Teaching the Lesson

Gear-up

Do the "Solar to Heat" experiment (see handout), and/or have students hold their hand near a light bulb, and then turn the light on. They can feel the heat almost instantly even though they are not touching it.

Explain that the heat is traveling by radiation, much the same way that heat travels to the earth from the sun.

Ask students for their ideas about what kind of work the sun's energy does when it gets to Earth.

Explore

Read and discuss the handout about energy from the sun.

Divide students into groups of two or three and assign one of the following to each group.

Hand out drawing materials and ask each group to make a large picture or sign that illustrates their word:

- Sun
- Heat
- Light
- Berries, roots, leaves (use names of plants in your part of the state that are eaten by animals and humans)
- Trees
- Caribou, fish, porcupine (use animals from your area that are used for subsistence)
- Small sea plants and animals
- Humans
- Moving Water
- Wind
- Electricity
- Oil
- Gas
- Coal

Play the following "Energy Chains" game in two or three teams, as a way of discussing and analyzing the ways in which all of the energy we use originally comes from the sun.

1. The first team draws a card with a use of energy. The team has three minutes to discuss and then hold up the pictures or signs to illustrate how the sun's energy is connected to the action. They should be able to answer questions to explain their connections. For each sign used correctly, they get one point for their team.
   For example, the action drawn is *"using a computer"*. Students might go up in front of the class and hold up the pictures: Sun-heat-wind-electricity. They would get 4 points for their team.
2. The other team(s) is invited to illustrate different ways that the same action is related to the sun. They also have 3 minutes to discuss and show the "energy chain" . Examples: Another team might show: Sun-light-small sea plants and animals-oil-electricity. They would get 5 points. A very astute team could show a "double" chain, with sun-light-"berries"-"caribou"-human beings (punching the keys) in one direction and sun-moving water-electricity in another direction and get 9 points, while another could show sun-electricity for 2 points.
3. Once each team has had a turn, it's time for the first team to draw a card again.

Variations

Students can make their own cards with ways that they use energy.

- Signs/pictures can be made ahead of time by volunteers, to save time.
- To make the game and lesson easier, eliminate types of energy (such as coal, wind, water) that are not used locally.
- All teams can build their "chains" at the same time and then tke turns comparing chains.

Generalize

Discuss the ways that most of our energy needs are provided by the sun, directly or indirectly. If students missed any important "energy chain" connections during the game, review those. Ask students if they can think of any kinds of energy that do not come from the sun, and discuss their answers.

Note: Some energy can also come from tides (gravitational forces), geothermal heat stored in the earth (from original Earth aggregation and radioactive decay), fission fuels (unstable uranium and thorium nuclei), and fusion fuels (deuterium and tritium).

Assess

Have students draw an energy concept map using the list of words that they illustrated and used in the game (see handout). Students should show how the words are related to each other, using connecting words like "driven by", "makes" or "comes from". There are many ways that the map can be drawn correctly, but you should expect students to illustrate the ways in which each word relates to the sun, to show several different sources of electricity, and to connect humans' energy back to the sun through a simple food chain.

Extensions, adaptations, and more resources:

Energy Sources and Natural Fuels Volume 2 NSTA/ API Monograph by Aldridge et al. (background for teachers).

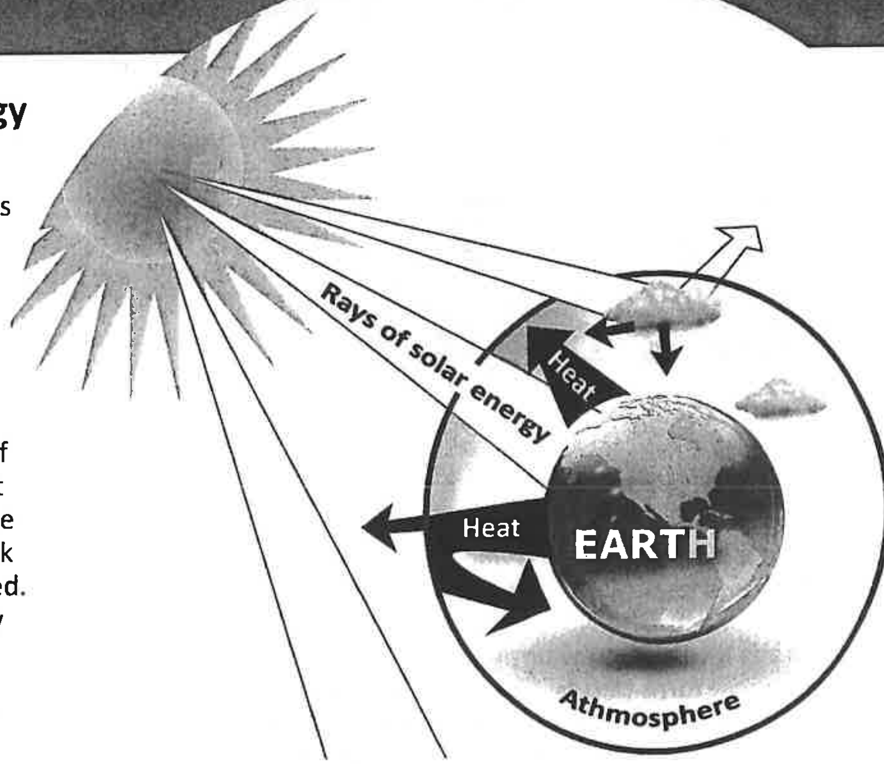
Handout

Solar Energy

Our earth gets most of its energy from the sun.

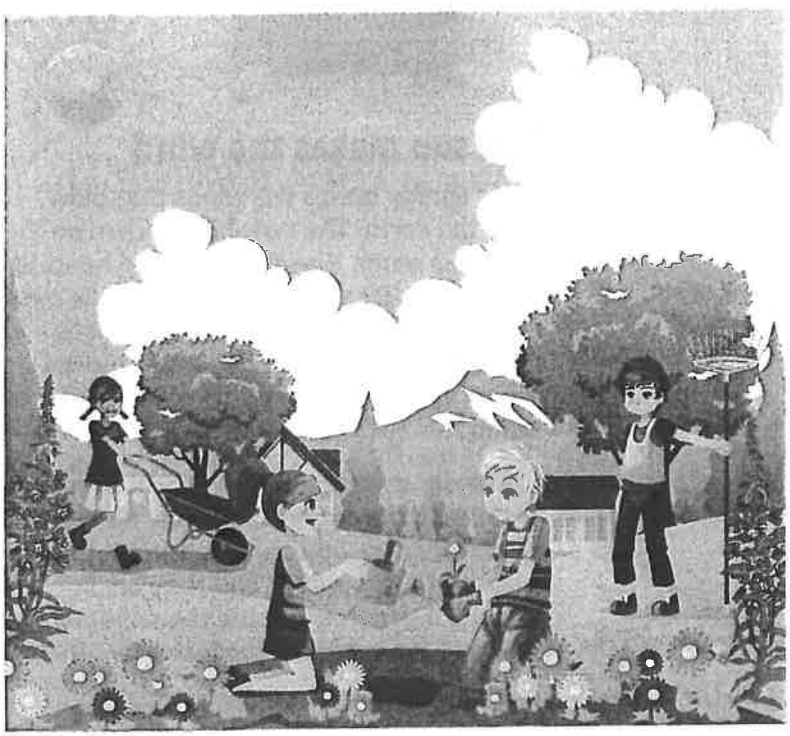
We call this energy solar energy. **Sol** means sun. Solar energy travels from the sun to the earth in rays. Some are light rays that we can see. Some are rays we can't see, like x-rays. Energy in rays is called radiant energy.

The sun is a giant ball of gas. It sends out huge amounts of energy every day. Most of the rays go off into space. Only a small part reaches the earth. When the rays reach the earth, some bounce off the clouds and back into space. In this way, the rays are reflected. The earth absorbs most of the solar energy and turns it into heat. This heat warms the earth and the air around it, which is the atmosphere. Without the sun, we couldn't live on the earth; it would be too cold.

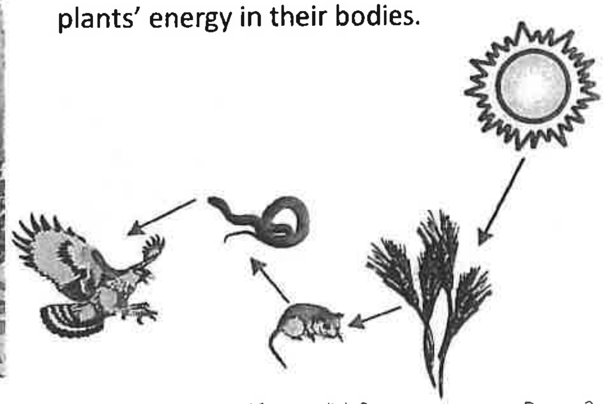


We use solar energy to see and grow things

We use solar energy in many ways. During the day, we use sunlight to see what we are doing and where we are going. Plants use the light from the sun to grow. Plants absorb (take in) the solar energy and use it to grow. The plants keep some of the solar energy in their roots, fruits, and leaves. They store it as chemical energy.



The energy stored in plants feeds every living thing on the earth. When we eat plants and food made from plants, we store the energy in our bodies. We use the energy to grow and move. We use it to pump our blood, think, see, hear, taste, smell and feel. We use energy for everything we do. The energy in the meat that we eat also comes from plants. Animals eat plants to grow. They store the plants' energy in their bodies.

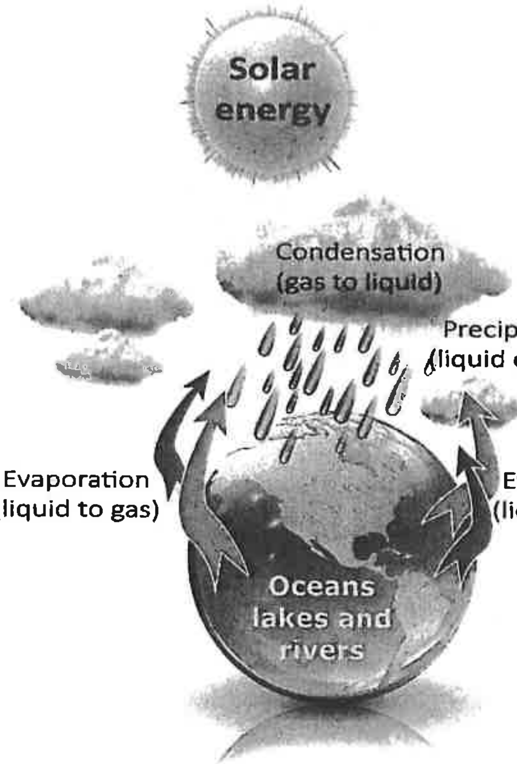


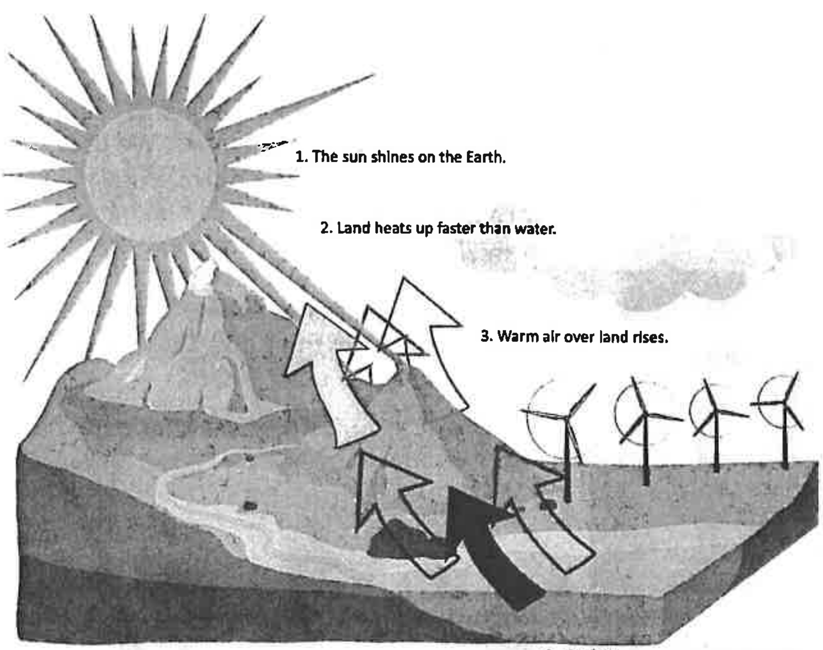
We can use the sun's energy for heat

We also use the energy stored in plants to make heat. We burn wood in campfires and fireplaces. Early humans burned wood to cook food, scare away wild animals, and keep warm. Solar energy turns into heat when it hits objects. That's why we feel warmer in the sun than in the shade. The light from the sun turns into heat when it hits our clothes or our skin. We use the sun's energy to cook food and dry our clothes.

The sun's energy is in many things

Solar energy powers the water cycle. The water cycle is how water moves from clouds to the Earth and back again. The sun heats water on the earth. The water evaporates, which means it turns into water vapor and rises into the air to form clouds. The water then falls from the clouds as precipitation, such as rain, sleet, hail, or snow. When water falls on high ground, gravity pulls it to lower ground. There is energy in the moving water. We can capture that energy with dams and use it to make electricity.





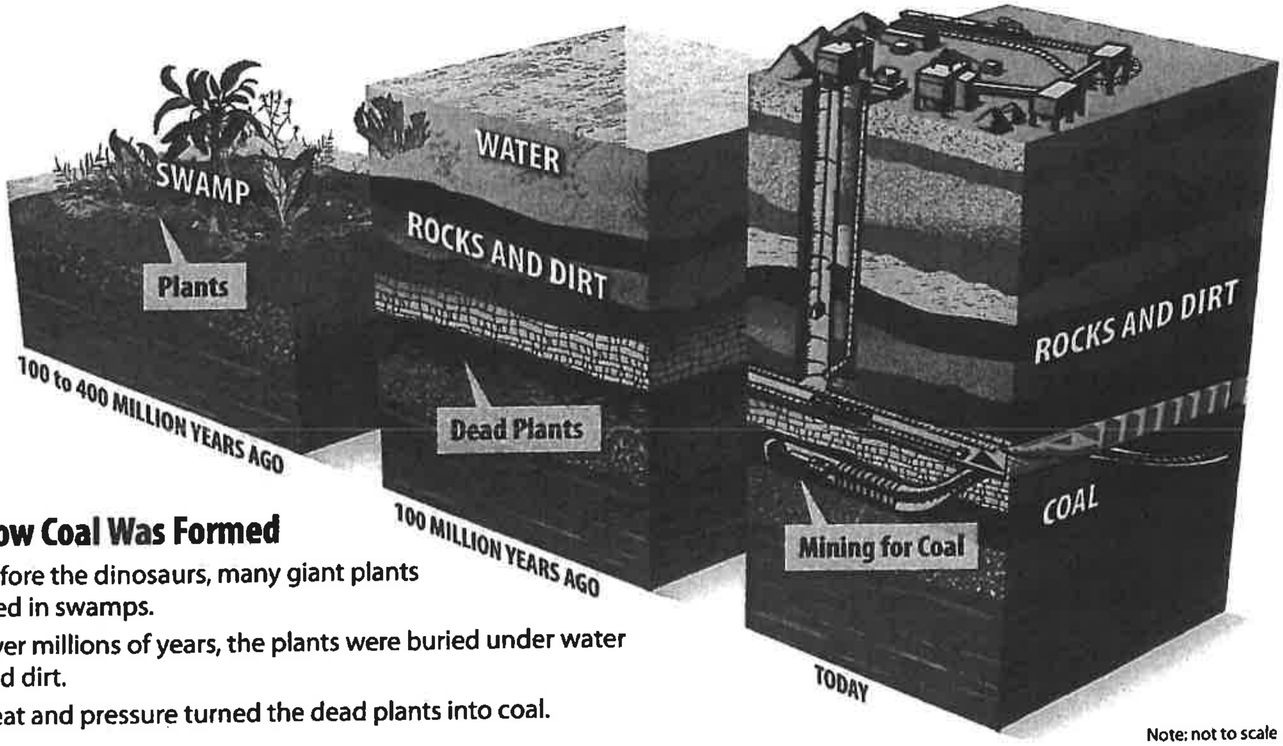
The sun makes the wind

Solar energy makes the winds that blow over the earth. The sun shines down on the land and water. However, the land heats up faster than the water, and then the air over the land gets warm. This warm air rises, and the cooler air over the water moves in where the warm air was. This moving air is wind.

Windmills can capture the wind's energy by turning the energy in moving air into electricity. The wind pushes against the blades of the windmill and they begin to spin. A generator inside the windmill changes the motion into electricity.

Fossil fuels have solar energy

Coal, oil, and natural gas are called fossil fuels because they were made from prehistoric plants and animals. The energy in them came from the sun. We use the energy in fossil fuels to cook our food, warm our homes, run our cars, and make electricity. Most of the energy we use today still comes from fossil fuels.



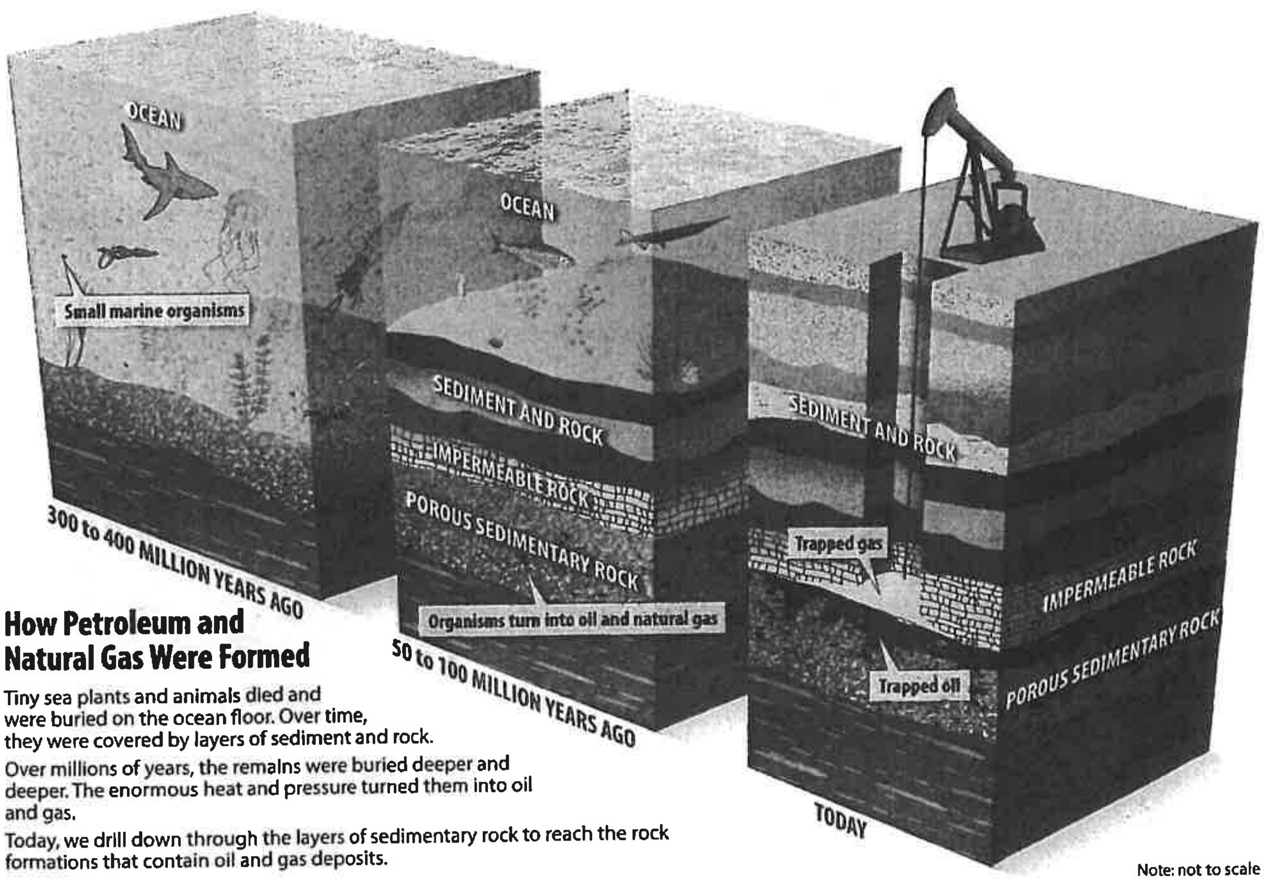
How Coal Was Formed

Before the dinosaurs, many giant plants died in swamps.

Over millions of years, the plants were buried under water and dirt.

Heat and pressure turned the dead plants into coal.

Note: not to scale



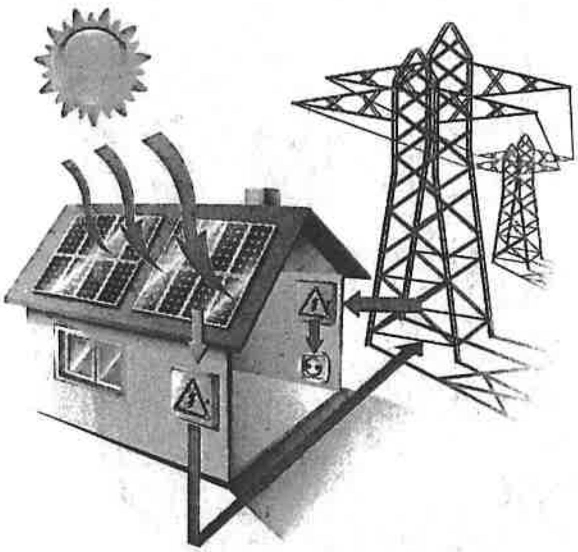
How Petroleum and Natural Gas Were Formed

Tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of sediment and rock.

Over millions of years, the remains were buried deeper and deeper. The enormous heat and pressure turned them into oil and gas.

Today, we drill down through the layers of sedimentary rock to reach the rock formations that contain oil and gas deposits.

Note: not to scale



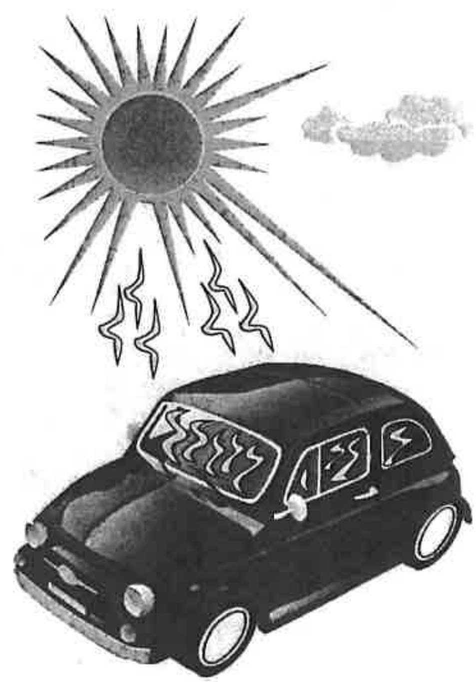
Solar energy can make electricity

Photovoltaic (PV) cells turn the sun's energy into electricity. "Photo" means light and "volt" is a measure of electricity. PV cells are made of two pieces of silicon, the main ingredient in sand. Each piece of silicon has a different chemical added. When radiant energy hits the PV cell, the layers of silicon work together to change the radiant energy into electricity.

Some toys and calculators use small PV cells instead of batteries. Big PV cells can make enough electricity for a house. They are expensive, but good for houses far away from power lines. Some schools are adding PV cells to their roofs. The electricity helps lower the amount of money schools must pay for energy. Do you have PV cells on your school building? Today, solar energy provides only a small amount of the electricity we use. In the future, it could be a major source of energy. Scientists are looking for new ways to capture and use solar energy.

Solar energy is renewable

Solar energy is free, clean, and renewable. We will never run out of it. The sun will keep making energy for millions of years. Why don't we use the sun for all our energy needs? We don't know how to, yet. The hard part is capturing the energy. Only a little bit reaches any one place. On a cloudy day, most of the solar energy never reaches the ground at all.



Ways we capture solar energy

Lots of people put solar collectors on their roofs. Solar collectors capture the energy from the sun and tum it into heat. People heat their houses and their water using the solar energy. A closed car on a sunny day is a solar collector. Solar energy passes through the glass, hits the inside of the car, and changes into heat. The heat gets trapped Inside.

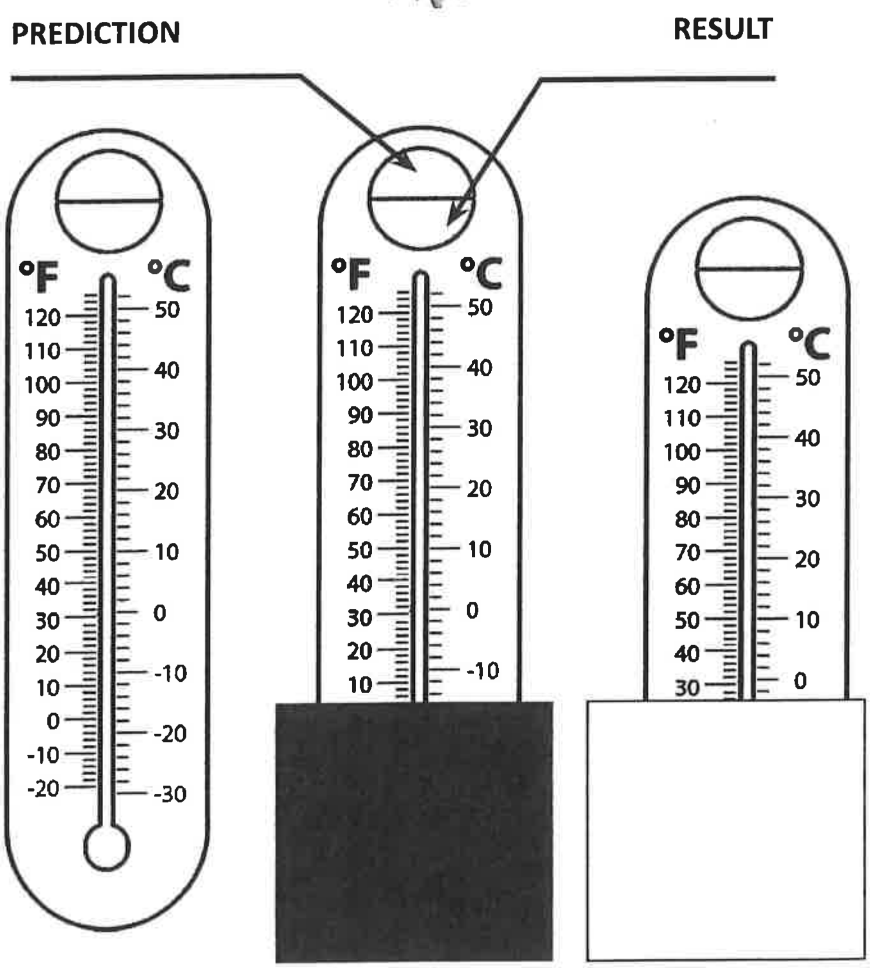
Energy Use Cards

Heating a house	*Paddling a kayak or canoe*	*Playing basketball*
Riding on a snowmachine	*Swimming*	*Turning on the lights*
Riding in a car	*Riding a bicycle*	*Cooking dinner*
Washing the dishes	*Flying a kite*	*Drying clothes*
Riding on a dog sled	*Walking to school*	*Watching television*

Activity
Solar to Heat

When radiant energy hits objects, some of the energy is reflected and some is absorbedand changed into heat. Some colors absorb more radiant energy than others.

Step 1 : Put three thermometers in a sunny place, or under a fixed light source.
Step 2: Cover the bulb of one with black paper. Cover the bulb of one with white paper.
Step 3: Predict which thermometer will get hottest. Number them 1-3, with 1 as the hottest.
Step 4: Observe the thermometer for three minutes.
Step 5: Record your results by coloring the tubes of the thermometers.
Step 6: Look at the results and number the thermometers 1-3 with 1 as the hottest.
Step 7: Explain your results.



Grade: K-2 & Grade 3-5| Time 30 minutes

ENERGY SAVERS

Essential Question: **How can we save energy?**

Overview

Students learn about conserving versus wasting energy and saving money and energy by playing an addition and subtraction game.

Assessment

Can students

- Name or draw 3 ways to save energy?
- Name or draw 3 ways to waste energy?

Vocabulary

- Reuse
- Recycle
- Repair
- Electricity
- Energy

Teacher Information and Procedure

Prior knowledge for students: Adding and subtracting numbers up to 20.

Source: New material © 2015 (Graphics from DepositPhotos.com)

Materials needed

Energy cards, cut out and mixed up in a box or hat (use the ones provided or make your own by asking children to suggest ways of saving energy and wasting energy)

Number Line marked 0-20

Two team "Markers" for the number line.

Play money - $40 in ones.

What to do in advance

If you don't have a number line on the wall, make one with numbers from 0-20 evenly spaced on the floor or whiteboard.

Teaching the Lesson

Gear-up

Engage students in a discussion of energy. What happens when you waste lots of energy? What are some ways that you waste energy? Discuss lights, TV, heat, and transportation, introduce the concept of recycling, reusing, and repairing things to save energy.

Explore

Tell students that you are going to play a game with money and energy. They are going to get a special allowance of "Energy Bucks" that they can use to pay for energy.

Divide class into two teams and give each team 20 dollars in play money.

Put both team's markers at the 20 on the number line.

The teams take turns drawing cards, and reading them (with help if needed) to the class. If the card tells them to spend money, they subtract the number of dollars spent from 20 (or whatever position they are at on subsequent turns) and move their marker accordingly. If the card says they save "bucks" they can add it to their position on the number line. If they are already at 20, or if the number of bucks added would put them over 20, they can save it and use it on a later turn.

The object of the game is to avoid getting to zero. When the first team gets to zero the game is over.

Turn off the lights for a minute to show that all the energy is used up!

After each tern, discuss why that activity wastes or saves energy.

Alaska Standards Addressed

Science GLEs

AAAS Benchmarks for Science Literacy

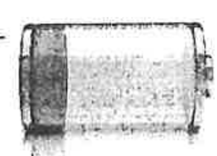
By the end of 2nd grade, students should know that people can save money by turning off machines when they are not using them.

Math GLEs

Readily give the sums and differences of single-digit numbers in familiar contexts where the operation makes sense to them and they can judge the reasonableness of the answer.

Alaska English/Language Arts and Mathematics Standards (2012):

- RI.K-5.4
- SL.K-5.1, SL.K-5.5



Generalize

Talk about the cost of using energy, and why it is a good idea to save money and resources by using less energy.

Assess

Ask students to name or draw 3 ways to save energy and 3 ways to waste energy.

Extensions, adaptations, and more resources

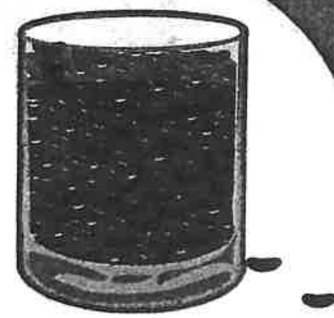
The game can be adapted for older students by using larger numbers, or by asking each student to make 3-5 "saver" cards and 3-5 "waster" cards to use in the game.

Leave the TV on all day Spend 6 ENERGY BUCKS	Have a parent drive you to school Spend 10 ENERGY BUCKS	Ride the bus to school Spend 2 ENERGY BUCKS	Use a wood fire to heat your house Save 3 ENERGY BUCKS
Turn on all the lights and leave them on Spend 8 ENERGY BUCKS	Turn off any lights that you don't need. Save 5 ENERGY BUCKS	Turn down the heat and put on a sweater Save 3 ENERGY BUCKS	Use a solar panel to recharge your phone Save 3 ENERGY BUCKS
Walk to School Save 4 ENERGY BUCKS	Leave the refrigerator door open Spend 5 ENERGY BUCKS	Leave the hot water running Spend 3 ENERGY BUCKS	Use a windmill for electricity in your home when windy Save 7 ENERGY BUCKS
Wash clothes in cold water instead of hot. Save 3 ENERGY BUCKS	Take a 1-minute shower Save 2 ENERGY BUCKS	Stay in the shower for 20 minutes Spend 6 ENERGY BUCKS	Use Tupperware instead of plastic bags Save 4 ENERGY BUCKS
Leave the outside door open (in winter) Spend 7 ENERGY BUCKS	Use a blanket to stay warm at night. Save 4 ENERGY BUCKS	Use your paper cup more than once Save 1 ENERGY BUCK	Ride a train just for fun Spend 4 ENERGY BUCKS
Walk to the store. Save 9 ENERGY BUCKS	Drive to the store Spend 9 ENERGY BUCKS	Use both sides of your paper Save 1 ENERGY BUCK	Heat your hot tub with Geothermal steam Save 5 ENERGY BUCKS
Fix your broken bicycle. Save 3 ENERGY BUCKS	Buy a new bicycle; the old one has a flat tire! Spend 6 ENERGY BUCKS	Recycle cans and bottles Save 2 ENERGY BUCKS	Plant new trees in your backyard Save 3 ENERGY BUCKS

Grade: 6-8 | Time: 2 hours

RENEW A BEAN

Essential Question: **What are renewable and non-renewable energy sources?**



Overview

Beans are used to represent renewable and nonrenewable energy in a simulation to help students understand how, over several years, nonrenewable resources will be depleted.

Assessment

Can students

- Give reasons for using renewable energy sources?
- Explain the difference between renewable and non-renewable energy?
- Classify energy sources as renewable or non-renewable?
- Use a simulation to help understand predictions about the use of energy resources?

Vocabulary

- Biomass
- Renewable
- Non-renewable
- Consumption

Alaska Standards Addressed

Science GLEs
The student demonstrates an understanding of:
- the attitudes and approaches to scientific inquiry by [8] SA2.1 recognizing and analyzing differing scientific explanations and models.

Math GLEs
[8] E&C-4 converting between equivalent fractions, decimals, or percent
[7] PS-5 using real-world contexts such as science, humanities, peers, and community.

English/Language Arts and Mathematics Standards (2012)

- RSL.6-8.4, RSL.6-8.6, RSL.6-8.9
- SL.6-8.1

Teacher Information and Procedure

Prior knowledge for students: None.

Source: Adapted from R.E.A.C.T. Teacher's Activity Guide, National Renewable Energy Laboratory Education Programs Home Page: http://www.nrel.govDownload guide from: http://www1.eere.energy.gov/education/science_projects.html#grades6to8 (Graphics from Depositphotos.com)

Materials needed

- Two open containers for every two students,
- Two types of similar shaped beans
- Blindfolds
- Handouts: Background Reading, Renewable Energy Data, Draw charts

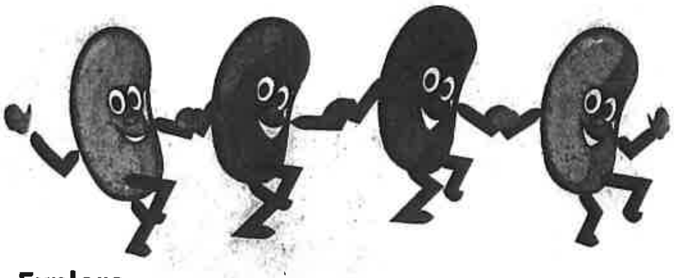
What to do in advance

- Give students the handout on practical sources of energy and read it together or ask them to read it as homework.
- Prepare two containers of beans.
  - ◊ 94% one color; 6% another color (i.e. one container has 94 pinto beans and one has 6 garbanzo beans). Be sure to maintain the 94:6 ratio to represent the ratio of nonrenewable to renewable energy consumption in the U.S.
  - ◊ For the first bean color, count 30 beans into a measuring spoon. Use that measure to put 3 X 30 beans into each student's container.
  - ◊ For the second color, count out 6 beans into the student's second container.
  - ◊ If you have more beans available, adjust accordingly.
- Make copies of handouts.
- Be sure to look the charts over before you begin so the procedure is familiar.

Teaching the Lesson

Gear-up

Review the difference between renewable and non-renewable energy and the classification of different sources by playing "20 questions". Only 20 yes or no questions can be asked to get the correct answer. Lead an example, and then divide students into pairs or small groups to play the game. The student answering the questions could use the handout on Practical Sources of Energy as a reference, if needed. As students play (for about five minutes), have them keep a list of renewable and non-renewable energy sources that they guessed. At the end of the game, ask students to write a paragraph explaining the difference between renewable and non-renewable energy sources.



Explore

1) Divide the students into pairs. Hand out the draw chart, and explain that you will play 5 rounds of the game. The first two rounds will NOT include renewable energy sources and the last three WILL include renewable energy sources.

2) Explain to students that because the U.S. depends on nonrenewable energy and because the human population is growing (thereby demanding more energy), we face the eventual depletion of this resource. But when? It all depends on how quickly and how much we use energy. If all our energy was renewable, we wouldn't have a problem...there would always be energy. This simulation will show the conditions that affect the depletion of nonrenewable resources. Students will experiment with these conditions to see how long they can extend the use of energy resources.

3) Discuss: Scientists, economists, and politicians frequently make predictions of how long various energy resources will last. In the early 1970's, it was predicted that we would run out of natural gas by the late 1980's! In the 1950's, some electric companies in California predicted that they would need a nuclear power plant every 10 miles along their coastline to meet their electrical energy needs.

Predictions are always based on some kind of assumptions, and it is important to understand those assumptions, when you hear or read a prediction. Maybe the prediction is based on the assumption that we will keep using energy at the same rate as we do now, like the predictions we just made. Or maybe it is assumed that we will use more and more energy each year. When the prediction says that we will run out, are they assuming that no new sources of energy will be found?

We will use some different charts that tell you how many beans to draw if you want to adapt for changes in rate of energy use. For example, if use remains constant from year to year, each person draws 10 beans. If you want to simulate an increase in energy use, you take out more beans each year than you took the year before.

4) Begin the Game

Round 1: The first round simulates a population with no population growth and constant energy needs for all 10 years.

Have the students predict how many years the energy source (beans) will last with 10 units (1 bean = 1 unit) being used each year.

Record the prediction on Data Chart #1.

One student will pull out 10 beans for each year until there is no longer enough to meet the energy needs of 10 units.

They will then record how many years (rounds of 10 beans) they could meet the energy needs.

Round 2: The second round simulates a growing population with growing energy needs each year.

Have the students predict how many years the energy source (beans) will last with the provided units (1 bean = 1 unit), listed on Draw Chart #2, being used each year.

Record the prediction on Data Chart #2.

One student will pull out the listed number of beans for each year until there is no longer enough to meet the energy needs.

They will then record how many years they could meet the energy needs.

Round 3: Add the 6 Renewable Beans to the bowl and blindfold the student that is picking the beans. The third round simulates a population with no population growth and constant energy needs for all 10 years, but with the introduction of Renewable Beans. The blindfold represents a population that is using energy without thinking about whether it is renewable or nonrenewable.

Note: Each renewable bean pulled can count towards that year's energy needs and then be replaced into the bowl.

Have the students predict how many years the energy source (beans) will last with 10 units (1 bean = 1 unit) being used each year, remembering Renewables are now in the mix.

Record the prediction on Data Chart #3.

The blindfolded student will pull out 10 beans for each year, replacing the renewable beans, until there is no longer enough to meet the energy needs of 10 units.

They will then record how many years (rounds of 10 beans) they could meet the energy needs.

Round 4: With the 6 renewable beans in the bowl, switch the blindfold to the other student. The fourth round simulates a growing population with growing energy needs each year, and with the introduction of Renewable Beans. The blindfold represents a population that is using energy without thinking about whether it is renewable or nonrenewable.

Note: Each Renewable bean pulled can count towards that year's energy needs and then be replaced into the bowl.

Have the students predict how many years the energy source (beans) will last with the provided units (1 bean = 1 unit), listed on Draw Chart #4, being used each year, remembering Renewables are now in the mix. Record the prediction on Data Chart #4.

The blindfolded student will pull out the listed number of beans for each year until there is no longer enough to meet the energy needs.

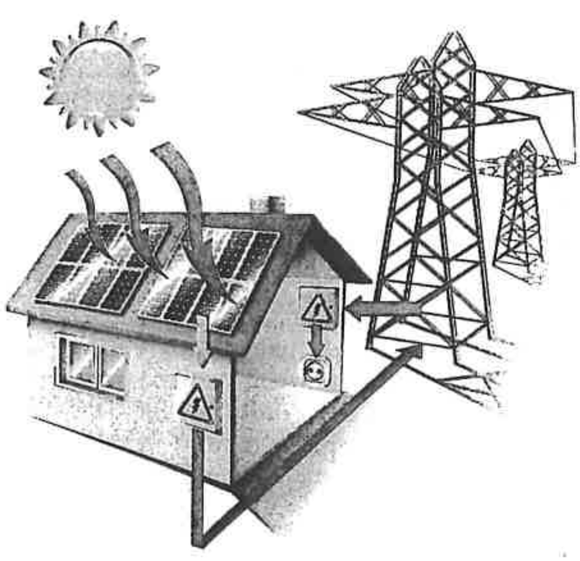
They will then record how many years they could meet the energy needs.

Round 5: With the 6 Renewable Beans in the bowl and NO blindfold.

Have the students see how many years they can make the energy last for a growing population with growing energy needs, but without the blindfold so that they can strategize how they would use their resources.

Challenge them see who can make their energy last the longest!

Discuss each group's strategy.



Generalize

1. At this point, tell students to design a way to extend the use of energy resources for as long as possible. The rules remain the same, however. Students are blindfolded, and they must begin by removing 10 beans. They are to establish a rate of consumption that will last longer than either of their previous trials. Have them record their trials in the remaining data boxes. (They should run at least two trials.)
2. When finished, discuss methods used to extend the energy resources, both renewable and nonrenewable. Have students write a conclusion about the use of renewable and nonrenewable energy.

Ask new questions

- What kind of energy will people be using in the future? Why?
- Why don't people use more renewable energy now?
- Are there reasons to use more renewables now rather than wait until the non-renewables run out?

Assess

Evaluate students' records from the trials that they designed, and the conclusions they wrote, using the rubric that is included.

Extensions, adaptations, and more resources:

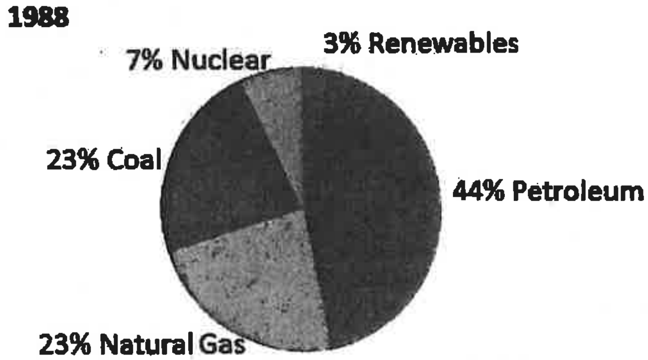
Make a plan to reduce the consumption of non-renewable energy sources in your daily life, your home, and/or your community.

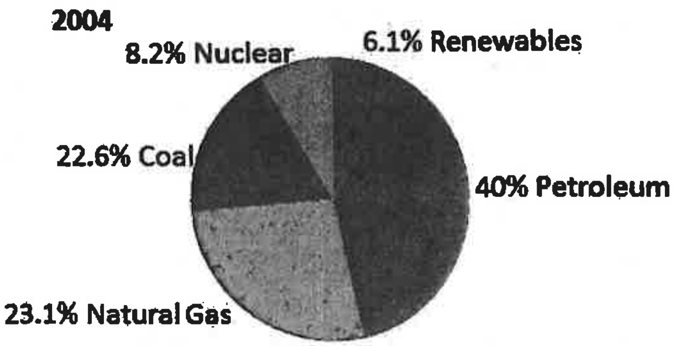
Learn about renewable energy sources that are being developed in different parts of Alaska.

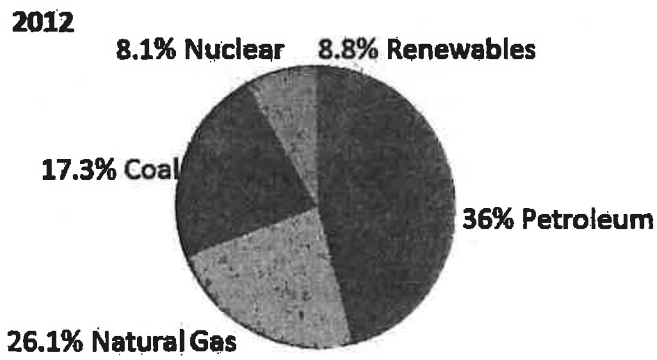
Do research on oil and gas reserves in Alaska.

Renewable Data Sheet

The United State derives approximately 97% of its total energy from nonrenewable resources. From 1986 to 1988 energy consumption increased by 12%.







(Note: Renewables are Solar, Hydro, Wind and other renewable resources.

These figures do not include direct solar-gain heating and lighting which is a major energy source.

Source: U.S. Department of Energy)

	In Progress	Meets Expectations	Exceeds Expectations
Students' simulations	Student designed and completed the simulation, but had some errors in their understanding of energy resource depletion.	Students were able to design and complete a simulation that made their beans last longer.	Students designed and completed more than one correct simulation, and were able to make sophisticated predictions based on different conditions
Students' conclusions	Correctly use the terms non-renewable and renewable, with examples OR explain reasons for using renewable energy	Correctly use the terms renewable and non-renewable and give examples of each. They give credible reasons for using renewable energy	Give many accurate examples of renewable and non-renewable energy sources, use data, and can give multiple reasons for using renewable energy.

Background Reading

WHAT ARE THE PRACTICAL SOURCES OF ENERGY?

- The practical sources of energy include fossil fuels such as natural gas, petroleum (or oil), and coal.
- Fossil fuels are referred to as nonrenewable energy sources because, once used, they are gone.

Scientists are exploring the practicality of other sources called renewable energy sources. These include sun, wind, geothermal, water, and biomass. The renewable energy resources are important in long range energy planning because they will not be depleted.

Natural Gas Sometimes natural gas is confused with gasoline, the fuel in cars. Gasoline is a mixture of liquids, while natural gas is mainly methane and is piped into buildings where it is used as a source for heating, cooking, washing, and drying. It is material to make other chemicals and is the cleanest-burning fossil fuel, which means it creates little environmental pollutants when burned.

Petroleum or Oil This is the black, thick liquid pumped from below the earth's surface wherever you see an oil rig. It is refined for use, which separates the gasoline portion that is used in transportation. Products from the remaining portions include synthetic rubber, detergents, fertilizers, textiles, paints, and pharmaceuticals.

Coal Coal is the most abundant fossil fuel. It supplies over half of the electricity consumed in the United States. Coal is mined from underground and from large surface excavations called open pits or strip mines. Most coal is transported from mines to power plants by trains and ships. While large amounts exist, it is non-renewable.

Solar The sun is 93 million miles away and yet this ball of hot gases is the primary source of all energy on earth. In the high temperature of the sun, small atoms of hydrogen are fused; the centers of the two atoms are combined. Fusion releases large amounts of energy. Without sunlight, fossil fuels could never have existed. The sun is the supplier of energy which runs the water cycle. Solar energy can be used to cook food, heat water, and generate electricity. It remains the cleanest energy source and it is renewable.

Wind The unequal heating of the earth's surface by the sun produces wind energy, which can be converted into mechanical and electrical energy. For a long time, the energy of wind has been used to drive pumps. Today windmills can be connected to electric generators to turn the wind's motion energy into electrical energy, and wind over 8 miles per hour can be used to generate electricity. It is a renewable energy source.

Hydroelectric (Falling Water) When water is collected behind dams on large rivers, it provides a source of energy for the production of electricity. The enormous power of falling water is capable of turning giant turbines. These turbines drive the generators, which produce electricity. The amount of power is determined by the amount of water and the distance it falls. Hydroelectric power plants do not cause pollution, but there are few places to build dams. Water is a renewable energy source.

Ocean Tides The currents created by daily tides are a form of kinetic energy that can be used to generate electricity. Channels and bays that focus tidal currents and surface motions created by waves can be used to run turbines and generators. Electricity generated from tidal movements is being used in places like Norway and is being investigated at many places along the world's coasts. Tidal energy is a renewable resource.

Geothermal The interior of the earth is very hot. This heat is left over from when the Earth first formed and from the decay of radioactive elements within it. There is a gradual increase of temperature with depth everywhere, but in some places the rocks are extra hot. Hot rocks are common around volcanoes, for example. Hot springs and geysers form where water comes in contact with hot rocks. Electricity can be generated by controlling the flow of hot water or steam through hot rocks. This is done several places around the world, including California. Iceland gets most of its electricity (and heats many of its facilities with hot water) from geothermal sources. Geothermal energy is not exactly a renewable resource, but there is a tremendous amount of it and it will last a very long time.

Biomass Biomass is living or recently living material that can be used for fuel. Wood is the principal biomass fuel, but other biomass energy sources include garbage and fuels such as ethanol (an alcohol distilled from plants) and biodiesel (fuel from animal or plant fats and oils). In some places, wood is still an important source of energy for individual families. Many biomass energy projects focus on the use of decaying organic matter in garbage as a source of methane or use garbage as part of the fuel burned in power plants. Biomass is considered a renewable resource.

Nuclear Fission In the 1930s scientists found that splitting the nucleus of an uranium atom releases a tremendous amount of heat energy. This knowledge was used to make atom bombs. Today, power companies use the heat produced by nuclear fission to produce electricity. Some countries (like France) supply most of their electricity from nuclear fission. Uranium is not a renewable resource.

Currently, nonrenewable resources supply the majority of our energy needs because they have been inexpensive and we have designed ways to transform their energy on a large scale to meet consumer needs. Regardless of the source of energy, the energy contained in the source is changed into a more useful form – electricity. Electricity is sometimes referred to as a secondary energy source. All the other sources are primary.

DRAWING A CHART

The following chart tells you how many beans to draw out of the container depending on the energy Before beginning each year predict how long it will take to remove all the NONRENEWABLE beans .

Complete the chart by recording the number of all beans left after each draw.

RULES:

1. Remove only the number of beans indicated on your chart
2. Always remove 10 beans in the first year
3. Put renewable beans back in the container after each pull. Count ONLY the beans left in the container.
NOTE you may not have enough beans to count to year 12; or you may have to extend this chart on the back!
4. The student pulling the beans out must be properly blindfolded. Consider it cheating to pick beans based upon how they "feel".
5. Keep all beans where they can be counted and returned to the container.

Data Chart #1 **ONLY NONRENEWABLES**

CONSUMPTION LEVEL	Prediction of years to deplete	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total Years energy needs were met
Number of beans to be removed		10	10	10	10	10	10	10	10	10	10	
Energy Needs Met? (Yes or No)												

Data Chart #2 **ONLY NONRENEWABLES**

CONSUMPTION LEVEL	Prediction of years to deplete	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total Years energy needs were met
Number of beans to be removed		10	12	14	18	22	25	30	32	36	40	
Energy Needs Met? (Yes or No)												

Data Chart #2 **ONLY NONRENEWABLES**

CONSUMPTION LEVEL	Prediction of years to deplete	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total Years energy needs were met
Number of beans to be removed		10	12	14	18	22	25	30	32	36	40	
Energy Needs Met? (Yes or No)												

Data Chart #3 **WITH RENEWABLES** Blindfolded

CONSUMPTION LEVEL	Prediction of years to deplete	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total Years energy needs were met
Number of beans to be removed		10	10	10	10	10	10	10	10	10	10	
Energy Needs Met? (Yes or No)												

Data Chart #4 **WITH RENEWABLES** Blindfolded

CONSUMPTION LEVEL	Prediction of years to deplete	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total Years energy needs were met
Number of beans to be removed		10	12	14	18	22	25	30	32	36	40	
Energy Needs Met? (Yes or No)												

Data Chart #5 **WITH RENEWABLES** NO Blindfold

CONSUMPTION LEVEL	Prediction of years to deplete	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total Years energy needs were met
Number of beans to be removed		10	12	14	18	22	25	30	32	36	40	
Energy Needs Met? (Yes or No)												

Group Member Names: ______________________________

RENEW A BEAN DATA COLLECTION SHEET

Data Chart #1 **ONLY NONRENEWABLES**

CONSUMPTION LEVEL	Prediction of years to deplete	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total Years energy needs were met
Number of beans to be removed		10	10	10	10	10	10	10	10	10	10	
Energy Needs Met? (Yes or No)												

Data Chart #2 **ONLY NONRENEWABLES**

CONSUMPTION LEVEL	Prediction of years to deplete	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total Years energy needs were met
Number of beans to be removed		10	12	14	18	22	25	30	32	36	40	
Energy Needs Met? (Yes or No)												

Data Chart #3 **WITH RENEWABLES** Blindfolded

CONSUMPTION LEVEL	Prediction of years to deplete	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total Years energy needs were met
Number of beans to be removed		10	12	14	18	22	25	30	32	36	40	
Energy Needs Met? (Yes or No)												

Data Chart #4 **WITH RENEWABLES** NO Blindfold

CONSUMPTION LEVEL	Prediction of years to deplete	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Total Years energy needs were met
Number of beans to be removed		10	12	14	18	22	25	30	32	36	40	
Energy Needs Met? (Yes or No)												

Grade 3-5 | Time: 1 hour

EVERY TREE FOR ITSELF

Essential Question:

What do forests need to survive and be healthy?

Overview

Students play a game to simulate how trees compete for their essential needs.

Assessment

Can students describe how varying amounts of light, water and nutrients affect a tree's growth?

Vocabulary

- Competition
- Drought
- Nutrients
- Succession

Information and Procedure

Prior knowledge for students: Basic tree anatomy would be helpful

Source: AMEREF Forestry Module Every Tree for Itself. Copied with permission, American Forest Foundation, Copyright: 1993-1998, Project Learning Tree Environmental Education PreK-8 Activity Guide. The complete Activity Guide and High School Modules can be obtained by attending a PLT workshop. For more information visit the Project Learning Tree website at (www.plt.org). (Graphics from Depositphotos.com)

Materials needed

- 8½" x 11" (22 cm x 28 cm) pieces of paper or paper plates
- Pieces of blue, yellow and green paper or three colors or poker chips
- Tally Sheet (attached)
- Markers or crayons
- Tree Cookie or tree branch cross-sections showing annual growth rings if available (often available from tree-trimming services or forest industries)

Alaska Standards Addressed

Science GLEs

The student demonstrates an understanding;

- that all organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy by:

[4] SC3.1 identifying examples of living and non-living things and the relationship between them (e.g., living things need water, herbivores need plants).

- those interactions with the environment provide an opportunity for understanding scientific concepts by:

[5] SA3.1 identifying the limiting factors (e.g., weather, human influence, species interactions) that determine which plants and/or animals survive.

Math GLEs

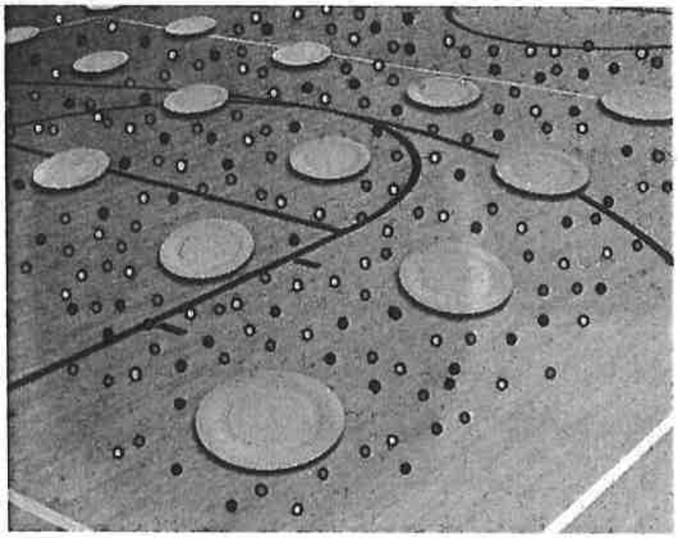
to classify and organize data by [3] S&P-1 [designing an investigation and collecting, recording L], organizing, displaying, or explaining the classification of data in real-world problems using bar graphs, and [Venn diagrams L]

[4] S&P-1 [designing an investigation and collecting L], organizing or displaying, using appropriate scale, data in real-world problems, using bar graphs, tables, charts, or diagrams with whole numbers up to 25

[5] S&P-1 [designing an investigation and collecting L], organizing, or displaying, using appropriate scale, data in real-world problems, using bar graphs, tables, charts, diagrams, or line graphs with whole numbers up to 50.

Alaska English/Language Arts and Mathematics Standards (2012)

- RI.K-5.4
- SL.K-5.1, SL.K-5.5



nutrients, water, and sunshine) while narrow rings often indicate less favorable conditions for growth (drought, short growing seasons, insect damage, lack of nutrients or competition).

What to do in advance

Cut at least four 3" x 3" (7.6 cm x 7.6 cm) squares out of blue, yellow, and green construction paper for each student. To save time, you could use colored poker chips. **Poker chips work much better than paper,** especially if you're doing the activity outdoors on a breezy day. Copy Tally Sheets for students.

Teaching the Lesson

Gear-up

Ask the students, "If you were a tree and lived in the forest, would you rather be a strong older tree, a regular size tree, a small tree just starting out, or a tree that preferred shade. Why?"

Pass out the Tree Cookie or any cross-sections of trees you have. Have your students examine the growth rings. (If you don't have an actual cross-section, draw a big one on the chalkboard.) Explain that the number of rings indicates a tree's age.

Discuss

- What do trees need so they can grow?
- Trees have some of the same needs as those of people and animals. For example, they all need plenty of water.
- They also need an abundance of nutrients, which they get from food. But trees and people don't get food in the same way. Plants make their own food by using energy from the sun.
- If trees don't get enough water, nutrients, or sunlight, they may grow slowly or die. Growth rings show this graphically. In general, wide rings indicate good conditions for growth (plenty of nutrients, water, and sunshine) while narrow rings often indicate less favorable conditions for growth (drought, short growing seasons, insect damage, lack of nutrients or competition).

Explore

Give a large piece of paper (at least 8½" x 11" or 22 cm x 28 cm) or a white paper plate to each student. Tell students to imagine that they are trees. Have them draw a cross-section of themselves representing their age in growth rings. (You might laminate these drawings for durability.)

Have students stand on their cross-sections (paper plates) about three feet (91 cm) apart from each other.

Equally distribute the colored squares (or poker chips) on the floor around the students so the squares (poker chips) are about one to two feet (30-61 cm) apart. See photo to the right.

Tell students that they'll be playing a game called ***"Every Tree for Itself."*** The object of the game is for the "trees" to gather as many colored squares (poker chips) as they can. Explain that each colored square (poker chip) represents a tree requirement. Blue represents water, yellow represents sunlight, and green represents a nutrient such as nitrogen, oxygen or carbon dioxide. Make appropriate adjustments if you use poker chips. (Blue = water, White = nutrient, Red = sunshine)

Rules:

Students must keep one foot (their tap root) planted on their cross-section (paper plate) at all times. They are not allowed to slide their cross-section (paper plate) along the floor or step off it; they will be disqualified for doing so.

Round 1:

Give a signal to start. Have student trees reach out with their roots and branches (arms and legs) to gather their requirements. Allow student trees to gather these requirements for one 30-second round. (They can either collect all types of requirements at once or one type of requirement each round.) Have students use a notebook or tally sheet (provided with this exercise) to record how many of each color requirement they gathered. Use the following questions to discuss the results of the first round:

- How many requirements did each tree get?
- Do any trees lack a particular requirement?

- What might happen to a real tree that lacked one of its requirements?
- (It might grow slowly or eventually die. Point out to the students, that different species of trees have different requirements.)
- Is there such a thing as too much water, sunlight, or nutrients? (Yes, every species has optimum levels for each requirement. Beyond which the tree becomes stressed.)

Round 2: Have students stand on their cross-sections in groups of three to five. Gather the colored squares and spread them around the room again. Play another round and have student trees record their results. Compare the results of this round with those of the first.

In most cases, students will notice that each tree gathered fewer requirements. Ask your students if they can reach any conclusion about trees that grow close to each other. (Such trees compete for requirements. Often they don't grow as well as trees that are more widely separated from one another.) Ask if any trees "died" because they couldn't get a particular requirement. (You can allow trees to fall down or look tired and droopy if they haven't received their vital requirements.) Try several more rounds, comparing the results each time.

Additional rounds: Here are suggestions for setting up additional rounds. As before, each student should examine his or her results in each round. Older students can record those results and later graph or chart the results of each round and draw conclusions.

- Have all the students stand closer together.
- Put students closer together, but have only half of the class participate.
- Use fewer water squares (representing a drought).
- Use fewer sunlight squares (representing lack of sunlight for young trees because of overcrowding).
- Use fewer nutrient squares (representing poor quality soil).

Generalize

Assign values to the amounts of requirements the students gather (see attached rubric on last page). For example, a collection of three or more of each requirement could represent superior growth. Two of each requirement could represent average growth. One or fewer of each could represent poor growth. Using these values as a basis, have students record the numbers of trees that are growing very well, fairly well, and poorly for each round. Students can use graphs to show results.

Foresters plant trees a certain distance apart so the trees will be able to get enough nutrients. The distance varies depending on the species of the tree. Foresters also thin young stands of trees. Ask students how foresters might use their knowledge of competition in caring for a stand of trees.

Assess

Ask students to describe on paper, what trees need to survive and how arrangement of trees in a forest can affect the growth of individual trees.

Extensions, adaptations, and more resources:

Follow-up with investigations of plant growth under crowded conditions (see the 6-8 grade lesson "Give Me Some Space" and adapt for younger students as needed)

For a visual way to portray water absorption by roots, try the following:

1. Explain, for many species of trees, the diameter of the spread of the tree's roots are roughly equal to the tree's height. Have students measure themselves and then make a circle (using chalk or string) with a diameter equal to their height.

2. Play the tree game with each student standing in the center of his or her circle. Tell the student trees they can gather water squares (poker chips) only within their circle of roots.

3. Play the game again using root circles, but this time have trees stand in clumps. Afterward, discuss the results of root competition.

- Forest Fires
- Spruce Bark Beetle

Date: ____________________ Name: ____________________

"EVERY TREE FOR ITSELF" Activity

Tally Chart

	ROUND									
Description	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Spacing from other trees										
Sun Intake										
Water Intake										
Nutrients Intake										
Other Factors										
	Health of the Tree Please circle one									
	Healthy	Healthy	Healthy	Healthy	Healthy	Healthy	Healthy	Healthy	Healthy	Healthy
	Slight Risk	Slight Risk	Slight Risk	Slight Risk	Slight Risk	Slight Risk	Slight Risk	Slight Risk	Slight Risk	Slight Risk
	Great Risk	Great Risk	Great Risk	Great Risk	Great Risk	Great Risk	Great Risk	Great Risk	Great Risk	Great Risk
	Dead	Dead	Dead	Dead	Dead	Dead	Dead	Dead	Dead	Dead

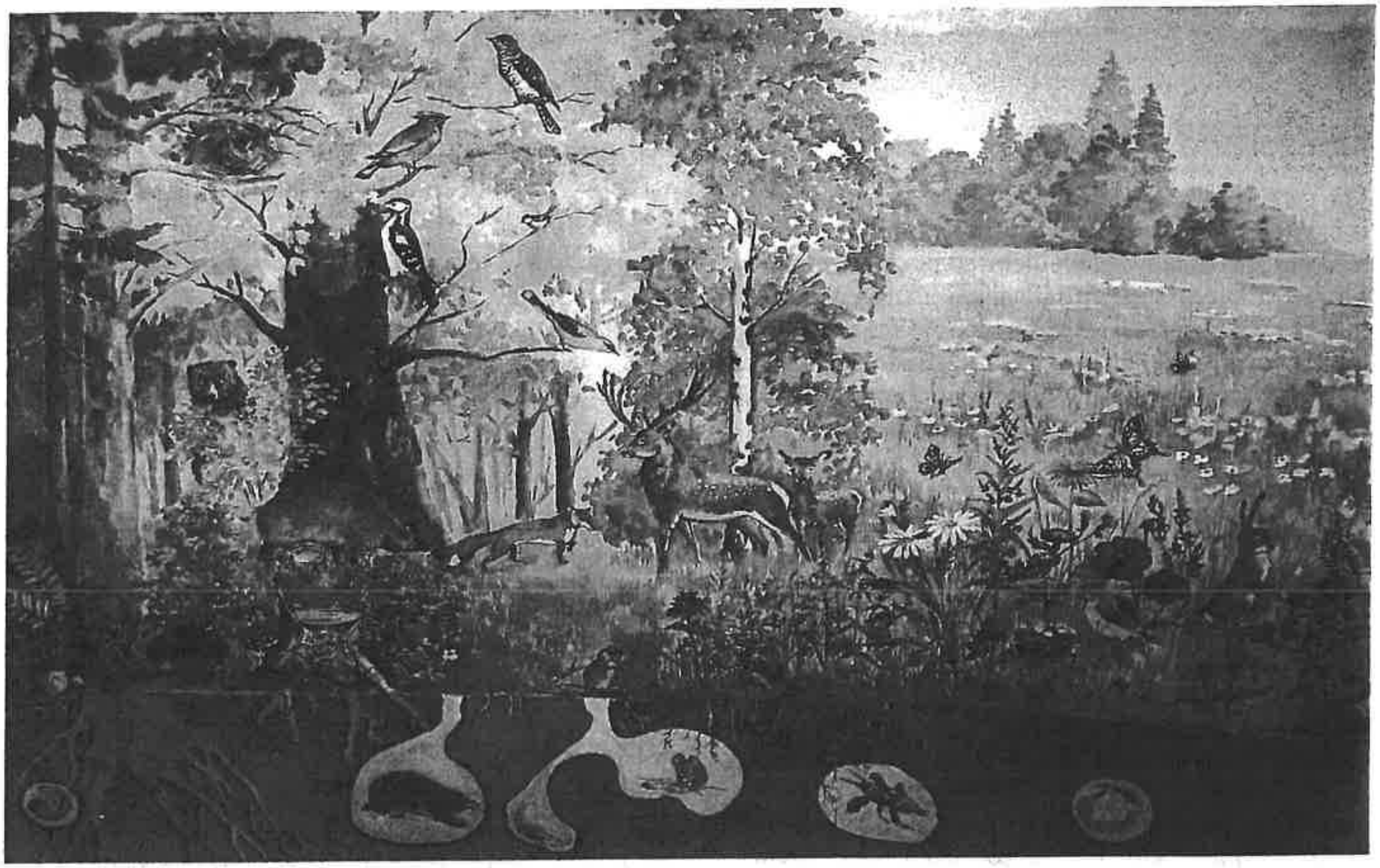
Healthy = 8 of Each Color Chips
Slight Risk = 6 of Each Color Chips
Great Risk = 4 of Each Color Chips
Dead/Dying = 2 of Each Color Chips

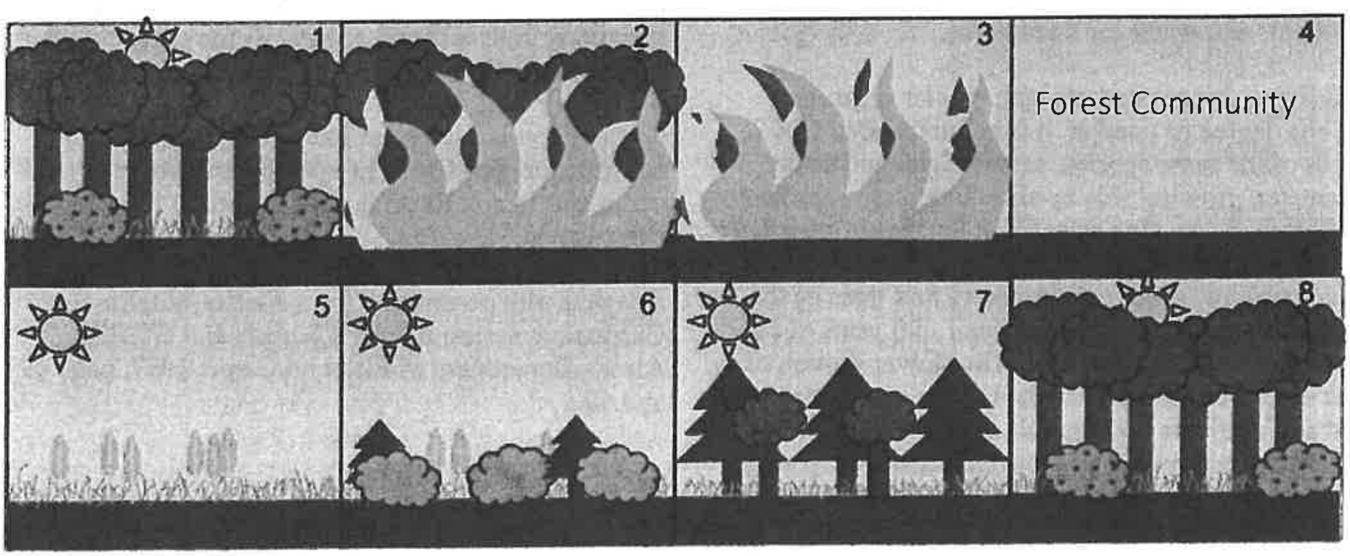
If one color greatly out numbers the others, then:

Too many water units = flooded roots, soil erosion, etc.

Too many sun units = very hot? Wilted? Or Drought if water is low.

Too many nutrient units = if not much water then nutrients could not be absorbed.





Kmurphy12/wikipedia.org

An example of Secondary Succession by stages:

1. A stable deciduous forest community
2. A disturbance, such as a wild fire, destroys the forest
3. The fire burns the forest to the ground
4. The fire leaves behind empty, but not destroyed, soil
5. Grasses and other herbaceous plants grow back first
6. Small bushes and trees begin to colonize the area
7. Fast growing evergreen trees develop to their fullest, while shade-tolerant trees develop in the understory
8. The short-lived and shade intolerant evergreen trees die as the larger deciduous trees overtop them. The ecosystem is now back to a similar state to where it began.

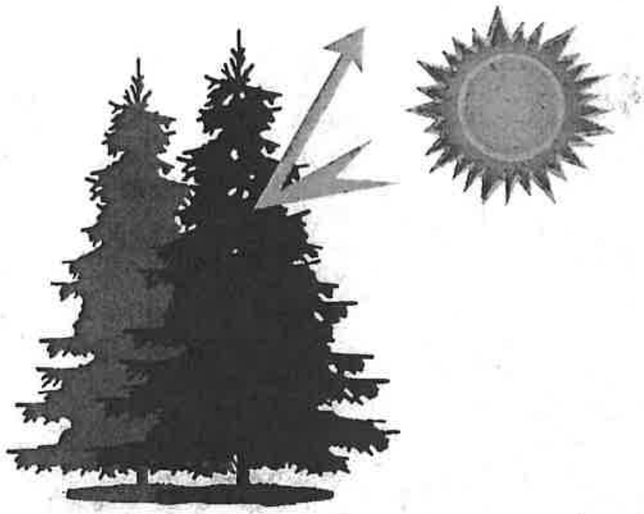
Background

The pattern of change from bare rock to deep forest is called succession – the order that plants colonize a barren site or reestablish themselves on a disturbed site. How a forest grows and which plants come first or second depends on 1) differences in the needs of the plants, 2) the effects of the non-living environment on plants and other living things and 3) competition. (Items #1 and #2 have been addressed in previous lessons.)

Competition occurs when the supplies of energy, nutrients, and space are limited. Any plant that can get more water, nutrients, and sunlight than its neighbors will grow better and be able to have more offspring.

Plants have a variety of adaptations to help them compete for the resources they need for survival and growth. Some plants grow tall, such as Sitka spruce, to get more of the available sunlight energy. Plants with long roots, such as black or white spruce, reach farther and get more water and nutrients than those with short roots. Some produce chemicals to kill the roots of other plants and assure a larger supply of nutrients and water for themselves.

All living things compete with similar organisms to one degree or another. It is not unusual to find 2 trees of the same species, same height, and same diameter, growing side by side, which are significantly different in age. One scientist in Southeast analyzed western hemlock trees growing next to one another. He found it was not uncommon to find trees of the same diameter in which one was 1,000 years old and the other only 200 years old. The slower growth of the older tree can be attributed to the competition for soil nutrients and sunlight during a time when the forest was young and overcrowded. The younger tree, growing in an old growth forest, which has more space, was able to grow quickly putting on more girth and height during a growing season than its next-door neighbor at its same age.



In early successional Coastal forests, trees will usually grow very closely spaced with several thousand trees per acre. Foresters often thin these young forests to several hundred trees per acre. In looking at these forests several years after such thinning, growth on the remaining trees is more extreme as the competition was minimized.

Competition is a constant interaction among ecosystem organisms. The specific mixture of organisms in any forest is due, in part, to the effects of competition.

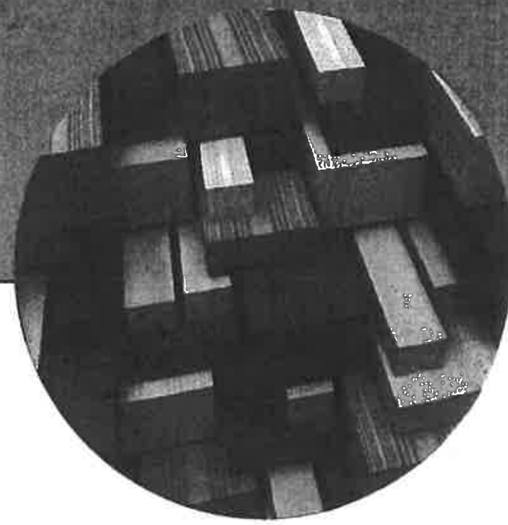
Adapted with permission from Alaska Wildlife Curriculum series, Alaska's Forests and Wildlife, Alaska Department of Fish and Game, 1999, page 49 and 65.

Grade: 6-8 | Time: 1-2 hours

STRING LINED DECISIONS

Essential Question:

What are the trade-offs associated with the use of forests?



Overview

Teams of students make and map management decisions about a forest.

Assessment

Can students

- Decide how a given area of forest should be used?
- Defend a point of view?

Vocabulary

- Multiple use
- Wilderness
- Subsistence
- Timber harvest
- Primitive use

Teacher Information and Procedure

Prior knowledge for students: None.

Source: Alaska Resource Education Forestry Module fm2 String Lined Decisions. (Graphics from Depositphotos.com)

Materials needed

- Copies of "String Lined Decisions" student page (or substitute ordinary graph paper)
- Copies of "String Lined Decisions Points of View"
- Scissors
- Masking tape
- 7-10 different colors of yarn or string (or use markers if string is too complicated)

What to do in advance

1. Copy both the "String Lined Decisions" and the "String Lined Point of View" student pages - 1 set per 4 students.
2. Different colored string can be made by painting it with tempera paint or coloring it with markers.

Alaska Standards Addressed

Science GLEs

The student demonstrates an understanding

-that interactions with the environment provide an opportunity for understanding scientific concepts by:

[8] SA3.1 conducting research to learn how the local environment is used by a variety of competing interests (e.g., competition for habitat/resources, tourism, oil and mining companies, hunting groups). (L)

-of how to integrate scientific knowledge and technology to address problems by: [7] SE1.1 describing how public policy affects the student's life. (e.g., public waste disposal). [8] SE1.1 describing how public policy affects their lives and participating diplomatically in evidence-based discussions relating to their community.

Geography

F3) analyze resource management practices to assess their impact on future environmental quality;

Government and Citizenship

F9) understand those features of the economy of the state that make it unique, including the importance of natural resources, government ownership and management of resources, Alaska Native regional corporations)

Alaska English/Language Arts and Mathematics Standards (2012)

- RSL.6-8.4
- WL.6-8.1, WL.6-8..2
- SL.6-8.1, SL.6-8.2, SL.6-8.4

Teaching the Lesson

Gear-up

3. Ask the students to list in 10 seconds all of the things they can do in a forest. Discuss their answers.
4. Ask students if they owned a forest, how would they use it and why?
   a. Would they allow hunting and fishing, would they allow timber harvest, would they allow mining? Discuss students' thoughts and points of view.

Explore

1. Divide the class into teams of 4. Tell each team that they need to read the differing points of view for forest use based on the student sheet provided called "String Lined Decisions, Points of View".
2. Pass out the student pages and tell the students to read the points of view and then discuss their ideas of forest use as a team.
3. Next pass out the grid sheet called "String Lined Decisions" page. Tape it to the table in the middle of the four students. Tell them this paper represents their forest.
4. Tell the 4 students to place a stream somewhere in their forest. Tell them they can add roads, a lake, or any other items that might be found in a forest.
5. After the students have designed their forest, tell them that each square represent a million acres of forest. They, as a managing group, must decide what areas of the forest will be used for what purposes (those listed on the Points of View student page). They may decide some areas can have multiple uses, while some may be more specific. It doesn't really matter how they divide up their forest, as long as they come to some kind of agreement and they see that all the acres can't be used for everything, but some can be used for more than one thing.
6. The string is used to mark the different areas, showing which area is to be used for what. Make sure students include some kind of key.

Generalize

1. Each team shares their forest and why they divided it in the way they did including biological, economic, and recreational reasons.
2. Did the students provide a mix of uses? If a particular use is lacking or is allocated to only a small portion of the forest (be it timber harvest, wilderness, or some other use), ask the students how this might affect use demands on other forests in Alaska or the world.

Assess

The generalize section can be used for your assessment.

Extensions, adaptations, and more resources

Have students make decisions about the forest use as a class, combining all of the teams' ideas into one.
After researching an area of forest near you, have students prepare a presentation regarding how they feel that part of the forest should be used.
Attend a public hearing regarding use decisions of a local forest.

See the "Land Graphs" activity, and use the background from this activity to make graphs of land use designations in the Tongass.