

Effects of the Nonliving Environment

Grade: 6-8

Time: 5-8 class periods over several months

Lesson #: A4

How do trees function as part of a forest system?

Overview:

Students set up and conduct experiments to determine how aspects of the nonliving environment affect plant growth.

Essential Questions:

How do physical conditions affect a tree's ability to survive?

What characteristics of forests help them to use resources in an ecosystem?

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Source: Vocabulary, Background, and Assessment questions from Alaska Resource Education Forestry Module ffe1 Effects of the Nonliving Environment. Materials and Advance preparation information from ffe2 How Plants Grow. The rest is new.

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Assessment

Can students:

- set up and conduct experiments to determine how aspects of the nonliving environment affect plant growth?
- collect and compare data regarding growth under different environmental conditions?

Vocabulary

- climate
- topography
- permafrost
- precipitation
- evaporation
- organic soil
- oxygen
- nitrogen
- muskeg
- elevation

Alaska Standards

Addressed:

Science GLEs

The student demonstrates an understanding The student demonstrates an understanding of the processes of science by:

[6][7][8] SA1.1 asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring and communicating. *

[6] SA1.2 collaborating to design and conduct simple repeatable investigations.

[7][8] SA1.2 collaborating to design and conduct simple repeatable investigations, in order to record, analyze (i.e., range, mean, median, mode), interpret data, and present findings. (L)

Cultural Standard

E Culturally knowledgeable students demonstrate an awareness and appreciation of the relationships and processes of interaction of all elements in the world around them. Students who meet this cultural standard are able to: 2) understand the ecology and geography of the bioregion they inhabit

Teacher Information and Procedure

Prior knowledge for students: Experience in designing and conducting experiments, or concurrent instruction and guidance.

Materials needed:

- 50 pea, bean or alfalfa seeds
- a large jar
- paper towels
- 20 plant containers (small pots, cups, plastic baggies or egg cartons)
- potting soil
- masking tape
- pens

What to do in advance:

Approximately three weeks before beginning the activity place about 50 bean, pea, or alfalfa seeds in a clear jar on a layer of damp paper towels and put the jar near a window. Monitor the seeds daily, and keep the paper towels moist.

What to do during the lesson:

Gear up:

Ask students to brainstorm and list environmental conditions in various parts of Alaska that might affect the growth of forests.

Explore:

1. Share the background information with students. Explain to students that they will be designing an experiment to test the effects of one condition on plant growth. Using the background information and the list that students brainstormed, have the class choose 5 conditions to test. They might include: slope, soil temperature, drainage, aspect (north- or south-facing) and precipitation.

2. Divide the class into five research teams to investigate the five conditions that you have chosen.

3. Discuss criteria for the students' experiments, and establish the requirements. They might include:

- A testable question
- A reasonable hypothesis
- A detailed, replicable procedure
- Control of variables
- Simulation of conditions that might actually occur in an Alaskan forest (for example, research and simulate actual precipitation amounts)
- Organized data and measurements
- A conclusion based on analysis of the data

Establish a timeline for the project

4. Allow students time over the course of several months to set up their experiments, measure and record their data, and analyze their results.

5. Have students share their experiment with the rest of the class in a scientific seminar or a poster session.

Generalize:

Discuss: What would be the ideal conditions in the nonliving environment for a forest to grow and flourish? How do Alaskan trees and forests adapt to less than ideal conditions?

Assess:

Assess using criteria established by the class in step 3.

Extensions, adaptations, and more resources:

Take a field trip or walk to observe forests (or other plant communities) with north or south aspects. Look for areas where drainage is poor and observe the effects on trees.

Research forests in other parts of the world and find out how they are different from Alaskan forests. How do the differences relate to environmental conditions?

Have the research groups replicate each others' experiments.

Background

The nonliving environment forms the basis for life in the forest. Three major components of the nonliving environment are climate (temperature, sunlight, precipitation, wind, day length), soil (characteristics, composition, texture, chemistry, depth), and topography (steepness, aspect). Because these factors vary from site to site, their influence on growth and development of a forest varies. Two examples - forests on north-facing slopes have different trees from those on south-facing slopes, and forests on dry sites are different from those on wet sites.

Alaska's extreme northern latitude gives most of the state a cold climate. The climate, in turn, influences forest growth and development. Cold temperatures in the boreal forest of Interior Alaska sometimes allows the ground to stay frozen year round. Areas of permafrost (ground which is permanently frozen) keeps water on the surface and limits root development to shallow surface layers. Water tends to pool on top of permafrost in summer, forming ponds or soggy bogs. Water seems abundant because snow melt and rain sit on top of permafrost. Amazingly, the total amount of precipitation that falls in the Interior is comparable to that of deserts. Rivers run in the summer because they are fed by melting snow and ice from the mountains and because Alaska's cooler temperatures limit evaporation.

By contrast, Alaska's Coastal forest is part of the temperate rain forest. It grows in a moderate, moist, cool climate. Temperatures do not vary greatly between summer and winter -compared with the 100-130 degree variation endured in boreal forests. Awash in rainfall, the Coastal forest produces lush forest growth with dense underbrush. There is no permafrost. Starting from glacial rubble recent glaciation over much of Alaska left behind coarsely crushed rock and fine rock flour devoid of organic materials. These young soils lack variety and depth. For organic soils to form on this mineral base, many years of plant growth and accumulation of plant debris are necessary. Soil depth and standing water affect the tree's ability to "breathe". Without oxygen, tree cells would die. Cells in leaves and branches absorb carbon dioxide from the air, but the cells in the roots must absorb oxygen from the soil (transpiration). Trees literally drown if their roots become waterlogged.

Even in arid environments like the Interior, trees can become waterlogged because permafrost does not permit water to drain away from the tree roots. Plants must also have nitrogen in order to grow. Most of the nitrogen on earth is in the air, but plants are only able to use nitrogen that is in the soil. Cold temperatures slow the growth and decay of plant materials and that slows the development of organic soils. If dead plants accumulate faster than they can be decomposed, an acidic basin called muskeg forms. Muskeg soils are notoriously poor environments for most plant growth.

Since Alaska rises from sea level to the highest mountain on the continent, the topography of the land plays an important role in shaping the pattern of our forests. Steep slopes drain moisture quickly and hamper soil development, limiting what can grow there. High elevation and cold temperatures contribute to poor growing conditions where only limited tree growth occurs. The tree line is the elevation where above no trees are found. This is caused primarily, by cold temperatures and short growing seasons. Low-lying areas or flats may be underlain by permafrost, creating boggy soils that limit tree growth by drowning their roots. The aspect, or compass direction of slopes, determines exposure to sunshine or wind, how soon the soil warms in the spring, and if snow will be scoured away or lay as a protective blanket.

In summary, all elements of the nonliving environment affect the kinds and numbers of trees that grow. In Alaska, those nonliving elements are dominated and influenced by the northern latitude.

Background used with permission from Alaska Wildlife Curriculum series, Alaska's Forests and Wildlife, Alaska Department of Fish and Game, 1999, pages 41-44.