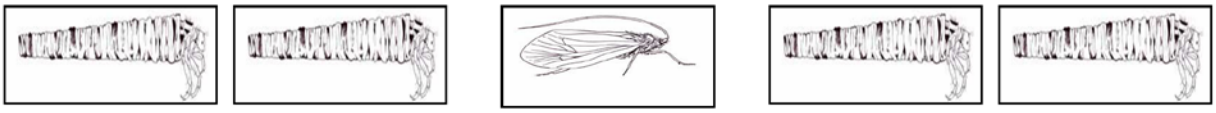


WATER

Water Quality Station

Teacher/Volunteer Summary

Objectives:

1. Learn about different types of aquatic organisms that live in Utah streams.
2. Learn about life cycles of aquatic macroinvertebrates
3. Learn adaptations of aquatic macroinvertebrates
4. Learn how pollution affects aquatic macroinvertebrates
5. Learn about the sources or causes of pollution

Core Curriculum Connections:

Standard 5: Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organism for each environment

Objective 2: Describe the common plants and animals found in Utah environments and how these organisms have adapted to the environment in which they live

a. Identify common plants and animals that inhabit Utah's forest, wetlands, and deserts
b. Cite examples of physical features that allow particular plants and animals to live in specific environments (e.g. gills, claws, specialized mouth parts)
c. Describe some of the interactions between animals and plants of a given environment (e.g. fish eat macroinvertebrates, birds eat fish)

Objective 3: Use a simple scheme to classify Utah plants and animals

d. Use a simple classification system to classify unfamiliar Utah plants and animals (e.g. macroinvertebrates)

Objective 4: Observe and record the behavior of Utah animals

e. Use simple classification schemes to sort Utah's common insects and spiders

Background:

The small animals living in water are called aquatic macroinvertebrates. These macroinvertebrates include many types of insects as well as other animals such as worms, mollusks and tiny crustaceans. Aquatic macroinvertebrates can be found in lakes, streams, ponds, marshes and puddles. They are important because they not only play an important role in the food chain, but they can help us determine the health of the water body in which they are found.

A measure of "water quality" can include the amounts of dissolved oxygen, temperature, turbidity, pH levels, algal growth and nitrate levels. Some aquatic macroinvertebrates such as stoneflies, mayflies and caddisflies breathe through gills and therefore require a high level of dissolved oxygen in the water. Their presence is often an

indication of good water quality. Other macroinvertebrates can survive at a lower dissolved oxygen level because they have adapted means of taking in oxygen at the surface either through a breathing tube (mosquito larvae) or by carrying an air bubble with them around their bodies (water boatman and backswimmers). Aquatic worms and leeches can survive at very low oxygen levels. Lower dissolved oxygen levels are often associated with polluted waters while high levels indicate good water quality.

Science language students should use:	Wetland, adaptation, invertebrate, insect, macroinvertebrates, larva, nymph, adult, head, thorax, abdomen, petri dish, pipette, substrate
Common animals:	Stonefly, mayfly, caddisfly, blackfly, cranefly, water boat men, dragonfly, planaria, aquatic worm

The water quality station begins with an introduction to water quality and aquatic macroinvertebrates for the entire group. The students will first participate in Build-a-Bug (see lesson plan on following pages), and then will be divided into two sub-stations that are 20 minutes in length. Each station has approximately 15-20 students

The two substations are:

1. Students will take a short walk to the Logan River and collect macroinvertebrates. A few volunteers will collect invertebrates using nets and waders; other students can look under rocks along the edge of the river for invertebrates (see Macroinvertebrate Collection on the following pages

2. Students will gather around the picnic tables to observe and identify aquatic macroinvertebrates. (See Macroinvertebrate Classification on the following pages)

Macroinvertebrate Collection

PURPOSE: To introduce students to macroinvertebrates through collection and observation

SUMMARY: Students will learn to collect macroinvertebrates

BACKGROUND: Many of the macroinvertebrates that live in streams make their homes in gravel and cobble substrate of riffles and pools. By turning over stones and rocks and examining the underside, you may find aquatic macroinvertebrates.

MATERIALS:

- Kick nets
- Plastic pans
- Waders or boots

SAFETY FIRST!

Always consider safety factors when working near water.

PROCEDURE:

1. Lead the students to the Logan River
2. Explain to the students that we will be collecting aquatic macroinvertebrates with nets and by looking on the underside of rocks.
3. Explain to your students how to collect a macroinvertebrate sample
    a. One student will wade into the stream and place the net so the mouth of the net is perpendicular to and facing the flow of water.
    b. Another student will stand upstream of the net and disturb the stream bottom with his/her feet and hands.
    c. Students can carefully pick up and rub stones directly in front of the net to remove attached animals. The stream bottom materials and organisms will be carried into the net by the current.
    d. Tell the students to continue this process until they see no more organisms being washed into the net.

4. Have the students hold the sample over a plastic pan filled with water and rinse the net into the water.
5. Have the students observe the organisms they find.
6. As students turn over rocks, talk about what they would find on the underside. Explain that invertebrates often use the underside as refuge from protectors

Macroinvertebrate Classification

PURPOSE: To give students an opportunity to observe the behavior of aquatic macroinvertebrates and teach them how to identify and classify them.

SUMMARY: Students will observe the behavior of aquatic macroinvertebrates in large tubs. They will also use simple dichotomous keys and pictures to identify and classify aquatic macroinvertebrates.

BACKGROUND: Scientists have developed and use dichotomous keys to classify plants and animals. A dichotomous key is made up of statements arranged in couplets. Each set of couplets consists of two descriptions that should represent mutually exclusive choices. Both choices are compared against the organism being identified. Once a choice is made, that selection directs you to another couplet. This process is repeated until a successful identification is made.

Stonefly- usually 2 tails, gills on the thorax ("armpits"), pollution intolerant, needs high levels of DO to breathe and survive, spends most of life as juvenile in stream, may begin doing "push-ups" in tubs to force water through gills.

Mayfly - usually 3 tails, gills along abdomen, pollution intolerant, also needs high levels of DO to breathe and survive, spends most of life as juvenile in stream, only lives a few days to a week as an adult, may begin doing summersault type movement to move water past gills.

Caddisfly - makes itself a case out of sand, dirt, sticks, or other small debris, has a long, white or greenish abdomen (not visible when caddis fly is inside case), pollution intolerant, spends most of life as juvenile in stream, will form pupae stage similar to butterflies and moths before emerging as adult, hair-like gills along abdomen.

Cranefly – worm like segmented body with thin, almost transparent skin, have spiracles on the posterior end of the body, can survive in somewhat polluted water, some crane flies breathe through the spiracles on posterior end, others breathe as oxygen is diffused through skin to tracheal gills.

MATERIALS:

- 8 large tubs
- Petri dishes (1 per student)
- Pipettes (1 per student)
- Magnifying glasses (1 per student)
- Dichotomous keys
- Aquatic macroinvertebrates collected previously from the stream

PROCEDURE:

1. Have students line up at the equipment table. Review with them the proper use of the equipment.
    a. **Petri dish:** can be used to carefully scoop up bugs or place bugs in with fingers or pipettes. Be sure to put water in the petri dish first!
    b. **Pipette**: used to suction water from the tubs to fill the petri dish. The pipette can also be used to suction up small bugs (Please do not allow students to suction up large bugs. It will rip their arms and legs off!)
    c. **Magnifying glasses:** used to look closely at macroinvertebrates and observe gills, claws, hooks, hairs, mouth parts, etc. Have student up magnifying glass to eye and then bring petri dish up to eye (or bed over to reach petri dish).
2. Let each student collect equipment and show them the tubs of macroinvertebrates.
3. Walk around the student sand help them reach the dichotomous keys. Challenge them to identify as many macroinvertebrates as they can.
4. As students ID bugs and ask questions, talk about the unique features of each macroinvertebrate. For example, point to the gills on stoneflies and mayflies, have students observe the caddisflies cases.

Build a Bug

PURPOSE: To introduce students to macroinvertebrates and the adaptations they have which allow them to live in an aquatic environment.

SUMMARY: By watching a presentation where one of their classmates is dressed up in a bug costume, students will learn what adaptations macroinvertebrates have in order to live in an aquatic environment.

BACKGROUND: The small animals that live in water are called aquatic macroinvertebrates. These macroinvertebrates include many types of insects as well as other animals such as worms, mollusks, and tiny crustaceans.

Most aquatic macroinvertebrates make their home in rocks, leaves, and the sediment of streambeds. These organisms have many special adaptations, allowing them to live in demanding environments. Macroinvertebrates that live in riffles and fast-moving water may have features that help them hold on to rocky or hard substrates, such as hooked feet, suction cups, and flat bodies. Macroinvertebrates that house themselves deep in muddy substrates may have adaptations for a low oxygen environment. See the "Adaptations" column in the following chart for more examples.

Adaptations	Item representing adaptations
Legs/claws	Water noodle with hooks on the end
Tails	Garland or rope
Compound eyes	Sunglasses with craft eyes glued on
Sensory hairs on head	Wig or furry hat
Gills	Feather Boa
Antennae	Store bought or homemade antennae
Air bubble (Plastron)	Balloon
Air tube	Straw
Specialized mouth parts	Fake vampire teeth
Net for catching food	Fishing net

MATERIALS:

- Items in the "Items Representing Adaptations" Column above

PROCEDURE:

1. Ask the students if they know what an adaptation is. Have them brainstorm different adaptations a bug would need to live in an aquatic environment
2. Choose a volunteer from the class. Explain that you will be preparing the student to live as an aquatic macroinvertebrate.
3. Ask the students to tell you adaptations the volunteer would need to order to live in the water.
4. As the students tell you adaptation ideas, dress the volunteer in the items from the table above that represents the adaptations.
5. Discuss the adaptations as you go along. Why would a macroinvertebrate need them? How do they help the macroinvertebrate survive?
6. After the students have named all the adaptations, ask the class if XXX (volunteer's name) could survive in the water like aquatic macroinvertebrates now that he/she has all these adaptations. Say "should we go throw him/her in the river now to see?"
7. Thank him/her and let them keep the teeth and straw.

NOTE: An individual macroinvertebrate may not have all the adaptations listed on the table. Your volunteer "bug" will have features found on many different types of macroinvertebrates.

WILDLIFE

Bear River Refuge
Migration Matters

Teacher/Volunteer Summary

Objectives:

- Students will understand the concept of migration/migratory birds and be able to name at least two migratory species
- Students will identify three reasons/barriers that explain why "migration isn't easy" (example: loss of food, habitat)
- Students will describe how invasive species impact migratory birds

Core Curriculum Connections:

Grade 4-Standard 5: Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment.

Objective 2: Describe the common plants and animals found in Utah environments and how these organisms have adapted to the environment in which they live.

a. Identify common plants and animals that inhabit Utah's forests, wetlands, and deserts
c. Describe some of the interactions between animals and plants of a given environment (e.g., woodpecker eats insects that live on trees of a forest, brine shrimp of the Great Salt Lake eat algae and birds feed on brine shrimp).

Key vocabulary:

- Bird
- Migration
- Flyways
- Wetlands
- Habitat
- Invasive species

Migration Matters

SUMMARY: Student participants increase their understanding of migration and migratory birds by playing Migration Matters. This game demonstrates the main needs (habitat, food/water, etc.) for migratory birds, and several of the pitfalls and dangers of NOT having any of those needs readily available along the migratory flyway.

BACKGROUND: Providing food, water, and habitat for migratory birds is a major portion of the US Fish and Wildlife Service (FWS) & Bear River Migratory Bird Refuge's (MBR) mission. Migratory birds are historically the reason the refuge exists, and teaching the students about the many species of migratory birds that either nest or stop-off at the refuge is an important goal.

The refuge hosts over 200 migratory species including large numbers of Wilson's phalaropes, Tundra swans and most waterfowl, and also has upwards of 70 species nesting on refuge land such as White-faced ibis, American Avocet and Grasshopper sparrows. Without large migratory stopover wetland and grassland habitats, many of these species would not have many alternatives for foraging or nesting habitat suitable to their needs, and the energy-consumption of migration, molting, and breeding could be detrimental without readily accessible food and shelter.

MATERIALS:

- Colored pipe-cleaners in rings to represent "food"
- 5-6 laminated representations of wetland habitats
- 35 Bird Name tags (1 bird per student; 5 spp/7ea)
- 2 long ropes to delineate start/end of migration

PROCEDURE:

Set-up/warm-up: Set up the "game board" in a large outdoor space – preferably on grass if possible. A large indoor space will work if weather does not allow outdoor time. A good alternative (if time permits) is to have the students/participants help set up the game area as it peaks their curiosity and keeps time interactive.

Start by placing your rope on the ground in two areas representing beginning and ending spots for migration. For example – one area will be roped off as "the Tundra" or the starting area where a large amount of migratory birds breed. About 30m away, will be the second area representing the southernmost portion of the migratory pathway such as Mexico or South America. Extra spaces and rope can be used dependent on the number of participants.

Then, place the large Bear River MBR habitat card on the ground in the center of the area, between the two roped off migratory destinations. Once this is completed, around the area and between the two final destinations…places several (4-5) smaller wetland cards that represent smaller wetland habitat that birds can use as stopover habitat. Next, spread out all of the colored pipe-cleaners that represent "food" for the migratory birds around these habitat cards. Place the

"food" rings close to the wetland habitat cards – and more near the Bear River card to illustrate that more food is available near good habitat and how important. Then, give each student a bird name tag to hang around their neck.

Before the game starts…explain to the students that they are each a migratory bird about to take a long trip along a flyway. Explain/discuss: (Migration: Bird migration is the regular seasonal journey undertaken by many species of birds. Flyway: discuss and show map of 3 North American flyways. Which one are we in? Bear River MBR actually is in parts of both the Central and Pacific Flyway.) Then – have the student "birds" flock together by bird species.

Activity:
The activity itself is simple, but can have several incarnations repeated to prove the point that "migration isn't easy."

1. All participants start at the northern portion of their trek. Each will have a bird name tag on so they can flock with birds of their same species, learn the bird names and how to identify, and their bird's song/call. See listing of calls at the bottom of lesson. Once you have given each student a bird tag and taught them their birds' call, you're ready to tell them the rules.
2. The rules are simple. Each bird needs to get to the other end of migration. They make a beak with their fingers, and while making lots of bird sounds, the students run to pick up one colored "food" ring with their "beak" and then go to the nearest wetland card (Bear River poster included) for shelter/water/habitat. They will rest here for a short moment- quietly to avoid predators- and then when the leader says go, continue on safely to the end of migration. That is the easy version – all birds got food and habitat and made it safely through migration.

Next, ask the participants to put all their food back and return to their new "southern" roosts. While they are doing this…quietly remove a few of the wetland habitat cards AND a few of the "food" rings and start the "return migration" by repeating steps the previous steps. This time…there may not be enough food for everyone, and a few of the stopover wetlands may be too crowded. If a student "bird" did not get food or did not get to a wetland…they need to sit out in a side area designated the "bird cemetery." This demonstrates that just the removal of a few small necessities can have large impacts. Discuss this with the participants.

Again, ask the students to return their "food" rings to the playing field. While they are doing this – remove a few more wetland cards and prepare to start the southern migration one more time. BUT, this time, instruct the participants that invasive plant species (explain what these are, how they got here, etc. Invasive plant species are European or Asian, non-native plant species that were planted usually for landscaping and have escaped into the wild – and now outcompete or choke out other native plants that the birds need as they may not be adapted to eat the invasive.) have taken over some of the land where in the past good feeding grounds existed, and that they can only "eat" or pick up "food" rings of one or two colors, as the other colors

represent the inedible or low-in-nutrition invasive plant. Start Migration and repeat steps 1-3! This time, many more students or "birds" will not be able to find food nor suitable habitat…and unfortunately, may not make it through this season's migration. Notice how many more birds are in the "bird cemetery" than made it through migration. Discuss this and some causes of food and habitat loss such as oil spills, proliferation of agricultural fields, suburban sprawl, etc.

Wrap up:
Have the students identify some of the dangers that face migratory birds, as well as reiterate the basic needs (food/water/habitat) for migratory birds. Ask the participants if they can identify any migratory birds that were mentioned during the game, and have the students explain why invasive plant species are an extra risk to migratory birds. Finish up by having students help pick up all the "food" rings and wetland cards if time permits, and to watch and listen for migratory birds on the walk back to the education center.

BIRD CALLS

Canada Goose: Honk, "Wa-AH"
Wilson's Phalarope: nasal "wok wok"
Snowy Egret: Small burp-ish "blaah"
Northern Pintail: high regular duck "quack"
Red-tailed Hawk: high, screeching and descending "weeeeeeessshhh"

Utah Division of Wildlife Resources
Track Stories

Teacher/Volunteer Summary

Objectives:

- Students will list at least three types of signs that wildlife leave behind (tracks, scat, scrapings, burrows, nests, bones, etc).
- Students will distinguish common animal signs from the natural landscape and form realistic hypotheses about that animal's behavior based on their observations.
- Students will identify the tracks, furs and skulls of common Utah animals.

Core Curriculum Connections:

Grade 4 - Standard 5: Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment.

Objective 2: Describe the common plants and animals found in Utah environments and how these organisms have adapted to the environment in which they live.

a. Identify common animals that inhabit Utah's forests, wetlands, and deserts.
b. Describe some of the interactions between animals and plants of a given environment (e.g., woodpecker eats insects that live on trees of a forest, brine shrimp of the Great Salt Lake eat algae and birds feed on brine shrimp).

Objective 4: Observe and record the behavior of Utah animals.

c. Describe how the behavior and adaptations of Utah mammals help them survive winter (e.g., obtaining food, building homes, hibernation, migration).

Key Vocabulary:

- Naturalist
- Hypothesis
- Nocturnal
- Diurnal
- Hibernation
- Track
- Trail
- Scat

Track Stories

SUMMARY: After discussing why humans infrequently see wildlife and listing the different types of evidence animals leave behind to suggest their presence, students will perform a group activity called Track Stories. Four groups will each examine their own "tracking site:" an area where the tracks of a specific animal are present. Using their observations and a laminated card with additional clues, students will agree on a realistic hypothesis that explains what the animal was doing to create those tracks or other signs. As a class, groups will discuss and illustrate their track stories.

BACKGROUND: Even in lush natural locations, humans are not guaranteed to see wildlife. Many species, such as mountain lions, are rarely seen. This is because wild animals tend to avoid contact with humans. Nocturnal species are not even active at the same time of day as diurnal humans. Animals that are in the process of hibernating are unlikely to be seen as well. Even if we cannot see these animals, they still leave behind signs that they were here:

- Tracks are individual footprints left behind by animals. Oftentimes tracks are lined up into a pattern called a trail. The best places to find tracks and trails are in mud and snow.
- Scat is a fancy word for poop. The shape and contents of scat can reveal information about the animal that made it and what that animal was eating.
- Homes/shelter such as nests and burrows reveal wild animals that live in the area. Different species live in different types of places within a habitat (e.g. tree cavities, near bodies of water, underground) and make different styles of homes.
- Body parts such as antlers and snake skins reveal those animals have been moving through an area. Fur clusters, bones, blood and carcasses suggest predation.
- Sounds are a strategy many wild animals take to communicate, even when hidden. Birds, for example, vocalize to announce their presence, maintain a territory, warn of danger, or attract mates.

MATERIALS:

- 4 large, laminated "Naturalist Know-How" cards
- Castings of animal tracks
- Beaver chew
- Caution tape and/or flags
- An assortment of furs, skulls or other visual aids that coincide with the animals in the activity
- Plastic tarp
- Large dry-erase board with markers
- Noisemaker such as whistle or duck call
- (If hard ground) Loose soil, trowel

PROCEDURE:

Set-up:

Select an area for the class to sit and lay out the tarp. Place the large dry-erase board and markers at the front of the tarp where all students will be able to see. On a table off to the side, set out an assortment of furs, skulls and other visual aids that coincide with the animals in the activity.

Find four spots in the station area to set up tracking sites. If the ground is too hard to stamp obvious tracks, dump water on the area and/or apply a layer of loose soil. After creating a site, block it off with flags and/or caution tape and take measures to prevent students from stepping on the tracks.

The tracking sites are as follows:

- Beaver: Use beaver track castings to stamp tracks around a beaver chew. The tracks may be arranged in a disorganized cluster.
- Coyote and rabbit: Use coyote and rabbit track castings to stamp tracks in a pattern that suggests an interaction between the two. Two parallel lines of tracks works well. Take care to make sure the tracks are realistically spaced (don't space them too close or too far apart considering the animal's size).
- Fox and vole: Build vole holes – loose soil and a trowel might be necessary -- or make scrapings at the base of a log. Stamp fox tracks around holes.
- Mule deer: Find a shrub or low-hanging tree. Break a branch or remove leaves in a conspicuous way, or use a plant that already has similar damage. Stamp mule deer tracks around the base.

Attempt to make the sites look as natural as possible. To make the station more convincing, consider stamping a few trails outside the delineated area. Students tend to be more engaged if they assume the tracks are genuine.

Warm-up:

Students will seat themselves on the tarp in front of you. After welcoming them to the station, ask students if there is any wildlife around us. Why can't we always see them? (They are wild animals, not pets; wildlife tends to shy away from humans; many animals are nocturnal; etc.) What are some ways we can tell that there is wildlife here? (Tracks, scat, scrapings, nests, bones, etc.)

Introduce yourself and explain to students that you are a naturalist, and part of your job is being able to read and understand these signs of wildlife to learn more about how they live. Explain that tracking is not just about being able to identify those signs; it's about looking at how those signs were made and coming up with a realistic explanation of what happened there. That way, you can understand more about which animals live here and what they're up to.
Tell students that in this station you are going to teach them how to be naturalists too.

Activity:
Tell students that you have four places roped off where you found some signs of animals. If they listen closely, you'll tell them which site they're going to in just a moment.

Students need to look carefully at what is inside the caution tape. There might be tracks, or there might be other signs. Their goal is to come up with, as a group, a realistic explanation of what those animals were doing to make those tracks or signs. They are essentially coming up with a story that explains what happened there. Each station has a laminated "Naturalist Know-How" card that gives hints and clues in the form of pictures. When they're ready, they should come back to the table and find their animal or animals on the table full of furs and skulls.

Emphasize that students are to go nowhere but their station and then the table. Do not let students wander off or visit other stations. Also emphasize that each group only has 5 minutes to decide on their track story. When you use the noisemaker (duck call, whistle, etc.), explain that students must immediately come to you and listen to your instructions.

Quickly divide students into four groups (e.g. by row they are sitting in) and send them off to their stations – walking, not running – one group at a time.

Students will perform the activity as described. Invite parent volunteers to rove around and help groups. Presenter will rove around the tracking sites to keep students engaged.

Have each group tell the other groups their track story. While this is happening, the presenter draws or writes what that group is describing on the dry-erase board to illustrate it. If feasible, walk as a group from station to station rather than sitting on the tarp.

Wrap up:
Reinforce the main idea: how do we know animals are here without seeing them?

Ask students if there is any way for us to know if our track stories are correct. (They might say yes, like in the off-chance you see an animal making the tracks). Tell them that might be the case, but most of the time you'll never know for sure. But if you go explore nature on your own time, and pay very close attention to your surroundings, and study animal signs, you can become a very skilled naturalist – which means there would be a better chance your hypothetical track stories actually happened.

If extra time is available, move as a single group or split into parent-led smaller groups to look for other signs of wildlife activity in the area.

UACD
Utah Association of Conservation Districts

SOILS

Soils

Teacher/Volunteer Summary

Objectives:

Students will:

- Describe a soil profile
- Learn how weathering and erosion play a role in the creating of each of the four layers found in a typical soil profile
- Define soil profile and its important to wildlife, plants, water quality and people.

Core Curriculum Connections:

Utah 4th Grade Science Core

Standard 3: Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.

> **Objective 2:** explain how the processes of weathering and erosion change and move the materials that become soil.
>
> **Objective 3:** Observe the basic components of soil and relate the components to plant growth.

Key Vocabulary:

- **natural resource**: anything that people can use that comes from nature
- **non-renewable resources**: limited natural resources that cannot be replaced
- **bedrock**: a more or less solid rock, may be beneath the soil or at the surface (Zion National Park)
- **parent material**: layer in the soil that contains broken up pieces of bedrock
- **subsoil**: the layer of earth below the topsoil
- **topsoil**: fertile upper layer of soil that is rich in organic matter
- **organic layer**: the very top layer of soil (within the topsoil) that is formed from decaying organic material such as leaves, wood, dead plants, insects, and animals
- **profile:** the position of soil layers as they are found in the ground
- **horizon**: the individual layers within a soil profile
- **fertile**: the presence of important minerals and organic material needed to support plant growth
- **weathering and erosion**: weathering involves two processes that often work in concert to decompose rocks. Both processes occur in place. No movement is involved in weathering. Chemical weathering involves a chemical change in at least some of the minerals within a rock. Mechanical weathering involves physically breaking rocks into fragments without changing the chemical make-up of the minerals within it. It's important to keep in mind that weathering is a surface or near-surface process.

(Metamorphism also produces chemical changes in rocks, but metamorphic chemical changes occur at depth where either the temperature and/or pressure are significantly higher than conditions found on the Earth's surface.) As soon as a rock particle (loosened by one of the two weathering processes) moves, we call it erosion, or mass wasting. Mass wasting is simply movement down slope due to gravity. Rock falls, slumps, and debris flows are all examples of mass wasting. We call it erosion if the rock particle is moved by some flowing agent such as air, water, or ice. **So, here it is: if a particle is loosened, chemically or mechanically, but stays put, call it weathering. Once the particle starts moving, call it erosion.**

Background:

If you dug deep enough in the ground, you would hit solid rock. This is called **bedrock**. But, before you reached bedrock, you would have dug through three or four different layers of soil (the **profile**). These layers are often referred to as **horizons**.

The first horizon, or layer, is usually darker in color and contains most of the organic matter in soil. **Organic matter** is the layer formed by plants and animals. In Utah, and the western United States in general, we have less organic matter, and in many rocky places it may be nonexistent. In an area where there is more moisture and plant life, you will find deeper layers of organic matter.

The first layer of soil is called topsoil. The **topsoil** is where plants take root and grow—and for good reason. This is where plants can absorb water, nutrients (minerals), and air (carbon dioxide). Minerals come from rocks. Minerals have several different ways of getting into the soil. Sometimes, they come from volcanic eruptions. Usually, the minerals come from rocks that have broken apart. Rain water flows into the cracks of rocks. When the water freezes, it expands and causes the cracks in the rocks to get bigger, and little bits of the rock break off. Sometimes, the roots of plants will grow into "soft" rock and cause them to break. Water and wind carry the tiny bits of rock along until they get trapped by the soil. You can see how weather and climate (physical forces) can play a big role in the development of soils. Chemistry also plays a role in developing soils. Many rocks are broken apart by lichens, tiny, crusty, coral-like, plants (green, orange, gray, etc.), that live on rocks. Lichens secrete an acid that dissolves some minerals. Also, organic matter is acidic. When water and organic matter mix, they form a slightly acidic solution that breaks down rocks in the soil. That is why soils in the eastern United States are more acidic than soils in the west. There is more rain and more organic matter in the eastern United States. Eastern topsoils are also generally deeper. Organic matter is good for plants. It keeps topsoil in its place, keeps soil particles together, retains soil moisture, and speeds up soil formation. **It takes between 100 and 500 years for just 1-inch of topsoil to form, depending on the type of rocks and climate.** In Utah, our topsoil depths range from 1-12 inches. However, topsoils can be several feet deep depending on their location. Because our topsoils are so shallow, farmers, ranchers, and others who are charged with caring for the land must use practices that conserve topsoils

and hold them in their place. Soil is considered a **non-renewable resource** because it takes so long to form. Topsoil is the thin line or layer that sustains life. If enough of the topsoil blows or washes away, we are left with subsoil.

The **subsoil** is the layer below the topsoil. It is usually lighter in color and less productive than topsoil. Minerals here are not in a form that is easy for plants to use. The subsoil is mostly made up of clay or sand and has very little organic material. Plants grow poorly in subsoil. That's why farmers must work hard to conserve their topsoil.

Between the subsoil and the bedrock is a layer of small rocks that have started to break off the bedrock. This layer is called the **parent material** of the soil. That is because most of what makes up the soil was once part of the rock.

Why soils are different in wetlands, deserts, and forests? A clue to help answer this is to think about the type and amount of plants that grow in each of these areas. Areas that have more water can grow more plants, which eventually die and decompose, creating more organic material and creates a **fertile** environment for more plants to grow. That is why soils look and act different in wetlands, forests, and deserts. Logan Canyon is forest, Cutler Marsh is wetland, and the dryer, lower areas around Utah are considered high mountain deserts.

Soil Tubes

SUMMARY: Students learn the basic components of soil, and how these components relate to plant growth, by creating soil profiles in soil tubes

MATERIALS:

- 6 ½ " x 1" soil tubes
- One cap per tube
- Plastic dividers
- Soils: bedrock, parent material, subsoil, and topsoil
- Dowels for packing tubes
- Labels to seal tube lids and write student's name
- Bags for teachers to carry soil tubes

PROCEDURE:

Set up:

1. Place the tubes at the head of the table.
2. Line up the tubs that hold the soil, with the bedrock/gravel first, followed by parent material, subsoil, and topsoil.
3. Put the containers holding dividers and dowels between the soil trays.

4. Place the container holding tube lids and the labels, with a marker, at the end of the table. Make sure there is also a bag at the end of the table for the teacher to use to carry the finished soil tubes.

Warm up:

1. Ask students to line up on each side of the picnic table and have a seat. Remind them that there is a lot of cool stuff on the table but for now they need to keep their hands at their sides.

2. Ask students the following questions: Would all the soil under your feet look the same if you could take a slice, just like slicing into a birthday cake? Why? What would you find? (Layers of different types of soil with different texture and color, etc.) How important is soil? (You could mention how everything we eat comes from the soil, give some examples, etc.) Describe a soil profile. (See poster).

3. Name the layers found in a soil: topsoil, subsoil, parent material, and bedrock. Point at the soil tubs as you describe each layer. (You may want to briefly define each layer here. See the above background and vocabulary sections for layer names and how they are created. Talk about weathering and how the bedrock/parent material breaks down to become finer soil. Weathering occurs when rock is at rest, and erosion occurs when the broken down pieces of rock move and are transported.)

4. Tell students that they are going to build their own soil profile, using a tube and the different layers of soil found in the tubs on the table. This model of a soil profile will provide students with a window to the Earth's surface.

Activity:

1. Ask the teacher if he/she would please move to the end of the table. They will be helping the students put write their name on a label and put it on the top of their tube.

2. While students are still sitting, demonstrate how to make their soil tube, including the labels and dropping them in the bag when they are done. Be very specific.

3. Put about 1 ½ inches of bedrock/gravel in the plastic tube.

4. Place a plastic divider in the tube, lip-side up (you can tell the students to think of it as a cereal bowl), and tap it firmly with a dowel to form a tight seal against the gravel.

5. Put about 1 ½ inches of parent material in the tube. Tap it firmly to pack it tight, and cover with a plastic divider.

6. Put about 1 ½ inches of subsoil in the tube. Tap it firmly to pack it tight, and cover with a plastic divider.

7. Fill the rest of the tube with topsoil, tap the topsoil firmly with a dowel, and place the cap on the tube.

8. Have the school teacher write the names of the students, as they see them coming down the line, on the nametags and then place the nametags on the tubes. When the student gets to the teacher, have the student name to the teacher, from memory, the different layers they created. The soil tubes should go in the bag and be carried by the teacher.

9. After the student has completed their soil tube they may draw the soil profile in their journals while they wait for everyone else to finish.

Conclusion/Discussion

1. Have the school teacher hold up three soil tubes. Ask the students if all the profiles are alike? (NO-*Describe why.*)
2. If you dug a hole here in Logan Canyon, a hole by your school, and a hole out in Cutler Marsh, would they look the same or different? Why? (Different-*Explain why*).

Soils

Teacher/Volunteer Summary

Objectives:

- Discuss how much of the Earth is available for farming the world's food
- Learn about the different soil particle sizes

Core Curriculum Connections:

Utah 4th Grade Science Core
Standard 3: Students will understand the basic properties of rocks, the processes involved in the formation of soils, and the needs of plants provided by soil.

Objective 2: explain how the processes of weathering and erosion change and move the materials that become soil.

Objective 3: Observe the basic components of soil and relate the components to plant growth.

Key Vocabulary:

- *natural resource:* anything that people can use that comes from nature
- *non-renewable resources:* limited natural resources that cannot be replaced
- *topsoil:* fertile upper layer of soil that is rich in organic matter
- *fertile:* the presence of important minerals and organic material needed to support plant growth
- *parent material:* layer in the soil that contains broken up pieces of bedrock
- *erosion*: the movement of materials
- *weathering*: the breaking and wearing down of Earth's rocks, soils, and minerals
- *sand*: soil particle that is classified between 2.00 and 0.05 mm, relatively large and gritty
- *silt*: a soil particle that is between 0.05 and 0.002 mm, medium particle size, feels like flour
- *clay*: any soil mineral particle less than 0.002 mm, cannot be seen by eyes alone

Background:

Agriculture is the nation's largest employer. Roughly one in five people rely on farms and farming for their livelihood. It costs the farmer more to produce good crops in poor soil. Soils produce our food, keeping us alive. The soils on this planet are essential to our survival! Good soils are a limited resource. One inch of topsoil takes 100-600 years or more to make. (In Cache County, it takes approximately 25 years to create soil in the thickness of a dime.) And, wind and water erosion can remove that much topsoil in a single year! So, soil is considered a non-renewable resource. We need to conserve what we have.

The soil is composed primarily of **minerals** that are produced from **parent material** (rock) that is **weathered**, or broken into small pieces. Beyond occasional stones, gravel, and other rock debris, most of the mineral particles are called **sand**, **silt**, or **clay**. These mineral particles give soil texture.

Soils containing relatively large particles are classified as **sand** and feel gritty to the touch. **Silt** is the size between sand and clay and feels like flour, or is powdery. **Clay** particles cannot be seen with the unaided eye. Clay is slick or rubbery when moist or wet but can be hard as a brick when dry. Clay retains the most water, sandy soils the least.

The size of soil particles is important. The amount of open space between the particles has a lot to do with how easily water moves through the soil and how much water it will hold.

Apples and Soil Particles

SUMMARY: Students will watch a demonstration displaying the amount of Earth's fertile soils. They will then play a game to learn about different soil types.

MATERIALS:

- Apples
- Knife and cutting board
- Sand, silt and clay samples

PROCEDURE:

ACTIVITY 1—SOIL, THE THIN PEEL

Go over the following cutting an apple into sections as you go. (*see demonstration board)*

1. Imagine the Earth as an apple. If it were sliced in four pieces, **three** pieces would represent bodies of water (ocean, lakes, rivers, etc.). **One** piece would represent land.

2. If the remaining slice were cut in half again, one half would represent the land on earth unsuitable for plant growth (deserts, ice caps, mountain peaks, etc.).

3. This leaves **one-eighth** of the apple, representing land that can potentially grow plants.

4. Of the remaining piece, **three-fourths** represent soil too poor for farming (could flood in growing season or be too hot for crops) or covered by cities, roads, and buildings. So, only **1/32nd** of the whole apple represents land that is actually used to grow food.

5. The **peel** of this section represents the thin layer of ***topsoil*** that supports plant life.

6. *Help the students realize just how small the portion of the Earth's surface is available for farming and growing all the crops needed to feed the world's population. Explain topsoil.*

ACTIVITY 2—SOIL PARTICLE SIZE

1. Discuss the different soil particle sizes (sand, silt, and clay). Sand is the largest particle size, and clay is the smallest particle size.

2. Which particle size does water move through the fastest? We are going to find out.

3. Assign one student to be a water droplet.

4. Everyone else will be a soil particle. First we will be sand. Everyone hold their arms straight out and stand so you are barely touching fingertips. Soil particles can rotate around but cannot move their feet. Then have students put hands down at their sides.

5. Ask the water droplet to move through the soil. How easy was it?

6. Everyone will now be silt particles. Everyone will put their hands on their hips and move closer together so elbows are barely touching. Then have students put hands down.

7. Ask the water droplet to move through the soil. How easy was it?

8. Everyone will now be clay. Everyone one will put their arms to their side and move closer together so shoulders are touching. Ask the water droplet if they could move through the soil very easily? (*For safety, don't let the water droplet move through soil.*)

9. Now ask the class again which particle size was easiest to move through.

10. Have students think of which soil particle they would now like to be. Don't tell each other which one; just think of it in your mind. Now put your arms in that position. This is how the soil under our feet looks like. It is made up of sand, silt, and clay. *Most soil is a mixture of all three. Plants grow best in a combination of sand, silt, and clay.*

Conclusion/ Discussion

1. Is it important to conserve topsoil?
2. What happens to water in sandy soil? In clay soil? What would you like to grow corn in?

PLANTS

Tree Factory

Teacher/Volunteer Summary

Objective:

- Students will understand the structure of a tree and how different parts of a tree help the
- tree function

Materials:

- Slips of paper
- Paper sack or bag
- Whiteboard and markers

Core Curriculum Connections:

Grade 4

- **Standard 5**- Students will understand the physical characteristics of Utah's wetlands,
- forests, and deserts and identify common organisms for each environment
    - **Objective 2**- Describe the common plants and animals found in Utah environments and how these organisms have adapted to the environment in which they live
        - B. Cite specific examples of physical features that allow particular plants and animals to live in specific environments
        - C. Describe some of the interactions between animals and plants of a given environment

Background:

From a tree's tiny **root hairs** buried in the ground to the highest leaves in its **crown**, each part of a tree plays a role in helping it to function. Here's a rundown of the various parts of a tree and what each one does:

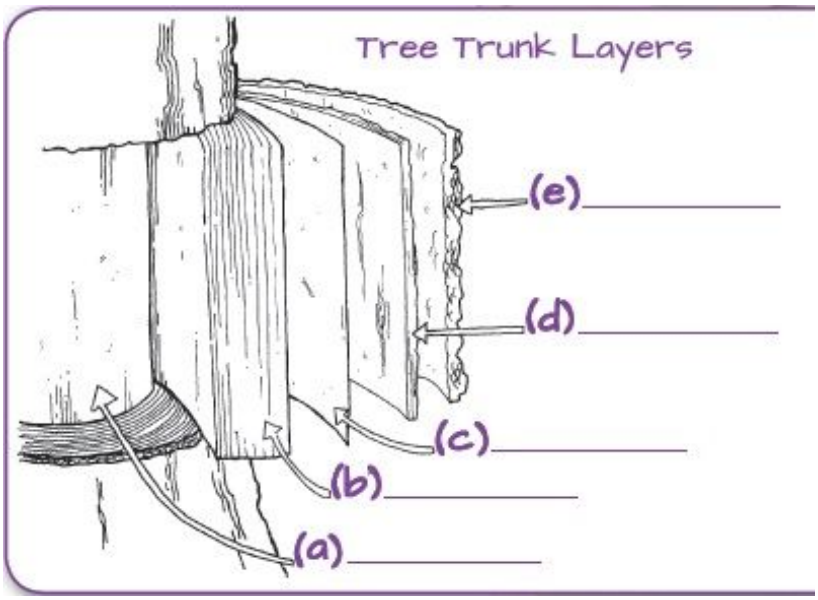
Leaves

Leaves are the food factories of a tree. Using energy from the sun, which they capture with a pigment called **chlorophyll**, leaves convert carbon dioxide and water into oxygen and sugar (food!).

This process is called **photosynthesis**. The gases needed for and generated by photosynthesis enter and exit through tiny holes called **stomata**, on the under-surface of the leaves. Water vapor also exists through the stomata in the process of **transpiration**.

Trunk and Branches

The trunk provides support for branches, which in turn support the tree's leaves. The trunk and branches contain the tree's "pipes" - the tubes that transport water and nutrients to the leaves, and sugar from the leaves to the rest of the tree. They also contain the growing layer of the tree that makes the trunk, branches, and roots of the tree thicker each year. Here's a look at a tree trunk from the inside to the outside and a description of what each layer does:



a. Heartwood forms the central core of the tree, is made up of dense dead wood, and provides strength for the tree.

b. Xylem, also called sapwood, carries water and nutrients up from the roots to the leaves; older xylem cells become part of the heartwood

c. Cambium, a very thin layer of growing tissue, makes cells that become new xylem, phloem, or cambium

d. Phloem, also called the inner bark, carries water and the sugar made in the leaves down to other parts of the tree such as roots, stems, buds, flowers, fruits.

e. Bark protects the tree from injury caused by insects and other animals, by other plants, by disease, and by fire; bark characteristics vary from species to species

Roots

A tree's roots help anchor the tree in the ground. They also absorb water and nutrients from the soil. Trees have lateral roots that spread out from the tree and cover a broad area. Some trees also have a taproot that grows straight into the ground. As a tree's lateral roots grow away from the tree, they branch into finer and finer roots called rootlets . The rootlets themselves are, in turn, covered by even finer root hairs. These root hairs absorb approximately 95% of the water and nutrients absorbed by the tree.

Procedure

Set-up:

1. Write the following parts of a tree on separate slips of paper and put them in a sack or bag.
    a. Heartwood (1)
    b. Xylem (2)
    c. Cambium (4)
    d. Phloem (5)
    e. Bark (6)

Activity:

1. Ask students what people need to survive (food, water, air). Identify parts of the body that help provide those basic needs. Explain that trees are like people in many ways.
2. Ask the group to think about trees and what they need to survive (food, water, sun, air, space). Write them on a whiteboard. When students have completed the list, ask them how the tree gets these things, especially since trees can't move around the way most animals can.
3. Tell students that they're going to create a tree by acting out the tree parts they just discussed. Have each student pick one slip of paper from the sack to find out what role to play in the tree. Take students to an area with lots of space to build the tree.
4. Ask students what makes up the center of the tree and gives the tree strength (**heartwood**). The student portraying the heartwood should stand in the center of the open area, tighten their muscles, and make heart noises, "bumbum -- bumbum," or beating on their chest the rhythm.
5. Ask students what tree part transports water to all parts of the tree (**xylem**). Have the xylem students join hands to form a small circle around the heartwood. Have these students make slurping noises as they raise their joined hands up and down.
6. Ask students what moves food from the leaves through the tree (**phloem**). Have the phloem students join hands and form a large circle around the tree. Then have them simulate the role of the phloem by reaching above their heads and grabbing (for food), and then squatting and opening their hands (releasing the food) while chanting "food, food, food."
7. Ask students if they've left out an important part of the inner tree. What layer produces new xylem and phloem to keep the tree growing and healthy? It's **cambium**. Have the cambium students form a circle between the phloem and xylem. Tell them to sway from side to side and chant, "New phloem, xylem, and cambium."
8. Ask students what final component of their tree is missing - it's something that protects the tree (**bark**). Have the bark students lock arms or hold hands and form a circle that faces out from the center of the tree. Ask them to look tough. Have them bark!
9. When the tree is completely assembled, have all students act out and chant their parts simultaneously, starting from the center.

Assessment

Debrief with students.

- What would happen if any part of a tree failed?
- Do you think all plants have these parts? If not, why not?
- If you were a hungry insect or animal, which part of the tree do you think would have the most nutrients? How would you adapt to effectively reach those nutrients?

The Forest Around Us

By Mark Larese-Casanova and Marni Lee

Teacher/Volunteer Summary

Objectives:

1. Create a dichotomous key.
2. Correctly classify and identify a plant using the dichotomous key.

Core Curriculum Connections:

Grade 4-Standard 5: Students will understand the physical characteristics of Utah's wetlands, forests, and deserts and identify common organisms for each environment.

Objective 3: Use a simple scheme to classify Utah plants and animals.

a. Explain how scientists use classification schemes.
b. Use a simple classification system to classify unfamiliar Utah plants or animals (e.g., tree/shrub/grass, deciduous/conifers).

Background:

Plants can be classified into five major groups, grasses, grass-like, forbs, shrubs and trees. Each group has common characteristics that one can observe and use to classify a single individual plant into a larger group of plant types. These groups of plants can be found in most deserts, forests and wetlands in Utah.

Grasses: A group of herbaceous (green-not woody) plants having long narrow leaves with parallel veins (veins that run the length of the leaf), leaves are attached to a main stem which has a seed head at the top.

Grass-like: Herbaceous plant similar in appearance to grasses, such as sedges and rushes. (We won't really discuss this group in the activity).

Forb: Herbaceous (green-not woody) plant with flowers. Forbs have solid stems (not hollow like grasses) and generally have broad, net veined leaves. Their flowers are often large, colorful, and showy.

Shrub: A low growing woody plant. It has multiple stems or trunks. Bushy. Less than 12 ft. tall.

Tree: A tree is a tall woody plant with a single trunk or stem. Has a large crown full of leaves or needles. Can be deciduous (leaves fall off in fall) or conifer (leaves stay on year-round, leaves are in the form of needles). If trees are pruned by wildlife or people, they can appear as shrubs.

Forest Plant Classification

PURPOSE: Students will understand the characteristics of Utah's forests and the process of classifying organisms using a dichotomous key.

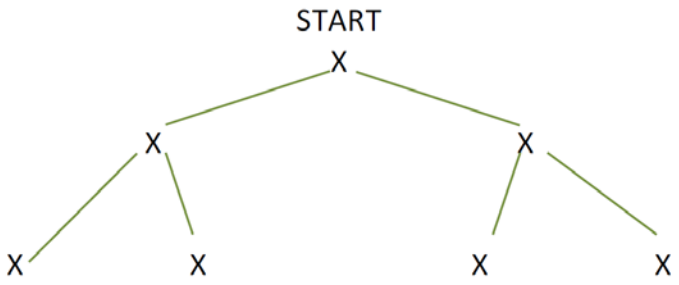
MATERIALS:

- Three plastic or real fruits (apple, orange, banana)
- Large laminated characteristic cards with Velcro on the back
- 2-3 ft. tall wooden stakes with the other side of the Velcro attached
- 18 bandannas

PROCEDURE:

Set up:

Prior to conducting this activity, set up a pyramid of 2-3 ft. tall stakes in the ground. The stakes should have one side of a Velcro strip staples onto which the laminated cards will be attached. Set them up in the following format with one stake at the start, two in the second level, and four in the third level. Make sure that the two pairs in the second level are visually separated from each other. Keep some extra stakes handy in case you need to add a third level somewhere.



Activity 1:

Engage (5min)- Introduce the idea of how to use characteristics of classify things.

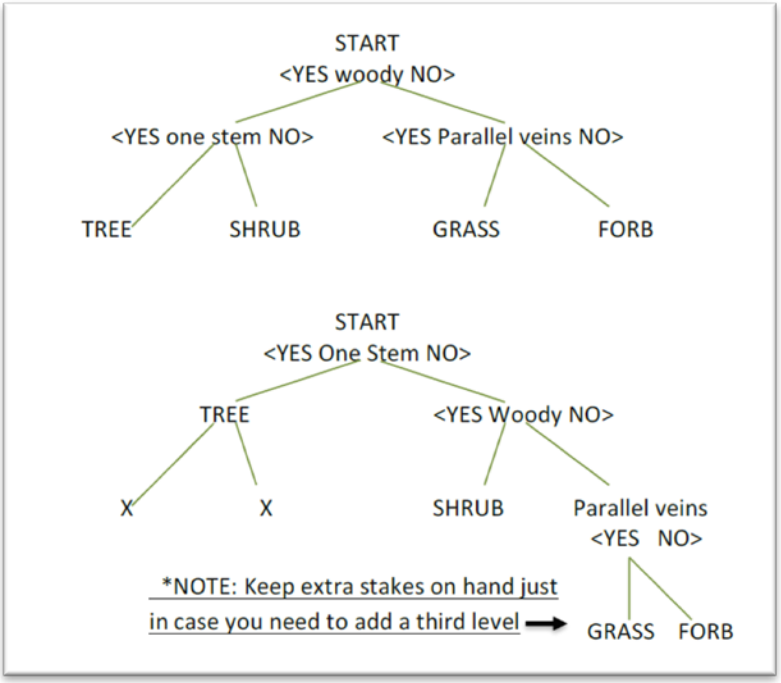
1. Show the class three different fruits (apple, orange, banana) and ask how they would describe each frit. Split the fruits into groups based on one characteristic at a time that the students choose. Explain that their descriptions are a way of classifying not just fruits, but other organisms in nature.
    a. Round/not round
    b. Small/large
    c. Color

Explore (14 min)- Understand the characteristics used in classifying organism, and develop a dichotomous key.

1. Explain that, while forests are mostly trees, there are other kinds of plants that grow in forests as well. Walk around the activity site and point out an example of each to the class while holding the laminated card for each
    a. Trees
    b. Shrubs
    c. Forbs
    d. Grasses

2. As you stop at an example of each type of plant, ask the class for words that describe each kind of plant. What characteristics would they use? Make sure the students mention at least those listed below, and recap this list at the end of the brief discussion.
    a. Tall (discuss how this can be very different for each type of plant. For example, a tree can be tall, but a baby tree is very short).
    b. Woody (trees and shrubs)/non-woody (forbs and grasses).
    c. One stem (tree)/many stems (all other plants)
    d. Parallel veins (grasses)/Branching leaf veins (all other plants

3. Show the students the laminated cards with each of these characteristics, and as which characteristic they want to start with (**NOTE: Do not use "TALL" unless you absolutely need to because it is too vague. Plant height is good to discuss, but can vary for single plant types, and may best be left out of the key**). Place that first characteristic's card on the first post in the pyramid, right above or below the START HERE sign. Then, have the students choose the second characteristic, and the third, and construct the dichotomous key, including the Tree, Shrub, Forb, Grass cards at the dead ends of the key. To the right are two examples of how the dichotomous key could be set up. Remember that there are many possibilities, and you may need to decide how to set it up if the students are not focused.



4. Have all of the students pair up. Ask for one person from each pair to come to you, lead them about 10 ft away from the rest of the group. Visually split this half of the group into four smaller groups and tell

each group that they need to help their partner find a tree, a shrub, forb, or a grass. Tell them that they have to keep it a secret!

5. Blindfold the other member of each pair and have his/her partner guide him/her to their designated type of plant. The blindfolded student will observe the plant through touch only. No peeking! Make sure the blindfolded student tells their partner the characteristics of the observed plant.

6. After a couple of minutes, call the class to the START of the dichotomous key and remove blindfolds. Allow each pair of students to travel through the dichotomous key together (following the correct route through the levels) while using only the observed characteristics from the blindfolded student and see if they arrive at the correct destination!

7. Bring all students back to the start. If time allows, have the students in each pair swap roles and repeat steps 4 through 6.

Explain (1 min)- Explain to the students that you hope this gave them a good look at how to classify and identify organisms using dichotomous keys. If we wanted to keep making our key bigger and bigger we could classify our plants to the exact species, or kind, like lodgepole pine or sunflower.

Assessment:
The ability of the students to learn the process of identifying organisms using characteristics and a dichotomous key will be assessed through whether the students are able to correctly identify their plant while traveling through the dichotomous key.

START HERE

WOODY?

YES

GO THIS WAY

NO

GO THIS WAY

TALL?

YES

GO THIS WAY

NO

GO THIS WAY

PARALLEL VEINS?

YES

GO THIS WAY

NO

GO THIS WAY

ONE STEM?

YES

GO THIS WAY

NO

GO THIS WAY

TREE

SHRUB

FORB


GRASS