources.
- Explain that when you say "compete" they will try to pick up as many resource cards as they can until you say "stop." They can only bend their bodies and move their arms; they cannot move their feet since plants cannot walk to get their resources.
- Once you say "compete," give students 10-15 seconds to gather their resources.
- Have the students gather back into a circle with their resource cards.

2. With the group, discuss the activity.

- Have the students share the resource cards they gathered. Ask the students, what might happen to the plants that did not get all three limited resources?
- Do you think plants experience resource competition like this in the schoolyard habitat?
- Remind students about adaptations, or inherited traits, covered during the Web It lesson. A plant species that adapted a particularly long tap root will be able to gather water deeper in the soil during a drought. A plant species that adapted to using very little sunlight to make food can survive living under the shade of a thick forest. Diversity is important for plants to minimize competition for survival.
- A plant that finds itself in a poor site with lots of competition will eventually die.

ACTION: Part II (15 minutes)

Investigation

1. Introduce the activity and remind students of the study area boundaries.
Explain that the students will investigate the plants in their study site, especially the part of the plant they rarely see – the roots.

- Explain/review that the above-ground part of the plant is called the ***shoot*** and includes the stem, branches, leaves, and flowers.
- Explain/review that the below-ground part of the plant is called the ***root***.
- Have the students look around in the study site. Can you tell by looking at the shoot what the root will look like? Why or why not?

2. Show the group the Mystery Plants one at a time.
Explain that the shoot is inside the bag – only the root is exposed.

- Mystery Plant 1: Ask the group to describe the root. Introduce the term ***fibrous root*** to describe the root.
- Mystery Plant 2: Ask the group to describe the root. Introduce the term ***taproot*** to describe the root.
- Optional: Have the students guess what the shoot might look like for each Mystery Plant – do not show them yet!

Keep in mind…

We are digging in a public space so we need to be respectful of gardens, be aware of what plants should not be dug up, and fill in any holes left behind by root removal.

3. Demonstrate how to dig up a plant. Not all students have used a trowel before, so it is important to demonstrate how to dig up a plant so that most of the root structure comes up also.

- Find the center of the plant that you wish to dig up. Push the trowel into the ground in a circle about 3-4 inches away from the center, around the plant. Then push the trowel into the soil at an angle around the circle, and try to work the root clump out of the ground – preserving as many roots as possible. Gently shake the plant to remove soil to really see the root.
- Point out the plants that should not be dug up. If the students have questions about what can be dug, have them ask you first.

4. Divide the group into teams of two, pass out the materials, and give the challenge.
Tell the students to find two plants that they think will have the two different root systems.

- When choosing a plant to dig, the shoots should be no larger than a student's hand to prevent them from making inappropriate choices.
- Hand each team a trowel.
- Remind the team of the boundaries and send them off to collect two plants per team.

7. Circulate among the teams as they dig. Assist the students as needed, making sure that they dig up all the roots. Have the students shake off as much loose dirt as possible.

8. When it is time to end the search, regroup your students in a circle
9. Examine the roots collection.

- Have each team lay out their roots.
- Have the group sort the roots into three different piles: tap, fibrous, and other.
    - Have each team sort their roots and explain why they made their decision.

- Discuss the taproot and the fibrous root pile.
  - Do all the roots in each pile look the same? If not, why might the differences exist?
  - What characteristics do the roots have to help the plant compete for resources?
  - How do these characteristics help the plant survive?
- Discuss the roots that may not have fit into either the taproot or fibrous root pile.
  - Do they really belong in one of the two piles or are they really a different type of root?
  - Does everyone agree? Have the students discuss their choice of placement and their opinion on whether the third pile should exist.
  - How might the roots in this pile have a stronger or weaker ability to compete for survival?
  - Explain that scientists looks for similarities and differences in plants to help explain how certain characteristics can help or hurt a plant's survival.

DISCUSSION (5-10 minutes)

Group guides will find most of these questions on their guide cards in the activity kits.

Prompt the students with questions like the following:

☐Why are plants important in a habitat?
- They provide food and shelter for other animals
- High diversity of plants in a habitat often leads to high diversity of insects and animals because there are plenty of food and shelter options
- They hold soil in place with their roots
- They produce oxygen for everything to breath

☐Why do plants have roots?

☐Were some roots easier to get out of the ground?

☐How do plants benefit from having different root systems?

☐If one type of root system isn't allowing a plant to compete successfully, can it switch to having a different type of roots system?

☐Has anyone heard the term ***invasive species***?
- Hand each student an invasive species card. They are to read about the adaptations of their plant that make it a strong competitor, and then share out one of the adaptations. Do any of the invasive species rely upon their root systems for the competition?
  - Answer: Ivy, Blackberry, Scotch Broom, Holly, Laurel, Butterfly Bush
- Have the students look around. Can they spot any invasive species from the group's study area? (An invasive species hunt is a great activity to keep the kids together during the walk back to the school, too.)

☐How do animals, including humans, use roots? Have you eaten a root? A shoot?

☐How do humans help or hurt some plants survival (excluding plants intentionally cared for in gardens)?

STUDENT JOURNAL (5-10 minutes)

Have the students complete the Roots and Shoots worksheets in their field journal.

CLEAN UP

The importance of clean-up is critical to the smooth operation of the program. Children are expected to help.

1. Collect and organize all materials. Put the activity materials back into the kit.
2. Wrap the strings around all hand lenses and return them to their plastic bag in the kit.
3. Remember the goal is to leave no trace. Replant or compost the roots collected during the lesson. Fill in any holes left by root removal.

CONCLUSION by TEAM LEADER (5 minutes)

After all the field groups have returned to the classroom, the Team Leader will do a brief wrap-up discussion at the end of the lesson. (If some students are already working on their field notes, have them put down their writing utensils so they will actively participate in the conclusion discussion.)

Concluding questions

- What interesting observation did you make about roots and/or shoots today?
- How do plants compete for survival?
- Why are invasive species able to outcompete so many other plants?
- Why is it important to have a variety of plants and plants with different root systems in a habitat?
- How do humans help some plants survive?
- How do humans cause some plants to lose the competition and die?

Talk briefly about the next activity.