Overview

Use a simple active game to explore the concept of how fire can spread quickly in a dry densely populated forest.

Objectives

Learn the meaning of density

Learn the difference between a wet year, dry year, and a critically dry water year.

Learn basic concepts of how a tree draws water up out of the soil in order to grow. The tree can hold water in the tissues of the tree (xylem, the phloem, leaves/needles). The tree also uses a technique called evapotranspiration to exhale water and oxygen. The roots of the tree can create soil by reaching deeper below the soil surface.

Our mountain forest environment holds water not only in streams, lakes, soil, soil beneath the surface the air, but also in the trees.

Subjects

Science

Grade Level

K-6, older children are more interested in the concepts and rather than the physical participation of the game

Length of Activity

1 hour to purchase material and cut into squares

Activity Location

Outside or inside (with a bit of open space)

Materials

A few yards of red, orange and blue material

Material needs to be cut into “handkerchief” sized squares

Water availability, Forest Density and Fire Activity

Introduction

In a forest, each tree needs a specific amount of water. Trees compete for water, but as long as there is enough water, they will use up as much as they need. Water is transpired as the tree breathes – it

travels from the soil through the tree roots and trunk to the tree leaves and then to the atmosphere. In a wet year, there is plenty of water for most trees in the forest. Small trees and shrubs germinate and the forest becomes denser. In a dry year, the soil moisture decreases, the trees and shrubs compete for water and nutrients. The shrubs and trees along with the soil become drier. The moisture in the air also decreases.

A dense forest has limbs that might touch another tree's branches. In a dry water year there may be dead or stressed trees. There may be dead and down trees that could provide fuel for a hot intense fire.

How do we make a forest less dense? (*mechanical thinning, hand clearing, prescribed fire*)

Figure 1 Dense forest growth Note very little sunlight penetrates the canopy

<u>In this activity the following terms will be introduced:</u>

Density

In mathematics, we describe the density of a fluid or element mass divided by volume. When one visits the dentist we are covered in a layer of lead a very dense material so that our internal organs are not exposed to harmful x-rays. However in the field we may define density of the forest cover as how many trees exist in a defined area. As we sit here/stand here we can sit/stand close together and we would be considered to be in a dense pattern arrangement. Bees and ants live closely to one another or in a dense living arrangement.

A dense forest or orchard will have very little light penetration to the soil surface (Figure 1). Limbs of trees may touch each other at the canopy level. Whereas a sparsely planted area, or perhaps thinned area may have very few trees in the same location and much more light may reach the soil surface with no touching branches.

Forest thinning

Forrest thinning is the selective removal of trees, generally smaller trees in an area. This activity may be done in order to increase the growth of nearby trees. Forest thinning could decrease the fuel in the area and decrease the chance of a hotter more intense fire. Overcrowding of trees lead to competition for nutrients and water among trees and may lead to stress between the trees. One can thin a forest by mechanical thinning, hand clearing, and prescribed fire.

Fuel

Fuel can be considered to be any of combustible material, trees, houses, fallen logs and is characterized by its moisture content (how wet the fuel is). Fuel can be tall mature trees with many branches, shrubs,

and the shrubs or trees in a given area could be in various arrangements across the area of the landscape. The moisture content of the fuel determines how quickly or readily that fuel will burn.

Cohesion

Cohesion is the action or property of molecules sticking together. Water is strongly cohesive, each water molecule may make as many as four hydrogen bonds in a tetrahedral configuration. Basically the molecule is charged oppositely charged on its poles this allows for the water molecules to be attracted to each other. The bulk liquid becomes cohesive.

Figure 2 Root growth formation. Note the increased density of roots in the larger trees.

Root formation and tree growth

Early root growth is located near the tip of the root. These root tips become the primary tissues of the root which elongates and through numerous processes that pushes the root tip forward in the soil and rock. Root cells differentiate and in time will become mature plant material. Roots will generally grow in which there are hospitable conditions of correct air, nutrients and water availability (Figure 2). Roots find it quite difficult to grow where there are little nutrients, soil medium and dry conditions.

Roots overtime and under the correct conditions are able to crack rock, foundation, waterlines and lift sidewalks. Roots have developed special growth mechanisms that will allow for some varieties to cling to walls. As trees grow some trees are able to grow through rock and create soil in which to live in.

Water and Trees

The roots, cambium, leaves, and xylem of a tree all contain large amounts of water. In a wet season when conditions are favorable trees are able to grow more rapidly than in a dry season. Many children have made “cookie chips”, these rings result from the change in growth speed through the year, and thus one ring usually marks the passage of one year in the life of the tree. In a dry year trees grow more slowly and the distance between the annual rings will be less. Dry seasons are able to stress the tree and any they can be more susceptible to diseases. Trees compete for nutrients and water located underground.

The movement of water from the liquid phase to the gas phase occurs by evaporation and or transpiration. Evaporation is the change of water from a liquid to a gas by heating. Transpiration is water released from plants. Combined, this process is called evapotranspiration.

The main driving force of water uptake and transport into a plant is the evapotranspiration of water from leaves. Evapotranspiration is the process of water evaporation through specialized openings in the leaves, called stomates. The rate at which occurs creates a negative water vapor pressure. This negative pressure pulls water all the way down through the vascular tissue, the xylem and to the roots. It is the cohesive forces of the water molecules in the xylem column. The column of water is continuous from the roots to the leaf of the tree.

Introduction

1.What does a dense forest look like? The concept of Densiometers could be incorporated here (Investigative instuments- 13 ; GLOBE, 2005 (*What does a less dense forest look like? Figure 1: dark shadows, lots of trees, lots of branches. Does it look like the forest around us? (in a playground one will find fewer trees and a lot less shade.*)

2. Ask the students: What is density? What does 'forest density' mean? How can you measure forest density?

3. What does a dense forest look like? (*dark shadows, lots of trees, lots of branches*)
What does a less dense forest look like? Does it look like the forest around us? (*fewer trees, higher branches*)
How do we make a forest less dense? (*mechanical thinning, hand clearing, and prescribed fire techniques*)

Water in a Forest game (multiple variations of the game to determine many variables that might exist in the forest)

4. "In a forest, each tree needs a certain amount of water. Trees compete for water, but as long as there is enough water, they will use up as much as they need. Water is transpired as the tree breathes – it travels from the soil through the tree roots and trunk to the tree leaves and then to the atmosphere.

"We will be playing a game to illustrate how forests use water. I'd like you all to stand – you should be able to touch each other if you reach out. These fabric pieces represent the available water in the soil and the tree. When I tell you to – (and we are going to do this next part nicely – no grabbing or fighting. One last parameter: no magic- this is not the *Wizard of OZ* nor the *Hobbit- the trees can't move or change location. Their roots are strongly fixed into the soil of the earth.*), you should each reach down and pick up 3 "waters".

- Did everyone get 3? If not why? (in this scenario there are too many trees for the available water)

- On each "go" everyone will throw one up in the air (the trees are conducting evapotranspiration) and we'll see how much water will be going to the atmosphere. (With this round, the water will last for less time.)

"Now, I need half of you to stand to the side. The other half will spread out – you shouldn't be able to touch each other's hands, even if you reach." Have them pick up the fabric again, then ask questions, then throw them again.

- How many "waters" did each tree get this time? Why? (More! There are fewer trees competing for available water)
On each "go" everyone will throw one up in the air and we'll see how much water will be going to the atmosphere." (With this round, water will last for much longer.)

Fire in a Forest game

5. Dense forests are more susceptible to intense fire. Why is that? (When trees are growing closer together, there is more material (leaves, pine needles, limbs and dead and down trees) on ground, trees have low branches that act as a "ladder" for fire to reach the canopy, the top of the tree.

"We are going to play the game again. In this round, I need 2 volunteers (get hands) - and everyone else will be trees. Everyone please pick up 2 red/orange "fire" fabrics – you can put them in your pockets. This time you will be dense formation, close again, and you will have low branches. The 2 volunteers will be the fire – the two volunteers will be "low intensity fire", and they'll crawl through the forest. Everyone whose branches you touch will catch on fire (so wave "fire" fabrics). If a tree that is on fire touches another tree that is not, both will catch on fire.

In the second fire round, the fire students will be "high intensity" fire, and whirl through the forest with arms waving – this scenario will attempt to duplicate a dense forest in a dry water year when the forest is in a dryer state; the soil is dryer, the trees are dryer, the shrubs are dryer, the atmosphere is dryer. More students will catch on fire.

In the third fire round, half of the students will sit out (if you do the water part, switch who is sitting out). This will represent mechanical thinning. Space the students further apart, and have them hold their "branches" higher up. Repeat the "low intensity" and "high intensity" fire steps. This time, fewer trees will catch on fire, especially with the low intensity step, and fire will not move as easily from tree to tree.

If time, you can do a fourth fire round. In this round, throw out some water pieces (or otherwise distribute them to the students). This can be done with either density. For each piece of water fabric that the student has, they can resist 1 touch of fire (either from the "fire" student or from a "tree" on fire).

Wrap-up

What type of forest has the least intense fire? (*thinned, higher branches, lots of water*)

The lesson is – the more water that is in the forest fuel, the milder the burn will be. A very dry forest will have a very intense burn. To illustrate this most clearly, you can divide the class in half and give the two halves different amounts of water, then let them burn at the same time.