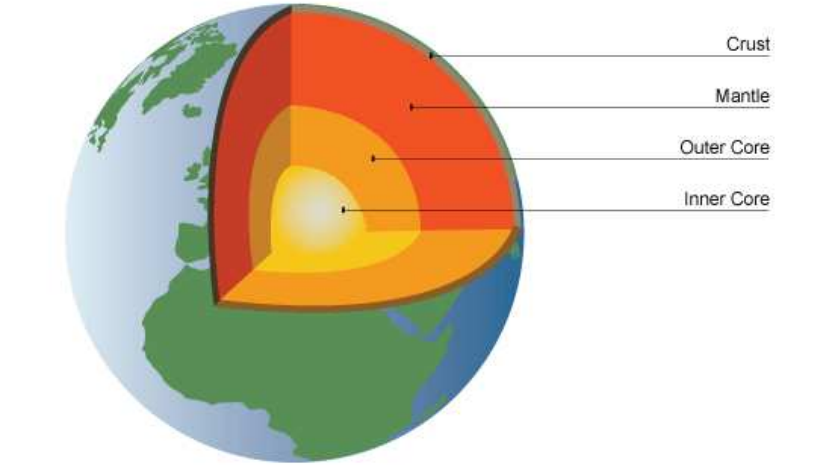
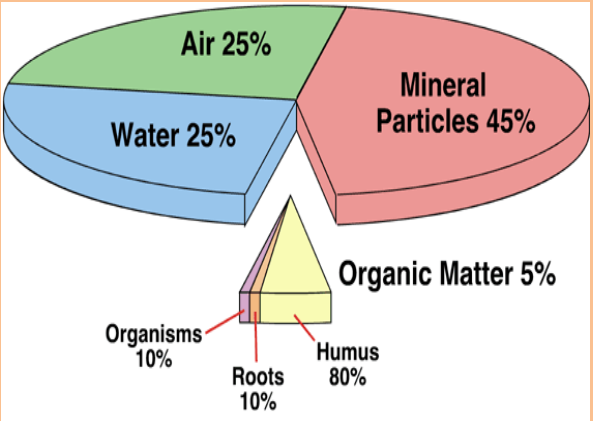
Soil Tunnel Exploration Guide

-A better idea of how to educate with the soil tunnel-

WHAT IS SOIL?

Soil is a naturally occurring mixture of minerals, organic matter, water and air which has definite structure and composition and forms on the surface of the Earth's Crust. Soil is a living ecosystem and is changing all the time.

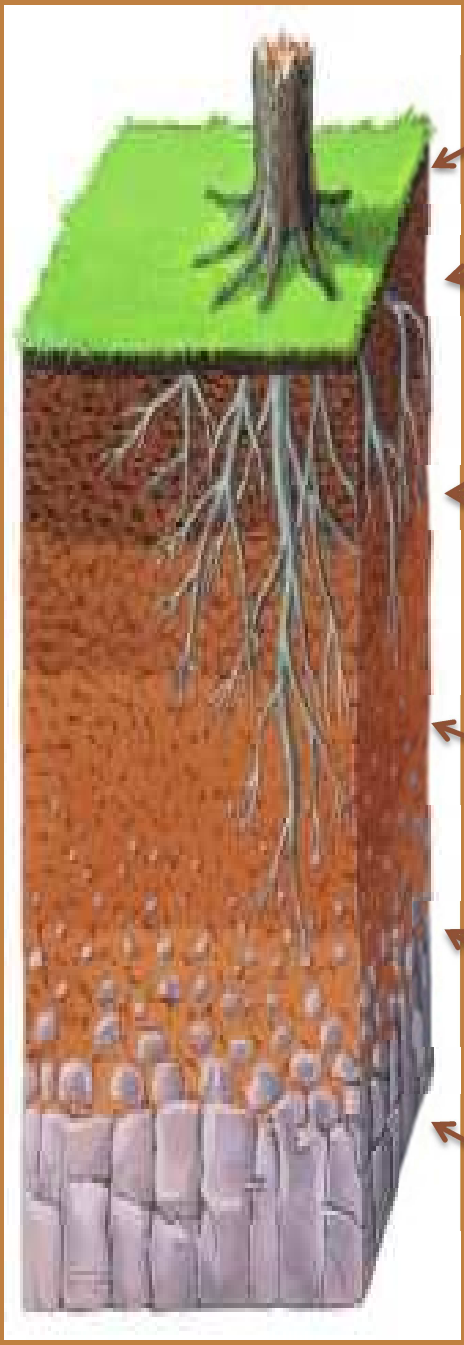




The ideal soil consists of two other components that are vital to living things on earth; water and air. The ideal soil is made up of 50% soil matter (45% mineral material and 5% organic matter), 25% air, and 25% water.

SOIL PROFILES

A soil profile shows how the soil beneath our feet appears. Soils develop into layers called horizons. Each of these horizons differs from the other because they are made up of different textures, and physical and chemical characteristics. Because of this, each horizon looks different from the horizon above or below it.



The ***O horizon*** is the top layer. It is made up of plant litter and keeps the soil very healthy. The plant litter decomposes into nutrients that enrich the soil and form the next layer.

The ***A horizon*** is also called the topsoil layer and is where the roots of plants grow best. It is also where bacteria and fungi live; they help the soil stay fertile and help soil hold water. Springtails and other soil critters do their best work in the O and A horizons.

The ***E horizon*** is found in forested areas. The “E” stands for eluvial, which means clay, iron, organic matter, and other minerals have been removed from this horizon. It is a zone of leaching and often appears white or lighter in color than other horizons. It is not present in every soil horizon.

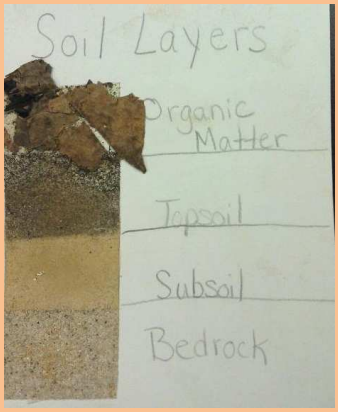
The ***B horizon*** is also called Subsoil. Some plants and animals have a hard time getting through the B Horizon. This layer has a lighter color and is formed from the accumulation of clay minerals and other compounds that seep down from above.

The ***C horizon*** can be very deep. It has less live material in it than any of the layers above. The C layer is formed by parent material that is created from weathered rock.

The ***R horizon*** or bedrock is unweathered parent material. It is a solid layer of rock found on or below the surface of the land. The R horizon is not found in all soil profiles.

ACTIVITY #1

Soil Layer Cards



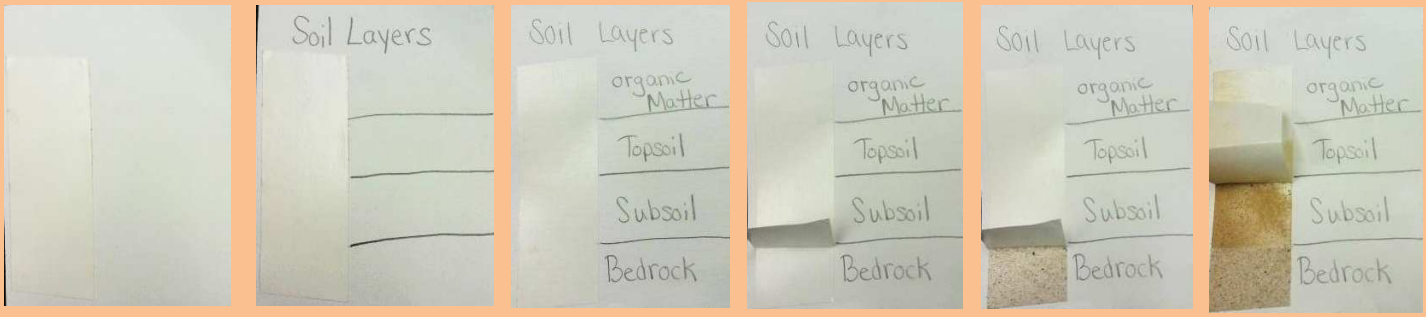
Supplies Needed:
Double sided carpet tape
Card stock paper cut into quarters to look like pictured card
Topsoil
Subsoil
Bedrock (fine sand sticks best to the carpet tape)
Leaves or grass to put on top of topsoil (optional)

Pre-Lesson Set-Up:
1. Cut each 81/2 x 11 sheet of paper into quarters
2. Collect samples of topsoil, subsoil, and bedrock (use sand as bedrock) and put them into labeled containers.

Directions:
1. Give each student a card. Have them stick a piece of doubled sided tape that is 5 inches long to the left side of the card. DO NOT pull the backing off the tape. The tape should like it is single sided right now.

2. Each student should title their card “soil layers.” Using 3 lines, divide the tape into 4 even sections. (See picture.) Extend the lines out to the right side of the card.

3. Label the sections as follows from the top to the bottom: Humus (or organic matter), topsoil, subsoil, and bedrock. There is not a line for bedrock. It simply gets written in the blank spot below the third line.



1. 2. 3. 4. 5. 6.

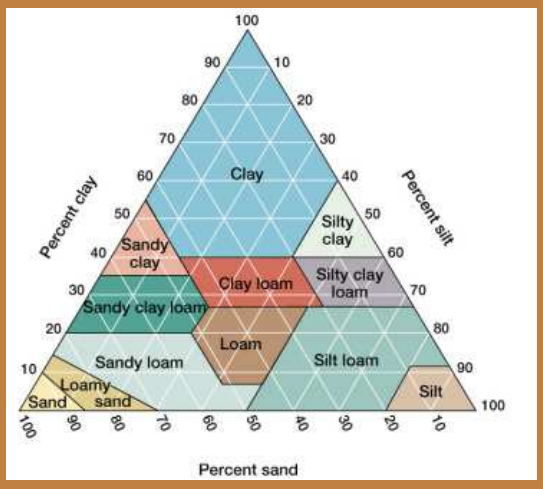
4. Going from the bottom, peel the tape backing up to the bottom line and crease it.

5. Add bedrock to the section of sticky tape that is revealed after pulling the tape back off of it.

6. Continue to peel the tape backing up, stopping at each drawn line, creasing, and adding the correct material.

HOW SOILS ACT, LOOK AND FEEL

Soil texture is a soil property that tells the text of soil based on the amount of sand, silt, and/or clay it contains. There a more than one way to determine the texture of soil.



When a soil scientist wants to determine an official soil texture, the soil scientist may use the soil texture triangle. By doing lab tests scientists can find the percentage of each type of soil and then use the texture triangle to find the soil texture.

Another way that soil scientists determine soil texture is by performing a ribbon test. To do a ribbon test yourself you take a small sample of soil, mix it with water and push the soil between your index finger and thumb. If the soil sample feels gritty and does not ribbon then it contains a lot of sand particles. If it feels sticky and does ribbon then it contains a lot of clay particles. If it feels smooth and partially ribbons, then it contains a lot of silt particles.

WHAT IS SOIL?

RELATIVE SOIL PARTICLE SIZES

Soil type is defined by the amount of sand, silt, and clay particles that are present in a soil sample as well as the texture or how it feels.

***Clay Particles are so small a microscope is needed to see the*

ACTIVITY #2

Loam Soil Model Lesson & Recipe

Supplies Needed:
3oz bathroom cups (3 per student) 1 labeled sand, 1 labeled silt, 1 labeled clay for each student
Salt (represents sand)
Flour (represents silt)
Corn Starch (represents clay)
Vegetable Oil (represents organic matter)
Food Coloring
Water
1 Tablespoon measuring utensil
Quart Size Ziploc bags (1 per student)
Drinking cups full of water (1 water cup per table of students)

Quantities of Salt, Flour, and Corn Starch:
1 – 1lb 10oz container of salt = 7 students
1 box of cornstarch = 38 students
5 lb. bag of flour = 48 students
48 fluid oz. Vegetable Oil = 100 students

Pre-Lesson Set-Up:
1. Fill one bathroom cup full of salt (labeled sand)
2. Fill one bathroom cup full of flour (labeled silt)
3. Put 1 tablespoon of cornstarch (labeled clay) in the remaining bathroom cup
4. Place a drinking cup full of water at each table

Directions:
Give students their sand, silt, and clay cups.

Have a discussion and demonstration on the texture of each soil, particle size, and capacity to retain water. Drop some of each material into the drinking cup of water and observe. Put clay on your finger and dip into water. Feel for a sticky material left on finger.

After investigation the students should dump each material into the Ziploc bag. Mix then to add air.

Add 1 tablespoon vegetable oil to each bag. This represents the organic matter in the soil. Close bag and mix materials. Have students describe what organic matter does to the soil, based on their observations.

Add 1 drop of food coloring if you are interested in coloring the soil.

Add 1 tablespoon of water. Close bag and mix thoroughly. What happens?

Add 2 more tablespoons of water. Close bag and mix until a soft dough is formed into a ball. Once a ball of soil is formed students may take it out of the bag.

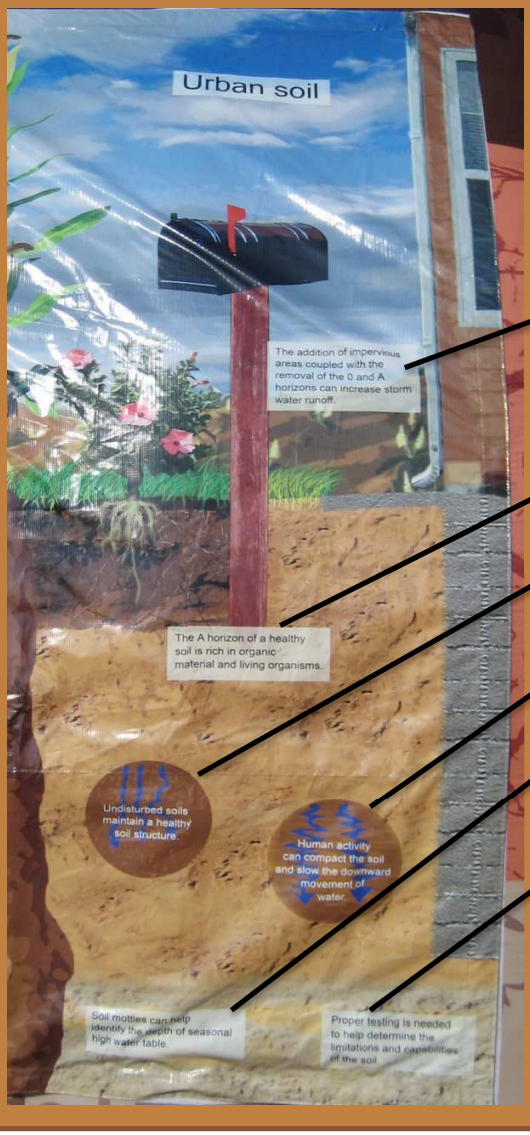
What would happen if too much water was added? What consistency is best for soil?
Additional Information:
Soil contains four ingredients – minerals (in this model, it's represented by sand, silt, and clay), water, air, and organic mater

Loam is a combination of sand, silt and clay, it generally contains more nutrients and humus than sandy soils, has better drainage and infiltration of water and air than silty soils, and is easier to till than clay soils.

Soil minerals are made from 3 particles – sand, silt, and clay. Most soils are a mixture of all 3 particles.

Another model of particle size would be a basketball (sand) baseball (silt) and a rubber bouncy ball (clay).

URBAN SOIL PROFILE



Knowing about soil, and its capabilities and limitations helps people in urban areas to make good decisions about using their soil as a basic and valuable resource. Soils in an urban area may share some properties with soils in forests, farm areas, and wetland areas.

The addition of impervious areas coupled with the removal of the O and A horizons can increase storm water runoff

The A horizon of a healthy soil is rich in organic material and living organisms

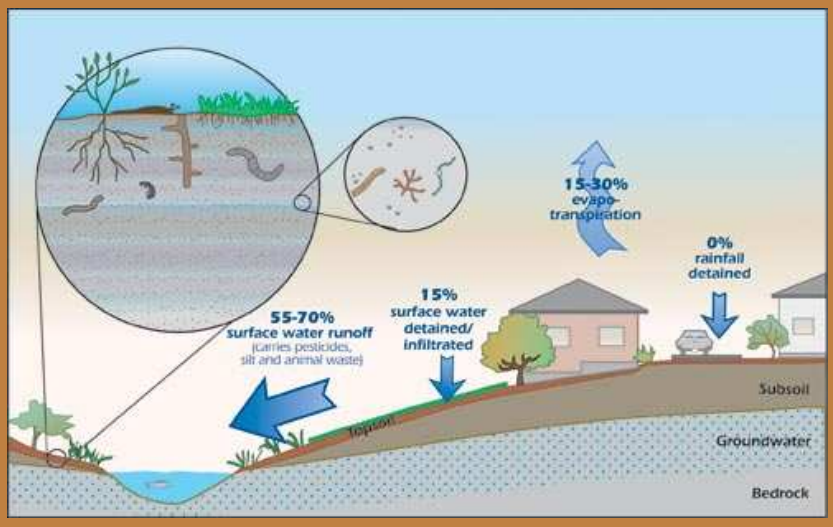
Undisturbed soils maintain a healthy soil structure.

Human activity can compact the soil and slow the downward movement of water.

Soil mottles can help identify the depth of seasonal high water table.

Proper testing is needed to help determine the limitations and capabilities of the soil.

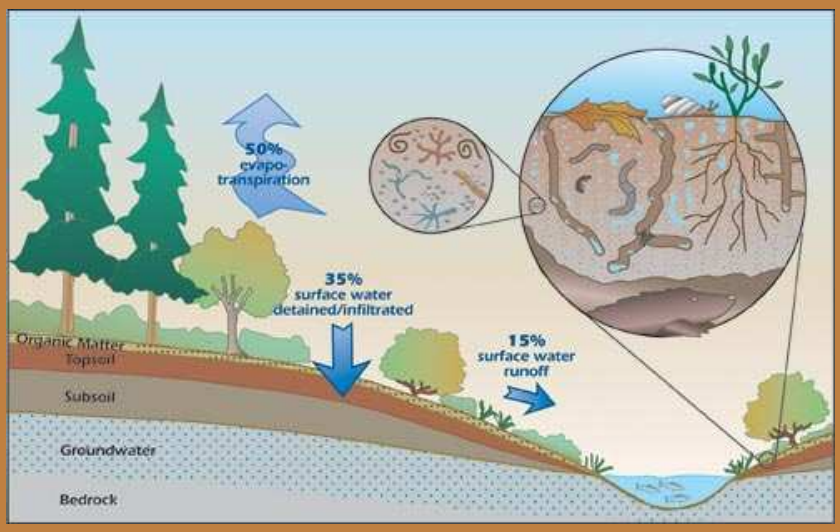
Soil acts like a sponge, soaking up rainwater and limiting storm water runoff. They impact ground water recharge. Soils also release water for plants and animals to use. Soils store carbon and prevent its loss into the atmosphere. Soils buffer and trap pollutants such as oil, pesticides, herbicides, and heavy metals and keep them from entering groundwater supplies.



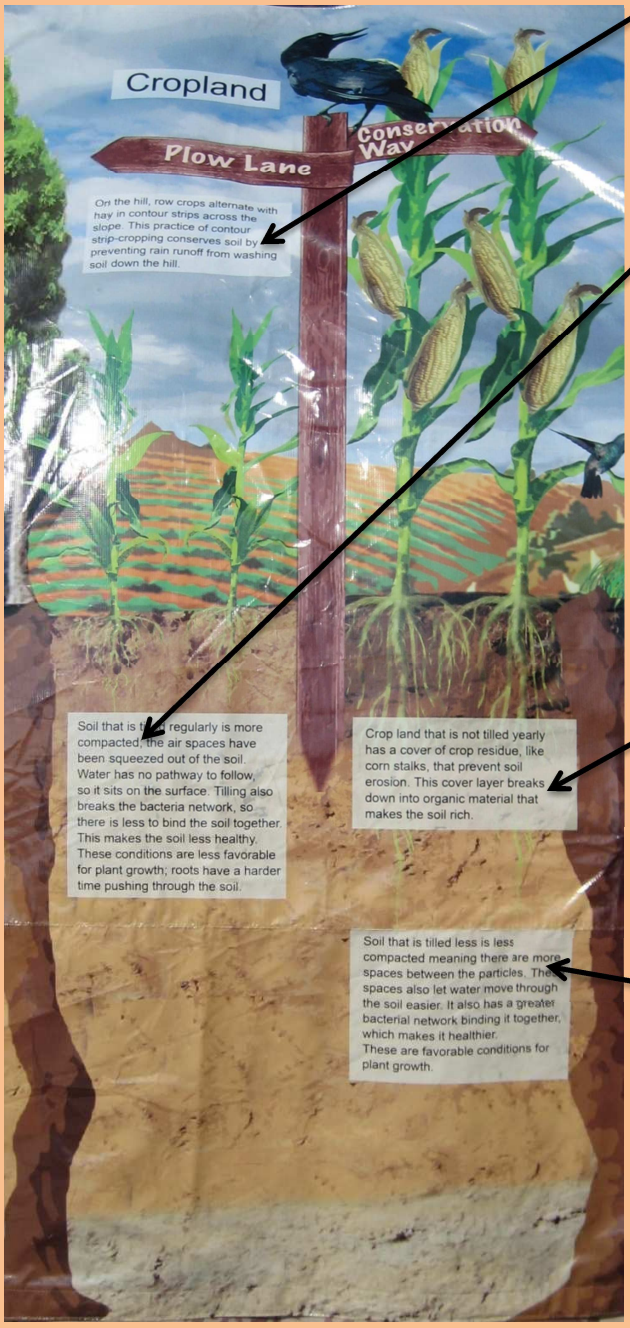
Human activities, such as excavation or other disturbances can change the way soils perform their functions. Construction activities, compaction, and surface sealing dramatically change soil properties. This can sometimes result in a reduced ability to perform the critical functions or activities of natural soils.

One function that can be adversely impacted by human activity is the movement of water into the soil. This movement depends upon soil texture, soil structure, slope, bulk density, compaction, and vegetation.

During construction, vegetation is removed and most of the organic soil horizons are stripped away. This can cause storm water to run off the land too quickly. When vegetation is removed the soil is exposed to erosion. Soil particles wash away with storm water runoff, carrying pollutants to nearby water bodies. Construction vehicles can compact the soil as they move over the surface of the land. This compaction is accelerated when wet soils are worked. When soil is disturbed and exposed by human activity the potential for wind erosion also occurs.



AGRICULTURAL SOIL PROFILE



On the hill, row crops alternate with hay in contour strips across the slope. This practice of contour strip-cropping conserves soil by preventing rain runoff from washing soil down the hill.

Soil that is tilled regularly is more compacted; the air spaces have been squeezed out of the soil. Water has no pathway to follow, so it sits on the surface. Tilling also breaks the bacteria network, so there is less to bind the soil together. This makes the soil less healthy. These conditions are less favorable for plant growth; roots have a harder time pushing through the soil.

Crop land that is not tilled yearly has a cover of crop residue, like corn stalks, that prevent soil erosion. This cover layer breaks down into organic material that makes the soil rich.

Soil that is tilled less is less compacted meaning there are more spaces between the particles. These spaces also let water move through the soil easier. It also has a greater bacterial network binding it together, which makes it healthier. There are favorable conditions for plant growth.

Soil horizons, or layers, make up the soil profile. The weather affects the horizons closer to the surface, while the lower layers resemble the original parent material more closely. The cut away view on page 3 shows how the soil profile might look. At the surface, the O horizon has the most organic matter. Below that is the A horizon, which has less organic matter. Generally

it is darker in color that the lower horizons. Next are the E horizon, and then the B horizon. Their color may be lighter; they may also have more minerals on the surface horizons. This happens because the mineral accumulate here after rainwater percolating from the surface washes then down to these levels.

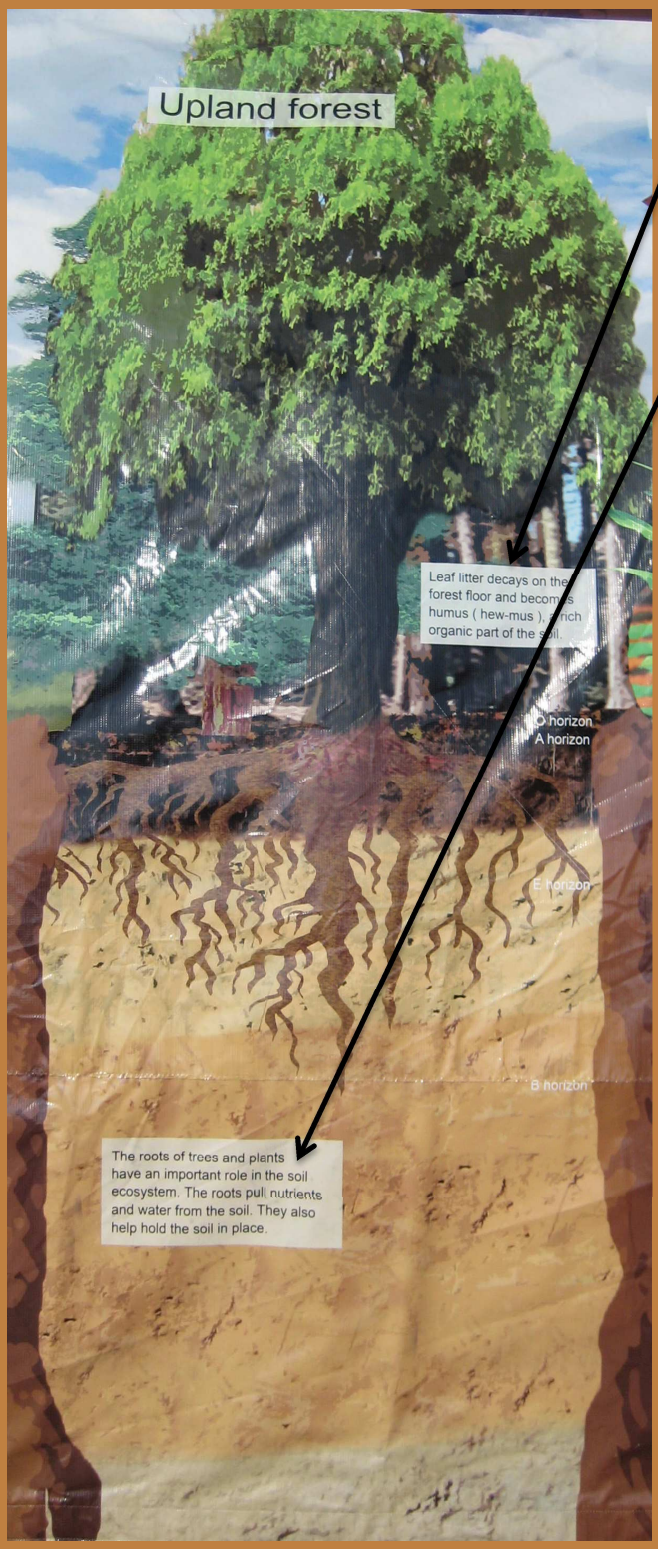
When is the soil tilled for farming the surface vegetation is removed and the soil lays bare. Rain can wash this bare soil and strong winds can carry soil particles away. In the early 1930s the United States endured what is known as the “dust bowl era.” Overworking of the soil, coupled with an extended period of drought created severe soil erosion problems for America’s farmers.

Traditional farming tills, plows and rakes the soil to prepare it for crops. This can lead to problems like soil erosion, soil compaction, and the loss of organic matter and microscopic soil organisms (fungi and bacteria). The organic layer is home to bacteria that holds soil clumps together. The photo portrays the thinness of the O horizon, which is caused by tilling the soil. While breaking down organic matter, microorganisms secrete glomalin, or glue, that holds soil particles together into soil clumps called peds. Fewer bacteria in the soil mean less glomalin to keep the aggregates together. If the aggregates break down, the channels in the soil that let rain water infiltrate the soil disappear. Without pathway, water will poll on the surface and cause erosion.

Healthy Alternative

One conservation practice that is used by farmers to help reduce the amount of soil lost to erosion is no-till farming. With no-till farming, seeds are plants directly into the soil, thus the O horizon remains undisturbed. The old stems and leaves of the previous crop remain on the field, protecting the soil from erosion. Bacteria break down the old crop remains to form new organic soil. The soil aggregates hold together permitting the formation of abundant channels to drain surface water into the soil. These conditions support healthy soil.

FOREST SOIL PROFILE



Leaf litter decays on the forest floor and becomes humus (hew-mus), a rich organic part of the soil.

The roots of trees and plants have an important role in the soil ecosystem. The roots pull nutrients and water from the soil. They also help hold the soil in place.

Healthy soil is an important component of the forest ecosystem. It is a strong foundation for trees and plants to grow on, a habitat for numerous insects, fungi and algae, and a lab where old organic matter is recycled back into the ecosystem. Trees are essential for maintaining the integrity of the soil.

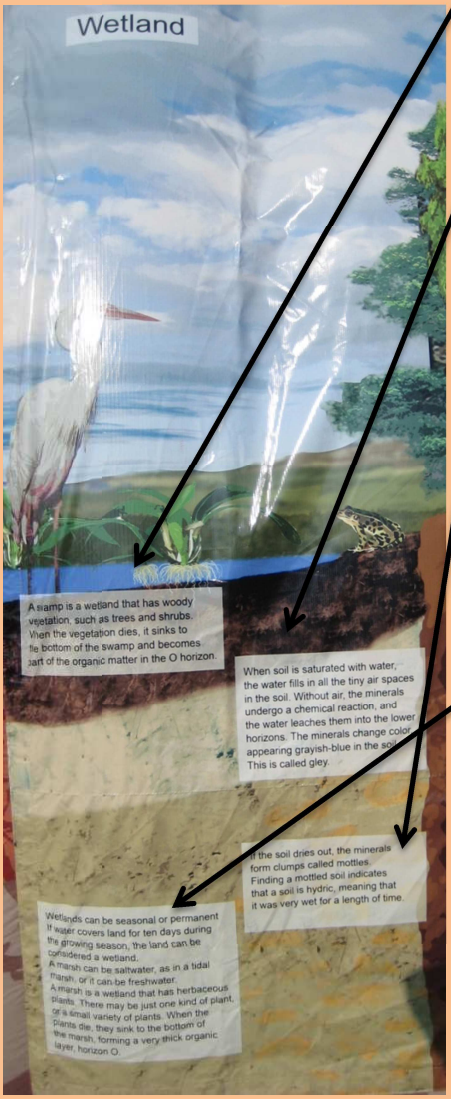
Topsoil in the forest provides the best environment for growing plant roots, microorganisms and other life.

Soil plays an important role in forestry. Rain water coming off trees gets trapped in the soil where it is used by trees and plants. This also serves to limit water run-off into streams and filters impurities from the water. If trees are removed, the soil is more at risk for erosion, or the washing away of soil.

Soil is most vulnerable to erosion after the removal of surface litter from trees and plants. Water runoff carries sediment and deposits it in stream beds, deltas, and oceans. The resulting siltation or the depositing of sediment, in stream beds causes increased flooding and pollution. Modern tree harvesting systems can greatly minimize soil disturbance. One of the key components of sustainable forestry is to keep soil in place. Roots hold the soil together and anchor it in place.

Forest vegetation protects soil from extreme heat and cold while slowing the natural forces of erosion from water, wind, and gravity. Soil sustains the forest, providing raw material for its life; fallen leaves, woody debris, and dead animals recycle nutrients through the soil.

WETLAND SOIL PROFILE



A swamp is a wetland that has woody vegetation, such as tree and shrubs. When the vegetation dies, it sinks to the bottom of the swamp and becomes part of the organic matter in the O horizon.

When soil is saturated with water, the water fills in all the tiny air spaces in the soil. Without air, the minerals undergo a chemical reaction, and the water leaches them into the lower horizons. The minerals change color, appearing grayish-blue in the soil. This is called gley.

If the soil dries out, the minerals from clumps called mottles. Finding a mottle soil indicates that a soil is hydric, meaning that is was very wet for a length of time.

Wetlands can be seasonal or permanent. If water covers land for ten days during the growing season, the land can be considered a wetland. A marsh can be saltwater, as in a tidal marsh, or it can be freshwater. A marsh is a wetland that has herbaceous plants. There may be just one kind of plant, or a small variety of plants. When the plants die, they sink to the bottom of the marsh, forming a very thick organic layer, horizon o.

What is a wetland?
Wetlands are areas where the soil is always wet or wet frequently enough to be populated by plants specially adapted to wet soils. In order for an area to be considered a wetland, it must possess water, wetland plants, and wetland soils.

Wetlands….

1. *Absorb excess water to protect us from floods and storm surges*
2. *Filter and cleanse water that replenishes the aquifers and wells from which we drink*
3. *Provide homes for many important animal and plant species*
4. *Support the multibillion dollar seafood industry and multimillion dollar recreation industry*
5. *Are a source of foods, such as cranberries*

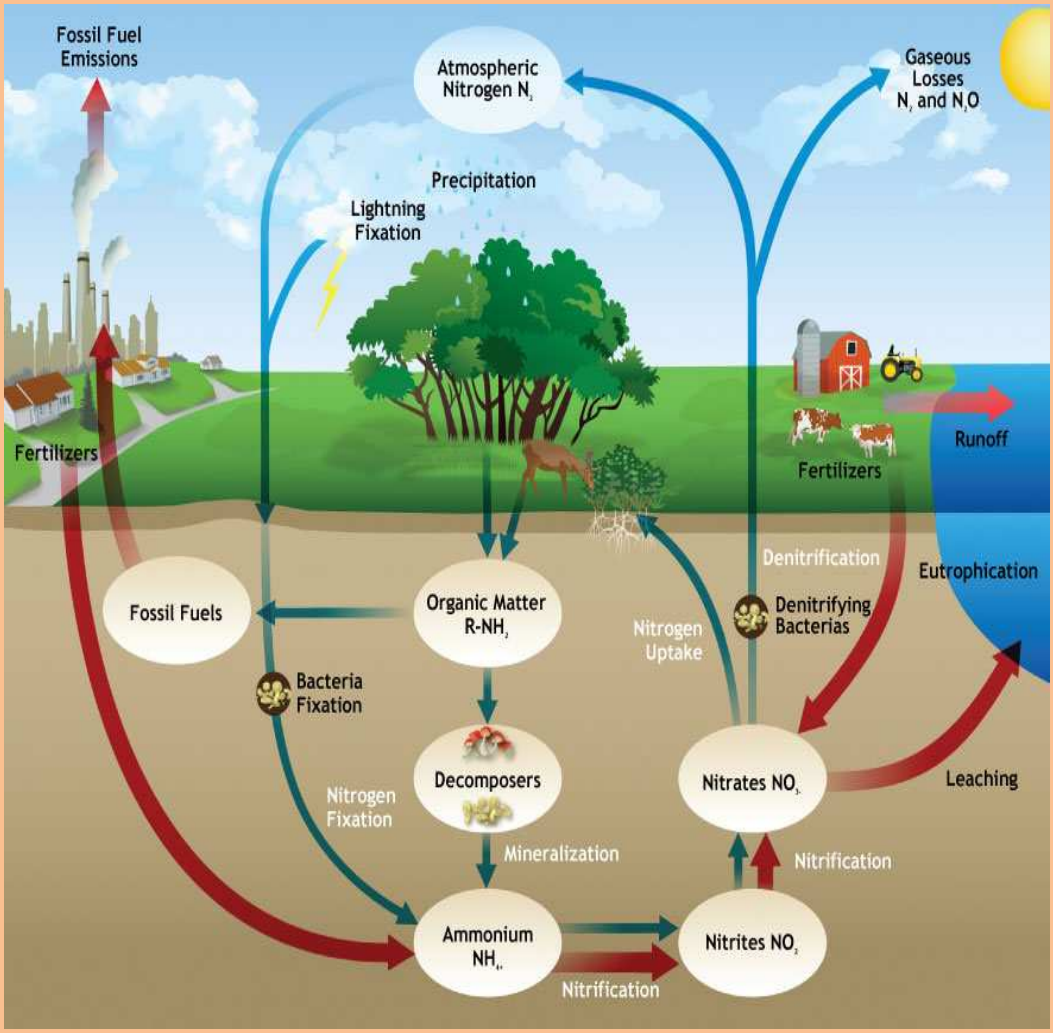
Wetlands may be freshwater or saltwater, inland or tidal. Sometimes they are lowlands where draining water accumulates as snow melts. Sometimes they begin as lakes that fill with soil. Depending on the region, a wetland may be called a bog, a more, a fen, a swamp or a marsh. Each area has different characteristics. Swamps and marshes, while similar to each other, have differences. Swamps are freshwater, have more woody vegetation such as trees or shrubs, and may be wet for a long time. Marshes can be either fresh or saltwater, and often look like fields of grasses.

Wetlands Soil Profile
The soils found in a wetland area are very different from soils found in a backyard or in a forest because these soils have been under water. Below the wetland that is a thick O (organic) layer that comes from decaying plants that lived in the wetland. Below the O horizon is an A horizon. If this soil becomes saturated, the water will seep into all the tiny air spaces. This water will leach the minerals from the soil, moving them to the grayish-blue. This is called gley. If this soil dries out, the minerals will reappear as brighter colored small clumps called mottles. The presence of mottles is a good indicator that the soil has been very wet for a time. Soils with these conditions are called hydric soils.

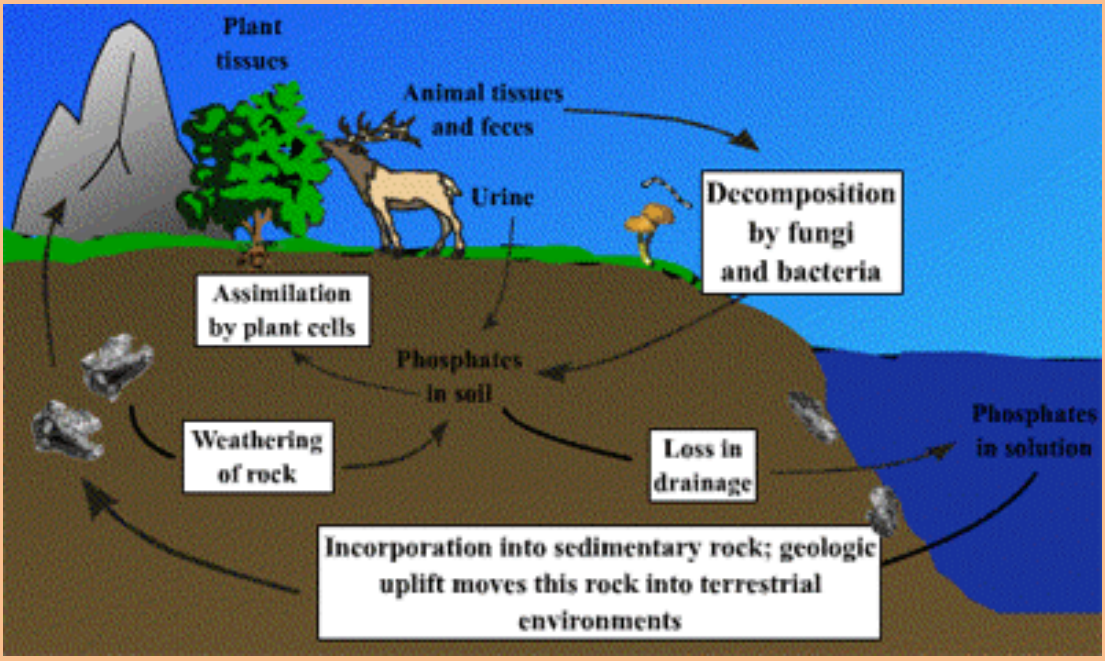
CHEMISTRY CYCLES IN SOIL

The release of nutrients into the soil is a very important process; there are three main nutrient cycles that affect soil. They are the nitrogen cycle, the phosphorus cycle, and the carbon cycle. Without these cycles plants and organisms would be unable to flourish in soil. These cycles not only affect the soil but the environment as well.

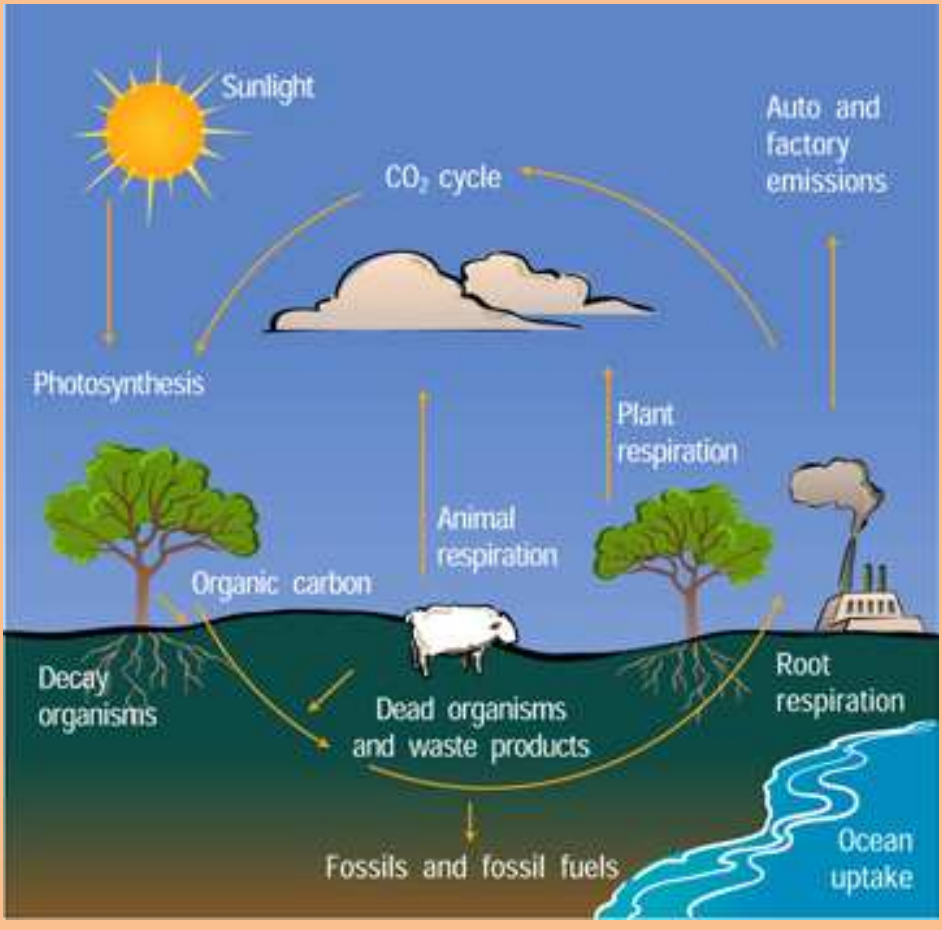
The Nitrogen Cycle



The Phosphorus Cycle



The Carbon Cycle



STORM WATER POLLUTION AND PREVENTION

Storm water interesting facts

- Soil and silt in the water increase water temperature and murkiness, which harm fish and their food supply.
- Decaying leaves and organic materials in the storm drain increase bacteria and mosquito production and decrease oxygen essential for fish life.
- Fertilizer from your lawn can cause excessive algae growth and oxygen depletion.
- One gallon of oil in the storm drain can pollute up to one million gallons of storm water.
- Our wastewater is cleaned and treated before it goes into the creek. Storm water runoff flows through the storm drain system and into the creek untreated.
- The three largest sources of storm water pollution are: herbicides and pesticides from agriculture, urban runoff, and sediment from construction sites.

ACTIVITY #3

Conservation Service Learning Project

Only Rain Down the Drain

Storm drains, commonly called storm sewers, line our streets in urban settings. Their purpose is to take the water off the roads during a heavy storm and keep the roads safe for travel by preventing flooded streets. These storm drains are piped directly to our closest creeks and rivers. As a result, anything on the road, sidewalk, or your driveway that is swept into the storm drain is carried directly to our waterways. This generally includes oil from cars and trucks, salt from treating the roads in the winter, soap from washing cars, fertilizers and pesticides from our lawns and litter. All of these items can have harmful effects on the water quality in our streams.

Details

- Raise awareness on water pollution prevention by participating in Storm Drain Labeling.
- Encounter a local watershed community
- Investigate different land use practices in the watershed
- Engage in an environmental action project, **S**torm **D**rain **L**abeling, (SDL)
- Help others understand how good land use practices can benefit watersheds
- This project is done in the City of Powell

How it is Completed

- ✓ Adults lead small teams of youth to assigned areas during labeling activities, or complete the project with family, friends, or neighbors.
- ✓ Work as buddies to assess and remove pollutants near the storm drains on public property
- ✓ Apply labels to the drains

Time Commitment

Individuals would spend about 2.5 hours on this project.

How to Arrange a Storm Drain Labeling Event:

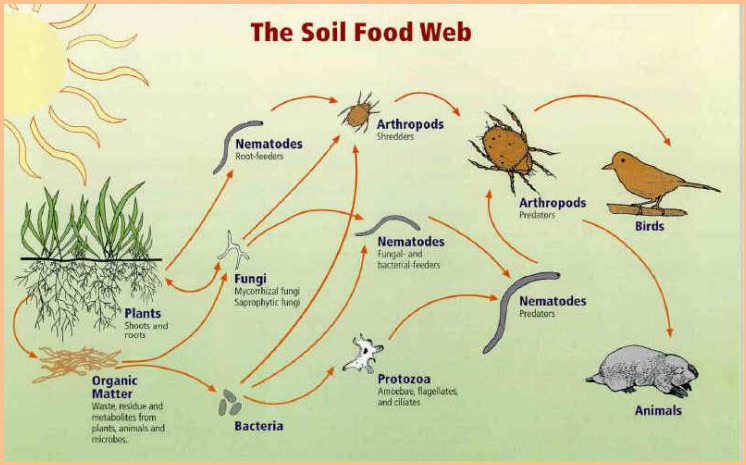
Contact Dona Rhea at the Delaware Soil and Water Conservation District at 740-368-1921, or dona-rhea@delawareswcd.org with questions and to arrange a storm drain labeling event.

WHAT LIVES IN SOIL?

An incredible diversity of organisms makes up the soil food web. They range in size from the tiniest one-celled bacteria, algae, fungi, and protozoa, to the more complex nematodes and micro-arthropods, to the visible earthworms, insects, small vertebrates, and plants.

As these organisms eat, grow, and move though the soil, they make it possible to have clean water, clean air, healthy plants, and moderated water flow.

These are many ways that the soil food web is an integral part of landscape processes. Soil organisms decompose organic compounds, including manure, plant residue, and pesticides, preventing them from entering water and becoming pollutants. They sequester nitrogen and other nutrients that might otherwise enter groundwater, and they fix nitrogen from the atmosphere, making it available to plants. Many organisms enhance soil aggregation and porosity, increasing infiltration and reducing runoff. Soil organisms prey on crop pests and are food for larger animals.



Earthworm facts

Did you know…?

- There are approximately 1 million earthworms per one acre of land!
- Earthworms do not have lungs, but breathe through their skin!
- Earthworms have 5 hearts!
- The largest earthworm was found in South Africa, measuring 22 feet long!
- Worm castings are rich in nutrients that are essential for plant growth!
- Earthworms do not have eyes but can sense light!
- If an earthworm's skin dries out, it will die!

Soil is FULL of living things. There is a whole community, or ecosystem, living right under your feet! If you scooped up a handful of soil and looked at it under a microscope, you would find millions of creatures that rely on the soil to live.

Let's take a look

Bacteria help break down dead plant and animals materials, and make a slime to help particles sticks together. The slime helps to hold water in the soil.

Amoebas help recycle nutrients in the soil by eating bacteria and then deposition nutrients in the soil. Plants need nutrients to grow.

Fungi break down the decaying organic material.

Mites break down the organic material into nutrients that other organisms rely on for food.

Roundworms eat bacteria and mites and add nutrients to the soil. Without them, bacteria could take over the soil!

Springtails chew up dead grass and leaves into smaller pieces that are decomposed by fungi and bacteria. They also release nutrients plants need and eat diseases caused by bacteria.

Many other critters such as **earthworms, ants, centipedes, spiders, snakes, moles,** and **shrews** make soil their home.

ACTIVITY #4

Soil Organism Dig

1. Discuss with students how to 'gently' sort through the soil and observe what they find. This is best done inside the classroom, prior to engaging in the activity.
2. Model a safe and efficient digging technique using a spade, shovel or fork depending on the plot. Suggested sample size is no deeper than 50cm with a maximum area no greater than 50cm by 50cm.
3. Have students find a place where they will be able to dig in the soil
   -The best places to look are underneath rocks, logs, or other damp and dark areas.
4. Using the two sheets on the following pages, have the students try to find the soil organisms on the sheet in the soil.
5. Use containers, sheets of paper or paper plates to enable students to look more closely at things that they find in the soil.
6. Discuss with students how you might sort and classify the things you find. For example: living and non-living; with legs or without legs; with wings or without wings; bigger than one centimeter or smaller than one centimeter; animal or plants etc.

Possible adaptations:

- If the weather is making observation difficult, take small samples into the classroom and examine them there. At or near the end of the lesson, return the sample and any living organisms to where they were collected. It may be helpful to keep a note of which sample came from where.
- Reduce or increase the number of different sites
- Repeat in another environment where you have permission such as a rural area, a wetland, forest ecosystem, etc.
- Repeat over time – do the seasons effect what lives in soil?
- Make changes to the soil to increase the soil biodiversity, develop a scientific investigation to observe and record findings.

Soil Organisms

Earthworm

Salamander

Nematode

Millipede

Nightcrawler

Grub

Pillbug

Common Woodlouse

Soil Mite

Chinch Bug

Rove Beetle

Bluegrass Billbug

Soil Organisms

Earthworm

Also called red wigglers. These worms eat half their weight in organic matter each day and leave fertile black compost behind. They grow to be about 4in. long and are often used in composting and vermiculture activities.

Salamander

There are many species of salamanders. They are amphibians that have a "lizard-like" appearance. Most salamanders have 4 toes on their front feet and 5 on their rear. They have moist skin and live in moist or wet environments.

Nematode

Also called roundworms. There are over 28,000 types of nematodes, many of which are considered parasitic. They are slender and typically less than 2.5mm long with a relatively distinctitve head.

Millipede

Narceus americanu

Millipedes are arthropods that have 2 pairs of legs per segment. Most have enlongated cylindrical bodies. Common species have 36-400 legs. They eat decaying and dead plant matter.

Nightcrawler

A.K.A. dew worms or garden worms. These worms are a grey color and can growup to 14in. long and can be seen feeding above ground at night when it is wet. They burrow during the day as deep as 6.5ft., consuming soil and transporting nutrients from deep in the ground to areas closer to the surface.

Grub

Grubs can be the larvae of Japanese beetles, masked chafers, and June beetles. Grubs are usually found laying at the soil in a "C-shaped" position, and are off-white in color with a dark head. They feed on grass roots, causing plants to die.

Pillbug

Armadillidium nasatum

Also called Roly Polies or Potato Bugs. These are the only crustacean that can live on land its entire life. Pillbugs are most known for their ability to roll into a ball. They live up to 2 years and are most active at night.

Common Woodlouse

Oniscus asellus

Also called woodlice, they feed on mildew and rotting plants. They are the most common type of woodlouse, can grow up to 16mm (0.6in.) in length. It is grey in color and it relatively flat. They store calcium and moult their shell.

Soil Mite

They only grow up to a millimeter long. Their color can vary, but they all have a hard exoskeleton (shell). Best seen under a microscope, they typically live in the top layers of soil and in very large numbers.

Chinch Bug

The adults are very small, but very characteristic in appearance; the wings are white with a black spot, making them appear to be "wearing a tuxedo." They have piercing-sucking mouthparts and they feed on the sap of grass plants.

Rove Beetle

The second largest family of beetles. Sizes range from 1 to 35mm (1.5in.).They are generally enlongated beetles with an ovoid shape. Their colors range from reddish-brown to black. Rove beetles eat almost anything except living plants.

Bluegrass Billbug

The most common type of billbug in Ohio. The adult weevils are 1/4-3/8 inch long, dark gray to black in color, with a tan or brown dusting of soil. The larvae are white with a brown head and look like small, legless white grubs

POLLUTION OR HISTORY?

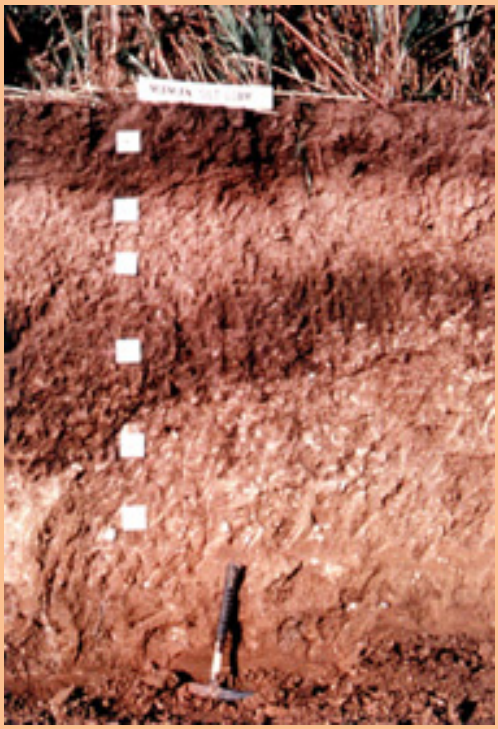
Digging in the soil, what treasures will you find? Will you find trash? An artifact? Maybe even a bone? Over the years, archeologists have made exciting discoveries that have taught us about history by what they have found in the soil. Paleontologists, or scientists who study prehistoric life, are able to figure out how old a dinosaur bone is by which soil layer its fossilized remains were found.

Items you find in the soil can help you learn about civilizations that lived in the same area where we live today. Often archeologists can find tools; pottery and jewelry that tell you how often advanced people were in that community.

Have you ever dug a hole in your backyard and gotten excited to find an artifact? An artifact can be anything from a piece of glass to an arrowhead. Some things that are found in soil may just be discarded trash that isn't an exciting treasure, and can be harmful for the environment. What if all the soil in your yard was full of someone else's trash? It takes hundreds to thousands of years for plastics, glass, and Styrofoam cup to disintegrate or break down and decay.

Miamian Soil

Miamian soils are the most extensive soils in Ohio. They occur on more than 750,000 acres in the state. They are productive soils. Corn, soybeans, and winter wheat are the primary crops.



Miamian Soil Profile

Surface layer: dark grayish brown silt loam

Subsoil - upper: dark yellowish brown clay loam

Subsoil - lower: yellowish brown clay and clay loam

Substratum: yellowish brown loam

This project was made possible through a grant received from the Ohio Environmental Education Fund.

Delaware Soil and Water Conservation District is proud to be able to have the opportunity to share this great project, and to educate both children and adults through this educational display.

If you have any questions, please contact our office:

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