Spring Fever: Taking a Prairie's Temperature

Activity Overview
Students compare temperatures above and below ground in early spring as the soil warms and plants begin to grow.

Objectives
Students will:

- Practice using thermometers
- Experience response in the environment due to seasonal change
- Understand what conditions are necessary for early plant growth

Subjects
Math and Science

Grades
3 through 12

Activity Time
50 minutes

Season
Early Spring through Late Fall

Materials
Thermometers, Clipboards, pencils

State Standards
Science:

Discover how organisms meet their needs (F.4.1)

Investigate how organisms respond to internal/external cues (F.4.2)

Investigate structure & function of organisms (F.8.1)

Show organism's adaptations (F.8.2)

Identify how technology is used in someone's job (G.4.1)

Discover changes in technology over time (G.4.2)

Determine how science discoveries change technology (G.4.3)

Identify uses of machines (G.4.4)

Explore how machines were invented & produced (G.4.5)

Identify skills needed for a career in science or technology (G.8.1)

Explain how discoveries influence careers (G.8.2)

Illustrate impact of science & technol-

Background

Soil temperature is an important environmental sign that helps to activate plant growth in the spring. Soil temperature is much more constant than the air temperature and changes more slowly. In fact, soil acts much like an insulator and in the winter the soil is generally warmer than the air (especially when covered with a blanket of snow). In the summer, the soil is often cooler than the air (especially when vegetation and ground litter provide shade).

During the winter, the prairie has cold feet. Living prairie plant roots wait in the soil for environmental signs that winter is over. In the spring time, the surface soil gradually warms up in response to warmer air temperatures, and this gives the plant's roots the signal to begin their season's growth. Other important environmental signals to plants are moisture/rainfall and for some, day length.

Soil temperature is different at different depths in the soil. The temperature of the "surface soil" (top 1" or so) changes most rapidly to changing air temperatures, while the soil at greater depths has a more constant temperature throughout the year. Soil ten feet or more below the ground's surface is fairly constant throughout the year (at approximately 40 degrees F). So during the winter, the surface soil is colder than the deeper soil (surface soil freezes during the winter). During the summer, the surface soil is warmer than the deeper soil. Prairie plant roots can extend to great depths in the soil, sometimes more than 10 ft. (3 meters). So roots near the surface "feel" the seasonal changes in soil temperature, while deeper roots live in a more constant environment.

Farmers know about the importance of soil temperature, and in the springtime they measure soil temperature daily in order to determine when the soil is warm enough to plant.

Fire is an important part of prairie ecosystems. When a fire sweeps across a prairie, dramatic changes occur in air temperature and surface soil temperature. Interestingly, the heat of a prairie fire does not penetrate very far into the ground, so the soil just a few inches below the surface often remains cool during a prairie fire. Prairie plants and animals are adapted to survive fires. Some animals (such as birds and large mammals) can escape a fire by simply flying or running away. Some animals (such as rabbits) go underground, where the cooler soil temperatures protect them. Soil organisms (such as earthworms and soil insects) move downward in the soil, seeking cooler temperatures. And plants, well, they can't go anywhere! But their deep roots are protected from the heat of prairie fires, and the living roots are the starting point for new growth after a fire. In fact, the blackened ground surface after a spring prairie fire warms the surface soil rapidly, and this helps to initiate plant growth.

ogy (G.8.3)

Design an applied science model or machine (G.8.4)

Investigate local problem & propose scientific or technological solution (G.8.5)

Math:

Use reasoning abilities (A.4.1, A.8.1, A.12.1)

Communicate mathematical ideas (A.4.2), logical arguments (A.8.2, A.12.2)

Connect mathematical learning with other subjects (A.4.3)

Use vocabulary, symbols, notation (A.4.4)

Explain solutions to problems (A.4.5)

Recognize & describe measurable attributes & units (D.4.1)

Demonstrate understanding of measurement (D.4.2)

Read & interpret measuring instruments (D.4.3)

Determine measurements by using standard tools (D.4.4)

Determine measurements by using basic relationships or estimations (D.4.5)

Analyze non-routine problems (A.8.3)

Develop effective oral & written presentations (A.8.4)

Explain mathematical concepts, procedures, & ideas (A.8.5)

Identify & describe attributes in situations not directly or easily measurable (D.8.1)

Demonstrate understanding of measurement facts, principles, techniques (D.8.2)

Determine measurement directly by using standard units (D.8.3)

Determine measurement indirectly (D.8.4)

Identify, describe, & use derived attributes (D.12.1)

Select & use tools to determine measurements directly (D.12.2)

Activity Description

Before measuring soil and air temperature, predict which will be warmer, the air, the surface soil, or the deep soil.

Directions for taking temperatures:

1. Insert a soil or cooking thermometer vertically into the ground by about ¾″. Wait one minute for the temperature to register. This can be done with a timer, watch or by counting "one potato, two potato, etc." Record the temperature on the worksheet.
2. Push the thermometer all the way into the soil. Wait one minute and record the temperature.
3. Remove the thermometer from the soil and hold it just above the surface of the ground. Wait one minute and record.
4. Finally, stand up, hold the thermometer at waist height and write that temperature down.

In the classroom:

First, calculate average temperatures and then calculate the classes averages. Discuss findings. The following questions will also help facilitate discussion:

- Which was warmer, the air or soil?
- Which was warmer, the surface soil or the soil at 5" deep?
- What do you think the soil temperature would be at 10 feet below ground level? 100 feet?
- How different were the temperatures and what might this mean for plants?
- How are prairie plants adapted to survive fire?
- What temperature do deep roots "feel"?
- How do plants know when to start growing?

Extensions

- Monitor air and soil temperatures over several weeks in the spring. Plot weekly or daily temperatures of air, surface soil, and deep soil on graph paper. Begin early in the spring, while it is still cold and before growth begins. Soil temperatures can even be taken beneath the snow! If possible, take each measurement at about the same time of day. Predict what soil temperature is needed for plant growth to begin. Then, by tracking temperature and watching for the appearance of green shoots, test your prediction.
- If you burn your school prairie, you can investigate the effect of the burn on temperatures by measuring soil temperatures before and after the burn, or in burned and unburned areas.

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Additional Resources

- Burg, B. Weigelt, S., Weigelt, U. (2005). *Spring fever.* North-South.
- Soil Temperature Maps by Green Cast http://www.greencastonline.com/SoilTempMaps.aspx

Assessments

- Draw a diagram of the conditions that exist when prairie plants begin to grow during the spring. Indicate soil and air temperature, as well as moisture levels and day light length. Then draw diagrams of site conditions in mid-summer, fall, and winter.

Spring Fever: Taking A Prairie's Temperature Field Sheet

Name(s):_____

During the winter, the soil beneath a prairie is frozen. When spring arrives, the air is warmer, the ground thaws, and the soil begins to warm up. The living roots of prairie plants have been in the ground all winter, waiting for signals that it is time to grow again. Finally, when the soil temperature is warm enough, the plants begin to send up their green shoots, and a new growing season begins.

Today you will measure the temperature of the air and the soil in your prairie.

STEP 1: Write down today's date and weather conditions.

Today's date is _____ .

The time of day is _____.

Today's weather is (sunny? cloudy? partly cloudy? raining? snowing?)

_____ .

STEP 2: Go outdoors to your prairie. Follow instructions to measure the temperature of your prairie in four places: two in the air and two in the soil.

STEP 3: Write down the temperatures you measured. This is your data.

TEMPERATURES IN DEGREES FAHRENHEIT (ºF)

Site	Soil 3/4˝ deep	Soil 5˝ deep	Air at surface	Air at waist height
1				
2				
3				
4				

STEP 4: Draw bar graphs of the temperatures you measured.

Figure out average temperatures for each soil depth and height in the air. Do this for your group, and then put the data from the whole class together and average it. What do you have to do differently? Do the averages change? Why might this be?

STEP 5: Answer the questions below.

1. Which was warmer, the air or the soil? _____

2. Which was warmer, the soil near the surface or 5" deep?_____

Spring Fever: Taking A Prairie's Temperature Field Sheet

3. Which was warmer, the air near the ground or at waist height?

4. Why might these temperatures be different?

5. In the spring, plants wait for the right signals before they begin to grow. Warm soil temperature is one signal. Can you think of some other signals that tell plants that it is time to grow? (Clue: Think about other things, besides temperature, that change in the spring).

6. Prairie roots go deep into the soil, sometimes more than 10 feet deep. What soil temperatures do you think these very deep roots would feel?

7. Fire is a part of the prairie ecosystem. Prairie fires can be extremely hot, and fires can move across the land very quickly. From the data you gathered, can you guess what happens to the soil temperature during a prairie fire? Where would you go to survive a prairie fire if you were:

- a bird?
- a bison?
- a rabbit?
- an earthworm?
- a prairie plant?