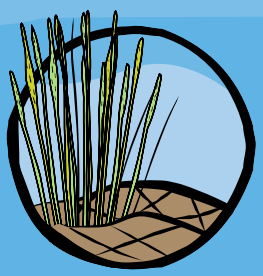

Grassland Soil Crust Study

LESSON

GRADE LEVEL:
Grade 4-9

CATEGORY:
Earth, Ecosystems and Ecology

TOPIC:
Grassland soil ecology

TIME:
- Part 1: 1-2 class periods spread over several days.
- Part 2: 1 day for field trip and follow up

SETTING:
- Part 1 school yard and classroom
- Part 2 outdoor - field trip to grasslands

GROUP SIZE:
Small groups and individual study

SKILLS:
Collecting, predicting, analyzing, measuring, comparing, describing and observing

SUBJECT AREAS:
Science

KEYWORDS:
Soil crust, arid, grassland, ecosystem, nitrogen fixation, carbon sequestration, cryptogamic, cryptobiotic, friable.

Overview

Students create a model of a soil crust and measure the impact of damaged soil crust on water retention in arid conditions. During a field trip to a grassland, students will examine soil crusts to learn about the interconnectedness of grassland organisms and the roles soil crusts play in the ecosystem. Understanding the soil crust's delicate and unique nature, students will begin to appreciate why recreational and agricultural activities are (or should be) restricted in grassland areas.

Objectives

Students will be able to:

- Explain the role of a biological soil crust in dry arid environments.
- Describe and identify biological soil crusts as a complex structure of many organisms.
- Consider why and how human actions and natural events like fire affect grasslands and why soil crusts do not regenerate quickly or easily.
- Understand that organisms in soil crusts sense and respond to their environment.

Materials

Part 1 - Soil Crust Models

- 3 different types of soil, about 500 mL of each, collected from different parts of the schoolyard or other area that is not sensitive to disturbance and where collection is permitted
- 6 margarine or yogurt containers
- 3 elastic bands
- Plastic wrap (3 pieces, large enough to cover 3 of the containers)
- 360 mL of water

Part 2 - Fieldtrip

- Field guides to native and invasive grassland plants (older students could research this prior to field trip in small groups to be able to identify the plants at the location)
- Magnifying glasses
- Journal, datasheets
- Clipboards

Method

Students use a structured inquiry to examine how soil crusts conserve moisture in dry environments in a model and then observe their effects during a field trip. The activity is written to allow for different levels of inquiry as is desired.

Background

Soils play important roles in ecosystems by conserving water, guarding against erosion, and supplying minerals. They also are home to microorganisms such as fungi and bacteria that recycle fallen leaves, and dead plants and animals. In forested ecosystems, the soil layer is easy to see and often several centimeters or even meters deep! In dry ecosystems, the soil layer is thinner and while this makes it hard to see, it is just as full of life only at a much smaller scale.

Unlike the soils that form in areas with more rainfall, the living soil layer (or crust) of grassland soils includes lichens, mosses, microfungi, algae, and cyanobacteria: a photosynthetic bacteria that is one of the oldest known life forms on Earth. This complex soil layer is called many names, including cryptogamic (reproduction using spores), cryptobiotic (capable of dormancy), micro-biotic (small life), or simply the biological soil crust.

A cryptobiotic organism is one that can withstand extreme conditions such as drought or below freezing by ceasing metabolic activity until better conditions return. Cyanobacteria is one such life form that when wet (or active) also leaves sticky fibers or filaments (small strings) between soil particles, small rocks, algae, mosses and lichens that keep the layer or crust together, even when dry. While often co-existing with biological soil crusts, physical soil crusts are different and can be caused by raindrops and accumulations of salts. Physical soil crusts do not support plant germination and growth.

The organisms in a biological soil crust perform many ecological roles when they are active (wet) or dormant (dry). In active periods, soil crusts make nutrients like nitrogen available to plants growing in the soil crusts through a process of nitrogen fixation. While abundant in the air, nitrogen is not available to plants unless converted to a form that plants can absorb by their roots. During dry conditions soil crusts act like a protective wrap by sticking together thereby retaining moisture, keeping temperatures down, and preventing soil erosion during wind and rain events. Soil crusts also play a role in regulating climate change by capturing carbon though photosynthesis (carbon sequestration) and having an albedo effect: reflecting light back into the atmosphere instead of absorbing it, meaning soil temperatures do not rise as quickly.

While teeming with life, soil crusts are delicate and friable (crumbly) when dry which means the desiccated mosses and lichens are easily damaged and crushed. Events like fire, recreation activities (hikers walking off designated trails and recreational vehicle use), and livestock movements can cause extensive damage to soil crusts quickly. Once damaged, biological soil crusts can take decades to hundreds of years to regrow and resume their ecological benefits because regrowth only happens when the crust is active under wet conditions, which, in arid landscapes, is not very often. Regrowth of damaged biological soil crusts is also very slow because mosses and lichens are cryptogamic; that is, their reproduction is by spores that germinate near parent plants rather than by flowers and seeds that spread more easily by wind or animal. Damaged soil crusts persist and this alters the life and health of the whole grassland ecosystem.

Part 1 – Make Soil Crust Models

Procedure

1. Obtain the soil samples prior to class or have the students select areas and collect soil.
2. Split each of the three soils so you have (6) 250 mL amounts. Put each one into its own container. You will have two samples of each of the 3 soil types.
3. For each container:
   - Label each container with the collection details.
   - Add about 60 mL of water to each container.
   - Cover one container of each soil type with plastic wrap held in place with an elastic band. Poke 5 small holes in each piece of plastic wrap.
   - Place all 6 containers under a lamp for 6-8 hours a day.

4. For the next three days make observations at the beginning of class and the end of the day.

5. Students may make hypothesis about what will happen and what might be observable if their predictions are correct.

Assessment

Use the student's observations during the activity and answers to questions such as:

- Which soil type is driest? Which is wettest? Hypothesize why this is so.
- What does the plastic wrap do for each of the three types of soil?
- How is this experiment a model of a soil crust? What function does the crust play that is like the plastic wrap? How might a soil crust help plants in the grasslands?

Part 2 – Visit a grassland

Procedure

1. Review outdoor rules and boundaries. Review any materials provided from organizations or at information booths if visiting a managed grassland site. Refer to the "Let's Go to the Grasslands" series at *www.hctfeducation.ca/lessons/outdoors-projects-and-places/* for location suggestions, activity ideas and information about planning a field trip to a grassland.

2. At the site, remind students of what they are there to study and how to avoid harming the important and fragile soil crusts. Watch your step and stay on established trails or boardwalks. In this case, we do not want to leave any footprints behind. Don't bust the crust!

3. Use clipboards, datasheets and nature journals to record observations, make sketches, and collect data. Some things to note and questions to ask:

    - Where does the crust grow? (Under plants, in the open, on slopes, in the sun or shade, north or south-facing aspect)?
    - Where is the crust absent? Is the crust found at all locations and elevations within the grasslands?
    - Do you see any signs of disturbance of soil crusts? What do you think caused the disturbance?
    - Look closely at the surface of the crust with magnifying glasses. What do you see? What colours and textures? Sketch what you see.
    - Collect information so you can compare areas where the soil crust has been disturbed (or absent) and where it is intact.
        - Are the plant species different?
        - Are the plants closer together or farther apart (measure the distances between plants)? Taller or smaller?
        - Sketch the different kinds of plants growing and describe them. Create a symbol for each.
        - Draw a map showing the locations of plants using the symbols you decided on. Change the size of the symbol to reflect what you see.

Assessment

1. Do students have a better understanding of the fragility of grasslands and the relationship between some human uses and grassland degradation?

2. Can students use observations to describe how soil crusts shape grassland environments and how soil crusts adapt to the arid environment. Why is this important?

3. Can students identify soil crusts and describe what they are made of and how they grow? Can they explain why soil crusts do not grow quickly?

4. Based on their observations and reflections, what are their understandings and feelings about grasslands?

Extensions

If possible, revisit the grassland during a different time (rainy or dry) and re-examine the soil crust. Have students look for and record any differences using the same data sheets and journals. Compare differences.

References

US Geological Survey publication "Cryptobiotic Soils: Holding the Place in Place." By Jayne Belnap in the Impacts of Climate Change on Life and Ecosystems workshop proceedings. 1997. Accessed June 30, 2019
https://geochange.er.usgs.gov/sw/impacts/biology/crypto/

Adapted from the Grassland Stewardship Manual, by Andrea Stevens. Northwest Wildlife Preservation Society, Grasslands Youth Stewardship Project.