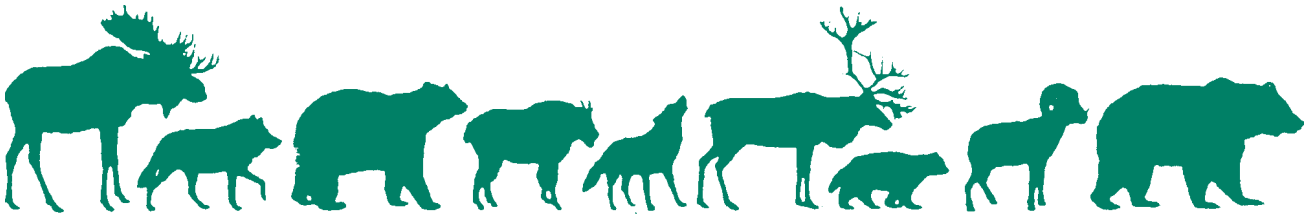
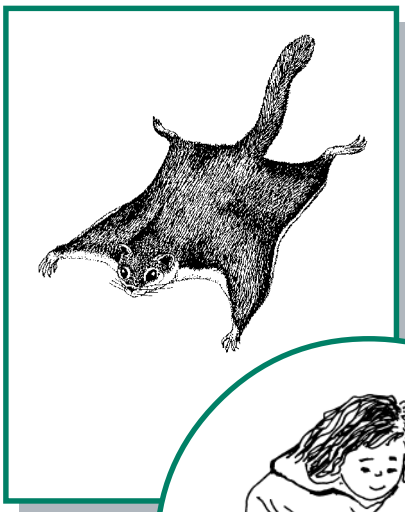


Alaska's Forests & Wildlife

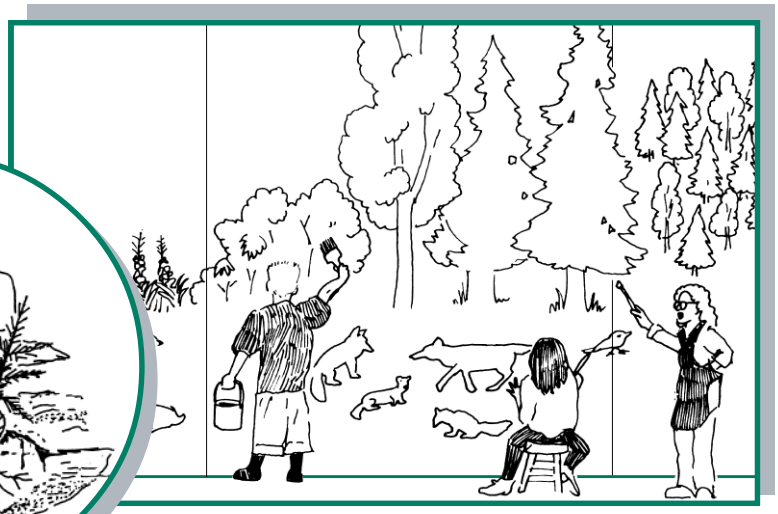
ALASKA WILDLIFE CURRICULUM TEACHER'S GUIDE



K-12

Teacher Background Information, Illustrations, and Resources, Student Activities and Investigation

Correlated to the State Standards



Alaska Department of Fish and Game

Alaska's Forests & Wildlife

REVISION 2018

Project Managers:
Robin Dublin, Jonne Slemons

Editors:
Alaska Department of Fish and Game: Robin Dublin, Karen Lew, Bruce Bartley
Expression: Elaine Rhode, Jeanne L. Williams, David Honea

Bibliographer: Jane Meacham

Reviewers:
Alaska Department of Fish and Game: John Wright, Jonne Slemons, Holli Apgar,
Alaska Department of Natural Resources, Division of Forestry: Dan Ketchum

Layout:
Classic Design & Typography: Chris Hitchcock

Illustration:
Conrad Field, Susan Quinlan, Garry Utermohle, Debra Dubac

Indexing & Educational State Standards:
Jennifer Coggins, Robin Dublin

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The *Alaska Wildlife Curriculum* is a resource for educators teaching today's youth about Alaska's wildlife. We dedicate this curriculum to you and your students.

ALASKA'S FORESTS & WILDLIFE is part of the *Alaska Wildlife Curriculum* that includes:

Alaska's Ecology
Alaska's Tundra & Wildlife
Alaska's Wildlife for the Future
Alaska Ecology Cards

These materials have been field tested in classrooms throughout Alaska. Our thanks to the many teachers, students, and resource agency staff who have worked with and evaluated these materials. Because of your work, these materials are accurate and well used.

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The Alaska Department of Fish and Game has additional information and materials on wildlife conservation education. We revise the *Alaska Wildlife Curriculum* periodically. For information, or to provide comments on this book, please contact us:

Division of Wildlife Conservation
Attention: Wildlife Education
333 Raspberry Road
Anchorage, AK 99518
907-267-2216

or visit our web site:
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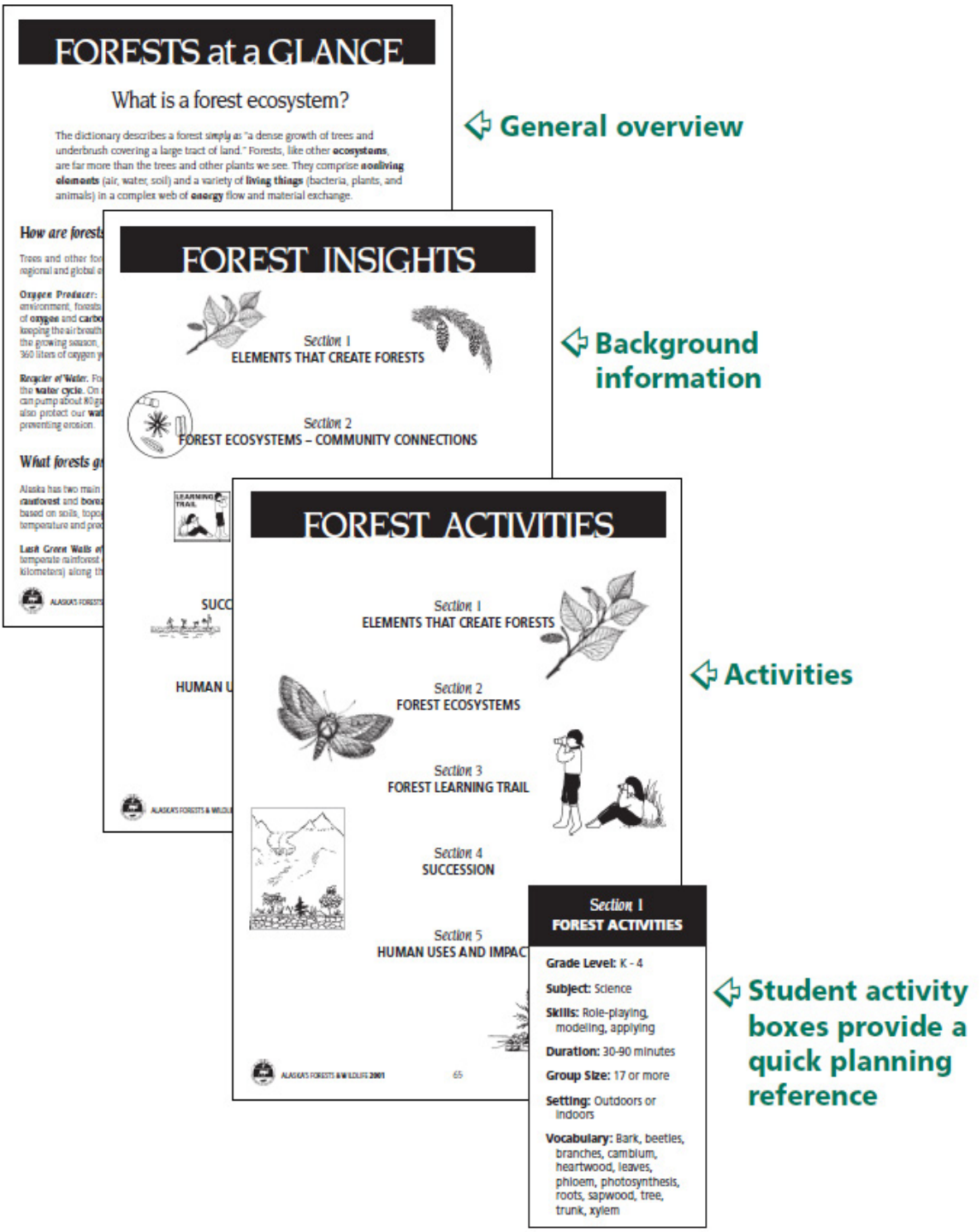
How to use this curriculum



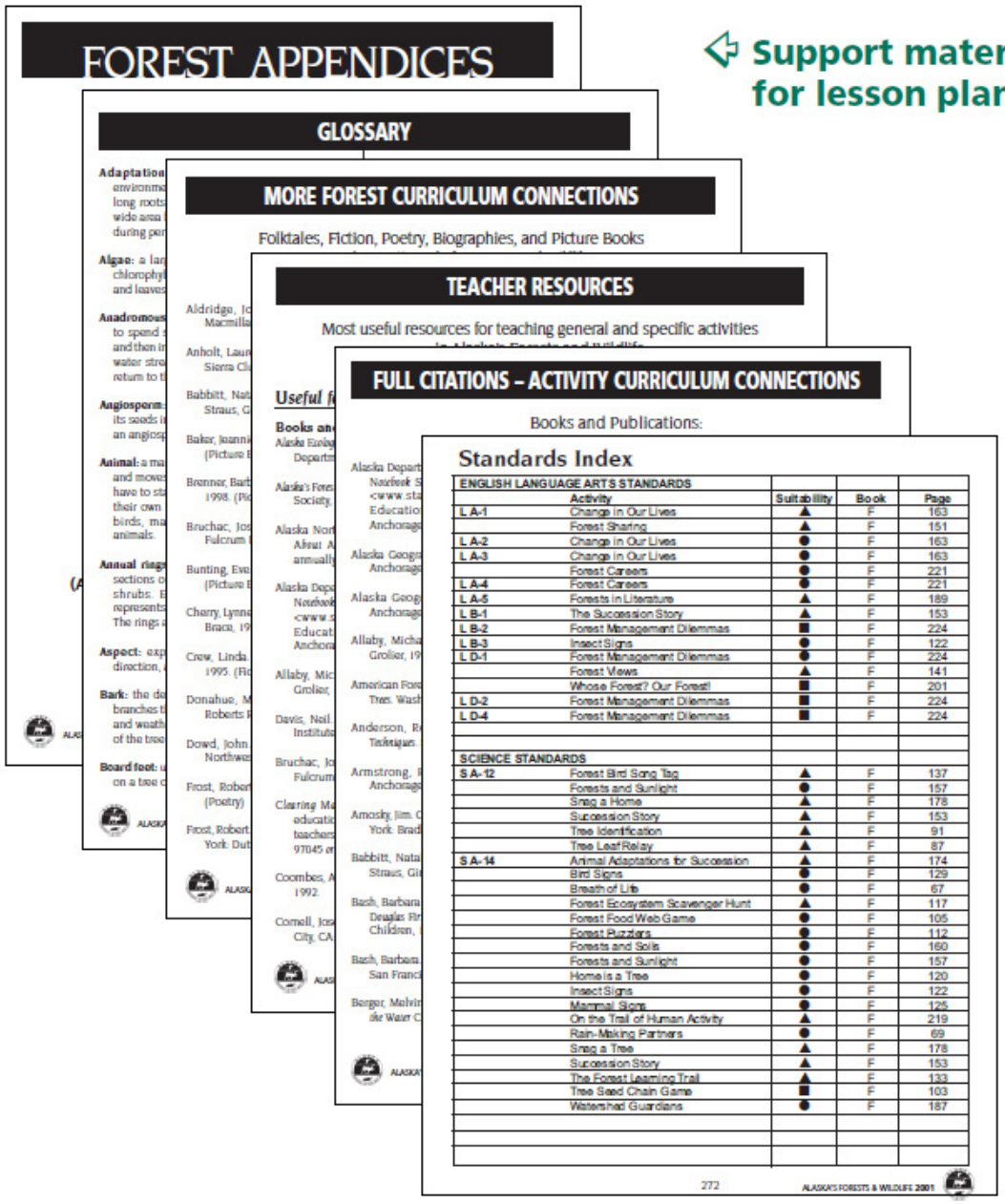
General overview

Background information

Activities

Student activity boxes provide a quick planning reference

How to use this curriculum CONTINUED



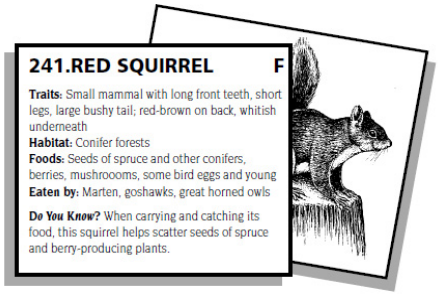
Support materials for lesson planning

ALASKA ECOLOGY CARDS

Alaska Ecology Cards* – Student-directed learning resources in ready-to-copy sheets applicable to all books in the *Alaska Wildlife Curriculum

Several lessons require or may be improved by use of the Alaska Ecology Cards. *To order, contact the Division of Wildlife Conservation/Wildlife Education.*

For more animal facts, refer to the Alaska Wildlife Notebook Series *available on the Web at* www.adfg.alaska.gov



Alaska's Forests & Wildlife

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FORESTS at a GLANCE

What is a forest ecosystem?

The dictionary describes a forest *simply as* "a dense growth of trees and underbrush covering a large tract of land." Forests, like other **ecosystems**, are far more than the trees and other plants we see. They comprise **nonliving elements** (air, water, soil) and a variety of **living things** (bacteria, plants, and animals) in a complex web of **energy** flow and material exchange.

How are forests unique?

Trees and other forest plants contribute to the regional and global environment.

Oxygen Producer: More than any other plant environment, forests help to maintain the balance of **oxygen** and **carbon dioxide** in our atmosphere, keeping the air breathable for all living things. During the growing season, one average tree supplies the 360 liters of oxygen you need each day.

Recycler of Water. Forests also play a major role in the **water cycle.** On a hot day, an average size tree can pump about 80 gallons of water into the air. They also protect our **water table** and our streams by preventing erosion.

What forests grow in Alaska?

Alaska has two main forest ecosystems: **temperate rainforest** and **boreal forest**. Their distribution is based on soils, topography, and climatic factors of temperature and precipitation.

Lush Green Walls of Towering Trees. The coastal temperate rainforest extends about 900 miles (1440 kilometers) along the Gulf Coast from the tip of Southeast Alaska north to Kodiak. Rainfall is abundant and temperatures are moderate year-round. The tallest tree on record in Alaska is a Sitka spruce 250 feet (76 meters) in height.

Taiga – Land of Little Sticks. Boreal forests grow in Alaska's Interior between the coastal rainforest and the treeless tundra of Western and Arctic Alaska. The climate is more extreme. Trees tend to grow shorter and more sparsely the farther north one goes, until a 50 year-old black spruce may be only several meters tall.

Who lives in Alaska's forests?

Think of the forest environment as many layers – from sky-scraping tree tops to moose or deer browse height, to beneath the roots and bark of all those tall trees. Each layer provides another **habitat** opportunity for wildlife.

Plenty of Homes for Wildlife. It is not surprising that many of Alaska's birds, mammals, amphibians *(yes, five!)*, bats, and insects make homes in the forest at least part of the year. All the trees and other plants produce a banquet of food for **herbivores**, which in turn attract **carnivores** and **omnivores**.

Underfoot, Another World. The quantity of organic material produced each year makes another banquet for microscopic organisms and tiny animal **detritivores** whose job it is to **recycle** the wastes into usable nutrients for future plants.

Let's not Forget Fish. Forests benefit fish by keeping their spawning and rearing streams flowing cool and clean. The roots of the trees hold the soil, preventing erosion. Trees shade the streams, keeping the water temperature stable. The roots of live and dead trees protruding into streams provide places for fish to rest and hide. The leaves and twigs that fall into streams feed the insects that fish eat.

Do forests change?

Alaska's forests keep changing – naturally. Just as a single tree grows from seedling to tree given the right conditions, so too does a forest.

Bare Rock to Deep Forest. 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.* Events that change succession include fire, avalanches, insect outbreaks, floods, volcanic eruption, and glacial advance or retreat.

Living Laboratory. Alaska has a virtual "time machine" of forest change in Glacier Bay. A dense forest has grown where only a wall of ice was visible 200 years ago. A continuum of change can be seen all along the route of the receding glacier.

Do humans affect forests?

Humans, like wildlife, find forests bountiful. We fish, hunt, photograph, and trap some of the forest wildlife. We conduct subsistence activities, picnic, gather plants and berries, watch birds, hike, study nature, and dream in forests.

Multiple Uses. In Alaska, we have two state and two national forests. We log the timber for wood products and to sell to international markets. We also cut down forests for the land under them in order to build homes, roads, communities, and businesses.

Shrinking Forests, Increasing Demand. Once covering two-thirds of our earth's land area, forests now cover less than one-third. Forest managers must consider many factors including forest health when deciding how competing resource demands can be met. Our northern climate makes their job even more challenging because it takes our trees centuries to grow.

Balancing Competing Uses. The dilemma today and challenge for the future is how to meet increasing human uses while protecting the environmental quality of forest ecosystems.

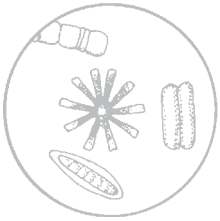
FOREST INSIGHTS

Section 1

ELEMENTS THAT CREATE FOREST

Section 2

FOREST ECOSYSTEMS – COMMUNITY CONNECTIONS



Section 3

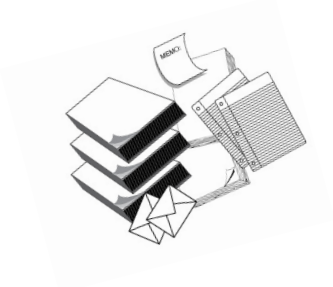
FOREST LEARNING TRAIL

Section 4

SUCCESSION – CHANGING FOREST HABITATS

Section 5

HUMAN USES AND IMPACTS IN FOREST ECOSYSTEMS



Each tree grows where it does and the way it does because of temperature, wind, rain, permafrost, soil, and topography.

Elements that Create FORESTS

Of the many types of forests in the world, Alaska has two: **temperate rainforest** and **boreal forest.**

All of Alaska's ecosystems are shaped by the **nonliving environment – climate** (temperature, sunlight, precipitation, wind,); **soil** (characteristics, composition, texture, chemistry, depth), and **topography** (steepness, aspect).

These elements determine where we find forest ecosystems and where trees lose the battle of survival to the treeless tundra ecosystem (*see the companion student activities in* Alaska's Tundra & Wildlife).

The nonliving environment also separates where and how well our two major forest types grow as well as where certain wildlife will find **habitat** that meets their requirements.

CLIMATE

Life Needs Warmth. Plants cannot produce food through **photosynthesis** *(make sugar from light energy, water, and carbon dioxide)* at temperatures below 19.4°F (-7°C). Other metabolic processes such as respiration do not occur at temperatures much below this point.

Boreal forest trees are better adapted to cold and temperature extremes. Temperate rainforest trees grow where temperatures vary little from season to season.

Sunlight and Life. The sun's energy is doubly vital: it warms the environment to a degree where life can occur; and it is a key ingredient in photosynthesis as trees and other plants produce the food that serves as the foundation for all other life.

Photosynthesis Process. Tree leaves absorb **photons** of sunlight from dawn to dusk. The energy contained in the photons is used by the cells to restructure chemical bonds and manufacture food sugars from mineral nutrients and water from the soil and carbon dioxide from the air.

Winter Dormancy. When cold temperatures and meager sunlight halt photosynthesis, plant growth stops and trees become dormant. Boreal forest trees have a long dormancy; temperate rainforest trees, short.

Summer Growth Surge. When temperature and sunlight allow, Alaska's trees grow more rapidly in order to complete their cycle in the short time available. Scientists studying white spruce in Alaska and Massachusetts found that the Alaska trees produced the same number of a certain cell, but in half as much time.

Comparative Study. Ironically, when scientists moved Alaskan trees to the Lower 48, they grew very slowly. In order to make them grow as fast as they do in Alaska, the length of daylight has to be increased to match Alaska summers.

Permafrost Inhibits Growth. Areas of **permafrost** (*perennially frozen ground*) in Interior Alaska's boreal forest keep water on the surface and limit tree root development to shallow surface layers. Water seems abundant because snowmelt and rain cannot drain away. Amazingly, the total amount of **precipitation** that falls in the Interior is comparable to that of deserts.

Rainy Rainforest. By contrast, Southeast Alaska's coastal rainforest grows in a moderate, moist, cool climate. Awash in rainfall, the coastal forest risks losing its shallow soil if its vegetation is stripped on steep slopes. There is no permafrost.

SOIL

Alaska's Young Soils. Recent glaciation over much of Alaska left behind coarsely crushed rock and fine rock flour devoid of organic material. These **young soils** lack variety and depth.

Other Plants Prepare a Base. Trees need a foundation for their **roots.** They depend on many years of other plant growth and accumulation of plant debris to form the **organic soils** that will support tree growth.

Roots Need to Breathe. Soil depth and standing water affect the tree's ability to "breathe." Without **oxygen**, tree cells die. Cells in leaves and branches absorb oxygen from the air, but the cells in the roots must absorb oxygen from the soil.

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.

Bacteria Make Nutritious Soil. Trees must also have **nitrogen** in order to grow. Most of the nitrogen on earth is in the air, but trees and other plants are only able to use nitrogen that is in the soil. Without the soil's nitrogen provided by microscopic bacteria called "nitrogen-fixers," trees could not survive.

Cold Creates Treeless Muskeg Soils. 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 a **muskeg** forms. Muskeg soils, often found within boreal forests, are notoriously poor environments for most tree and plant growth.

TOPOGRAPHY

Sea Level to Mt. McKinley. 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.

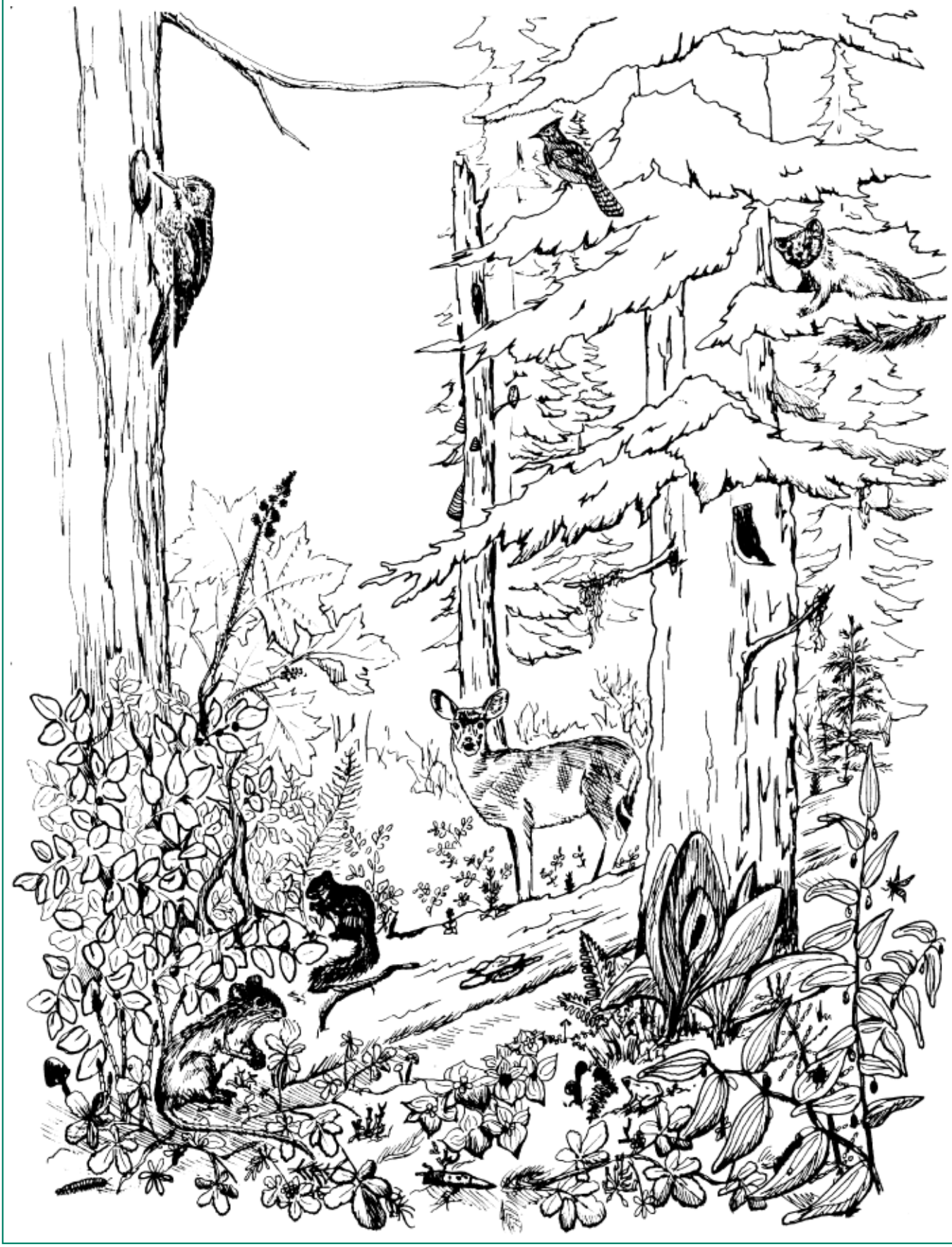
Drainage or Pooling? Steep slopes drain moisture quickly and hamper soil development, limiting what can grow there. Low-lying areas or flats may be underlain by permafrost, creating boggy soils that limit tree growth by drowning their roots. Forests on dry sites are different from those on wet sites.

Look for a Sunny Slope. The **aspect** or compass direction of a slope determines exposure to sunshine or wind, how soon the soil warms in spring, and if snow will be scoured away or lay as a protective blanket. Forests on north-facing slopes have different trees from those on south-facing slopes

TEMPERATE COASTAL RAINFOREST

LOCATION. Our coastal rainforest extends about 900 miles (1,440 km) along the Gulf Coast from the tip of Southeast Alaska north to Kodiak. The forest is a continuation of the temperate rainforest of British Columbia, Washington, Oregon, and Northern California.

Coastal Rainforest



CLIMATE. Like other temperate rainforests, Alaska's has a moderate, moist, cool, cloudy climate. Seasonal temperatures do not vary much, ranging from the upper 50s (13-16°C) in summer to the low 20s or mid 30s (-6 to +2°C) in winter.

Plenty of Rain. Annual precipitation is abundant, from 220 inches (near Ketchikan) to 25 inches (in Homer). Snowfall may be heavy, but much of the precipitation falls as rain.

So much water (both rain and snow) falls along Alaska's south coasts that it produces rainforests. So little falls in the Interior that the land qualifies as a desert.

SOILS. Typically, soils in the coastal rainforest are relatively thin. Some glaciers are still receding and making way for future forests.

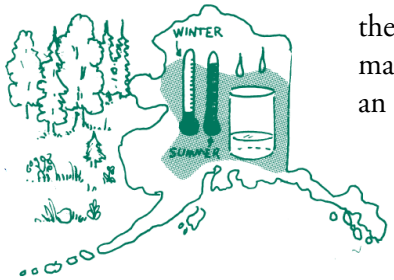
TOPOGRAPHY. Alaska's coastal rainforest grows from sea level to a treeline between 2,000 and 3,000 feet (460- 915 meters). The terrain is typically steep and rugged. Narrow fjords scallop the coastal edges.

Champion, Ancient Trees. Most of the trees are tall, conifers, predominantly western hemlock and Sitka spruce. Thus, the Alaska's coastal rainforest is often called the "hemlock-spruce" forest. These trees can live to be 300 to 1000 years old and grow to heights of 175 feet (53 meters) and greater. The tallest tree on record in Alaska is a Sitka spruce at 250 feet (76 meters).

Environmental Influences within Forest. Where the soil is soggy, Alaska cedar, western red cedar, and lodgepole pine grow. At high elevations, severe winter conditions exist. Mountain hemlock is the most common conifer. Hardwood trees are scarce in the coastal rainforest, but red alder, cottonwood, and some willow can be found, especially along rivers.

BOREAL FOREST

LOCATION. Alaska's farthest north forest grows in the Interior between th coastal rainforest and the tree



less tundra of Western and Arctic Alaska. It is a circumpolar forest, also found across much of Canada, Scandinavia, and Siberia.

CLIMATE. Trees of the boreal forest are tested to the limit with climatic extremes. Winter temperatures below –40°F (-40°C) are common. In contrast, summer temperatures can soar into the 90s (above 30°C).

Permafrost Stretches Precipitation. Permafrost is scattered in the southern range of the boreal forest but it is continuous in the northern sections. Precipitation is light, less than 15 inches (38 centimeters) annually, but evaporation is low and permafrost inhibits drainage so bogs and wet areas are common.

Long, Dark Winters; Bright Summers. Snow cover persists from mid-October until mid-April. Daylight varies from up to 24 hours in summer to only a few hours in winter.

SOILS. Roots of boreal forest trees grow horizontally, rather than vertically, to take advantage of the shallow soil. Winds and floods can easily uproot the trees.

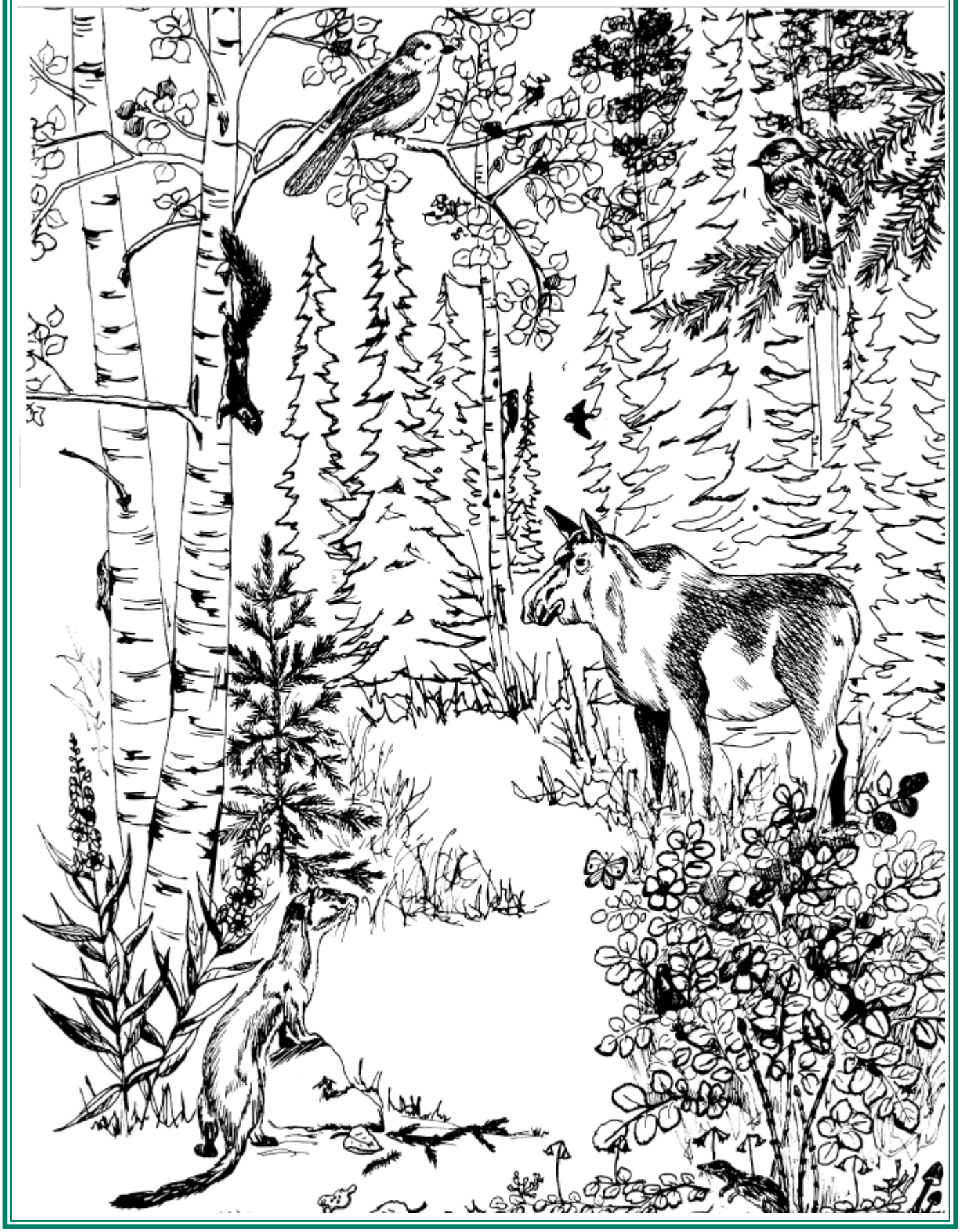
TOPOGRAPHY. Slope and aspect provide micro-climates of warmth and wind protection where the trees of the boreal forest can grow to their greatest potential.

Trees Under Stress. The boreal forest is a patchwork mosaic, affected by frequent lightning fires, permafrost, and slope. The trees are a mixture of white and black spruce, aspen, and birch. Because of this, the forest is also called "spruce-hardwood."

Different Sites for Spruce. White spruce grows best in warm, dry sites that are free of permafrost, while black spruce and tamarack often grow on wet, cold sites on top of permafrost.

Taiga. The trees tend to grow shorter and more sparsely the farther north one goes, until a 50 year-old black spruce may be only several meters tall. Russian's gave this forest an appropriate name: ***taiga*** – *land of little sticks.*

Boreal Forest



FOREST FACTS - TREE BASICS

Trees are plants with leaves, a tremendous underground root system, and stems and branches. Each part of the tree has a separate and important function.

PARTS OF TREES

Roots – The roots anchor the tree to the ground and absorb water and minerals from the soil. In a majority of Alaska trees, the roots spread horizontally rather than vertically, often reaching outward as far as the trunk reaches skyward.

Trunk – The trunk of a tree and its branches connect the roots with the leaves. The trunk and branches are made of special cells that form long tubes for carrying water, minerals, and food between the tree's parts. Those cells also give the tree structural support.

Leaves – The leaves of a tree, like those of all plants, are chemical laboratories. They manufacture their own food by capturing light energy and combining it with air and the water pumped from the roots. This process of making food is called **photosynthesis**.

Trees use this food (along with minerals absorbed by the roots) to create new cells. Each year trees grow more roots, new leaves, taller and broader trunks, and more branches.

CONIFERS
are also called: gymnosperms, evergreens, or softwoods

TWO KINDS OF TREES

You can easily separate the two major kinds of trees by looking at their leaves.

• If they have broad, flat leaves – the kind that press nicely for fall classroom decorations – the tree is called a **broadleaf, angiosperm,** and **hardwood** (although some have soft wood).

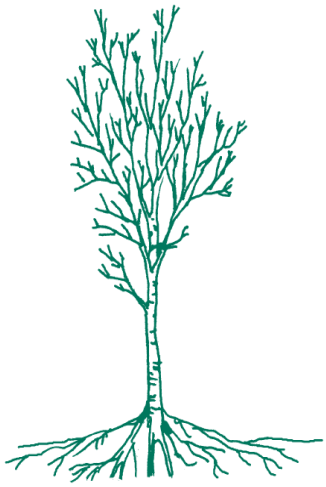
• If the leaves look like needles – just picture a Christmas tree – the tree is called a **conifer, gymnosperm**, and **softwood** (although some have wood that is quite hard).

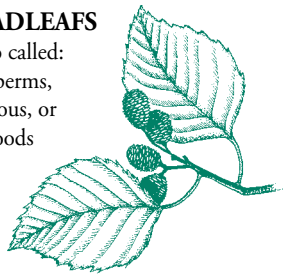
Broadleafs – Broadleaf trees have flowers as well as broad, flat leaves. Flowers on a majority of Alaska's broadleaf trees are small and green and do not look like a typical flower petal.

Broadleaf trees in Alaska are **deciduous**, losing their leaves in the fall. They become **dormant** as an **adaptation** to the cold and reduced daylight. (Some broadleaf trees in tropical areas keep their leaves all winter.)

Conifers – Conifer seeds grow inside **cones** rather than flowers and sometimes hang on the tree for several years. The tree's **crown** looks like a cone as well. Since conifers typically keep their narrow, needle leaves all winter they are also called **evergreens**.

A few conifers (the tamarack in Alaska) are deciduous and lose their needles each autumn.





BROADLEAFS
are also called: angiosperms, deciduous, or hardwoods

NAMING A FOREST

If a forest is mostly conifers, it is called coniferous. If broadleafs dominate, the forest may be described as hardwood. Some forests are called "mixed" when neither category of trees seems to be more abundant.

TREE TRUNKS

Trees are plants with a single large stem called a **trunk**. The trunk of a tree and its branches connect the roots with the leaves. The trunk and branches are made of special cells that form long tubes for carrying water, minerals, and food. Those cells also give the tree support.

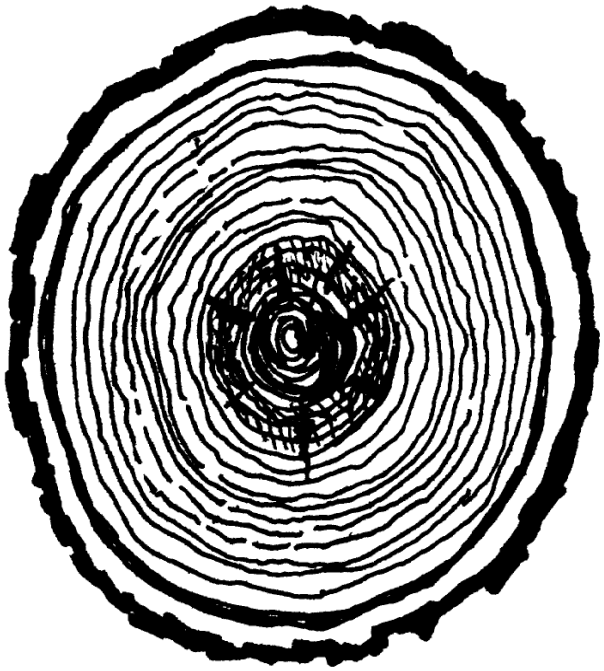
Look at a Cross-Section

A **cross-section** of a tree trunk shows multiple rings of cells. Each has a special function. The outer layer of **bark** protects the inner parts from invasion by insects and diseases, and prevents loss of water. Just inside the bark is a ring of cells called the **phloem**. Channels in the new phloem cells carry dissolved sugars and nutrients made in the leaves *down* to other parts of the tree, including the roots.

Beneath the phloem is the only growing layer of the trunk, the **cambium**. The cambium produces both the phloem cells and the next inner ring of cells called the **xylem**. New xylem cells carry water and dissolved minerals from the roots *up* to the leaves and other parts of the tree. Sometimes these cells are also called **sapwood**.

Special cells connect across the tree as well. They are called **parenchyma cells**, and their job is to carry food and water across the width of the tree.

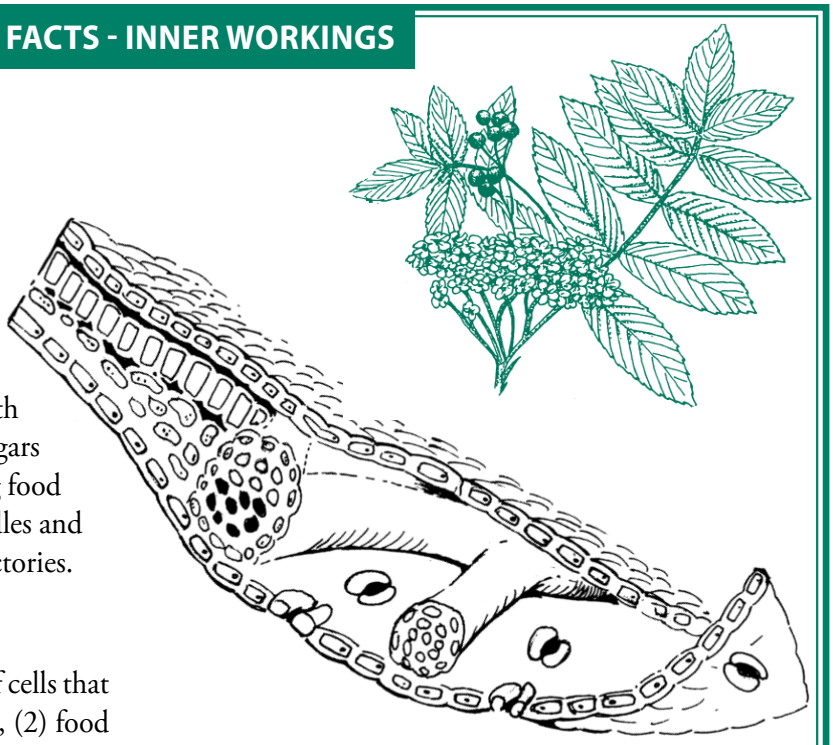
As a tree grows, the cambium produces new rings of cells. The cells added in spring are light in color (*when more water is usually available*) and those added in summer are dark. This produces the easily visible rings in a tree trunk. One can discover the age of a tree by counting either the dark or light rings. When we count tree rings, we are counting the year's xylem growth. New cells are produced with the food made in the leaves and with minerals absorbed by the roots.



Trees grow taller only at the tips of their trunk and branches. The region where new growth occurs is called **meristematic tissue**. Each year trees grow more roots, new leaves, more branches, and broader trunks and stems.

As a tree trunk grows, part of its cells die. The old phloem cells form bark, and the old xylem cells become **heartwood** – the center of the tree trunk. Even though its cells are dead, heartwood is rigid and strong and supports the branches, leaves, and **crown** of a tree. Most of the trunk of a mature tree is heartwood. Loggers utilize the heartwood when they cut trees for timber.

TREE LEAVES



Leaves are the food factories of trees. Leaves capture light energy from the sun and gases from the atmosphere. They combine those with water pumped from the roots to make the sugars the tree uses for food. This process of making food is called **photosynthesis**. Skinny spruce needles and broad cottonwood leaves all work as food factories.

Look at a Cross-Section

A cross-section of a leaf shows several layers of cells that are organized in three systems: (1) protective, (2) food producing, and (3) transporting.

1. Protective

A protective "skin" covers the entire leaf. It has two layers: the **epidermis** and the **cuticle**. The cuticle is a waxy layer that is usually thickest in plants growing in windy or hot, dry regions. The skin lets in light, but blocks the movement of water and gases.

Little "mouths" or **stomata** in the skin on the under-side of the leaf open and close to let in carbon dioxide, release oxygen, and control the loss of water. A single leaf has many thousands of these little mouths. In most plants, the stomata open in the day for gas exchange during photosynthesis and close at night to prevent water loss.

2. Food Producing

The producing system of a leaf, the **mesophyll**, has several layers. The **palisade layer** has thin-walled cylindrical cells called **chloroplasts**. These close-packed cells contain **chlorophyll**, the pigment that absorbs light energy in photosynthesis.

Beneath the palisade is the **spongy layer** which has loose-packed, irregularly shaped cells that form large air spaces. Most gas exchange – oxygen (O_2) and carbon dioxide (CO_2) – occurs in this area.

3. Transporting

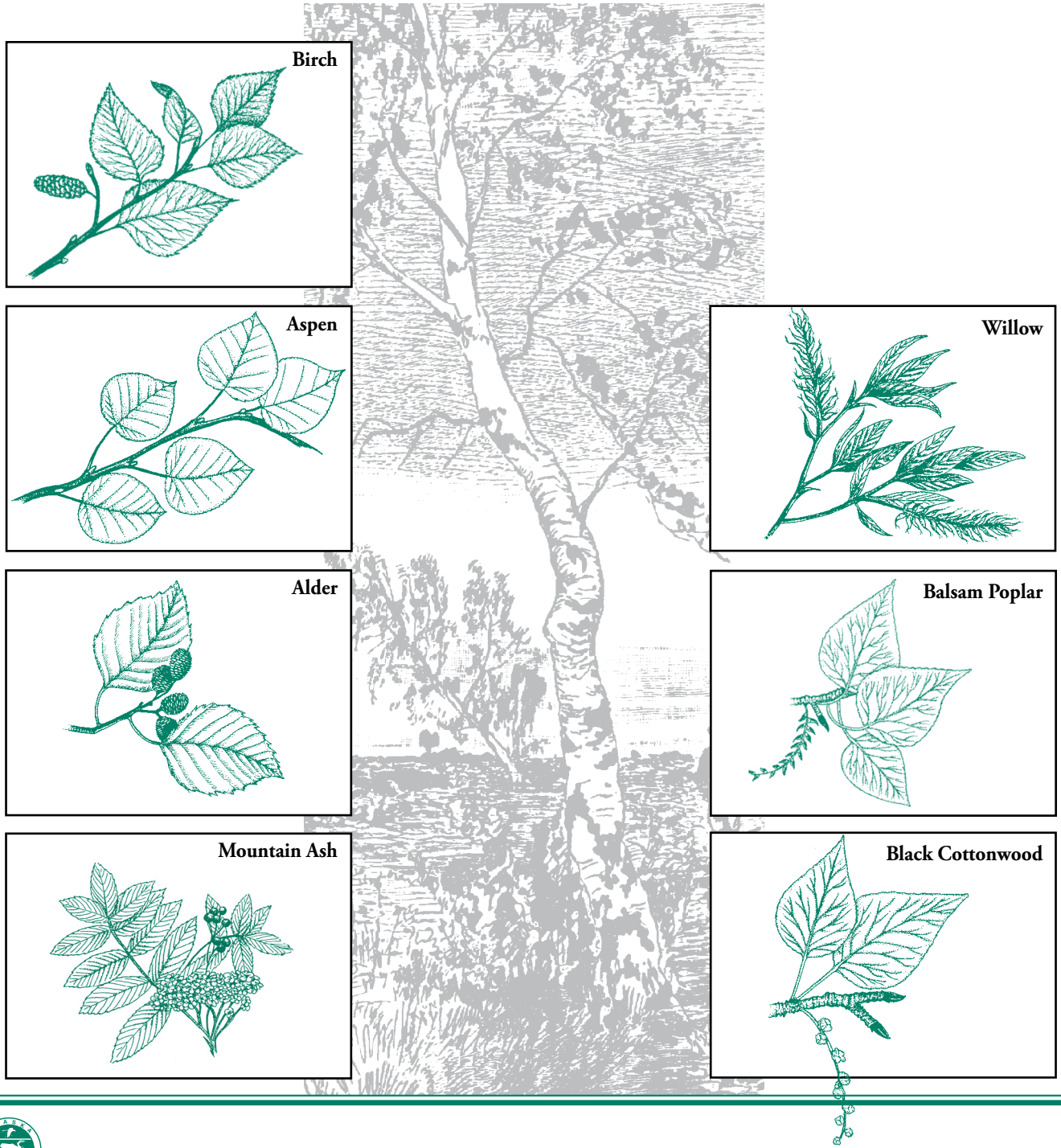
Veins transport materials to and from the leaf. The veins are tubes divided into the **xylem** and the **phloem**. The xylem carries water and minerals *up* from the roots. The phloem transports food produced by the leaf *down* to the rest of the tree.

ALASKA'S BROADLEAF TREES

Look at the leaves.
• If they are broad, flat leaves, the tree is a **broadleaf, angiosperm,** or **hardwood**.

Broadleaf trees have flowers as well as broad, flat leaves. Flowers on a majority of Alaska's broadleaf trees are small and green and do not look like a typical flower petal.

Broadleaf trees in Alaska are **deciduous**, losing their leaves in the fall. They become **dormant** as an **adaptation** to the cold and reduced daylight.



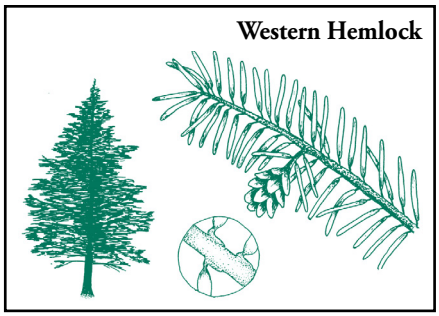
ALASKA'S CONIFER TREES

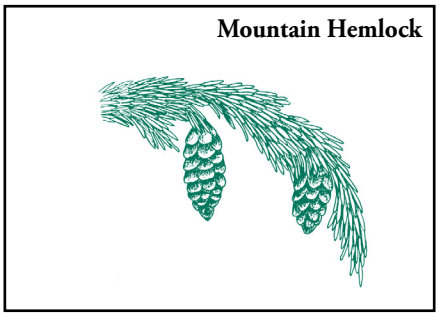
Look at the leaves.

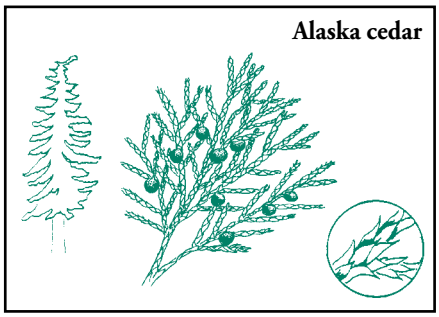
- If the leaves look like needles or scales – just picture a Christmas tree – the tree is a **conifer, gymnosperm**, or **softwood.**

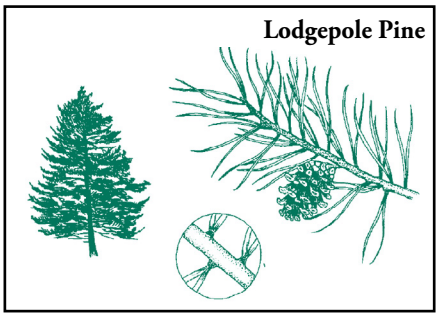
Conifer seeds grow inside **cones** rather than flowers and sometimes hang on the tree for several years. The tree's **crown** looks like a cone as well.

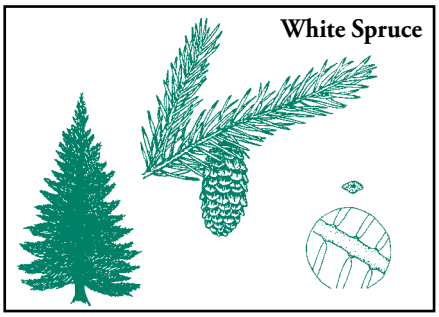
Since conifers typically keep their narrow, needle leaves all winter they are also called **evergreens**. One Alaskan conifer – the tamarack – is **deciduous** and loses its needles each autumn.

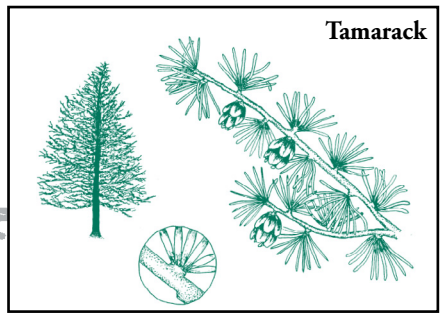


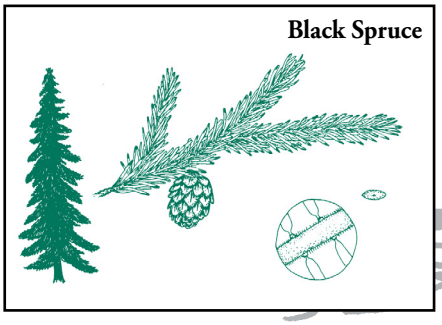












PROFILES OF ALASKA FORESTS

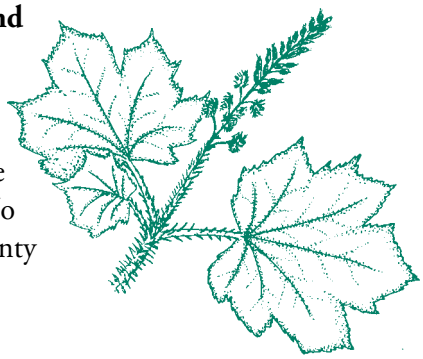
Three Living Layers

Trees are not the only green, growing things in a forest. Three layers of plants make up our forests. They shade the forest floor, stabilize and aerate the soil, moderate the climate, and purify the air.

1. Canopy
Older trees form the top layer or **canopy** of the forest. Those trees receive the most sunlight.

2. Understory
Shrubs and young trees – closer to human height – grow protected and somewhat shaded beneath the old trees in the **understory**. The young trees will someday become the canopy.

3. Ground Cover
Small plants grow – under our feet — as **ground cover** on the forest floor.



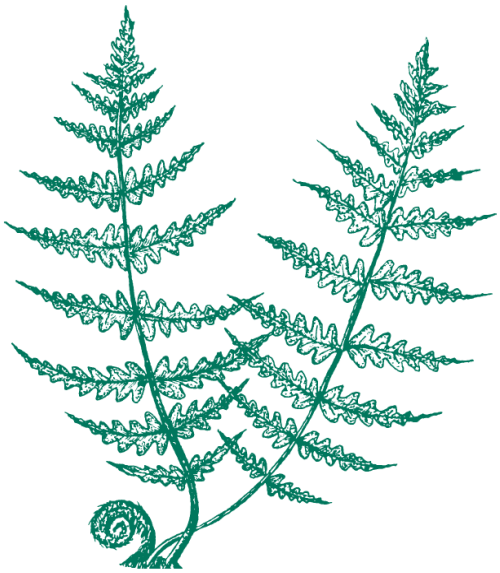
Coastal Rainforest

Alaska's temperate rainforest doesn't fit the image many people have about rainforests. No steamy tropical jungles here, but do have plenty of rain!

1. Canopy
Hemlock and spruce trees

2. Understory
Blueberry, salmonberry, devil's club, and elderberry shrubs

3. Ground Cover
A dense jumble of ferns, mosses, dogwood, liverworts, twisted stalk, trailing bramble, and false lily-of-the-valley



Boreal Forest

Alaska's boreal forest struggles to survive. Where it loses the struggle, the treeless tundra begins.

1. Canopy
A mixture of white and black spruce, aspen, and birch

2. Understory
High bush cranberry, buffaloberry, Labrador tea, and wild rose

3. Ground Cover
Crowberry, dwarf dogwood, twin flower, low bush cranberry and some ferns, mosses, liverworts, and club mosses

THE GIVING FORESTS

Unique Contribution. Forests, more than any other plant ecosystem, contribute to the nonliving environment that originally shaped them. Their influence is felt both locally and globally.

Breath of Life.
Trees remove **carbon dioxide** from the air and return **oxygen** in the process of **photosynthesis**. Animals, including humans, need oxygen to breathe. After our lungs process the oxygen, we exhale a waste product – carbon dioxide. Just what the forest and other plants need!

Forests help to maintain the balance of oxygen and carbon dioxide in our atmosphere, keeping the air breathable for all living things. During the growing season, one average tree supplies the 360 liters of oxygen you need each day.

An acre of forest plants restores 2 to 3 times more air per day than an acre of meadow or tundra plants. About 10 million acres of the Tongass National Forest are comprised of trees. That's a lot of oxygen!

Air cleaner, wind break.
Studies have shown that air in forests contains much less dust and air pollutants than air in other areas. Leaves and branches trap dust and pollution particles, provide moisture, and slow the wind. A forest can reduce a howling wind to a gentle breeze.

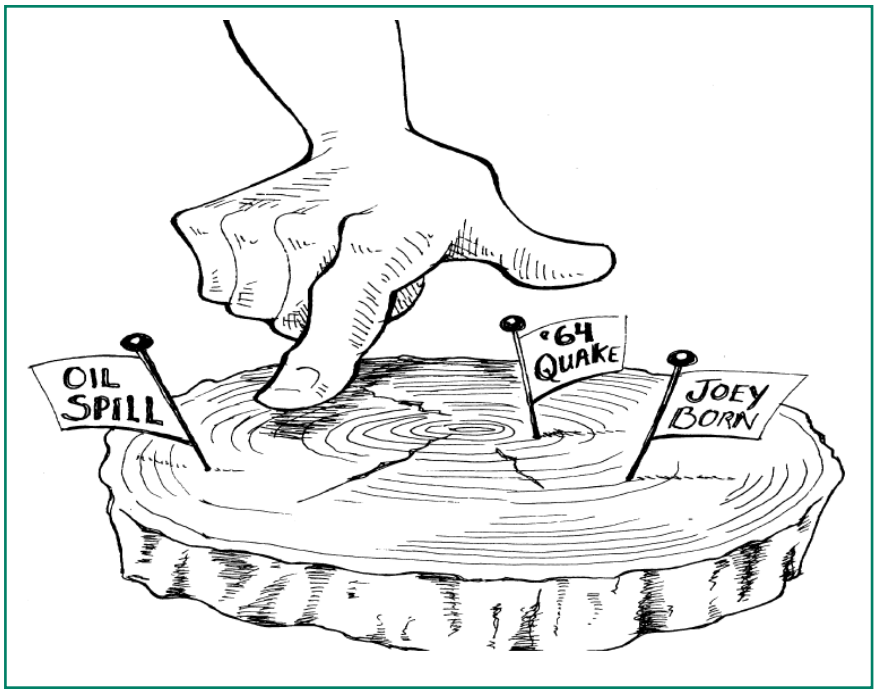
Global water cycle.
When scientists looked for the source of rain and snow clouds, they discovered the **water cycle** and the important role of trees in returning moisture to the atmosphere. Forests recycle water that falls to earth in two ways:

(1) Rain and snow are trapped on leaves and branches and then evaporate.

(2) Water that reaches the roots is used by the tree and then exhaled back into the atmosphere through **transpiration**. A single tree may pump 80 gallons of water into the air on a hot day.

In this way, forests help make the rain that falls on the earth.

READING TREE RINGS



1 – Age and Conditions of Growth
A **cross-section** of any tree trunk reveals the different layers that make up a tree *(see "Inner Workings – Tree Trunks" for details)*.

Each year the **cambium** forms a layer of light-colored cells in spring and a layer of dark-colored cells in summer. These are called **annual rings**. You can "read" the age of the tree by counting either the light or dark rings in a cross-section of the trunk.

The annual rings vary in width depending on the weather and growing conditions.

Because trees are sensitive to climatic changes, scientists can learn about past climates by studying the ring patterns of very old trees. This study is called **dendrochronology**.

An adequate amount of rainfall in the spring will ensure that the **earlywood** (*light-colored ring*) is relatively wide. In contrast, a period of summer **drought**, when little rain falls, will result in a narrower, darker band because the tree was unable to grow as much.

Bristlecone pines *(not found in Alaska)* are so long-lived that scientists can track rainfall during several thousand years!

Other events in the ecosystem also influence the size of the annual rings: forest fire, wind damage, attack by viruses or bacteria, and a long winter with a late spring. All are factors that affect the width of the growth rings.

Fires and parasites, for example, leave scars. In the past, people who managed forests tried to put out all fires. The Smokey the Bear campaign taught generations of Americans that fire is bad for forests. In studying fire scarring in tree rings, however, we see that periodic fires are a natural part of healthy forest ecosystems.

2 – Cross-Dating the Rings
Cross-dating is another important technique used by dendrochronologists. Cross-dating compares the growth rings from one tree to the growth rings of another tree and matches the ring patterns of the years when the two trees both lived.

Scientists take a **core sample** to look at the rings of a living tree without cutting it down. By drilling into the center of a tree trunk with an instrument called an **increment borer**, they can remove a piece of wood that is about the thickness of a soda straw.

The growth rings of the tree show up as lines on the core sample. Scientists count these lines to determine the tree's age *(see diagram next page)*.

HERE'S HOW CROSS-DATING WORKS:

1. Scientists first take a core sample from a living tree that produces distinct, reliable annual rings. *(Conifers growing in the American southwest produce some of the most reliable, drought-sensitive rings.)* By counting backward from the outer ring *(the current year)*, they can assign each ring a year, then figure out when the tree sprouted and how old it is.

2. Scientists find an older tree to compare with the younger tree. The older tree must (a) be the same kind of tree *(trees of the same species have similar growth rings)*, (b) grow or have grown in the same area, and (c) have been alive for part of the time that the younger tree was growing up.

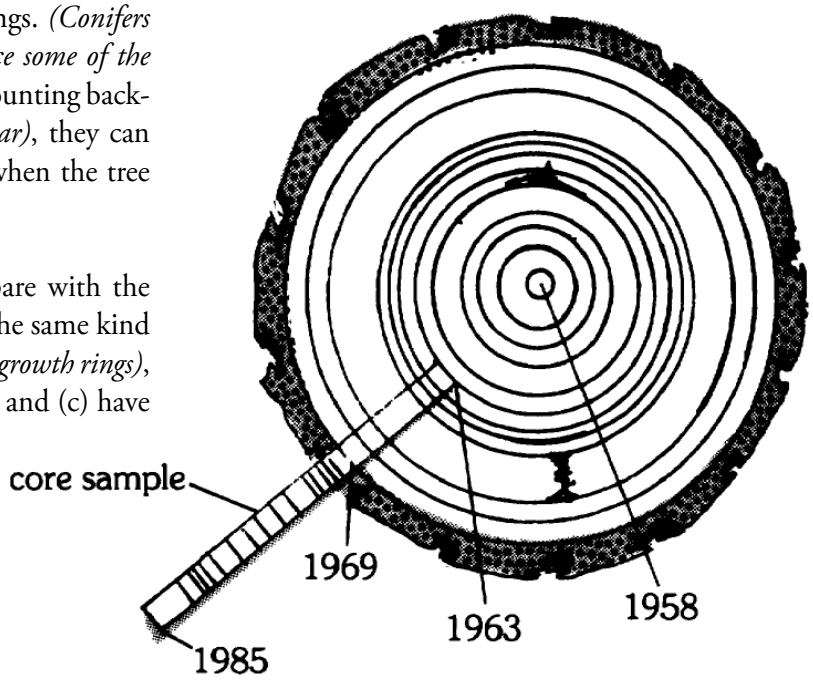
(In cross-dating, scientists often use stumps, logs, beams in old building, or any part of a tree trunk that clearly shows the annual rings.)

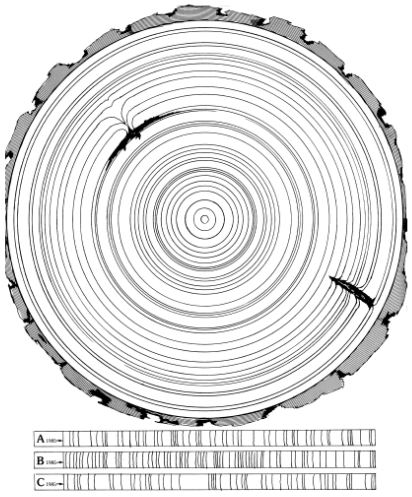
3. Dendrochronologists then compare the inner *(oldest)* rings of the core sample with the outer *(youngest)* rings of the stump or log to find a section where the ring patterns match *(see diagram).*

4. Since the scientists have already assigned dates to the younger tree, they can now assign the same dates to the overlapping rings on the older tree. Then they can count backward to date all the rings on the older tree.

5. By finding still older trees, and overlapping them with increasingly older trees, scientists have discovered cycles of drought from more than 10,000 years ago, the dates ancient cities were built, and even the age of the wood used to frame paintings done by Rembrandt! ***(Cross-dating is more accurate than radioactive carbon dating, a method used to tell the age of fossils and ancient artifacts.)***

CROSS-DATING TECHNIQUE





FOREST Ecosystems – Community Connections

The forest ecosystem is like a finely woven tapestry. Elements of the **nonliving environment** – climate, soil, topography *(see INSIGHTS, Section 1)* – create the support threads, while a myriad of living things supply the pattern threads. The energy exchange and interactions between and among nonliving and living things weave the threads into the forest tapestry we see around us.

Section 2
FOREST INSIGHTS

Energy Transfer – *the basis of all life*

Where the next meal comes from is a constant priority in any organism's life. The following pages describe how energy is transferred and materials are recycled in forest ecosystems. Recycling here is not just an option, but is critical to continued survival of the ecosystem.

FOOD WEBS – WHO EATS WHOM?

[see the following "Forest Facts" for the Five Kingdoms of Life, and Alaska Ecology Cards *for more species illustrations]*

Producers. A plant is exquisitely equipped to convert the nonliving — air, water, minerals, and sunlight — into food for itself and others. Plants and algae that make food from nonliving materials are called **producers**.

Consumers. The other living things in the forest that depend on food manufactured by producers are called **consumers**. Consumers divide into four groups: **herbivores** (animals that eat plants), **carnivores** (animals that eat other animals), **omnivores** (animals that eat both other animals and plants), and **detritivores** (animals and other organisms that eat dead or decaying material).

Food Chains and Web. The pathway of **energy** and **minerals** from the nonliving environment, through producers, to consumers, and back again through detritivores creates a **food chain**. All the food chains of a forest are connected into a **food web – the energy circulatory system of an ecosystem**.

Energy Lost and Found. At each intersection in the web, some energy is returned to the nonliving environment as heat. That energy is not passed on and cannot be reused by living things. The lost energy is replaced during photosynthesis by the capture of energy from the sun.

Mineral Recycling. Minerals are always passed along at each web intersection until the detritivores return them to

the environment in a form usable by plants. The producers use them again to make new food – and the cycle continues.

PRODUCERS CONVERT RAW MATERIALS

Using the process of **photosynthesis**, producers combine energy from sunlight with carbon dioxide from the air and minerals from water, soil, and rocks to produce the sugars and oxygen that help all other living things survive. Plants, algae, and lichens are important producers in forest ecosystems and are the first life forms in food chains.

Measuring Production. Scientists measure this flow of energy and minerals by determining the weight of carbon that is "fixed" or changed into living material by producers each year. Basically, the measurement is the dry weight of all new growth – leaves, roots, flowers, seeds – produced each year.

High Productivity Compared to Tundra. On average, forest producers together make 3 to 10 times as much food each year as producers in tundra ecosystems. That is why some tundra consumers migrate to forested environments for part of the year *(see* Alaska's Tundra & Wildlife*, Section 3: "Migration").*

HERBIVORES EAT PRODUCERS

Some of the largest and smallest forest wildlife are herbivores. Moose, deer, and snowshoe hares receive all their nutrition from the stems, bark, and leaves of plants. Porcupines grow strong on the cambium layer of trees. Dozens of other small animals prefer tree seeds (red squirrels, mice, voles, juncos, grosbeaks, and crossbills).

Multitude of Busy Invertebrates. Yet, these examples are overwhelmed in number by the smallest forest herbivores – the millions of leaf-eating, wood-drilling, sap-sucking, twig-boring insects and other often overlooked invertebrates.

To Each Its Own Meal. Each herbivore is adapted to eat specific kinds of plants and cannot live where those plants are absent.

Some Plants Defend Themselves. In defense, some plants create barriers against being eaten. Devil's club arms itself with prickly spines. Alder and spruce trees produce chemicals that make their leaves toxic or taste terrible to many herbivores.

Starvation in Midst of Abundance? Sometimes even if a favorite food plant seems abundant, animals can be thwarted by a plant's defenses. Birch and willow saplings, for example, are favored by snowshoe hares. But after the hares start to devour them, those plants produce so many chemicals that the hares stop eating them. Many have died of starvation.

Plants Linked to Hare/Lynx Populations. Some scientists think that birch and willow plants may cause the 10- to 12-year cycle of highs and lows in the numbers of snowshoe hares and, in turn, of their main predator, lynx. *(Student Activity "Predator/Prey Predicament" in* Alaska's Wildlife Conservation *lets students actively examine this situation.)*

CARNIVORES EAT HERBIVORES — AND EACH OTHER

Herbivores such as voles, snowshoe hares, marmots, moose, and deer are food for many carnivores (lynx, foxes, owls, hawks, weasels, wolves, and bear). Another name for carnivore is **predator**, one that kills and eats other living things.

Some Insects Prey on Insects. Herbivorous insects are food for insect-eating carnivores (shrews, woodpeckers, warblers, thrushes, beetles, spiders, centipedes, and carnivorous plants such as sundews).

Carnivores Do Not Discriminate. Carnivores do not limit themselves to dining on herbivores. All will eat each other if the opportunity arises.

Amount of Herbivores Influences Carnivores. Carnivores cannot survive without adequate populations of prey. So the numbers and kinds of herbivores in a forest, in part, determine the presence and abundance of carnivores.

Carnivores Impact Numbers of Herbivores. Carnivores influence the numbers and kinds of herbivores in a forest, too. If a population of herbivores grows too large, those

animals may eat all their food supply and starve. Healthy populations of carnivores (predators) reduce the chance of such herbivore population explosions and crashes. When an explosion does occur, carnivores lessen the effects on plants.

Predators to the Rescue. Scientists studying the spruce budworm in the Pacific coastal forest discovered that ants and birds prey on so many budworms that they decrease the amount of tree damage by one-half.

OPPORTUNISTIC OMNIVORES

Food in the forest can be scarce, especially for big eaters. Therefore, consumers that eat a variety of foods have a better chance of survival.

Bears Say Yes to Everything. Bears are good examples. They eat roots, grasses, herbs, and berries as well as small and large mammals, insects, fish, and carrion. With an omnivorous diet, bears are well-adapted to whatever the season offers.

Tiny invertebrate animals in the soil (*detritivores*) eat nine times more forest plant material than all the moose, deer, voles, birds, and other large-animal plant eaters (*herbivores*) combined.

Mosquitoes Need Blood, Nectar. Mosquitoes are infamous for their abundance in Alaska. Both male and female mosquitoes sip plant nectar as herbivores, but the female is omnivorous. She needs a blood meal from a warm-blooded animal to produce the eggs she will lay on the surface of any nearby water.

DETRITIVORES REUSE AND RECYCLE

The greatest number and variety of consumers in any ecosystem are the detritivores which eat dead things and waste materials.

Essential for Ecosystem Operation. They are very important to the forest because they return all the minerals stored in the food chains to the soil for reuse by forest plants. Without detritivores, producers would soon run out of the minerals they need to make food, and the forest would smother in tons of debris.

Big and Small. Some well-known animals such as ravens, crows, and bald eagles are detritivores. But the most important detritivores are tiny, extremely numerous – and ignored. These include animals that live in forest soil, many **fungi**, and a multitude of **microscopic organisms**.

What's Under Your Foot? Every time you put your foot down in a forest, you are stepping on tens of thousands of (1) tiny animals, (2) miles of fungi, and (3) an almost unimaginable number of microscopic organisms.

Too Much to Consume. Every year about one to two tons of plant debris fall on each acre of forest floor. It takes all the kinds of detritivores to keep up with the task of digesting that organic material.

(1) Animal detritivores eat more plants than moose!

The most noticeable detritivores are tiny animals without backbones (**invertebrates**) – **mites**, **springtails**, and **nematode worms**, all dormant through the winter in the boreal forest.

Thousands Under Foot. Mites, tiny bright-red relative of spiders, can be as thick as 10,000 under a footstep by late summer. Springtails, an mobile insect without wings, might number 2,000 per footstep.

Can You Hear Them Chewing? Scientists in Fairbanks calculated that these tiny animals would form a mass of 34,000 pounds in one square mile of boreal forest soil. They say that would be equal to 43 moose in body weight.

Olympic Consumers. Therefore it is not surprising that these small animals eat most of the food produced by forest plants. According to some estimates, these tiny invertebrates in the soil eat nine times more plant material than all the moose, deer, voles, birds, and other large-animal herbivores combined.

(2) Fungi detritivores – an out of body experience!

Fungi are by far the most prolific of all the detritivores in

our forests because they are adapted to acidic soils. Mushrooms, shelf fungi, and less noticeable molds, mildews, and rots are some examples.

Fungi Rate Own Kingdom. Fungi are similar to plants in that they are immobile. In fact, scientists used to consider them to be plants. But fungi are very different from plants in cell structure and in the ways they live, so scientists now place them in a separate kingdom of living things.

More Than Meets the Eye. Usually, we see only the fruiting, or reproductive part of a fungi *(a mushroom, for example)*. Its main body is hidden from view. The body of a fungus is made up of **hyphae**, microscopic hair-like structures that reach out through forest soil or into trees. A handful of forest soil may contain over two miles of fungal hyphae!

Unusual Way of Eating. Fungi use their hyphae and digest their food outside their bodies! The cells of fungal hyphae give off digestive enzymes like those found in our own stomachs. These enzymes break down wood, leaves, and other material. Then the fungal hyphae absorb the scattered sugars and minerals and use them to grow.

(For more information about the Five Kingdoms of Life including Fungi, Protista, and Monera, see Forest Facts in this section.)

(3) Microscopic detritivores – small but mighty

Like fungi, **monerans** and **protists** play a large role in creating soil. Until recently, these microscopic living things were considered to be small versions of plants and animals. But scientists recently created two new kingdoms for them.

Million on the Head of a Pin. Monerans, the smallest microscopic organisms, do not have nuclei in their cells. **Bacteria** and **cyanobacteria** (or **blue-green algae**) are examples of monerans. *A million monerans would fit on the head of pin.*

Protists Live, Eat in Group. Larger microscopic organisms that have cell nuclei are called protists. These include **algae**, **paramecia**, **amoebas**, and many others. Some protists live together in large groups that can be seen without a microscope, but the individual organisms are microscopic.

Microscopic Recycling Factories. Although some of these microscopic creatures are herbivores and others are carnivores, the majority (especially monerans) are detritivores. They are primarily responsible for returning minerals in waste and dead things to the soil for re-use by plants and other producers, ensuring that the cycle of life can continue.

Community Interactions – competition & symbiosis

The forest food web just described portrays life and death relationships in the forest ecosystem. There are other equally influential relationships that do not involve eating the next in line: **Competitive relationships** occur within and between species. **Symbiotic relationships** (literally *"living together"*) describes three forms of forest neighborliness: **mutualism**, **commensalism**, and **parasitism**.

COMPETITION – I can grow faster

Competition occurs when the supplies of energy, minerals, and space are limited. Any plant or animal that can get more water, more minerals, or more energy, more space, or better shelter than its neighbors will grow better and leave more offspring.

All Fair in Competition. Plants have a variety of adaptations to help them compete for the resources they need for survival and growth. Some plants grow tall, like trees, to get more of the available sunlight energy. Plants with long roots reach farther and get more water and minerals than those with short roots. Some plants produce chemicals to kill the roots of other plants and assure a larger supply of minerals and water for themselves.

More than 90% of Alaska's plants could not grow without a certain fungi that helps them absorb minerals.

Your Food? My Food! All living things compete with similar organisms to one degree or another. Herbivores such as moose and snowshoe hares eat the same kinds of plants and compete with one another for available food. Carnivores such as weasels and foxes eat the same kinds of prey and compete.

Constant Interaction in Ecosystem. Birds such as chickadees and swallows need the same kinds of nest sites and compete with one another for the available sites. Competition is a constant interaction. The specific mixture of organisms in any forest is due in part to the effects of competition.

MUTUALISM – the friendly symbiosis

Both organisms benefit from the symbiosis of mutualism. The relationship of flowering plants to the animals that carry their pollen is a good example.

A Nutritious Attraction. Flies are attracted to decaying things, so some flowers (chocolate lily) actually produce rotten odors to attract flies. Both plant and pollinator benefit. The plant gets its pollen carried to other flowers, and the insect receives nectar, or food, from the plant.

Aerating the Soil. Many insects and small herbivores such as voles help forest plants by tunneling through forest soil in search of food. Tunneling creates spaces for air and water to seep, mixes the soil, and helps speed decay of organic matter and recycling of minerals.

Larger Benefits for the Species. Even though herbivores harm some individual plants by eating them, many of those plant species would not grow, expand their range, or survive without herbivores.

Beg to be Eaten. Some plants benefit by producing tasty seed pods. When an animal eats that food, it digests only the fleshy part, and the hard-coated seed inside passes through the animal's digestive tract intact. The seed thus gets a ride to a new area where it may grow.

Secondary Processing of Seeds. Some plants, like dwarf dogwood, produce seeds that will not grow unless they pass through the digestive tract of an animal first! Red squirrels also spread spruce seeds this way as well as when they forget where they buried their cones.

Fungi aid plants in mineral absorption

One of the most important mutualistic symbioses in a forest is the association between plants and certain fungi called **mycorrhizae**. The hyphae of these fungi seek out the roots of plants, and then grow around or even into the plant's fine root hairs.

Mutual Help. At one time scientists thought these fungi were harming the plants. Instead, they actually help plants get minerals from the soil.

Minerals Not Otherwise Available. In one study scientists found that a pine tree living with mycorrhizal fungi grew twice as fast and absorbed 86% more nitrogen, 75% more potassium, and 234% phosphorus than did a tree without mycorrhizae. In addition, scientists now think that some mycorrhizal fungi actually help protect plants from certain diseases.

In Trade for Sugars. The fungi also benefit from the association. Plants pump sugar made in their leaves down to root hairs. This provides energy for the fungi. Many of the mushrooms we see in the forest are the fruiting bodies of mycorrhizal fungi.

Owe Our Trees and Berries to Fungi. More than 90% of the plants in Alaska, including all our trees and berry-producing plants, could not grow without these mycorrhizal fungi.

Moneran bacteria help release nitrogen

Another important mutualistic association occurs between certain plants and monerans. Plants must have nitrogen in order to grow, but they are only able to use nitrogen that is in the soil. Most of the nitrogen on earth is in the air, making it useless to plants.

Nitrogen – Fixers Aid Plants. Microscopic bacteria known as "nitrogen-fixers" take nitrogen from the air and convert it to a form that is usable to plants.

Why Alder is a Pioneer Plant. One example in Alaska occurs between alders and nitrogen-fixing bacteria that live in bulbous growths on alder roots. The bacteria takes the nitrogen from the air and converts it to a form that is usable by alders. In exchange the alder provides sugars (food) that the bacteria need. This symbiosis allows the alder to grow on poor soil where most other plants cannot survive. The alder/bacteria combination improves soil conditions for future plant growth.

COMMENSALISM – no harm done

In commensalism, another form of symbiosis, one species benefits while the other is neither helped nor harmed.

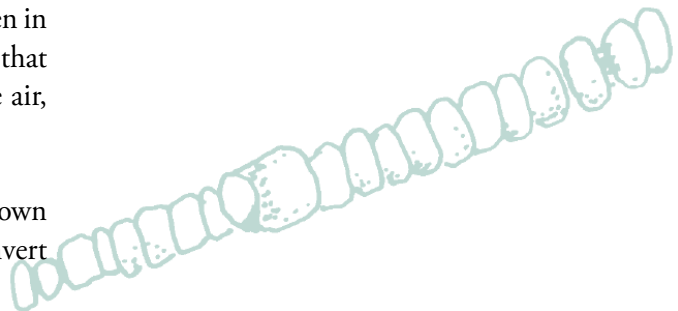
A Nest Cavity for Free. Woodpeckers dig holes in trees for nesting and winter roosting, but they use them only for a year or two. Owls, which cannot dig holes in trees, are able to use the abandoned woodpecker holes as nest sites.

No Harm Done. In this symbiosis, the owl benefits from the woodpecker's efforts, but the woodpecker, which had abandoned the hole, is not affected.

Transplanting Seeds. Moose and other large forest animals give free rides to grass seeds that get caught in their hair.

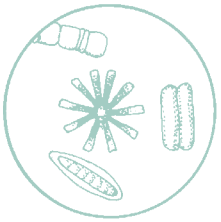
PARASITISM – a win/lose situation

In the third type of symbiotic relationships, the parasite benefits and the host is harmed or eventually killed. Parasites fulfill useful roles in the forest ecosystem by helping to prevent plant and animal population explosions.



Tree Case Study. A fungi *(the parasite)* lands on a tree *(the host)* and infiltrates the bark. The hyphae of the fungi spread up and down from their entry point. As they grow, the hyphae break down and digest the tree trunk. The tree fights back by walling off the sections invaded by the parasite. The tree resists the fungal invasion and survives for many years, but eventually some fungi kill the tree.

Eventually Someone Benefits. Although parasites harm, they are part of the natural cycle of life and death. A tree killed by parasites becomes a shelter for organisms that live in dead trees. Detritivores now have a new source of food and minerals for recycling. And by dying and falling, the tree opens the canopy, letting in more sunlight and providing space for new trees and plants to grow.



Tapestry Pattern

Living things are bound together and to their nonliving surroundings in many ways – like patterns in a tapestry. Cut a few threads in a weaving: the piece still holds together. Cut too many: the tapestry weakens until it unravels.

Similarly, a forest ecosystem can survive some changes. Each small change, however, affects many members of the forest community through the interrelationships of food webs, symbioses, and competition.

1 AND 2 – MONERANS AND PROTISTS

Small but mighty

Monerans and protists create soil and clean up forest debris. Until recently, these microscopic living things were considered to be small versions of plants and animals. But the more scientists learned about them, the less they seemed to fit in either category.

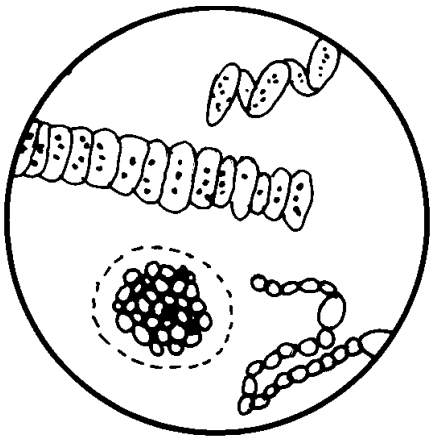
Given Their Own Kingdoms. Some not only make their own food, like plants, but also move around and catch and eat other living things. Additionally, their cell structure is quite different from those of either plants or animals.

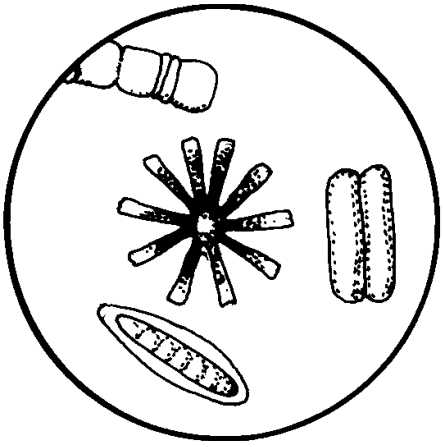
MONERANS, the smallest microscopic organisms, do not have nuclei in their cells. **Bacteria** and **cyanobacteria** (or **blue-green algae**) are examples of monerans. *A million monerans would fit on the head of pin.*

PROTISTS are larger microscopic organisms that have cell nuclei. These include **algae**, **paramecia**, **amoebas**, and many others. *Some protists live together in large groups that can be seen without a microscope,* but the individual organisms are microscopic.

All Ecological Roles. Some monerans and protists are **producers**. Like plants, they are able to photosynthesize *(to make food from air, water, and sunlight)* and are food for very small animals. Others are **herbivores** or **carnivores**.

Unsung Heroes. The majority, however, are **detritivores**, especially monerans. Some are "nitrogen-fixers," taking nitrogen from the air and converting it to a form usable by plants. These unsung heroes recycle waste and dead things. Their recycling allows life to continue.





Microscopic organisms are abundant and important in all ecosystems, including forests. The majority are detritivores that replenish the soil with recycled nutrients.

3 – FUNGI

An out of body phenomenon

Fungi are by far the most prolific of all the **detritivores** in our forests because they are adapted to acidic soils. Mushrooms, shelf fungi, and less noticeable molds, mildews, and rots are some examples.

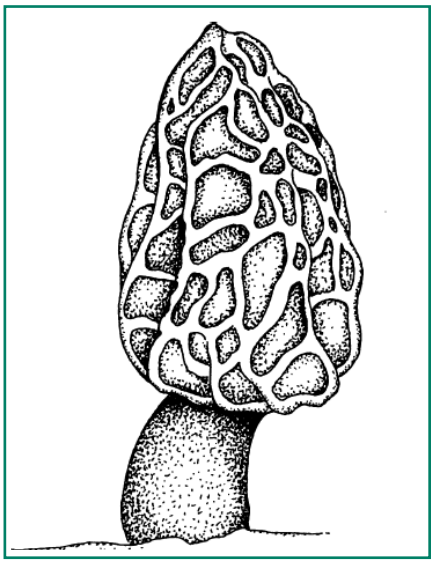
Fungi are similar to plants in that they are immobile. In fact, scientists used to consider them to be plants. But fungi are very different from plants in cell structure and in the ways they live, so scientists now place them in a separate kingdom of living things.

More Than Meets the Eye. Usually, we see only the fruiting, or reproductive part of a fungus *(a mushroom, for example).* Its main body is hidden from view. The body of a fungus is made up of **hyphae**, microscopic hair-like structures that reach out through the wood, soil, leaf litter, roots, or other material on which the fungus is growing. A handful of forest soil may contain over two miles of fungal hyphae!

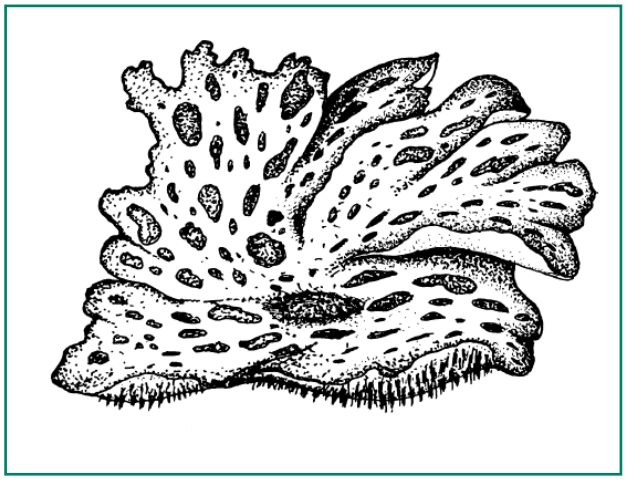
Unusual Way of Eating. Fungi use their hyphae and digest their food outside their bodies! The cells of fungal hyphae give off digestive enzymes like those found in our own stomachs. These enzymes break down wood, leaves, and other material. Then the fungal hyphae absorb the scattered sugars and minerals and use them to grow.

Trading Minerals for Sugars. Some fungi form symbiotic associations with plants and help them obtain needed minerals *(nitrogen, potassium, phosphorus)* from the soil in exchange for the sugars the plant produces. More than 90% of the plants in Alaska, including all our trees and berry-producing plants, could not grow without these mycorrhizal fungi.

Mutual Symbiosis. Lichens, one of the most visible fungi in forests, are actually a partnership between a fungus and alga or cyanobacteria. The fungus provides the structural protection, and the alga produces the food.



Mushrooms are the fruiting, or reproductive parts of certain fungi. Tiny hair-like structures, called hyphae, are the main body of many fungi.



Lichens are the most visible fungi in forest ecosystems.

4 – PLANTS

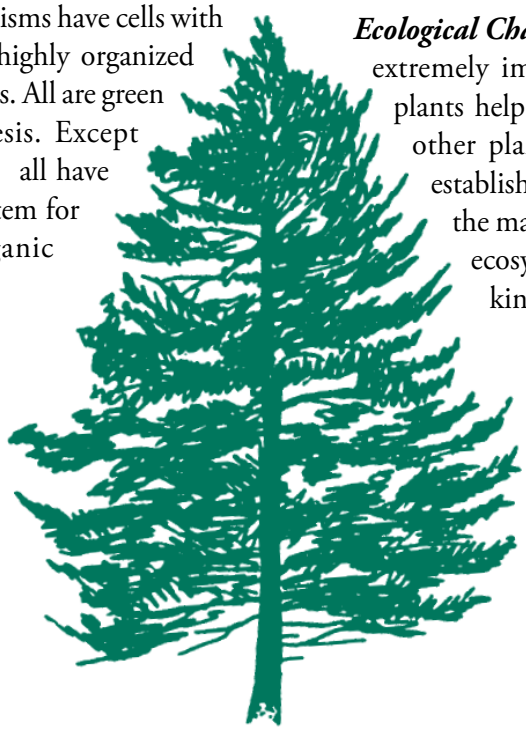
From small to tall

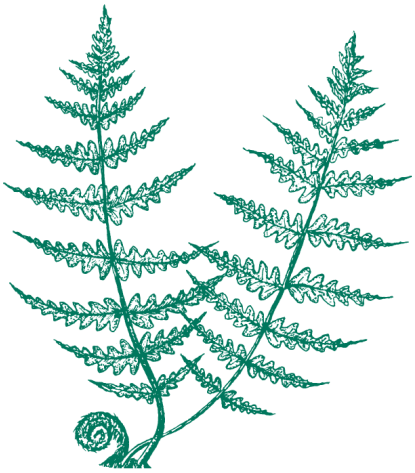
Trees are the dominant plants in forest ecosystems. Nevertheless, the texture of the forest is rich with many other plants as well. This kingdom includes small to tall – mosses, liverworts, ferns, and horsetails to spruce and birch trees.

Green Producers. These organisms have cells with nuclei and a cell wall and a highly organized arrangement of their many cells. All are green and capable of photosynthesis. Except for the mosses and liverworts, all have leaves, roots, stems, and a system for transporting water and organic materials among the cells.

Help Accepted. All plants live a stationary life. Many rely on wind, insects, birds, and some mammals to pollinate their flowers or to help carry their seeds to new areas. Plants can live for a remarkably long time. Some bristlecone pines are more than 4,000 years old.

Ecological Champions. Plants are extremely important ecologically. (1) **Pioneer** plants help to create the organic soils that all other plants need before they can become established in a new location. (2) They are the major **producers** *(of food)* in terrestrial ecosystems. Without them, the animal kingdom would not survive.





5A – ANIMALS (Invertebrates)

Mind-boggling multitudes

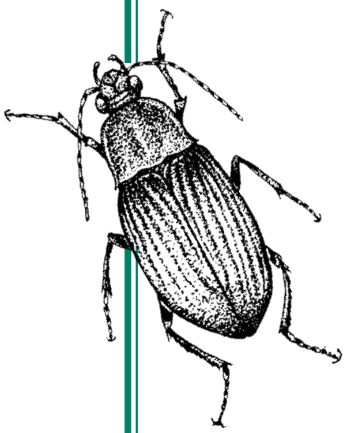
Invertebrates animals are multicellular organisms that lack a backbone or spinal column. They make up the majority of the animal kingdom, both in number of species and in populations.

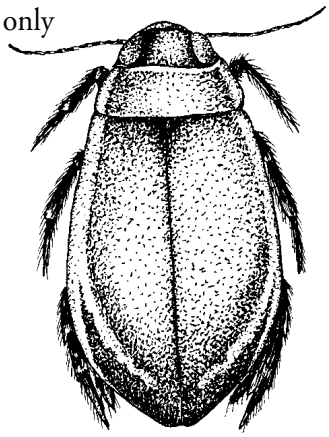
Like other animals, invertebrates obtain energy and minerals by eating other living things – plants, fungi, or other animals. They are **consumers**. Many also function as **detritivores**, helping to recycle the minerals and nutrients in dead organic material.

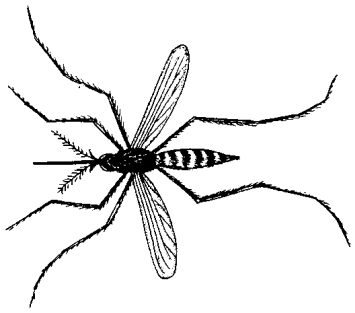
Need External Warmth. Invertebrates need external warmth to function. Forest invertebrates are only active during the warmer months which in the boreal forest is limited to a few summer months. Even then, despite their numbers, few humans notice them.

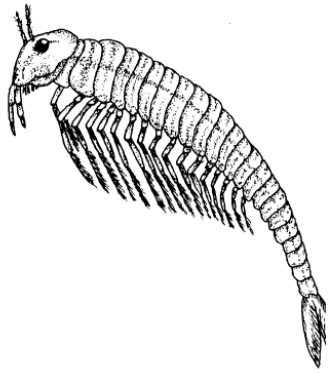
Mosquitoes and Other Buzzing. Arthropods *(spiders, centipedes, millipedes, and insects)* are the most conspicuous. Flying insects include butterflies, bumblebees, moths, ichneumonid wasps, crane flies, and midges. Mosquitoes, blackflies, and other biting flies can occur in great abundance.

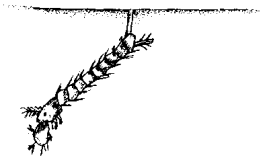
Look Under Bark, Logs. Forest invertebrates also include segmented worms, snails, and slugs. Sawflies, aphids, bark beetles, carrion beetles, and ground beetles are among the insects that live on plants or in the leaf litter. *For a more complete list and illustrations, see the Alaska Ecology Cards.*





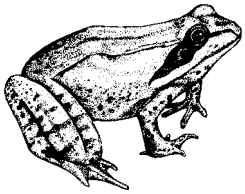


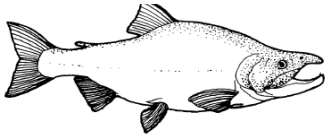


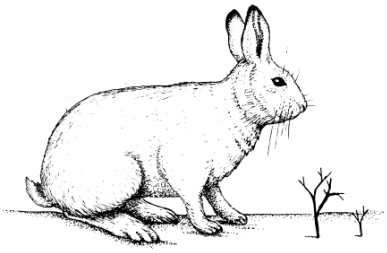


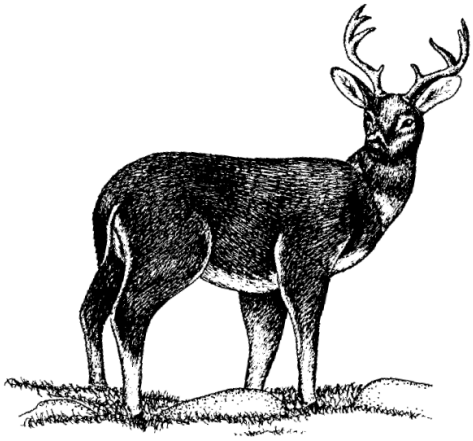
5B – ANIMALS (Vertebrates)

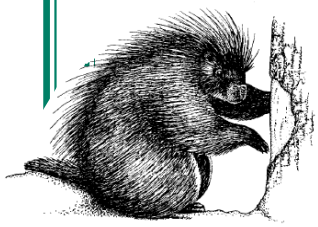
Frogs, Bats, Hummingbirds – in Alaska!











Vertebrate animals are multicellular organisms with a backbone or spinal column. Alaska's forest vertebrate animals include humans and other mammals, birds, fishes, and all five of the state's amphibians *(wood frog, spotted frog, western or boreal toad, long-toed salamander, and rough-skinned newt).*

Reptiles are the only major group of vertebrate animals absent from Alaska and its forest ecosystems.

No Producers, Only Consumers. All animals obtain energy and minerals by eating other living things – plants, fungi, or other animals. They are mainly **herbivores** and **carnivores**. Vertebrate animals can move about and actively search for food.

Fishy Habitat. Lakes and rivers in forested areas are prime habitat for Alaska's fishes including lake trout, whitefish, and the salmon species that hatch in the clear, cool waters and then migrate to the ocean before returning to spawn.

Stick Nests and Plenty to Eat. Bald eagles feast on those fish and nest in the huge trees. Forest birds are abundant and varied, including the northern goshawk, at least five species of owls, three species of grouse, the rufous hummingbird, and woodpeckers and other songbirds that eat insects or seeds.

Forests Fit Many. Red squirrels, flying squirrels, snowshoe hares, porcupines, coyotes, wolves, black bear, Sitka black-tailed deer, moose, marten, mink, and river otters are forest animals. Little brown bats also live here. *For a more complete list and illustrations, see the Alaska Ecology Cards.*

FORESTS PROVIDE SHELTER AND FOOD FOR WILDLIFE.

HIDDEN BY THE LEAVES

A place to rest — Many birds rest in trees. The great-horned owl may rest in the branches during the day or perch there at night to look and listen for voles and other prey.

Nesting high – A tree is the perfect place for a black-billed magpie to build its domed nest of sticks. Robins, gray jays, and bald eagles and some other animals such as squirrels also build nests in the branches.

A treetop smorgasbord – Pine grosbeaks, crossbills, and red squirrel spends most of their time in the treetops where they feed on cone seeds.

Blending in – Lacewings, aphids, and sawflies feed on tree leaves.

BENEATH THE BARK

Growing up inside a tree – Some animals spend most of their lives beneath the bark. Bark beetles lay eggs under the bark. After the eggs hatch, the larvae cut patterns in the wood as they eat it. Horntails, bristletails, and some ants also feed on or under the bark.

Nesting within – Hairy woodpeckers chisel out their own nesting holes in trees. When woodpeckers abandon these nests, other wildlife move into the cavities – bees, flying squirrels, and chickadees.

Fruiting fungi – Many fungi grow on trees. Their threadlike mycelium spreads beneath the bark, hidden from view. Only the fruiting bodies of fungi such as shelf fungus are easy to spot.

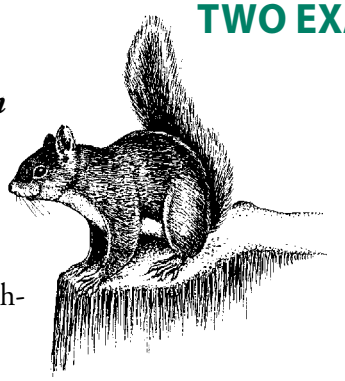
AROUND THE ROOTS

Feeding on the roots – Many insects, spiders, mites, millipedes, fungus gnats, and pill bugs spend part of their lives in the ground.

Burrowing, furrowing– Earthworms, voles, and shrews dig tunnels in the soil beneath trees. As they churn up the soil, they make it easier for a tree's roots to grow and absorb oxygen.

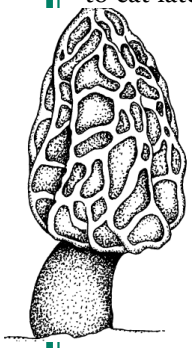
TWO EXAMPLES

What do a mushroom and a squirrel have in common?



You know what a squirrel looks like. You also probably know what a mushroom looks like.

Well, squirrels and other small animals such as voles like to eat mushrooms. They find them and eat some right away. But they find more than they can eat, so they store the mushrooms in their secret hiding places to eat later.



Mushrooms are the fruiting bodies of a living thing called a **mycorrhizal fungi.** The **spores** of the mushroom act like seeds to make more fungi. When squirrels hide them, new fungi can start growing from the spores at this new spot. Plants like to grow where fungi grow.

Who benefited? The fungi doesn't have legs or wings, so it could not travel on its own. Most plants cannot grow well without this fungi. Squirrels and other small mammals cannot live without plants and fungi to eat.

All of these organisms need each other to survive. They are **interdependent**.

Who will help me carve my nest?

Bark beetles drill a hole in the bark of a spruce tree and lay their eggs. When the eggs hatch, the beetle **larvae** feed on the live wood cells of the tree.

When the beetle entered the tree, it accidentally carried with it **spores** of a **parasitic** fungi. The fungus starts to grow inside the tree. The fungus softens the wood around it in order to eat it.

Now a woodpecker can more easily drill holes in the trunk to find bark beetle larvae and to make a nesting **cavity.**

A year or two later, that nest hole made by the woodpecker will become home for other cavity-nesting animals such as swallows, boreal owls, or flying squirrels.

Who all helped make that nest hole for the owl?

FOREST Learning Trail

Section 3
FOREST INSIGHTS

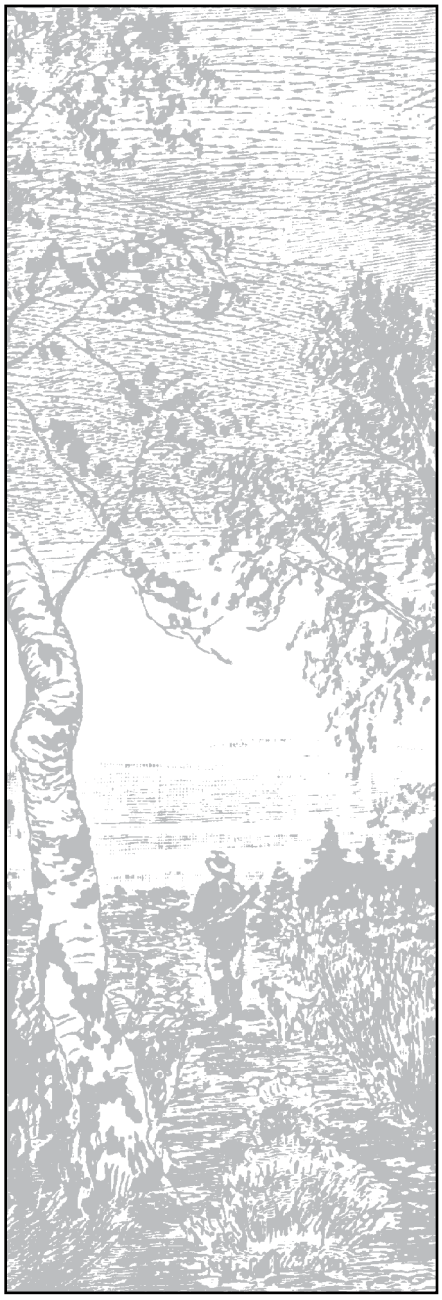
What is the Learning Trail?
How do I use the activities?
Where do I go for more information?

INSIGHTS 1, 2, 4, and 5 contain subject-appropriate backgrounds to the activities.

WHAT IS THE LEARNING TRAIL?

The Forest Learning Trail is a set of activities to spur children out of their classroom seats and actively engage them in the forest environment. It is designed to promote critical thinking and elicit responses to higher order questions.

The 20 activities offer a multi-sensory experience with kinesthetic learning opportunities. Students are encouraged to synthesize what they know and make new discoveries. The activities draw on the multiple intelligences.



HOW DO I USE THE ACTIVITIES?

(1) Each of these activities is written as a stand-alone lesson plan so it can be used independently, one or more at a time.

(2) Or they adapt easily for use on a multi-station trail. As such, they could be the • culmination of classroom learning in forest ecosystems, • organized as a field trip, • or they could be an initial exploration of forests while immersed in the subject environment.

WHERE DO I GO FOR MORE INFORMATION?

The "How to Set Up Stations" for the Learning Trail in *Student Activities, Section 3*, lists all the Trail activities and their teaching objectives at a glance. That section contains 8 activities that offer unique sensory and higher learning experiences. The 12 other Learning Trail activities are interspersed in the subject-appropriate sections and marked with this symbol. The activities are yours to pick, mix, or match.

Small seabirds called marbled murrelets nested in secret until recently. What a surprise when they were discovered miles inland from their ocean habitat nesting in some of the oldest trees in the coastal rainforest.

Succession - Changing Forest Habitats

One of the differences between living and **nonliving things** is that living things grow and change in a predictable pattern. Communities of living things – **ecosystems** – also are dynamic and change.

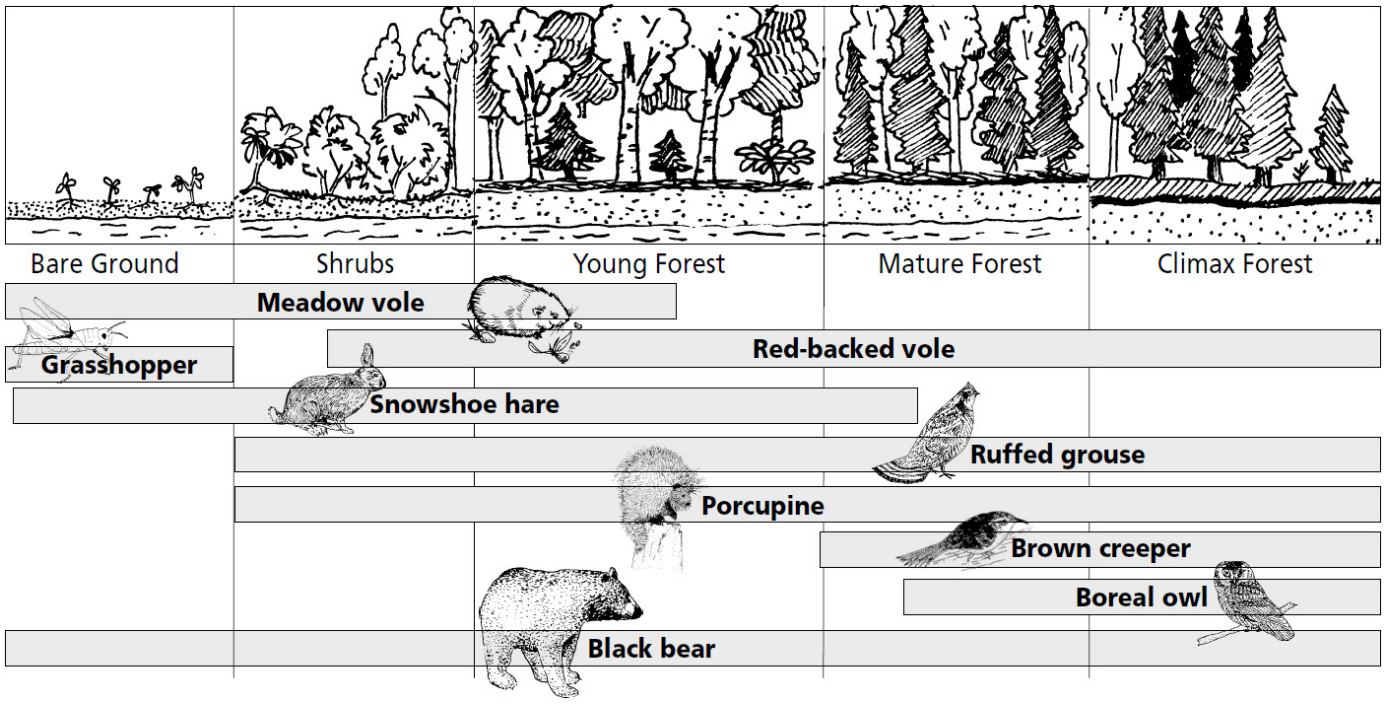
Succession describes the *patterns of change* in ecosystems when a new environment is formed or after an existing environment is disturbed. Succession occurs in all types of ecosystems, from oceans and wetlands to tundra, deserts, and forests.

Bare Rock to Deep Forest. If we could look back in time, we would see some currently forested lands that once showed no sign of trees or any other plants *(described in the following "Glacier Bay Time Machine).* Over time, a specific order of plants colonized the barren or disturbed site.

How Does It Happen? How a forest grows and which plants come first or second depends on
(1) competition,
(2) differences in the needs of plants, and
(3) the effects of the nonliving environment on plants and other living things.

Dynamic Wildlife Habitat. As the forest **habitat** changes, so does the list of wildlife that can call that stage of the forest their home.

Where Some Animals Fit in Boreal Forest Succession



Alaska's Very Own Time Machine

As glaciers recede *(melt)*, they uncover a raw, new land – giving us a glimpse of how our continent looked thousands of years ago.

We can board the glacier "time machine" in Glacier Bay to see in minutes what took hundreds of years of natural forest growth.

GLACIER BAY:
View 200 Years in a FLASH

Historical records show that only 200 years ago in Glacier Bay there was no bay, no forest – just a huge glacier.

Now the main glacier has receded many miles, leaving a time-machine record of how forests develop.

Year 0: Nearest the glacier's toe, where the ice most recently melted, the land is barren rock and silt-laden runoff. No plants inhabit this area.

Year 10: A short distance outward, where the ice has been gone about 10 years, we see scattered patches of moss, fireweed, and dryas *(all **pioneer plants**)* among the gray rocks.

Year 30: We walk among alder, willows, and cottonwoods, stepping on grasses, dryas, and other herbs.

Year 50: Farther along the glacier's former path, the alders and cottonwoods are taller than we are. But we can step over small spruce that are just sprouting.

Year 200: Near Bartlett Cove, where 200 years ago local Natives and explorer George Vancouver encountered a wall of ice, we now see a dense spruce forest covering the land like a green glacier. Little light reaches the forest floor under the spruce **canopy** so there are few **understory** shrubs, and the **ground cover** is mainly moss. Scattered in the dark forest, small hemlock saplings strain upward to find sunlight.

Stages of Succession

Alaska's two forest types go through similar stages in succession. Although the stages are listed below as a linear order, succession is usually cyclical.

PRIMARY SUCCESSION

Primary succession occurs when **disturbances** *(such as glacial advances and retreats, volcanoes, earthquakes, landslides, scouring floods, or very hot-burning fires)* remove the soil and organisms from a site, leaving only bare rock, gravel, silt, or sand.

It is "primary" because soil – the foundation for everything else – starts here. Soil formation begins with slow breakdown of rocks by weathering. Dust, silt, and sand collect in these pockets of **mineral soil**. At the same time, **pioneer plants**, some animals, and other living things *(microscopic organisms)* colonize the site. As they grow, die, and decay, a layer of **organic soil** is formed.

The stages of primary succession are as follows. *Each stage is also called a **sere** by foresters.*

Pioneer
Tall Shrub
Young Forest
Mature Forest
Climax (or Old-Growth) Forest

If no new disturbance occurs, the site passes through the stages until a climax forest is formed. Each stage is characterized by a different **community** or mixture of plants. Each stage is distinguishable, but the change from one stage to another is gradual.

SECONDARY SUCCESSION

Secondary succession starts when a disturbance (*such as wind storms, insect outbreaks, logging, avalanches, bulldozers, or fire*) leaves the soil intact. Seeds, spores, and roots usually remain as well.

Sites that begin with secondary succession reach the next stage more quickly than during primary succession. Plants are often more crowded because the soil is deeper and more uniform. The crowding leads to intense **competition** for soil nutrients and light. This makes it difficult for new species to invade.

The stages of secondary succession are as follows.

COASTAL RAINFOREST
Regrowth Stage
Second-Growth Forest
Old-Growth Forest

BOREAL FOREST
Regrowth Herb Stage
Regrowth Shrub Thicket
Regrowth Young Forest
Mature Forest
Climax Forest

Fire as a Catalyst. Despite Smokey Bear's admonition to prevent them, fire is a natural component of many forest ecosystems including Alaska's boreal forest. Fire does indeed design the boreal forest by restarting succession at various stages *(see following)*.

Note: While the term "secondary" suggests that it occurs after primary succession, the two do not form a sequence.

FIRE DESIGNS BOREAL FOREST

Fire is often succession's driving force, especially in Alaska's boreal forest ecosystem. The dry climate, long days and hot summer temperatures create perfect conditions for fires to spread.

Born of Fire. In Interior Alaska up to 2 million acres of forest burn every year due mainly to lightning strikes. Foresters at the University of Alaska estimate that almost every part of the boreal forest burns at least once every 200 years.

Patchwork Quilt

Fires in Alaska's boreal forests leap and dance across the land, burning everything to charcoal in one spot, barely singeing tree branches in another. Succession begins whenever fire passes.

- If fire kills trees and removes all the surface organic matter, **primary** succession begins with soil building. **Pioneer plants** in the boreal forest are liverworts and mosses followed by plants with windblown seeds such as fireweed, grasses, willows, and cottonwoods.

- In places where fire has burned less hotly and soil remains intact, **secondary** succession begins using remnant seeds or any blown in from surrounding areas. Plants that grow the fastest and tallest shade out competitors to become dominant.

"Stump" the Scientists

In Interior Alaska, the pattern of succession is unclear to scientists, even now. There are few mature spruce forests with trees older than 200 years even though white spruce are long-lived trees.

Evidence suggests that as the mossy carpet on the forest floor grows thicker, it insulates the ground and allows **permafrost** to rise closer to the surface. Ultimately, all boreal forests might become black spruce and tamarack, two species that tolerate permafrost.

In most boreal forest areas, succession never reaches "climax" stage because a disturbance stops the clock and starts the process over again.

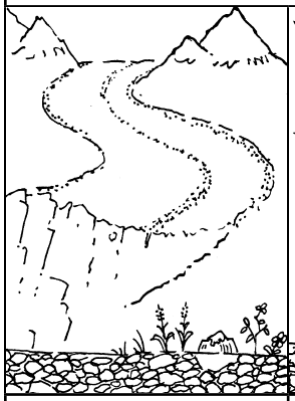
Fire Thrives in Mature Forests

As the boreal forest grows, so too, does its **fuel** for wildfires. A patch of pioneering willows on a sandbar is meager food for a lightning strike. But a strike within a mature coniferous forest can start a fire that gets hotter and hotter as it consumes trees, shrubs, grasses, and all the natural **litter** left by slow decay in cold climates.

Mosaic of Succession. The longer a forest has been without a fire, the more fuel it will have – and the hotter it will burn. Where fires are frequent, the forest is usually a mosaic of successional stages.

Primary Succession in the Coastal Rainforest

Areas where **glaciers** have retreated provide a living laboratory for the study of primary succession. The chart below illustrates the pattern of change after glaciers retreat. Primary succession also occurs on new lands created by **rivers**, **earthquakes**, **landslides**, or **volcanoes**. The patterns on these sites are similar, but pioneer plants may differ.



PIONEER STAGE:

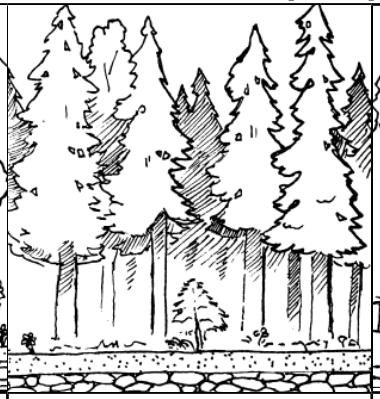
Common **pioneer plants** include dryas, fireweed, willow, alder, and soapberry. Alder and dryas have symbiotic bacteria in their roots which take nitrogen from the air. This allows these plants to grow on soil that lacks an organic nitrogen-rich layer. The leaves of these plants, once decayed, form an important part of the **organic soil** layer. Several feet of snow may accumulate on the ground in protected sites in winter. Strong winds will keep most other areas snow-free.

TALL SHRUB STAGE:

Within **5 to 20 years** after the retreat of a glacier, a layer of **organic soil** has developed on some sites. The **pioneer** willow, alder, and soapberry continue to grow taller. Cotton-wood, Sitka spruce, and other plants begin to invade the site. Most of the shrubs and saplings are deciduous and do not trap much snow in winter. The leafless shrubs slow the winds, however, so several feet of snow may accumulate on the ground.

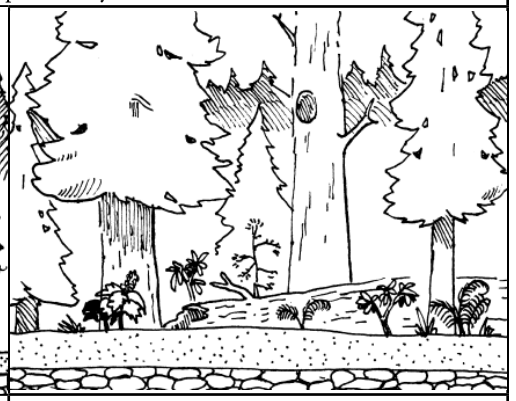
YOUNG FOREST:

70 to 100 years after glacial retreat, cottonwoods, red alder, and some willows have reached tree height. A few tall spruce are present and many spruce saplings grow beneath the broadleaf **canopy**. Strawberry, lupine, club mosses, and others form the **ground cover**. Because many of the trees are deciduous, the winter snows reach the ground and accumulate.



MATURE FOREST:

150 to 200 years after glacial retreat, Sitka spruce trees form the forest **canopy**. Because cottonwood and alder trees only live 70 to 100 years and their seedlings can not survive in the shade of conifers, few broadleafs remain. Hemlock seedlings are tolerant of the shade and some grow beneath the spruce. The needles of spruce are slow to decay, so many litter the forest floor. Relatively few **ground cover** plant species can grow amid these needles and in the shade. Mosses, huckleberry, and wintergreen are often present. The dense tree **canopy** intercepts most of the snow that falls, so that relatively little snow accumulates on the ground.



CLIMAX FOREST (or Old-Growth):

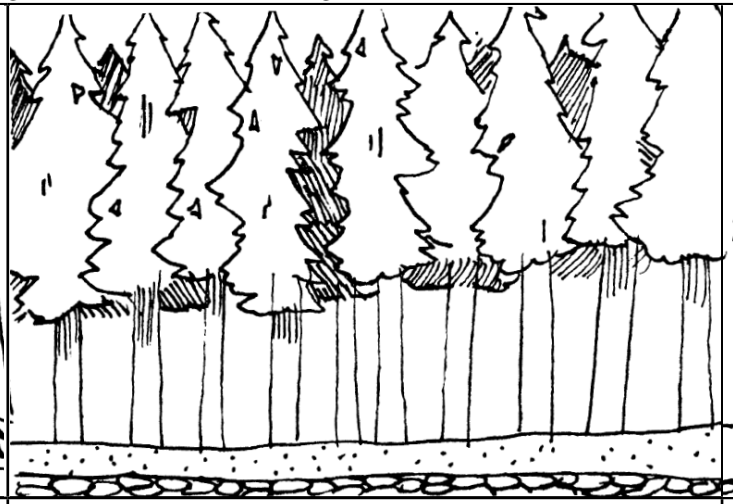
The length of time required varies, but some scientists estimate **250 to 600 years**. On well-drained sites the **canopy** trees are hemlock and Sitka spruce. Many large old conifers have died and fallen. Sunlight reaches the forest floor. Trees of all ages (seedlings, saplings, young trees, and old giants) are present. This forest will replace itself. Shrubs and herbs grow in the filtered sunlight including alder, salmonberry, devil's club, elderberry, huckleberry, skunk cabbage, false lily-of-the-valley, trailing bramble, ferns, and mosses. Trees branches are covered with lichens and mosses. **Snags** are riddled with woodpecker holes. Large branches of old trees catch much of the winter snow, so relatively little snow accumulates on the ground.

Secondary Succession in the Coastal Rainforest

Avalanches, **severe wind storms**, **outbreaks of insects** and **tree diseases**, and **human activities such as timber harvest** are the main events triggering secondary succession in the coastal rainforest. These events can disturb small or large areas. The pattern of regrowth shown in the chart below occurs if the site is not disturbed again. Repeated disturbances of a site can restart the process, setting back the clock to an earlier stage.

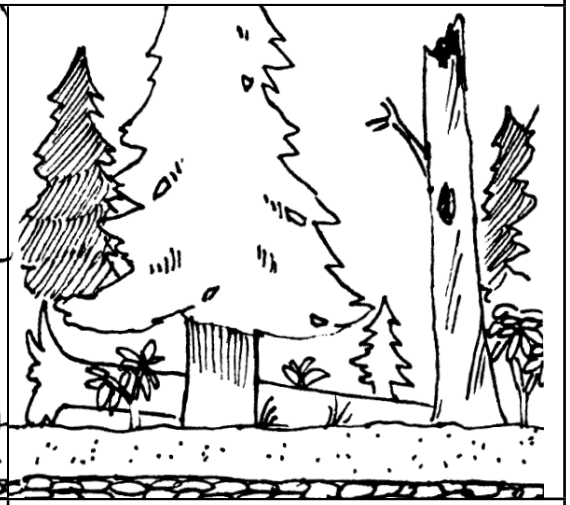
REGROWTH STAGE:

Alder, devil's club, elderberry, huckleberry, seedling spruce, and hemlock flourish within a few years if the **organic soil** layer remains. Many sprout from seeds or roots buried in the soil, while others sprout from seeds carried in by the wind or animals. Downed trees and branches cover much of the ground, making walking difficult. Large standing dead trees – **snags** – may be present if outbreaks of insects or disease started the succession. Snags may or may not be left during timber harvest. Several feet of snow usually accumulate on the ground in winter.



SECOND-GROWTH FOREST:

Within **25 to 35 years** conifers, particularly western hemlock, crowd the site. They are near the same size and age, giving this forest the name "even-aged forest." Few plants can grow in the deep shade and thick layer of needles from the hemlocks. Shrubs are few. Mosses and liverworts are the primary **ground cover**. The **snags** are too small for use by animals. In winter the dense **canopy** of conifers catches most snow, so little accumulates on the ground. *(This stage of succession is similar to the young and mature forest stages of primary succession, but here conifer trees are more numerous and more closely-spaced.)*

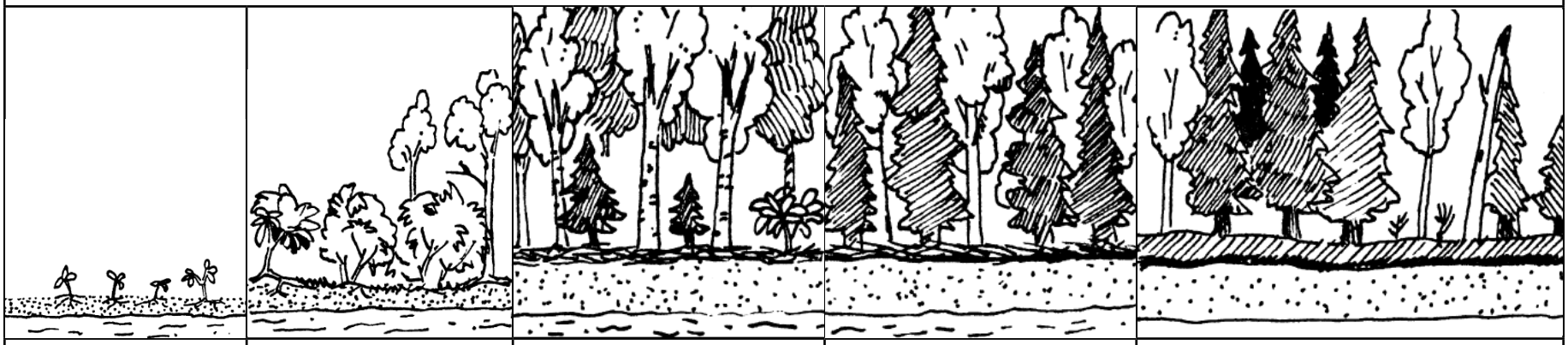


OLD-GROWTH FOREST:

After **200 or more years** the **canopy** trees are hemlock and Sitka spruce. Trees of all ages (seedlings, saplings, young trees, and old giants) are present. This forest will replace itself. Many large old conifers have died and fallen, opening the canopy. Sunlight reaches the forest floor. Shrubs and herbs grow in this light and include alder, salmonberry, devil's club, elderberry, huckleberry, skunk cabbage, false lily-of-the-valley, trailing bramble, ferns, and mosses. Tree branches are covered with lichens and mosses. Many **snags** contain nesting holes. Large branches of old trees catch much of winter's snow. Little snow accumulates on the ground beneath the trees, but may accumulate in the larger openings.

Primary Succession in the Boreal Forest

In Alaska's boreal forest, **rivers** often abandon old banks and sandbars to carve new channels. The chart below illustrates the pattern of change on abandoned river sites. Patterns of change would be somewhat similar on new lands created by **glaciers**, **landslides**, **earthquakes**, **volcanoes**, and **severe forest fires** that burn all organic soil. Pioneer plants invading each site may differ.



PIONEER STAGE:

Only hardy **pioneer plants** (willow and alder) take root in floodplains. The rocky base is usually covered with mineral salts. During high water, the site may flood. Roots of the willows and alders help to hold sand and trap more silt from the river. Silt combines with decayed leaf litter to eventually form **soil**. Symbiotic bacteria in the roots of the alder take nitrogen from the air and make it available to the roots. This allows these plants to grow on soil that lacks an organic, nitrogen-rich layer.

SHRUB STAGE:

In **10 to 30 years**, willow and alder grow into tall shrubs. Newly created soil and frequent deposits of silt raise the land level so it floods less often. Now other plants can invade including poplar, birch, rose, high-bush cranberry, and a variety of grasses and herbs.

YOUNG FOREST:

In **30 to 100 years**, poplars and birch have reached tree height, casting too much shade for sun-loving pioneer willows and alders. The better-developed soil layer and rarity of flooding allow white spruce to colonize the site. Rose and high-bush cranberry shrubs become more common.

MATURE FOREST:

In **100 to 200 years**, the **canopy** is a mixture of balsam poplar and smaller white spruce. Rose, high-bush cranberry, and other shrubs form the **understory**. Fireweed, horsetails, and grasses occur in the **ground cover**. When spruce trees dominate the canopy, shade-tolerant mosses take over the forest floor.

CLIMAX FOREST (or Old-Growth):

Few forests in Interior Alaska survive to this stage; fire or flood usually turns back the clock. After **200 years**, white spruce trees form the **canopy** and **understory**, spanning all ages from seedling to old giant. At this stage the forest becomes self-renewing. A few poplars and birch grow here but seldom live more than 100 years. Their seedlings cannot survive in the shade of the spruce. Dead broadleafs or white spruce fall, creating openings in the canopy and exposing bare soil. Sunlight reaches the forest floor and new spruce seedlings start on the exposed soil. The forest floor is covered by feather moss and some reindeer lichen. Shrubs and herbs that grow in the filtered sunlight include alder, rose, a willow, wintergreen, low- bush cranberry, twinflower, and bunchberry.

Secondary Succession in the Boreal Forest: Non-Permafrost Sites

Wild fire is succession's driving force here. The chart below illustrates the pattern of change after fire on a **well-drained site**. Regrowth following **flooding**, **insect outbreak**, **avalanche**, **timber harvest**, or **land clearing** would be somewhat similar. **Fire benefits the forest** in ways the other events do not. Fire (1) releases minerals stored in wood, ensuring a nutrient-rich soil for the next stage, and (2) leaves many standing dead trees – **snags** – so more animals can occupy the early regrowth stages.

REGROWTH HERB STAGE:

Fire returns the **minerals** stored in trees to the soil, creating a nutrient-rich bed for plant growth. At least an inch of **organic soil** must remain for regrowth (rather than primary succession) to begin. Seeds and spores buried in the soil start to sprout. Other seeds blow in from surrounding areas. Some plants start from roots and stumps not killed by the fire. Common plants include fireweed, wild geranium, rock harlequin, horsetail, chiming bells, raspberry, rose, aspen, birch, willow, alder, and spruce. Mosses, liverworts, and lichens also grow on recent burn sites. Many **snags** will be present if regrowth starts from a mature or climax forest site.

REGROWTH SHRUB THICKET:

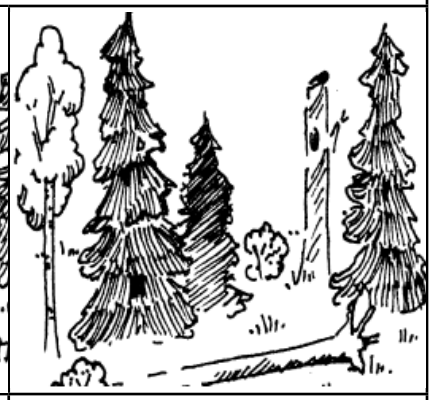
Within **3 to 25 years** after a fire, most sites are covered by a variety of shrub and sapling trees including willows, alder, raspberry, rose, birch, aspen, and poplar. A few white spruce seedlings start their slow growth. Fireweed, grasses, horsetails, chiming bells, and rock harlequin are the most common herbs. There are fallen trees and large **snags,** many with woodpecker holes.

REGROWTH YOUNG FOREST:

From **25 to 45 years** after fire, the **organic soil** layer is at least 2 inches deep. Birches, aspens and/or poplars form a dense forest **canopy**. If present, the slow-growing spruce are smaller than the broadleafs. Seedlings of birch, aspen, and poplar cannot survive in the shade so they are absent. Few tall shrubs are present except for rose, alder, willows, and high-bush cranberry. Labrador tea, lingonberry, bunchberry, twinflower, and wintergreen are common **ground cover** plants. Feather mosses are abundant. Most fire-killed trees have fallen and are decaying into the soil. There are a few small **snags**.

MATURE FOREST:

From **45 to 150 years** after fire, **organic soil** is several inches thick. A mixture of broadleafs and white spruce form the forest **canopy**. The abundance of white spruce varies among sites. The canopy is more open, so some birch and aspen seedlings and saplings grow in the **understory**. High-bush cranberry and rose are the major tall shrubs; there are few willows. Low shrubs and **ground cover** plants thrive and include kinnikinnik, lingonberry, Labrador tea, twinflower, fireweed, horsetails, and timberberry. There are fallen dead trees and a few large **snags**.

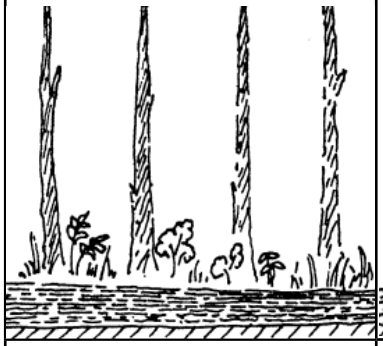


CLIMAX FOREST (or Old-Growth):

Some **150 to 300 years** after fire, if a site is not disturbed again, this **self-renewing** stage will be reached. **Organic soil** is about 5 inches thick. White spruce dominate the forest **canopy**, but some birch, aspen, and poplar may be present. The canopy is fairly open, so some sunlight reaches the forest floor. High-bush cranberry and rose are the main tall **understory**, though some alder may be present. Low shrubs and **ground cover** plants are mainly wintergreen, horsetails, and twinflower. Feather mosses, and sometimes lichens, are abundant. There are many fallen logs and **snags**, some with woodpecker holes.

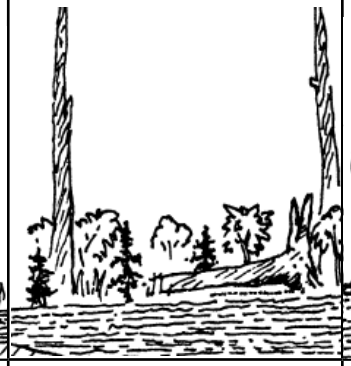
Secondary Succession in the Boreal Forest: Permafrost Sites

Wild fire is succession's driving force here. The chart below illustrates the pattern of change after fire on a **poorly-drained site**. Regrowth following **flooding**, **insect outbreak**, **avalanche**, **timber harvest**, or **land clearing** would be similar. The old-growth stage may never be reached if fires and other disturbance events occur too frequently. **Fire benefits the forest** in ways the other events do not. Fire (1) ensures a nutrient-rich soil for the next stage by releasing minerals stored in wood, (2) releases seeds of black spruce, a common tree on permafrost sites, and (3) leaves many standing dead trees – **snags** – so more animals can occupy the early regrowth stages.



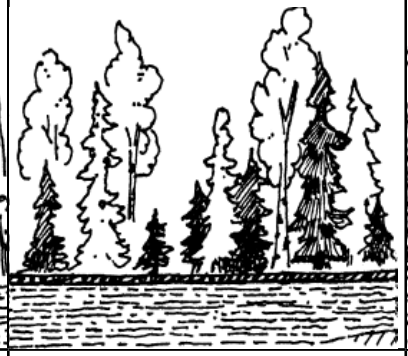
REGROWTH HERB:

Fire returns the **minerals** stored in trees to the soil, creating a nutrient-rich bed for plant growth. At least 3 inches of **organic soil** remains for regrowth (rather than primary succession). **Permafrost** may be 20 inches or more below the surface. Seeds and spores buried in the soil start to sprout. Willow, rose, grasses, blueberry, Labrador tea, mosses, and cloudberry sprout from existing roots. Wind and animals bring in more seeds: willow, lingonberry, resin birch, and spores of various liverworts and mosses. Fire and sun opened the cones of black spruce so their seedlings soon became numerous. Many **snags** will be present if regrowth starts from a mature or climax forest.



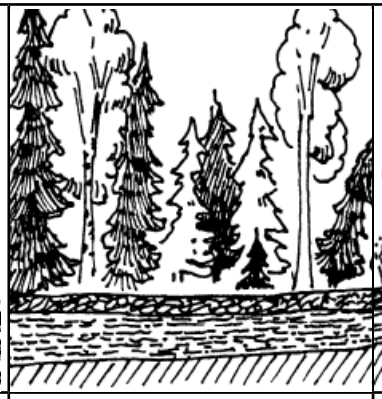
REGROWTH SHRUB THICKET:

From **5 to 30 years** after a fire, the **organic soil** layer increases to about 7 inches. Most sites are covered by tall shrubs and sapling trees. Willows are most common, but aspen, birch, and black spruce seedlings and saplings are also abundant. Mosses, grasses, fireweed, blueberry, Labrador tea, and lingonberry are the most common **ground cover** plants. Some **snags** are drilled with woodpecker holes.



REGROWTH YOUNG FOREST:

From **30 to 55 years** after fire, the **organic soil** layer remains about 7 inches thick, and **permafrost** has thawed to a least 30 inches or more below the surface. A dense stand of black spruce with some birch and aspen, or birch and aspen alone, form the **canopy**. Spruce seedlings crowd the ground. Seedlings of birch, aspen, and poplar cannot survive in the shade and are uncommon if spruce dominate the canopy. Few tall shrubs grow except for willow, resin birch, alder, and rose. Labrador tea, lingonberry, and blueberry are fairly common, but mosses and lichens cover much of the ground. Almost all of the trees killed by the fire have fallen and decayed, returning to the soil. This forest has many small **snags.**



MATURE FOREST:

From **55 to 90 years** after fire, **organic soil** thins as more mosses insulate the ground and permafrost rises to less than 23 inches below the surface. The **canopy** may be pure broadleafs, a mixture of broadleafs and black spruce, or nearly solid black spruce. The few tall shrubs include willows, rose, and alder. Lingonberry, blueberry, bunchberry, grasses, mosses, and many black spruce seedlings cover the ground. Some small **snags** are present, but few are large enough for nest holes. There are some fallen dead trees.

CLIMAX FOREST:

After **90 to 200 years**, if not disturbed again, this **self-renewing** stage is reached. The depth of **organic soil** and permafrost remain the same as in mature forest stands. Black spruce dominate the forest **canopy**, but some birch may be present. Alder and black spruce saplings form the **understory**. Low shrubs and **ground cover** plants are mainly Labrador tea, lingonberry, and timberberry. Feather mosses and sometimes reindeer lichens cover the ground and provide insulation that prevents the ground from thawing. There are many fallen trees and some **snags**, many with woodpecker holes.

Wildlife Follow the Habitat

All living things have **adaptations** or special traits that let them thrive in a particular environment. These adaptations may be structural *(body size and shape)*, physiological *(diet, cold- or drought-tolerance)*, or behavioral *(finding mates or defending territory)*.

Some species *(such as brown bears)* have broad habitat requirements and wide ranges of tolerance for environmental conditions, so they occur in many different environments. But species with narrow ranges of tolerance and very specific **habitat** requirements occur only in specific environments.

The list of wildlife found in Alaska's two forest types changes as certain habitats become available during succession. Many animals, however, use more than one stage of succession as habitat, especially in different seasons.

To determine if an animal could live in a habitat created by a stage of succession, ask: Does it contain the food, shelter, water, and/or space needed by that animal?

Nonliving Elements Restrict Users. In early successional stages, for example, the environment is open and windy. Lots of sunlight reaches the ground. The temperatures can change quickly, and rain and snow have a great effect on the plants and animals. There are often daily and seasonal extremes of temperatures, wind, and moisture. Animals residents are restricted to those that can nest or hide near the ground.

Can I Reach My Food? The shrub thicket stage provides the dietary needs of moose and snowshoe hares. But as trees get older and taller, both moose and hare are at a disadvantage. They can no longer reach the new branches. Neither animal is adapted to use mature forests except for shelter.

Snag a Home. Birds such as woodpeckers, chickadees, and boreal owls nest in cavities in the decaying soft wood of **snags** (*standing dead trees*). Their adaptation for cavity-nesting works well in old-growth climax forests where snags are abundant. In turn, this adaptation limits their use of earlier successional stages that contain few snags.

Fish Need Forests Too. To hatch their eggs, salmon and other fish need (1) streams with a certain temperature range and amount of oxygen and (2) streambeds of gravel of a certain size. Forests provide cool and clean stream habitat.

Trees Protect Stream Habitat. Tree roots hold the soil, preventing erosion. Trees shade the streams, keeping the water temperature stable. The roots of live and dead trees that protrude into streams provide places for fish to rest and hide. The leaves and twigs that fall into streams feed the insects that fish eat.

The following text highlights some wildlife facts not covered in the preceding forest succession charts. For complete species reference, check the forest-coded ("F") *Alaska Ecology Card* for "Habitat" information.

Wildlife in the Coastal Rainforest

After **pioneer** plants start making the soil that allows other plants to follow, wildlife will be able to use the area. The plants produce food for **herbivores** such as insects and birds. Coyotes and ermine **(carnivores**) move in to feed on these herbivores.

Detritivores Close the Cycle. The spores of **detritivores** (fungi and microscopic organisms) are blown in by the wind, and these begin the process of decay and mineral recycling. Thus an ecosystem is formed. It is not yet a forest ecosystem, and forest animals could not survive in it, but it is a step toward the establishment of a forest.

In a true old-growth stand of coastal rainforest, spruce and hemlock trees may range in age from seedlings to 750 years old.

TALL SHRUB /YOUNG FOREST – MOOSE MOVE IN

When alder, willow, and cottonwood move in and shade the sun-loving pioneer plants, moose and mountain goats (large herbivores) come to feed as the shrubs grow taller. Bears and wolves (large carnivores) quickly follow. More insects can now survive, and with them come their **predators** (shrews, swallows, and yellow-rumped warblers).

MATURE FOREST – SHADES OUT WILDLIFE

In the **mature forest**, towering Sitka spruce shade everything. Because few plants can survive under the dense spruce canopy, this succession stage provides meager food for herbivores such as deer, voles, and mice.

Food Sources Scarce. When herbivores are less common, carnivores are scarce. Treetop-feeding birds (kinglets, warblers) find habitat in the upper branches of the spruce, but ground-feeding thrushes, sparrows, and grouse move away.

OLD-GROWTH – MOST DIVERSIFIED HABITAT

Sitka spruce can live for 500 to 750 years. As the spruce die, shade-tolerant hemlock saplings become giant trees, and the forest changes to an old-growth, **climax forest**. At this stage, 250 to 600 years after the retreat of a glacier, the forest becomes self-renewing.

Death Leaves Openings. The large, old spruce die and fall, creating openings. Wildlife adapted to life in this old-growth forest often use it for part of the year as a sheltered place to give birth and raise their young.

Snow-Free Sanctuary. In summer, Sitka black-tailed deer feed on the shrubs and herbs in the pockets of early succession forest. In winter, the deer retreat to areas of old-growth where they can find adequate food and shelter from heavy snows. There, the branches of the giant trees trap the snow and keep the ground relatively clear, giving deer easy access to food.

Summer Food, Winter Shelter. Many birds feed and nest in the forest openings in summer. Some of these fly south when fall comes, but non-migrating birds (chickadees, crossbills, siskins, nuthatches, boreal owls, and winter wrens) spend the winter in old-growth forest. The towering trees offer shelter and food (seeds and insects).

Safe Nursery. Biologists working for the Alaska Department of Fish and Game have found that brown bears, river otters, and even mountain goats survive winter by using old-growth forests and return to them for safety while raising their young.

Good Source for Dinner. Mice living in old-growth forests have high birth and survival rates. They in turn are regular menu items for many forest carnivores and **omnivores**. Coastal forests in the climax stage of succession are a safety net for many animals.

Wildlife in the Boreal Forest

For many years, people thought that fire was bad for the boreal forest and its inhabitants. Researchers now recognize that wildlife in this ecosystem thrive on the patchy forest created by fire and succession. Foresters and wildlife managers sometimes deliberately set a controlled fire to lessen the build-up of fuel in the forest and to create a patchwork of habitat for wildlife.

BEFORE THE SMOKE CLEARS

Even before the smoke clears in secondary succession, the first pioneer animals (such as longhorn beetles) zero-in on dying trees. They lay their eggs beneath the bark where their young can hatch and gorge themselves on the **cambium** of the trees.

Nomadic Fire Chasers. Flying in pursuit of the beetles are their main predators, black-backed and three-toed woodpeckers. These birds may be nomadic, traveling from one fire site to the next. At each new site they spend a few years feeding on the beetle larvae that flourish in the scorched trees.

Food Web Rebuilds. Other pioneering birds and mammals return as soon as fireweed (*note the appropriate name!*) and willows take hold. Savannah sparrows perch atop the blackened branches of fallen trees, singing their raspy courtship calls, while caterpillars and aphids gnaw the new greenery. As populations of these herbivores grow larger, their predators can survive.

SHRUB TO YOUNG FOREST – WILDLIFE HAVEN

Five to 30 years after a fire, the site is likely to be alive with wildlife. Moose and snowshoe hares find ideal feeding grounds amid thickets of willows and other favorite shrubs.

Wildlife "Loggers." Many of the standing dead trees have been expertly felled by the combined effort of beetles, woodpeckers, and the fungi whose spores the beetles and woodpeckers carried in on their feet. These fallen trees, along with the rich growth of herbs and shrubs, provide excellent habitat for voles. Foxes, weasels, and marten can then move in to feast.

Predators Come for Prey. Lynx venture into shrub thickets to hunt the numerous snowshoe hares. Juncos, white-crowned, tree, and fox sparrows feed on the seeds of the abundant grasses, flowers, and shrubs.

Air to Ground Activity. While woodpeckers and beetles continue their tandem attack on remaining snags, abandoned woodpecker holes provide nest sites for owls and swallows. The swallows and flycatchers snatch insects as they buzz between flowers and shrubs, while shrews and beetles ravage those that live on and in the ground.

Wildlife Using Boreal Forests

The following lists compare the animals likely to be found in two stages of boreal forest succession.

EARLY PIONEER STAGE

ruffed grouse
savannah sparrow
white-crowned sparrow
snowshoe hare

CLIMAX STAGE

(Many of the above animals may use the climax forest part of the year, especially winter.)

boreal owl
great gray owl
goshawk
spruce grouse
woodpecker
hermit thrush
moose
lynx
red fox
Swainson's thrush
American robin
Townsend's warbler
marten
short-tailed weasel

MATURE TO CLIMAX FOREST

The variety of wildlife continues to increase as the forest moves toward climax. Crossbills, chickadees, spruce grouse, varied thrushes, and ruby-crowned kinglets are among the more numerous birds.

Openings Expand Wildlife Use. As trees die and openings are created, the understory and ground cover plants grow. Vole populations again increase. Marten, weasels, goshawks, and boreal owls then move in to prey on both the small mammals and forest birds. Red squirrels dine on spruce seeds by day. At night flying squirrels glide between the trees in search of fungi feasts. Porcupines like this habitat too.

Patchwork Reduces Travel Time. Wildlife in Alaska's boreal forest are as varied as the patchwork of habits that fires and succession bring. Boreal wildlife seldom need to travel far to find the food, shelter, water, and space they need for that season.

Human Uses and Impacts in Forest Ecosystems

Earlier sections focused on the interrelationships of the nonliving environment, the forest plants, and the forest wildlife (from microscopic organisms to moose). This section introduces the human component in the forest web of life and examines how we use and impact forests.

Elements of Life

Everyday, for bodily survival, we use air and water contributed by forests.

OXYGEN AND RAIN

We breathe the **oxygen** produced by trees and other forest plants during **photosynthesis.** In turn, forests use the **carbon dioxide** that all animals exhale as waste.

Natural Resuscitation. An acre of forest plants restores two to three times more oxygen per day than an acre of meadow or tundra plants. Each of us uses about 360 liters of oxygen daily – one day's production from one tree.

Moisture for Future Rain, Snow. Forests also maintain the global **water cycle** by returning the rain they use to the atmosphere. In a process called **transpiration**, a single tree may pump 80 gallons of water **vapor** into the air on a hot day. Next time you are in a forest, notice how the humidity level is higher than in an adjacent non-forested area.

(*For more information and a handy fact sheet, see INSIGHTS, Section 1, Elements:* "The Giving Forests.")

WATERSHED GUARDIAN

Forests slow and even stop **erosion**. Tree and plant roots secure the soil while leafy branches minimize the impact of even the hardest rain or heaviest snow. Have you ever taken shelter from a downpour by going into a forest?

Good Drinking Water. The streams that start in or run through forests are clear and cool and have a more constant flow. The water table is recharged as forests protect **watersheds**.

Ensuring Fishing Opportunities. Both freshwater and **anadromous** fish use forest streams and lakes for spawning. Their young find the ideal combinations of food and shelter in those waters. Their survival – and our fishing opportunities – depend on the maintenance of those streams.

(*See INSIGHTS, Sections 2 and 4, for other examples of wildlife that depend on forests.*)

Long Tradition of Use

Forest resources have been used since prehistoric times, as they are today.

- We continue to harvest fish, wildlife, and plants from the forest ecosystem.
- We harvest the trees themselves for a full spectrum of our needs from tools and building materials to traditional items for art and ritual.
- We use forests for seasonal recreation and daily scenic and mental enjoyment.

NATIVE ROOTS

Forests are part of the heritage, mythology, and customs of Native Alaskans. Some Native cultures arose from the forests.

Even "Traveling Trees" Important. Cultures from non-forested areas traded for goods and materials from forest-based cultures or migrated seasonally to take advantage of the forests plants, wildlife, and shelter. Even those who always lived on the coastal tundra counted on "traveling forests" – driftwood – to provide materials for living.

Artisans in Wood. Alaska Natives continue their distinctive use of wood in Aleut visors, Tlingit and Haida totems and canoes, Yup'ik driftwood masks, Athabaskan birch-bark baskets, and Inupiat harpoon shafts and drum rims.

Filling Utilitarian Needs. Fish drying racks and other useful objects at summer fish camps are typically made from nearby wood. Driftwood remains an important energy source.

HISTORIC MILESTONES

Forest resources contributed to many of Alaska's historic milestones. Forests fed the growing number of newcomers and kept them from freezing. The first ocean sailing ship built on the west coast of North America used timber from the Russian-American Company shipyard in Resurrection Bay near Seward.

Gold Rush Partner. In Alaska's series of gold rushes, wooden sluices and rocker boxes caught the golden treasure. Miners built their cabins and the towns that sprang up in their wake from the surrounding forests. Local sawmills kept busy.

Snowshoes and Steamboats. Trees, at a rate of two **cords** an hour, fueled the boilers of steamboats that carried passengers and cargo along the Yukon and all the other major rivers. Timber hewn into ties literally supported the railroads over the White Pass, to the Kennecott copper mines, and between Seward and the Interior. Snowshoes, sleds, and the beds of early roads all came from the forest.

Where We Are Today. It is hard to imagine where Alaska would be today if not for its forest resources.

TANGIBLE, INTANGIBLE RESOURCES

Every year more log homes, firewood, and other utility wood products come from our local and regional forests. Some fine woods have been turned into musical instruments and works of art.

Timber Industry. Alaska's large-scale timber industry has exported logs, pulp, and wood chips on the international market. The pulp has been used for paper, **rayon**, **cellophane**, and food fiber. Smaller scale businesses cut and prepare logs for the local market.

Forests for People. People purposely seek Alaskan forests for a variety of reasons. They carry on subsistence traditions, watch birds, fish, hunt, study nature, gather mushrooms and plants, hike, trap, photograph nature, and picnic.

World Looks to Alaska's Forests. As wild areas around the world become more scarce and people are crowded into cities, many people throughout the world are placing a higher **value** on forests. Some consider Alaska's forests particularly valuable because, for the most part, they have not yet been significantly changed by human activities.

Shrinking Forests

Alaska's Copper River Delta in the Chugach National Forest has a unique management directive. Unlike most USDA Forest Service lands where multiple use prevails, the Delta is managed primarily for the conservation of fish and wildlife resources and their habitats.

The world's population today is expanding by 92 million people each year. Globally, we surpassed six billion in 1999. With the exploding population comes an increasing demand for forest goods,

land, and the mineral resources that lie underground.

Forests Fall to Other Land Uses. Once covering two-thirds of our earth's land area, forests now cover less than one-third. About 80 acres of forests are cleared *each minute* in the world to develop farmlands, raise cattle and sheep, and make space for housing, communities, roads, reservoirs, and industries.

The dilemma today and challenge for the future is how to meet increasing human needs while protecting environmental quality.

Managing Our Forest Needs

If forests are to remain healthy for the children of the future, then human uses of forests must be consciously weighed and managed. **Forest managers** study forest ecosystems, consider the sometimes conflicting demands, and recommend how to balance human use with forest health.

Career Opportunities. Forest managers and others in forestry-related careers can be found in a variety of employment situations including industry, government agencies, Native corporations, universities, and conservation organizations. *(See following "Forest Organizations and Careers" fact sheet.)*

We Have a Role. Individual landowners can be small-scale forest managers if trees already grow on their land or if they plant trees. *(See following "Plant a Tree" fact sheet.)*

The "Public" of Public Lands. And all of us have a role in state and national forest management because we are the "public" of public lands.

ALASKA'S OFFICIAL FOREST LAND

Here is a quick summary of Alaska's forests.
Total area of State: 365 million acres
Forested land 120 million acres
Coastal forest 14 million acres
Boreal forest 106 million acres

Public agencies, native corporations, and various private owners manage Alaska's forest land. Only four areas are specifically set aside as "forests."
Haines State Forest 247,000 acres
Tanana Valley State Forest 1.8 million acres
Tongass National Forest 16.9 million acres
Chugach National Forest 5.9 million acres

And even those areas are not 100% forest. The Tongass, for example, includes 6.9 million acres of non-forested land: tundra, glaciers, rocks, and water. *(See following chart for details.)*

TWO STATE FORESTS

Alaska's two state forests represent about 2% of state-owned land. They were designated in 1982 (Haines) and 1983 (Tanana Valley) to perpetuate "personal, commercial, and other beneficial uses of resources through **multiple use** management."

Sustained Yield of Many Resources. The Alaska Department of Natural Resources manages the state forests for sustained yield of many resources: fish and wildlife habitat, clean water, opportunities for recreation and tourism, mining, and timber harvest.

Agency and Citizens Together. For each state forest, the Department's Division of Forestry prepares an inventory and plan to guide management, including allowable cut for timber harvests. Citizens' advisory committees help to oversee management and revise the plans. The Haines State Forest coordinates its plan with that of the adjacent Alaska Chilkat Bald Eagle Preserve.

Harvesting on Other State Land. In addition to state forests, much of the other state-owned land is available for multiple use, including timber sales.

TWO NATIONAL FORESTS

The USDA Forest Service manages much of Alaska's coastal rainforests and their productive old-growth forests *(defined as containing at least 8,000 board feet per acre of trees that are at least 150 years old).*

The Tongass National Forest in Southeast and Chugach National Forest in Southcentral are the two largest national forests in the United States.

Reducing Wildfire Risk. In the Chugach National Forest, few areas are harvested. Instead the timber is managed to reduce possible fuels for wild fires or other health risks.

Tongass Harvest History. Large scale logging on the Tongass began in the 1950s after the forest managers created two 50-year timber sale contracts. Pulp mills in Ketchikan and Sitka began operation, selling their product to Asian markets. In the 1990s those pulp mills closed.

Diversifying for Local Businesses. Foresters are designing many timber sales so they can be sold to small, local enterprises. The Southeast timber industry is diversifying to take advantage of markets for specialty wood products.

Multiple Uses. Fish and wildlife habitat, subsistence, watershed protection, mining, recreation, and wild spaces are some of the other multiple use demands met on Alaska's national forests.

Duties As Assigned. Foresters inventory and map the forests. They make sure forests regenerate naturally (90% do) or are replanted after harvesting or natural disturbance. Forest Service employees work in partnership with the state on forest health problems such as spruce bark beetle infestation. They also work with a team of agencies on fire fighting and prevention.

ALASKA FOREST RESOURCES & PRACTICES ACT

The Alaska Forest Resources and Practices Act governs how timber harvesting, reforestation, and timber access occur on state, private, and municipal land. The Act protects fish habitat and water quality and ensures prompt reforestation. Forest management standards on federal land must meet or exceed these state standards.

1. Landowners must notify the state prior to timber operations.
2. The state establishes standards for forest management along water bodies, including buffers beside fish streams and prevention of erosion.
3. Reforestation is required except on land where the harvest is dead or dying trees.

Forest Constituents – many voices

Just how forests should be used, conserved, and managed is defined differently by different groups:

- Logging company executives may describe forest management as the science of ensuring that the forest continually provides timber harvest opportunities.
- Hunters may say it is the science of making the forest suitable for the animals they harvest.
- Hikers might define forest management as the science of preserving forests in their most natural state.
- Landscape architects might consider it the art of shaping the forest to frame scenic vistas.
- Poets or philosophers may suggest that forest management is providing a sanctuary for the human spirit.

Long-Term Consequences

Forest managers must consider many factors including forest health when deciding how competing resource demands can be met. Our northern climate makes their job even more challenging.

Alaska's forests require 200 to 600 years to reach climax or old-growth, the maximum stage in forest **succession** *(see INSIGHTS, Section 4)*. Once logged, our forests need 200 to 300 years to return to old- growth. That means forest management decisions of today will affect future users not yet born.

Ever since earliest time, humans have used trees for shelter, weapons, heat, utensils, toys, transportation, building material, and art. Wood is valuable because it has so many uses and because it is an organic, ***renewable resource***.

Forests Shrink as Population Expands. As our human population increases, our demand for wood and wood products grows. Are the forests expanding at the same rate as our population, or are they shrinking?

Recycling to Conserve Forests. People are searching for substitutes for wood to ease the pressure on forests. Some wood products – paper and cardboard – can be **recycled**.

Searching for Substitutes. Plastics and other petroleum-based products can be used as some substitutes. Although petroleum is a non-renewable resource, the good news is that some plastics are recyclable – milk jugs, for example, can make indestructible boards for wet environments.

How to Achieve Balance? We need trees in forest ecosystems and for wood products. Our challenge is to achieve a balance.

Alaska Trees – Wood Products

BIRCH

- Bowls
- Cabinets
- Matchsticks
- Tongue depressors
- Dowels
- OSB *(particle)* Board
- Flooring
- Veneer
- Toothpicks
- Golf tees
- Pulp
- Firewood

COTTONWOOD/POPLAR

- Cabinets
- Pulp
- Old-fashioned fruit baskets
- Bridges
- Pallets
- Veneer

SPRUCE

- Pulp
- Railroad ties *(when treated)*
- Bridges *(when treated)*
- Musical instruments *(Sitka spruce mostly)*
- Scaffolding
- Fish containers
- Lumber
- Bowls
- House logs
- Airplanes
- Canoe paddles
- Boats
- Firewood

WESTERN HEMLOCK

- Pulp
- Lumber
- Cabinets
- Furniture
- Poles
- Veneer
- Railroad ties
- Flooring
- Broom handles

ALASKA YELLOW CEDAR

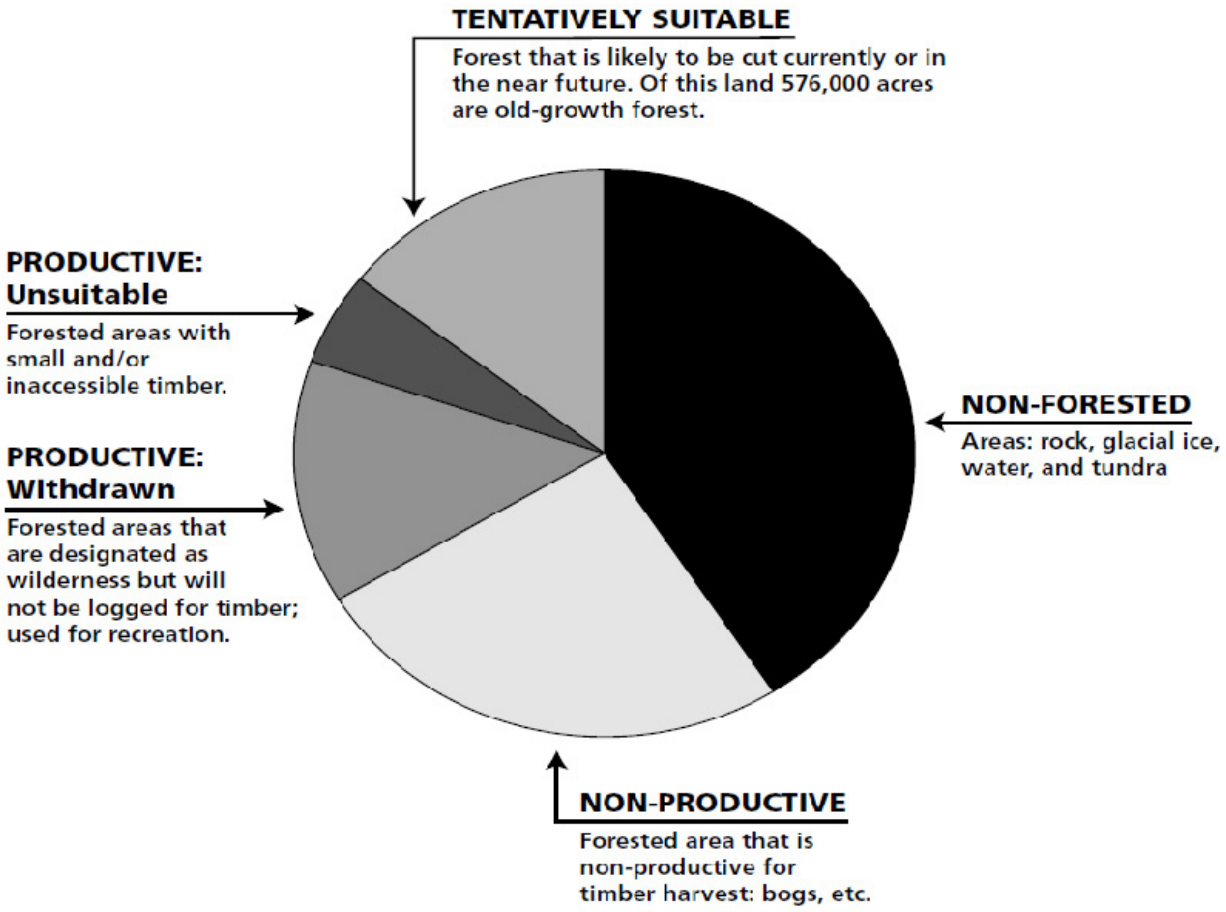
- House construction
- Decking
- Poles
- Boats
- Cabinets
- Trail planks
- Bridges
- Furniture

WESTERN RED CEDAR

- Chests
- Basket weaving
- Fence posts
- Lining for inside clothes closets
- Canoes
- Shingles

Tongass National Forest Is Huge!

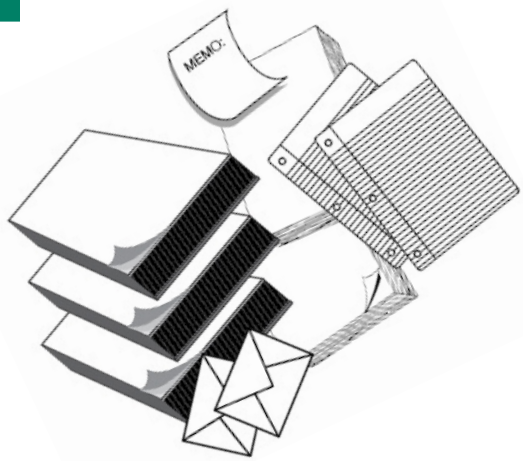
16.88 million acres of land in all.
Here's how the Tongass breaks down, in terms of timber harvest.



*Values are in million of acres

HOW MUCH PAPER DO WE USE?

Americans use more paper than people in any other country, more than 50 million tons yearly. We use about 25 million tons of printing paper, 14 million tons of newsprint, 6 million tons of tissue products, and 5 million tons of packaging.



Anchorage. In 1997, the city of Anchorage collected 87,000 tons of wood and paper product waste of which only 9,800 tons was recycled. The remaining 77,200 ended up in landfills.

Alaskans Toss More Than Others. Americans throw away an average of 3.5 pounds of materials per person each day. Each Alaskan on average throws away even more – 6 pounds daily. More than half of the total waste is paper: cardboard makes up 7% of the total; newspaper, 14%; and other paper, 31%. Paper takes up as much as 50% of all our landfill space.

Paper Recycling Savings. If we recycled our newspapers, ***each of us*** would save about 4.6 average-sized trees yearly. Paper can be recycled about five times before the fibers weaken. When one ton of newsprint is recycled, •3 cubic meters of landfill space are saved, •13 to 17 trees are spared, •7,000 gallons of water are saved, and •380 gallons of oil are not used.

Reduce, Reuse, Recycle. We will save money and resources if we **reduce** our paper consumption, **reuse** what we do use several times, and then **recycle** it.

Local Recycling Center. The Anchorage Recycling Center collects recyclable materials from throughout Alaska. In 1997 the Center shipped 18,000 tons of recyclables (including paper) to out-of-state markets. Groups are urging local industries to find ways to use our paper in recycled products.

Local Industries Reuse. Some paper is recycled here in Alaska. For example, Thermo-Kool Alaska buys about 2,500 tons yearly to use in insulation, animal bedding, and hydroseed mulch.

Shipping to Outside Markets. Most of the office grade paper *(which would include most of the paper used at school)* has to be shipped to Washington or Oregon. Other papers, like magazines and phone books, are sent to other countries of the Pacific Rim for recycling.

Rural Alaska – Prevent Waste. In rural Alaska, recyclers emphasize prevention of paper waste. Shipping costs are too high to find a market. RurAL CAP and the Alaska Intertribal Council are encouraging recycling in rural communities with help from AmeriCorps volunteers.

Ways to avoid paper waste include the following.

- Shop consciously: buy the product that comes with the least amount of packaging.
- Use the back side of writing paper and junk mail.
- Think "reuse" by asking: now what can I make with this box to use it again?

Arbor Day in Alaska

Arbor Day occurs on the third Monday in May. Students can join in planting trees and celebrating Arbor Day with the help of the following organizations:

Alaska Division of Forestry
http://forestry.alaska.gov
The Urban and Community Forest Council
550 W. 7th Avenue
Anchorage, Alaska 99501
(907) 269-8465
Offers tree planting grants to communities.
Coordinates poster contest for 5th grade students.

USDA Forest Service, Alaska Region
www.fs.fed.us/regions/alaska
Public Affairs Office
P.O. Box 21628
Juneau, Alaska 99802-1628
(907) 586-8806
Offers information about public and private support or tree planting.

National Arbor Day Foundation
www.arborday.org

Alaska Cooperative Extension Service
www.uaf.edu/coop-ext/
(various offices statewide)
Main Office:
Cooperative Extension Service
2221 E. Northern Lights Blvd., Suite 118
Anchorage, Alaska 99508
(907) 279-6575
Offers information, brochures and activity suggestions for celebrating Arbor Day.

1. Keep roots moist at all times. Dry roots die.

2. Dig a hole large enough to spread the roots apart. Place the tree in the hole at the proper depth. Add loose soil.

3. Add more soil and firm with foot.

4. Gently mulch with wood chips.

5. Water regularly.

Forest-related Organizations and Careers

Forest science used to be relatively simple: Identify the most economically valuable tree species, assess the best timber harvest methods, and find ways to control insects.

Now forest science encompasses the forest ecosystem, fisheries and wildlife biology, soil conservation, medical research, recreation planning, and climate studies – just to name a few. We no longer manage and study forests by focusing on timber alone.

A. *USDA Forest Service* (forest planning and management, wildlife biology, **silviculture**, hydrology, ecology, geology, forest recreation, fire management and control, plant **pathology**, **entomology**, international forestry aid, personnel, budgeting) <www.fs.fed.us> and <www.fs.fed.us/alaska.

B. *Bureau of Land Management* (land-use planning, wildlife biology, ecology, plant pathology, entomology, personnel, fire management and control) https:www.blm.gov/alaska

C. *National Park Service* (park planning and management, wildlife biology, fire management, law enforcement, recreation, education) <www.nps.gov/state/ak

D. *Alaska Department of Natural Resources* (land-use planning, forest management, fire management and control) <www.dnr.. alaska.gov

E. *Alaska Department of Fish and Game* (research and management of forest wildlife) <www.adfg.alaska.gov

F. *Native groups* (forest management, land-use planning, environmental education, forest or natural resource law, **lobbying**) Contact the Alaska Native Knowledge Network's regional coordinators <www.ankn.uaf.edu>

G. *U.S. Geological Survey* (study of forests as watersheds, research, soil science) <www.usgs.gov>

H. *University of Alaska* or other universities — (research and teaching in forest ecology and management, **horticulture**, plant pathology, entomology, land-use planning; Institute of Northern Forestry) <www.uaf.edu/coop-ext/forestry/>

I. *USDA Forest Service Forest Products Laboratory* (wood products research, chemistry, laboratory technology, statistics, library, computer technology) <www.fpl.fs.fed.us>

J. *The Alaska Forestry Association* (represents the forest products industry) <www.akforest.org>

K. *Timber harvesting companies* (planning, budgeting, forest engineering, surveying, logging operations, truck driving, forest or natural resource law, lobbying) *(refer to Alaska Forestry Association for contacts at above web address)*

L. *Lumber mill* (mill work, mechanical operations and maintenance, management, accounting, forest or natural resource law, lobbying) *(refer to Alaska Forestry Association for contacts at above web address)*

M. *Lumber store* (sales, stock handling, transportation, managers, accountants)

N. *Greenhouses and landscaping companies* (tree and shrub **horticulture**)

O. *Conservation organizations* (These groups use people with careers in biology, ecology, forestry, lobbying, natural resource law, forest conservation, resource education, natural interpretation, marketing and fund-raising) Examples include:

Alaska Outdoor Council and the *Alaska Fish and Wildlife Conservation Fund* <www2.polarnet.com/users/outdoor>
Alaska Trappers Association <http://paulbunyan.net/users/trappers/ata.html>
National Audubon Society <www.audubon.org>
National Wildlife Federation <www.nwf.org>
The Nature Conservancy www.tnc.org

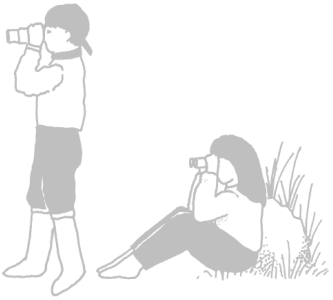
P. *Tourist guiding companies* ("ecotourism" guides may be knowledgeable about forests, forest recreation) Alaska Wilderness Recreation and Tourism Association www.travelalaska.com

Q. *Occupational Handbook*
<http://stats.bls.gov/ooh describes all occupations.

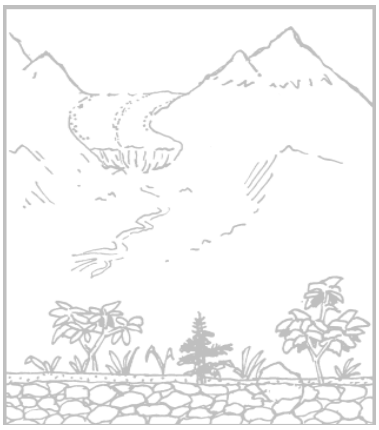
FOREST ACTIVITIES

Section 1
ELEMENTS THAT CREATE FORESTS

Section 2
FOREST ECOSYSTEMS



Section 3
FOREST LEARNING TRAIL



Section 4
SUCCESSION

Section 5
HUMAN USES AND IMPACTS

Breath of Life

Section 1
FOREST ACTIVITIES

Grade Level: K - 12

State Standards: S A-14, S B-1, Geo E-5
NGSS: K-LS1-1, 5-LS1-1, MS-LS1-6., -LS2-5
Subjects: Science, language arts

Skills: Observing, notetaking, applying, analyzing, writing

Duration: 60 minutes and periodic observation

Group Size: 2-4

Setting: Indoors

Vocabulary: Carbon dioxide, oxygen, photosynthesis, recycle

Objectives:
Students will observe the role of plants in releasing oxygen.

Teaching Strategy:
Students conduct experiments to determine the rolel plants play in the web of life.

Complementary Activities:
OUTDOOR: "Forests and Air" *in this section;* "Forests and Sunlight" *and* "Forests and Soils," *both in Section 4, Succession, compare forested and non-forested sites. INDOOR:* "Rain-Making Partners" *in this section.* "Watershed Guardians" *in Section 5, Human Uses and Impacts.*

Materials:
2 medium-sized jars with tight lids, fruit flies or other insects, 1 plant small enough to fit into the jars, 2 pieces of fruit.

Background:
See INSIGHTS, *Section 1, Elements that Create Forests: "The Giving Forests."*

Natural History Tips:
In 1772, scientist Joseph Priestly conducted experiments on air quality. He found that a mouse died if placed in a covered jar by itself, but could live if placed in a jar with a plant. Priestly's discovery eventually led to an understanding that plants remove **carbon dioxide** from the air and return **oxygen**.

Procedure:
1. Students keep a daily log of the experiment. Each page should include the date, the subject, a drawing of it, and two or three sentences describing changes.

2. Students place a piece of fruit in each of two jars. Place the small live plant in one jar. Then, release several fruit flies in each jar and close the lids tightly.

3. Ask the students to predict what they believe will happen over the next several days. Students should record their observations in their journals.

The number of flies in each jar will initially increase if they reproduce. Then, the number of flies in the jar with no plant will decrease as they run out of oxygen. (Fruit flies are short-

lived, so some of those in the jar with the plant will die. As long as they have food, however, they will continue to reproduce, so live ones should remain.)

4. Students compare their experiments to the world around them. (a) Why did the fruit flies in the jar with no plant die even though they had plenty of food? (b) Compare the earth's atmosphere to the air in the jar. (c) Why do astronauts have to wear space suits? (d)What would happen to us if all the forests and plants ceased to exist?

Evaluation:

1. Pairs or groups of students write an analysis of the experiment and the question discussions.

2. Students compare their experiment to real forest issues such as reforestation of beetle-killed or logged forest land. Students present their experiment and their comparisons to another class.

3. Students design other experiments to demonstrate the possible complications of deforestation.

Credits:

Adapted from American Forest Foundation, "Nature's Air Conditioners," *Project Learning Tree Supplementary Activity Guide for Grades 7-12*. 1987.

Curriculum Connections:

(See appendix for full citations)

Books:

Be a Friend to a Tree (Lauber) K-3

Focus on Trees (Ganeri)

How Leaves Change (Johnson)

Photosynthesis (Silverstein)

Science Project Ideas About Trees (Gardner)

Shrinking Forests (Tesar) 7-12

A Tree is Growing (Dorros)

Media:

Trees (Eyewitness Video)

Website:

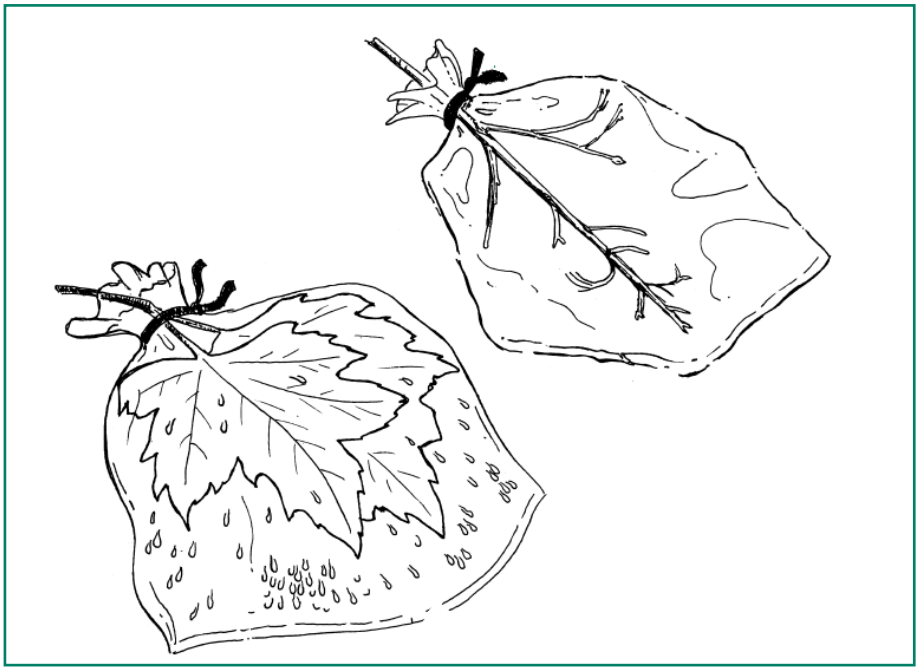
Alaska Science Forum
<www.gi.alaska.edu/ScienceForum>

Teacher Resources:

(See appendix)

Forests help to maintain the balance of oxygen and carbon dioxide in our atmosphere, keeping the air breathable for all living things.

Rain-Making Partners



Section 1
FOREST ACTIVITIES

Grade Level: K - 12

State Standards: S A-14, S B-1, Geo E-5
NGSS: 2-ESS2-3.,5-LS1-1,5-LS2-1 5-ESS2-1, MS-LS1-6, MS-ESS2-4 HS-LS2-5

Subjects: Science, language arts

Skills: Observing, note-taking, applying, analyzing, writing

Duration: 60 minutes and periodic observation

Group Size: 2-3

Setting: Indoors

Vocabulary: Recycle, transpiration, water cycle

Objectives:
Students will learn the role plants play in the water cycle.

Teaching Strategy:
Students will conduct an experiment to demonstrate the process of transpiration.

Complementary Activities:
Any water cycle discussion. *OUTDOOR:* "Forests and Air" *in this section;* "Forests and Sunlight" *and* "Forests and Soils," *both in Section 4, Succession, comparing forested and non-forested sites. INDOOR:* "Breath of Life" *in this section.* "Watershed Guardians" *in Section 5, Human Uses and Impacts.*

Materials:
For every 2-3 students: 2 plastic bags, a live plant with leaves and branches, a branch from a dead plant, rubber bands or twist-ties.

Background:
See INSIGHTS, *Section 1, Elements that Create Forests: "The Giving Forests."*

Procedure:
1. Students keep a daily log of the experiment. Each page should include the date, the subject, a drawing of it, and/or 2 to 3 sentences describing changes.

2. Each group puts a plastic bag around one branch of a live plant (recently watered), and another bag over the dead branch. Seal the bags around the branches using rubber bands or twist-ties. Place both the live plant and the dead branch in the sun.

3. Ask students to predict what they believe will happen over the next several days. As students record their observations, *they should note that water will appear inside the bag on the branch of the living plant, but none will appear inside the bag on the dead branch.*

4. Students compare their experiments to the world around them. If the single branch of the live plant put water droplets into the air, imagine the 80 gallons per day that a tree **transpires** into the air! How much water might a large forest **recycle** into the air? What happens to the water that forests recycle into the air? What would happen if all the forests were lost? How would that affect the **water cycle**?

Evaluation:

1. Depending on grade, pairs or groups of students write an analysis of the experiment and the question discussions.

2. Students compare their experiment to real forest issues such as reforestation of beetle-killed or logged forest land. Students present their experiment and their comparisons to another class.

3. Students design other experiments to demonstrate the possible complications of deforestation.

Credits:

Adapted from American Forest Foundation, "Snow Use," and "Nature's Air Conditioners," *Project Learning Tree Supplementary Activity Guide for Grades 7-12*. 1987.

Curriculum Connections:

(See appendix for full citations)

Books:

Be a Friend to a Tree (Lauber) K-3

How Leaves Change (Johnson)

A Tree is Growing (Dorros)

Water Up, Water Down (Walker)

Water, Water Everywhere: A Book About the Water Cycle (Berger) K-3

Website:

Https://www.gi.alaska.edu/AlaskaScienceForum/administration

Teacher Resources:

(See appendix)

Forests & Air

Section 1
FOREST ACTIVITIES

Grade: K-12
State Standards:
S B-1, S B-5, S C-2
NGSS: 5-LS1-1,5-LS2-1, 5-ESS3-1,-ESS2-1.,MS-LS1-6, MS-ESS2-4, HS-LS2-5

Subjects: Science, social studies

Skills: Observing, measuring, predicting, comparing, contrasting, inferring
Duration: 2 days, 30 minutes classroom, 60 minutes outdoors each day
Group Size: 2
Setting: Outdoors/indoors
Vocabulary: Broadleaf, carbon dioxide, conifer, ground cover, hypothesize, oxygen, shrub, transpiration

Objectives:
Students will conduct an identical set of air quality and moisture experiments and compare the results to learn how forests effect air quality.

Teaching Strategy:
Students conduct identical experiments in two different ecosystems, compare results and draw conclusions.

Complementary Activities:
OUTDOOR: "Forests and Sunlight" *and* "Forests and Soils," *both in Section 4,* Succession, *compare forested and non-forested sites. INDOOR:* "Breath of Life" *and* "Rain-Making Partners," *both in this section.*

Materials:
Small plastic bags, rubber bands, petroleum jelly, index cards, string, pinwheels or wind gauges, and hand lenses for each site. Clipboards and writing paper or field note books, pencils or pens for each student. "Science Cards" for both forested and non-forested sites *(following pages).*

Background:
See INSIGHTS *Section 1, Elements that Create Forests.*

Procedure:
IN ADVANCE, locate two sites for taking measurements, one forested and one non-forested.

DAY ONE

1. Brainstorm potential differences between forested and non-forested sites. Lead the discussion to the differences in wind, dust, and water vapor.

2. Introduce the experiment by asking for ideas on how to measure the differences.

3. Introduce the tools that will be used: wind gauge, petroleum-jelly-smeared cards, and plastic bags. Explain that the students will use these to conduct identical experiments at forested and non-forested sites.

4. Introduce the Science Cards.

5. Have students prepare their observation notebooks by writing the heading "Forests and the Air" across the top of a page. Tell them to draw a line down the center of the page, and put the heading "Forested Site" at the top of the left side and "Non-Forested Site" at the top of the right side.

6. Go OUTDOORS. Each team will set up their experiments at the sites and take initial wind measurements.

7. ***At the forested site***, each team places plastic bags around leafy branches of a **conifer**, a **broadleaf**, and a dead stick. Tightly seal each bag around each branch with a rubber band. *This experiment will work well only if the ground is thawed.*

8. Each team ties an index card to a branch of a tree or shrub, and then spread petroleum jelly over it. This will trap dust in the air.

9. Using the pinwheels or a wind gauge, measure the wind at the site. Students record in their notebooks *(under the appropriate column)* whether they observe any wind at this site and whether the wind caused the gauge or pinwheel to turn: (1) not at all, (2) very slowly, (3) slowly, (4) fairly quickly, or (5) very quickly.

10. ***At the non-forested site***, each team places plastic bags around a leafy branch of a **shrub**, **ground cover** such as grasses, and a dead stick. Tightly seal each bag around each branch with a rubber band. *This experiment will work well only if the ground is thawed.*

11. Each team ties an index card to a branch of a shrub, and then spread petroleum jelly over it. This will trap dust in the air.

12. Using the pinwheels or a wind gauge, measure the wind at the site. Ask students to record in their notebooks *(under the appropriate column)* whether they observe any wind at this site and whether the wind caused the gauge or pinwheel to turn: (1) not at all, (2) very slowly, (3) slowly, (4) fairly quickly, or (5) very quickly.

DAY TWO

Go OUTDOORS. Using the Science Cards as format, students observe, collect, and record data from both sites.

Classroom Follow-Up:

Compare the two sites. Discussion questions include:
(a) Did one site have stronger wind? Which one? Why do students think there was a difference? If students did not observe a difference, do they think they would have found a difference on a windy day? Which do students **hypothesize** would be more windy? Why do they hypothesize this?

(b) Which site had the least dust? Why do students think this difference occurred? Did the leaves of conifers or broadleafs trap dust? How might this affect the air quality?

(c) Based on the bags sealed on branches, did students conclude that the plants were putting moisture into the air (**transpiration**)? *If they did, their answer is correct. A tree may pump 80 gallons of water into the air in a single day.* Which of the two sites do they think is most likely to have moist air?

Students should find less wind and less dust in the forested site, and predict the forested site would have the most moisture in the air. Students should conclude that forests break the wind, remove dust from the air, and add moisture. They should remember that trees and other plants, and therefore forests, add ***oxygen*** *and remove* ***carbon dioxide*** *from the air.*

Evaluation:

Based on their observations, students name three ways that forests affect the air. *(Hint: remember* ***photosynthesis****)*

Curriculum Connections:

(See appendix for full citations)

Books:

America's Forests (Staub)

Biomes of the World (v.1) (Allaby) 7-12

Forests and Woodlands (Pipes) K-6

Taiga (Kaplan)

Taiga (Sayre)

U-X-L Encyclopedia of Biomes (v.3) (Wigel) 7-12

Website:

Alaska Science Forum
<www.gi.alaska.edu/AlaskaScienceForum>

Teacher Resources:

(See appendix)

SCIENCE CARD

Forests & Air: Forested Site

1. Record the data under the column "Forested Site" on the page "Forests and the Air."

2. Measure the wind on this day also. Hold the pinwheel or wind gauge over your head and slowly turn around. If there is any wind, the gauge or wheel will turn. Record whether you observe any wind at this site and whether the wind caused the gauge or pinwheel to turn: (1) not at all, (2) very slowly, (3) slowly, (4) fairly quickly, or (5) very quickly.

3. The card tied on the tree is a trap for dust in the air. Use a hand lens to look at it closely. Record the amount of dust it has collected: (1) none, (2) a few specks, (3) 10-20 specks, (4) 20- 50 specks, (5) over 50 specks.

4. Look at a branch of a conifer tree using a hand lens. Record the number of dust specks on it using the same scale as above.

5. Look at the leaf of a broadleaf tree for dust specks. Record the number of dust specks on the leaf using the same scale.

6. The plastic bags that are tied around the branches of a conifer, a broadleaf, and a dead branch were all dry when tied to these trees. Record which, if any, bags now contain water. How do you think this water got into the bag?

SCIENCE CARD

Forests & Air: Non-Forested Site

1. Record the data under the column "Non-Forested Site" on the page "Forests and the Air."

2. Measure the wind on this day also. Hold the pinwheel or wind gauge over your head and slowly turn around. If there is any wind, the gauge or wheel will turn. Record whether you observe any wind at this site and whether the wind caused the gauge or pinwheel to turn: (1) not at all, (2) very slowly, (3) slowly, (4) fairly quickly, or (5) very quickly.

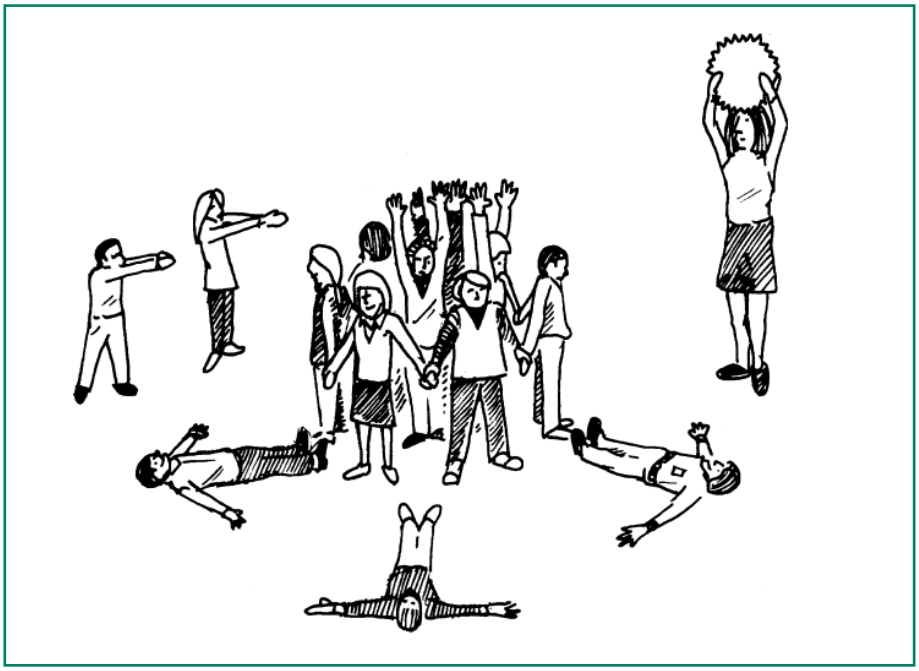
3. The card tied on the tree is a trap for dust in the air. Use a hand lens to look at it closely. Record the amount of dust it has collected: (1) none, (2) a few specks, (3) 10-20 specks, (4) 20- 50 specks, (5) over 50 specks.

4. Look at a branch of a shrub using a hand lens. Record the number of dust specks on it using the same scale as above.

5. Look at the leaf of a shrub or grass blades for dust specks. Record the number of dust specks using the same scale.

6. The plastic bags that are tied around a shrub branch, ground cover plant, and a dead stick were all dry when tied. Record which, if any, bags now contain water. How do you think this water got into the bag?

Role-Play a Tree



Section 1
FOREST ACTIVITIES

Grade Level: K - 4

Subject: Science

NGSS: 4-LS1-1.

Skills: Role-playing, modeling, applying

Duration: 30-90 minutes

Group Size: 17 or more

Setting: Outdoors or indoors

Vocabulary: Bark, beetles, branches, cambium, heartwood, leaves, phloem, photosynthesis, roots, sapwood, tree, trunk, xylem

Objectives:
Students will identify and describe the parts of a tree.

Teaching Strategy:
Students role-play parts of a tree and pantomime the functions of the various parts.

Complementary Activity:
OUTDOOR or INDOOR: "Trees to Imagine" *in this section.*

Materials:
OPTIONAL: large ball or circle of paper painted yellow to represent the sun; twigs and elastic headbands to represent beetle antennae.

Background:
See INSIGHTS *Section 1, Elements that Create Forests,* "Tree Basics" *and* "Inner Workings –Tree Trunks" *Fact Sheets.*

Procedure:
1. Introduce the background of the activity. Draw a diagram of the **tree** on the board and name the parts.

2. Depending on group size, pick 1-3 strong, tall students to be the **heartwood**. These students stand at the center of the space allotted with their backs to each other. *Explain to the class that these students make the tree tall and strong, and that it is their job to hold up the **branches** and **trunk** so the leaves get lots of sunshine. Although the heartwood used to carry water and food, its tubes are now dead.*

3. Choose at least four students to be the **roots**. Some should have long hair to represent the millions of hairs at the end of each root. These students lie down with their feet next to the heartwood, their bodies pointing away from the center, and their hair spread out from their heads.

Explain to the class that Alaska trees have strong roots not very far underground which stretch out from the trunk sideways and help the tree drink water quickly, even in areas that are dry in summer. Roots also help the tree absorb oxygen; too much soil on top of the roots suffocates the tree. Roots serve as an anchor, keeping the tree solidly on the ground even in windy places.

Tell the roots to imagine themselves holding the tree to the ground and taking in water and oxygen. Then have all the roots perform their job: taking in water and oxygen.

When you give the signal, "Let's slurp," all the roots suck in "water."

4. Pick several students to be the **sapwood**, or **xylem**. Select enough children to make a circle all the way around the heartwood. These students stand facing the heartwood and hold hands *(and do not step on any of the roots!)*. Their job is to take water from the roots all the way up to the tips of the branches. *Acting as an efficient pump, the xylem carries many gallons of water every day from the roots to the leaves.* When the leader gives the signal, "Carry the water up," the sapwood takes the water from the roots by raising their hands high in the air and saying "Wheeeeee!"

5. Choose several more students to be the **cambium/ phloem** layer, forming a circle outside the xylem. They stand facing in, or alternating in and out, not holding hands. *Tell the students that the functions of the cambium/ phloem are the growing layer of the tree and taking food made by* ***photosynthesis*** *in the* ***leaves*** *down to all parts of the tree.*

These students pretend their hands are leaves, stretch their hands toward the sun, and make food by wiggling their fingers and hands. Tell the group that their *first* signal is "Let's make food" – students raise their hands and move their "leaves" to take in light energy from the sun and make food. After the leaves make food, the leader gives a *second* signal to "Bring the food down" – students drop the top of their bodies toward the ground and say "Whoooo."

6. After all the students know their signals and their roles, they practice living like a tree. Give the signals: "Let's slurp!" "Let's make food!" "Carry the water up!" "Bring the food down!"

7. Designate 1 or 2 students to wait on the side. Whisper to them that they will become the attacking **beetles** in the next step, and they should go "behind a shrub" and wait.

8. All remaining students should then take the role of the **bark**. These students form a circle around the other parts of the tree and face out. Ask the students to protect the tree. Show the bark a football-blocking stance to use for protecting the tree. Ask students if they hear a distant *whine*, and tell them it is a spruce bark beetle about to attack the tree.

9. Students waiting "behind a shrub" form their fingers into a "drill." They return to the tree as *spruce bark beetles, which drill through the bark to lay eggs in the cambium layer. There the eggs hatch, and the larvae eat tunnels for a year before emerging as adults.*

10. Student beetles circle the tree, attempting to break through the bark's defenses. The bark should try to protect the inner part of the tree.

11. While the beetles circle the tree, the teacher calls out the commands so that the tree people act the parts of the tree. Review the parts of the tree the first time by calling the name of the part and the action signal. Eventually, just give the signals.

VARIATIONS:
A. Have a golden "sun" signal food making instead of the commands. Use a paper cutout or a big ball spray-painted yellow. Walk around the tree raising or lowering the sun over your head. When raised, the sun triggers photosynthesis, and the "tree" wiggles its leaves. When the sun is lowered, the tree doesn't make food.

B. Use twigs to represent antennae on the spruce bark beetle. Hold twigs in place with an elastic headband.

Evaluation:

Students build a tree using these materials: straws, sponges, tiles, sticks, small pieces of green paper, glue, tape, scissors and clay (for a stand).

Credit:

Adapted from Joseph Cornell, "Build a Tree," *Sharing the Joy of Nature: Nature Activities for All Age*s, 1989.

Curriculum Connections:
(See appendix for full citations)

Books:
Bark (Chambers)

Big Tree (Hiscock)

Outside and Inside Trees (Markle)

The Tree (Jeunesse)

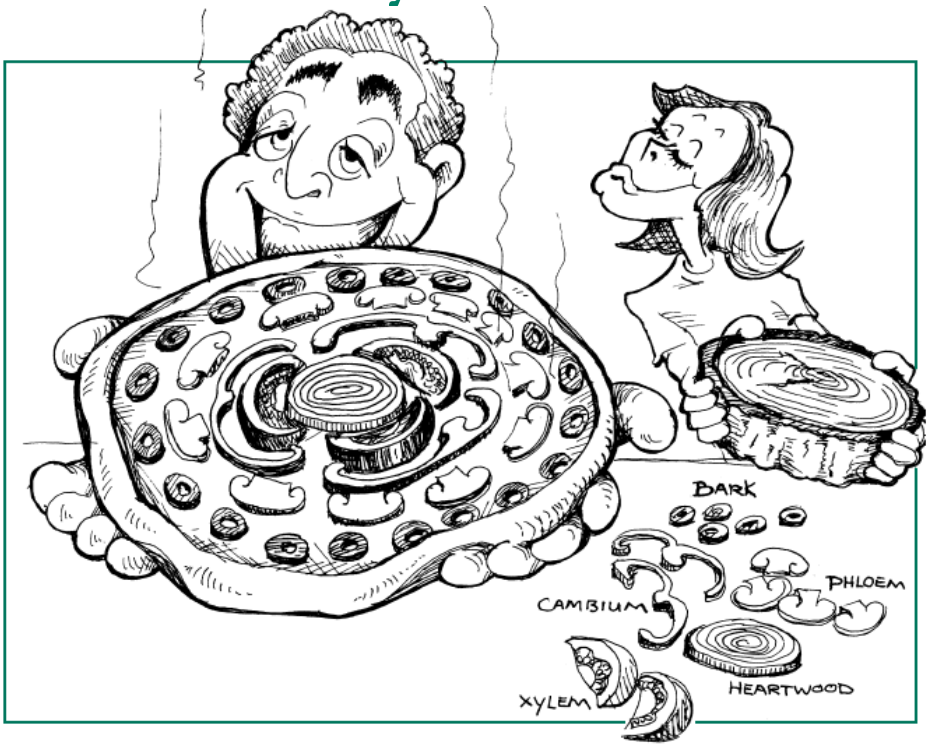
A Tree is Growing (Dorros)

Trees (Eyewitness Explorer) (Gamlin)

Media:
Dirt Made My Lunch (Audio Tape or CD) (Banana Slug String Band)

Teacher Resources:
(See appendix)

Build a Tasty Tree Trunk



Section 1
FOREST ACTIVITIES

Grade Level: 5 - 12

Subject: Science

NGSS: 4-LS1-1.,HS-LS1-1

Skills: Analyzing, comparing

Duration: 2 class periods

Group Size: Groups of 8

Setting: Indoors

Vocabulary: Bark, cambium, consumers, cross-section, crown, heartwood, meristematic tissue, parenchyma cells, phloem, producers, roots, trunk, xylem

Objectives:
Students will identify and describe the parts and functions of a tree trunk.

Teaching Strategy:
Students create edible tree trunk cross-sections and compare them to real tree trunks.

Complementary Activities:
OUTDOOR: "Tree Trunks;" *INDOOR:* "Make a Tasty Leaf," *both in this section.*

Materials:
Copies of "Trees" worksheet *(following pages)*. For every eight students: pizza pan, pizza dough or ready-made crust, tomato sauce, mozzarella cheese, paring knives, oven, pizza cutter, plates. Vegetables such as onions, zucchini, broccoli or asparagus stems, corn kernels, peas, carrots, cooked potatoes.

Background:
See INSIGHTS *Section 1, Elements that Create Forests,* "Inner Workings – Tree Trunks" *Fact Sheet.*

Procedure:
DAY ONE:

1. Draw a diagram of the tree trunk on the board. Review its main parts with the class. Complete the "Trees" worksheet.

2. Describe the activity. Explain that each group of eight students will assemble an edible tree trunk cross- section. List the tree trunk parts once again – bark, phloem, cambium, xylem, heartwood – and ask each group to brainstorm a vegetable that might represent that part on a pizza. Remind them to consider the role each part plays in the function of the tree.

3. If the students are stumped (pun intended), you might suggest: **bark** – mushrooms, onions, artichoke leaves; **phloem** – zucchini, celery; cambium: corn kernels, peas; **xylem** – broccoli stems, asparagus stems; **heartwood** – carrot slices, cooked potato slices.

4. Each group will bring in vegetables ready to put on a pizza, or have a shopping committee purchase the ingredients. Ask for pizza pan, dough, cheese, and sauce contributions.

DAY TWO:
1. Prepare the pizza base with dough (the **"soil**") on the bottom, tomato sauce **(water**) next, and then a layer of grated cheese **(minerals**). These are all needed for the tree to exist. Assemble the cross-sections with the vegetables.

2. Bake each pizza 10-12 minutes at 450ºF or as recommended for that particular dough.

3. Eat and enjoy.

4. During or immediately after the feast, discuss the concept that plants are the **producers** of food not only for themselves, but for most of the animal world. We are **consumers**. What other creatures are consumers?

VARIATION
Instead of a tree pizza, make tree trunk cross-sections with non-edible objects, Each student can work individually to create a cross-section suitable for display using found or recycled materials.

Evaluation:
Students sketch and label cross-sections of a tree trunk.

Credit:
Adapted with permission of National Wildlife Federation, *Trees are Terrific!* (Ranger Rick's NatureScope), 1992.

Curriculum Connections:
(See appendix for full citations)

Books:
Bark (Chambers)

Focus on Trees (Ganeri)

Outside and Inside Trees (Markle)

Science Project Ideas About Trees (Gardner)

Tree (Eyewitness Book) (Burnie)

Media:
Dirt Made My Lunch (Audio Tape or CD) (Banana Slug String Band)

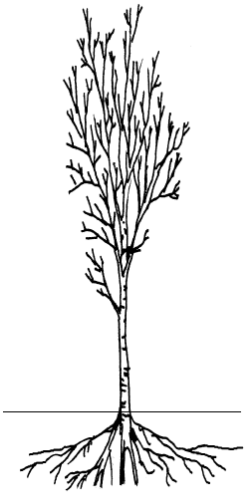
Think about the Planet (Audio Tape) (Rodden)

Teacher Resources:
(See appendix)

Trees Worksheet

Name _____

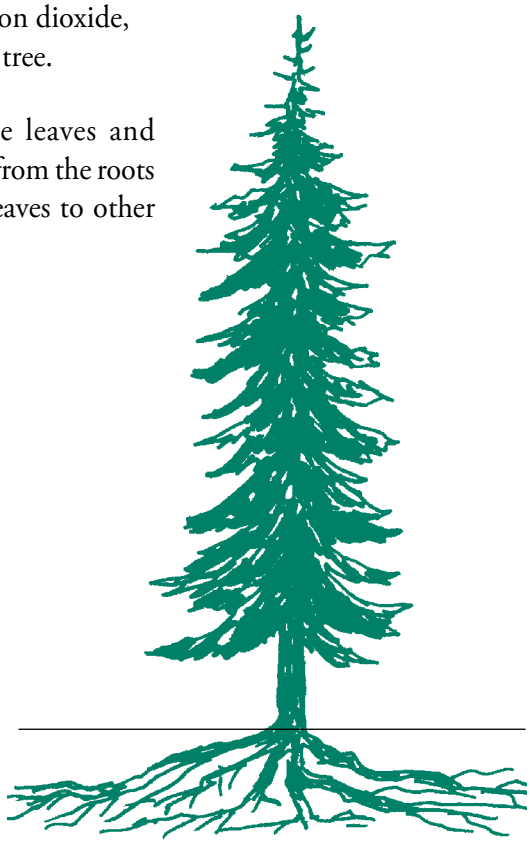
Use the following words to fill in the blanks below: **bark, cambium, cross-section, crown, heartwood, leaves, meristematic tissue, phloem, roots, trunk, xylem**



1. The _____ of a tree is made of the leaves and branches.

2. _____ use sunlight, carbon dioxide, and water to make sugar (food) for the tree.

3. The _____ holds the leaves and branches up, carries water and minerals from the roots to the leaves and sugars made in the leaves to other parts of the tree.

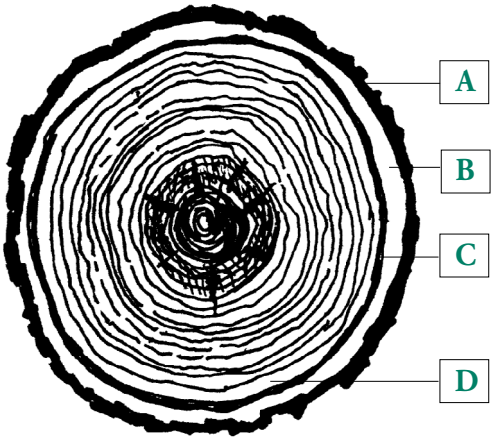


4. When trees are cut for timber, the logger wants the _____ which makes up most of the trunk.

5. The tips of the branches and roots have actively growing and dividing cells called _____.

6. _____ anchor the tree to the ground and get water and minerals from the soil.

7. This drawing shows a _____ of a tree trunk.



Fill in the blank spaces. Then write the letter identifying the correct part of the tree in the box at the end of the statement.

8. The _____ protects the tree from insects, diseases and weather. ☐

9. The _____ is the living and growing part of the tree. ☐

10. The sapwood or _____ carries water and minerals from the roots to the leaves. ☐

11. The _____ carries sugars made in the leaves to other parts of the tree. ☐

Make a Tasty Leaf

Section 1
FOREST ACTIVITIES

Grade Level: 5 - 12

Subject: Science

NGSS: 4-LS1-1., HS-LS1-1

Skills: Analyzing, comparing

Duration: 2 class periods

Group Size: Groups of 8

Setting: Indoors

Vocabulary: Chlorophyll, chloroplasts, consumers, cross-section, cuticle, epidermis, leaves, mesophyll, palisade layer, phloem, photosynthesis, producers, spongy layer, stomata, veins, xylem

Objectives:
Students will identify and describe the parts and functions of a tree leaf.

Teaching Strategy:
Students create edible leaves and compare them to real leaves.

Complementary Activities:
OUTDOOR OR INDOOR: "Tree Leaf Relay;" *INDOOR:* "Build a Tasty Tree," *both in this section.*

Materials:
Copies of "Leaves" worksheet and "Leaf Mold" directions *(see following pages).* For every eight students: one shallow square or rectangular glass pan. For each pan: one (6 oz) package of green gelatin, two envelopes of clear gelatin. Apples, bananas, green grapes, melons (preferably two kinds that can be cut into long strips and then split lengthwise), water, paring knives, spoons, mixing bowl, stove, refrigerator or freezer.
OPTIONAL: green food coloring, whipped cream.

Background:
See INSIGHTS *Section 1, Elements that Create Forests,* "Inner Workings – Tree Leaves" *Fact Sheet.*

Procedure:
Allow for four 30-60-minute intervals while gelatin sets.

Collect the food ingredients and utensils. Ask for food contributions. Locate a refrigerator or freezer for fast setting of the gelatin.

DAY ONE:
1. Draw a diagram of a leaf on the board. Review its parts with the class. Complete the "Leaves" worksheet.

2. Divide students into groups of eight. Give each group a copy of the leaf mold directions.

3. Each group should slice apples **(stomata**) through the core and layer them on the bottom of the glass pan in pairs. Each pair of apple slices should form a pattern like an "O."

4. Prepare the green gelatin according to the package directions. Add a few drops of green food-color (optional). Pour a layer **(epidermis**) just to cover the apples. Keep the remaining gelatin covered at room temperature. Chill the apple/gelatin layer until the gelatin is firm (one hour – or less in a freezer – to overnight).

5. Prepare the clear gelatin. Hold at room temperature.

6. Cut two kinds of melons into strips. Cut strips in half lengthwise and stack one from each melon on top of the other **(xylem** and **phloem**). The combined strips should be no higher than 1/2 inch. Lay them in a row **(vein**) on the middle of the green gelatin.

7. Cut the bananas **(spongy layer**) into pieces about 1/2 -inch thick and loosely cover the rest of the gelatin, leaving spaces.

8. Pour half of the clear gelatin **(mesophyll**) over the banana and melon. Cool until the clear layer is firm.

DAY TWO:
1. Arrange the green grapes (palisade layer) in tight rows on the firmed clear layer. Pour the last half of the clear gelatin **(mesophyll**) over the grapes.

2. When the clear/grape layer is firm, pour the last green gelatin layer **(epidermis**) on and cool until firm.

3. Optional: Spread whip cream **(cuticle**) over the top.

4. Before cutting into the leaf mold, ask students if they can figure out what each layer represents. Discuss the layers and their functions.

5. Discuss the concept that plants are the **producers** of food, not only for themselves, but for most of the animal world. We are **consumers**. What other creatures are consumers?

VARIATIONS:
A. Substitute vegetables for the fruits.

B. Combine the tree pizza *(previous activity)* and leaf mold for a single plant feast.

Evaluation:
Students sketch and label cross-sections of a tree leaf.

Credit:
Adapted with permission of National Wildlife Federation, *Trees are Terrific!* (Ranger Rick's NatureScope), 1992.

Curriculum Connections:
(See appendix for full citations)

Books:
Focus on Trees (Ganeri)

How Leaves Change (Johnson)

Outside and Inside Trees (Markle)

Science Project Ideas About Trees (Gardner)

Tree (Eyewitness Book) (Burnie)

Teacher Resources:
(See appendix)

Leaf Mold Directions

1. Slice apples through the core and layer them on the bottom of the glass pan in pairs. Each pair of apple slices should form a pattern that looks like an "O."

2. Prepare the green gelatin according to the package directions. Add a few drops of green food color (optional). Pour a layer just to cover the apples. Keep the remaining gelatin covered at room temperature. Chill the apple/ gelatin layer until the gelatin is firm (oone hour – or less in a freezer – to overnight).

3. Prepare the clear gelatin. Hold at room temperature.

4. Cut two kinds of melons into strips. Cut strips in half lengthwise and stack one from each melon on top of the other. The combined strips should be no higher than 1 /2 inch. Lay them in a row on the middle of the green gelatin.

5. Cut the bananas into pieces about 1 /2-inch thick, and loosely cover the rest of the gelatin leaving spaces.

6. Pour 1 /2 of the clear gelatin over the banana and melon. Cool until the clear layer is firm.

7. Arrange the green grapes in tight rows on the firmed clear layer. Pour the remaining clear gelatin over the grapes.

8 When the clear/grape layer is firm, pour on the last green gelatin layer, and cool until firm.

9. Optional: Spread whipped cream over the top

Leaves Worksheet

Name _____

Write the following words on the appropriate lines: **chlorophyll, chloroplasts, cuticle, epidermis, mesophyll, palisade, phloem, photosynthesis, spongy, stomata, vein, xylem**. Then write the letter identifying the correct part of the leaf in the box at the beginning of each statement.

1. _____ is the process of making food from light, carbon dioxide, and water.

2. The pigments that absorb light energy and produce the green color of plants are called _____.

☐ 3. The outer waxy layer of the leaf is the_____.

☐ 4. The _____carries the "food" manufactured in the leaf to other parts of the tree.

☐ 5. The "skin" of the leaf is also known as the _____.

☐ 6. The _____ of the leaf contains the xylem and phloem tubes.

☐ 7. The middle area of the leaf where light, water, and gas exchanges happen is called the _____.

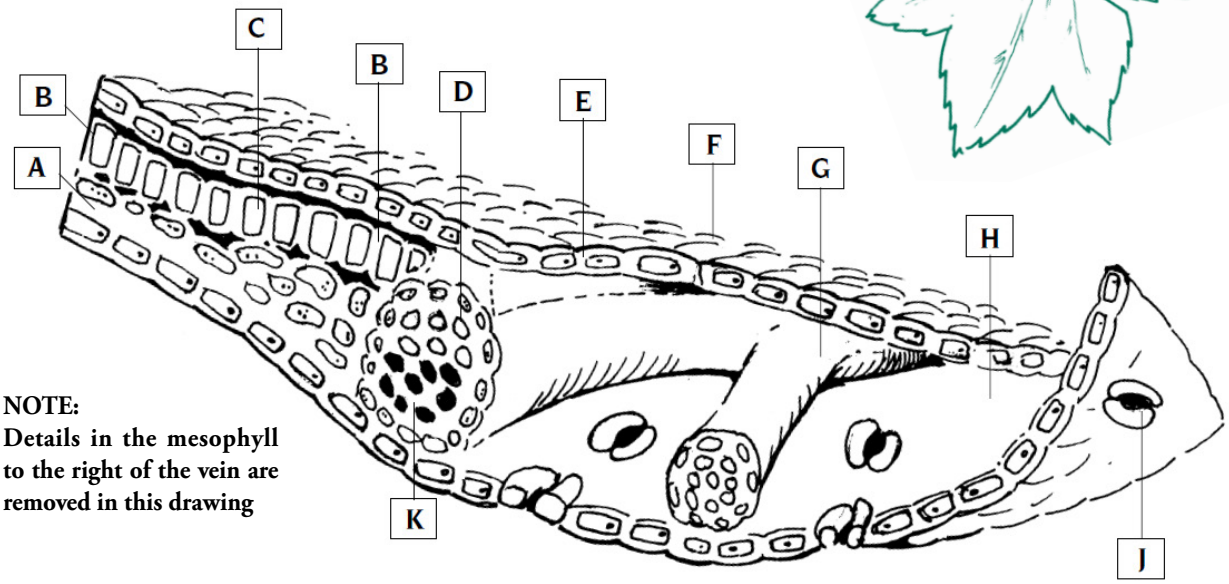
☐ 8. The _____ layer is where light is absorbed in photosynthesis.

☐ 9. _____ are the thin-walled cylindrical cells in the palisade layer that contain chlorophyll.

☐ 10. _____cells carry water and dissolved minerals in the leaves.

☐ 11. _____ are the small pores on the underside of the tree's leaves that open to absorb carbon dioxide.

☐ 12. The _____ layer is where most gas exchanges occur in the leaf.



NOTE:
Details in the mesophyll to the right of the vein are removed in this drawing

Trees to Imagine
3 EXTENSIONS

Section 1
FOREST ACTIVITIES

Grade Level: K - 5

Subjects: Science, language arts, dramatic arts
NGSS: 4-LS1-1., 5-LS1-1

Skills: Listening, visualizing, identifying, describing

Duration: 20-30 minutes

Group Size: Individual

Setting: Indoors or outdoors

Vocabulary: Broadleaf, cone, conifer, crown, deciduous, evergreen, roots, sap, seeds, trunk

Objectives:
1. Students will name the parts of a tree and describe the function of each.

2. Students will describe the seasonal cycle in the life of a tree.

Teaching Strategy:
Students imagine themselves to be trees in the forest.

Complementary Activity:
OUTDOOR/INDOOR: "Role-Play a Tree" *in this section.*

Materials:
Copy of a guided imagery *(following page or story of your own)*

Background:
See INSIGHTS *Section 1, Elements that Create Forests.*

Procedure:
1. Outdoors: Students stand against the trunk of a tree, close their eyes, and imagine that they are the tree. Indoors: Students draw each part of the tree as it is discussed in the guided imagery.

2. Guide the students through a year of a tree as you review the roles of the various parts of a tree by reading the story.

3. If you want to change this guided imagery or repeat it with a **deciduous broadleaf** tree, change the shape of the crown and add details about leaves changing, falling in autumn, and growing again in the spring.

4. In summary, ask students to name the parts of a tree and their jobs. Ask students to name changes that take place in the annual cycle of tree life.

Evaluation:
1. Students name the parts of a tree and describe their functions.

2. Students describe changes in the life of a tree over a year.

EXTENSIONS:
A. **Adopt a tree.** For an ongoing extension, each student adopts a tree in the area. Students can keep daily or weekly observation logs on their trees throughout the year. Encourage students to draw conclusions from their observations.

GUIDED IMAGERY:

You are a **conifer** tree. Your **crown** is shaped like a cone and stretches far up into the sky. Your **trunk** is straight and strong, so strong that winds don't blow you over. Your trunk holds up all your branches and needle-like leaves.

Your **roots** are planted solidly in the cool soil. They grow only a few inches below the ground and stretch outward from your trunk as far as your trunk reaches skyward. They mingle with the roots of other trees of your forest. Your roots are soaking up water and minerals from the soil Those nutrients (called **sap**) are slowly drawn upward through the inner layers of your trunk. You feel the cool moisture traveling upward, then out to your branches and into your leaves.

Your **leaves** look pretty just hanging there, but they are really busy working. Leaves are the kitchens of trees. They are soaking up warm sunshine and the cool air. They mix sunshine and carbon dioxide from the air and add water sent up from your roots. This makes a feast of sugars.

These sugars move from your leaves and slowly seep through the outer layers of your branches and trunk to reach all parts of you. These sugars are food for your trunk so it can grow taller and stronger. These sugars are food for your cones and the seeds that are forming inside. And these sugars are food for your roots so they can grow longer and find more water and minerals.

Day in and day out, your **sap** flows through your trunk. Your leaves are busy capturing the energy of sunlight. You grow taller. You grow new leaves at the tips of your branches. And you form new **seeds** and **cones** to protect the seeds..

Soon summer is ending. The cool air dries your leaves and the wind shakes some needles from your branches. Just as the thick bark on your trunk and branches protected you from the insects and sun of summer, now that bark protects you from cold, dry winds. Some mornings there is frost creeping over your roots, making your sap flow more slowly.

By the time the winter snows fall, you have stopped growing for a while. You keep your needles so you are called **evergreen**. Your roots hold you solidly to the ground as the winter winds howl and toss your branches. When the wind stops, your branches fill with heavy snow, bending them to the ground. You sleep and wait for warmer weather, more sunshine, and another season to grow.

You have lived through 100 winters. Months of cold and darkness move slowly before you feel spring arriving. Then, one day, cold meltwater begins to seep through the soil; your roots wake to the icy cold water. You begin growing again as the sunlight shines on you for longer hours.

A bird perches in your branches and sings a song. It's spring and time to get busy. You begin adding another ring of cells to your trunk, more branches and leaves to your crown, and you begin making more seed cones. Life continues.

Measure each tree's girth and height during the year. *To measure height by triangulation, see "Champion Tree" in Section 5.* In multi-grade classes, students can measure their tree from year-to-year.

B. **Build a classroom tree with "found" parts.** Build a classroom tree using real, "found" tree parts. Draw the shape of a tree on a large piece of butcher paper. Glue on small branches, bark, leaves, cones, and others that the children bring to class. Caution them about not tearing off living plants.

C. **Build a classroom tree with paper.** Build a model of a tree in the classroom. If you use long cardboard tubes from

wrapping paper, you have a way to make "winter trees" or tree silhouettes.

(1) Collect as many wrapping paper tubes, paper towel tubes, toilet tissue tubes, and drinking straws as you can, to represent trunks and long branches, shorter branches, and twigs.

(2) Stand the long tubes in a 5-gallon bucket filled with sand.

(3) Cut slits along the long tubes and attach long and shorter tubes for branches and twigs. Try to make a pattern resulting in silhouettes of various Alaska tree species.

Credits:

Adapted from Susan. Quinlan, "Alaska's Forests: More Than Just Trees." *Alaska Wildlife Wee*k, Alaska Department of Fish & Game, 1987.

Extensions contributed by Jean Ward, Chugach Optional School, and Patrick Ryan, Northwood Elementary, Anchorage, Alaska.

Curriculum Connections:

(See appendix for full citations)

Books:

Ancient Ones, The World of the Old-Growth Douglas Fir (Bash)

Just a Dream (Van Allsburg)

Old Elm Speaks (O'Connell) (Poetry)

Owl Moon (Yolen)

Tree of Life, The World of the African Baobab (Bash)

Media:

Billy B Sings About Trees (Billy B)

Teacher Resources:

(See appendix)

Tree-Leaf Relay

3 EXTENSIONS ***ALERT: ALASKA ECOLOGY CARDS OPTIONAL***

Section 1
FOREST ACTIVITIES

Grade Level: 3 - 12

State Standard: SA-12, SA-15
NGSS: 3-LS4-3. 4-LS1-1. MS-LS1-4

Subjects: Science, physical education, math

Skills: Observing, comparing

Duration: 30 minutes or more

Group Size: 1-4

Setting: Indoors /outdoors

Vocabulary: Broadleaf, conifer, deciduous, evergreen

Objectives:

1. Given a set of pictures, students will identify the major Alaska tree species (or trees in your area).

2. Given a set of pictures, students will distinguish conifers from broadleaf species.

Teaching Strategy:

Students use leaves or pictures of them in a relay race to identify or classify common Alaska trees.

Complementary Activities:

OUTDOOR: "Tree Identification;" *INDOOR:* "Make a Tasty Leaf," *both in this section. OUTDOOR:* "Champion Tree" *in Section 4, Succession.*

Materials:

A set of tree pictures *(all available in the* Alaska Ecology Cards *series)* or leaf specimens from a variety of the following trees: balsam poplar, black cottonwood, willow, paper birch, alder, aspen, mountain ash, mountain hemlock, Alaska cedar, tamarack, lodgepole pine, white spruce, black spruce, Sitka spruce, western hemlock. Copies of "Broadleafs and Conifers" worksheet *(following pages),* pencils, paper.

OPTIONAL: construction paper leaves (enough leaves for two teams), a collection of live branches from Alaska trees, copies of "Alaska's Trees" worksheet *(following pages).*

Background:

See INSIGHTS *Section 1, Elements that Create Forests:* "Tree Basics," "Alaska's Broadleaf Trees," "Alaska's Conifer Trees," and "Profiles of Alaska's Forests" *Fact Sheets.*

Procedure:

1. *BEFORE CLASS,* place tree cards from the *Alaska Ecology Cards* or other pictures of trees at different stations around the room. If leaves and live branches are available, put them next to the cards. Whenever possible, take students outside to look at the species of trees nearby.

2. Students visit each station, noting traits that will later help them identify the tree and its leaves.

3. After students have observed the cards and/or specimens, review the differences they see between broadleafs and conifers. Each student labels a paper with two columns, BROADLEAFS and CONIFERS, and places each trait in the appropriate column. Distribute the "Broadleafs and Conifers Worksheet."

4. Take students outside. Divide the class into several teams. Each team makes a collection of dead leaves from the trees nearby, noting the species. Students collect enough dead leaves from each type of tree to share with each team. *Treat the trees gently; do not strip live leaves from the trees.* If necessary, the teacher can use clippers to cut small samples from live trees.

5. On one side of the relay area, make a pile of leaves for each team. Include at least one leaf from each kind of tree in both piles. Make a third pile with sample leaves of all the species for the teacher. Teams line up on the opposite side of the area.

6. When the teacher holds up a sample leaf and/or calls out the name of the tree, the first student in each team runs to that team's pile, finds a matching leaf, and holds it up for the teacher to check. After positive identification, the player returns the leaf to the pile and goes to the end of the line. A team receives a point for each correct leaf identification.

7. Play until everyone has had a turn, or as long as time and interest permit.

8. Back in the classroom, students list the names of the trees observed in the game. They describe the differences between broadleafs and conifers.

Evaluation:

1. Students list three differences between broadleaf trees and conifers.
2. Students identify 2-10 Alaska tree species from pictures or live samples.
3. Given the worksheet, "Alaska's Trees," students match the names of trees with the pictures.

EXTENSIONS:

A. **Illustrate a guide to Alaska trees.** Students make their own illustrated "Alaska Tree Log." The class can decide on evaluation criteria and format.

B. **Create a video on community trees.** Students work in teams of 2-4 to create a nature-guide video for Alaska trees, describing each tree's characteristics and name.

C. **Bark and leaf rubbings.** Students make bark and leaf rubbings of different tree species using drawing paper and the flat edge of a crayon. Label and identify.

Credit:

Adapted from the American Forest Foundation, "Leaf Hunt Relay," *Project Learning Tree Supplementary Activity Guide for Grades K-8,* 1987.

Curriculum Connections:

(See appendix for full citations)

Books:

Alaska Trees and Shrubs (Viereck)

Crinkleroot's Guide to Knowing the Trees (Arnosky) 3-5

National Audubon Society First Field Guide: Trees (Cassie)

Tree (Eyewitness Book) (Burnie)

Teacher Resources:

(See appendix)

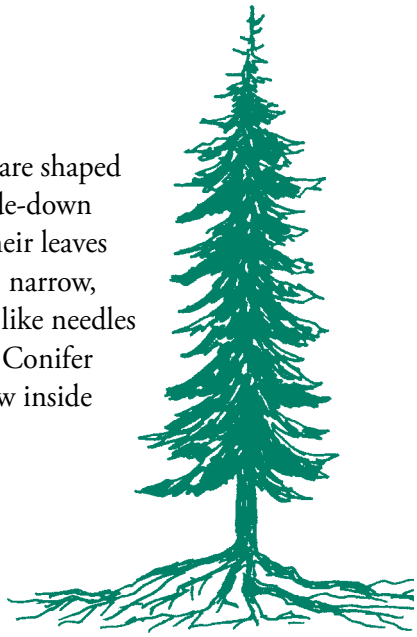
Unlike most conifers, the tamarack in Alaska is deciduous, losing its needles annually.

Broadleafs and Conifers Worksheet

NAME_____

Broadleaf trees have broad, flat leaves. Their seeds grow in flowers.

Conifers are shaped like upside-down cones. Their leaves are small, narrow, and look like needles or scales. Conifer seeds grow inside cones.



Some of the pictures shown below are of conifers and some are of broadleafs. **Circle** the letter of each **broadleaf** drawing. Put a **square** around the letter of each **conifer** drawing.

A

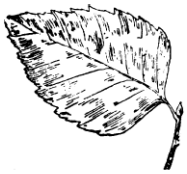
B

C

D

E

F



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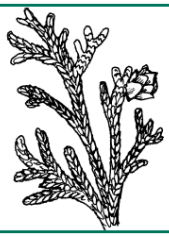


J

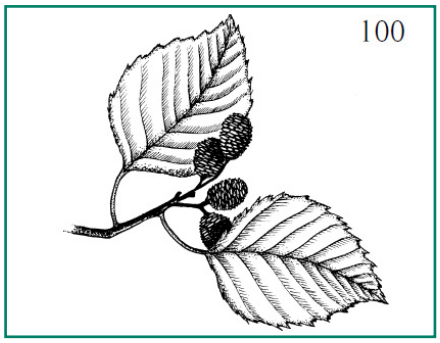
K

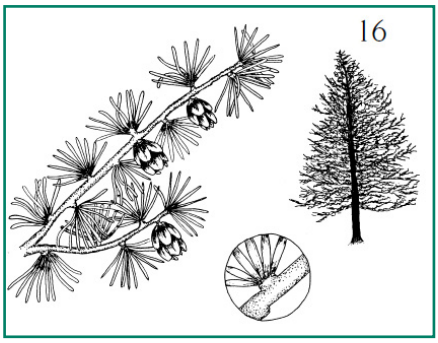
L

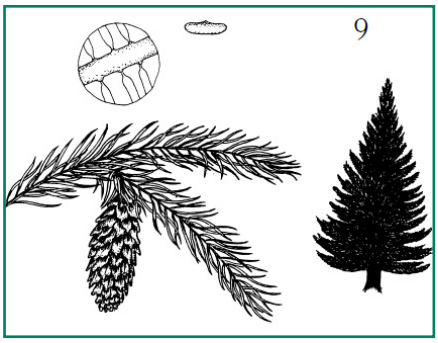
Alaska's Trees Worksheet

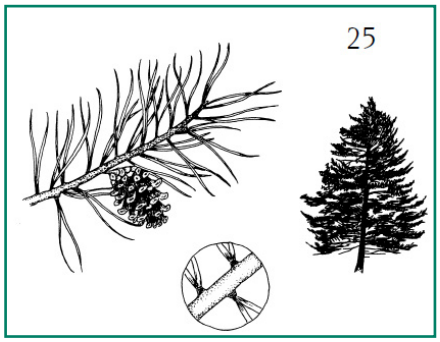
NAME_____

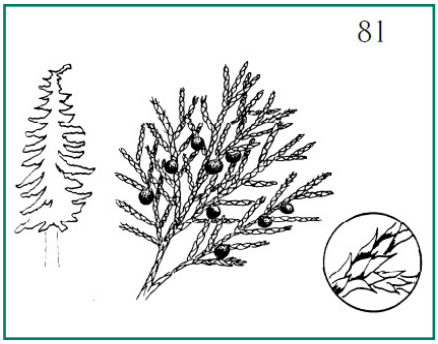
Match each drawing to the correct tree name. Write the name in the box of the appropriate picture. You can check your answers by finding the square root of the number in the corner of each square. The answer will match the number of the correct name.

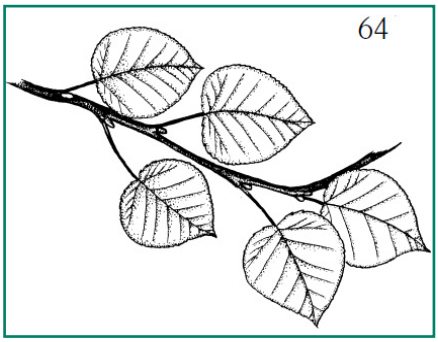


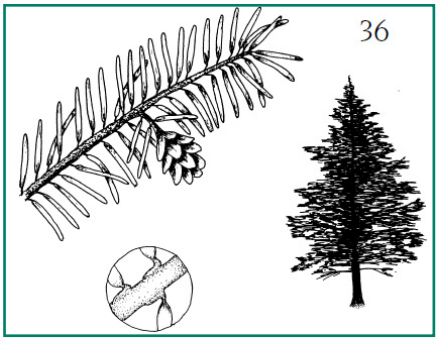












1. White spruce
2. Black spruce
3. Sitka spruce
4. Tamarack
5. Lodgepole pine
6. Western hemlock
7. Birch
8. Aspen
9. Alaska cedar
10. Alder
11. Willow
12. Mountain ash

List the numbers of the trees that are conifers.

List the names of the trees that grow in your area. (You may need to consult a reference book.)

Tree Identification

1 EXTENSION

ALERT: ALASKA ECOLOGY CARDS OPTIONAL

Section 1
FOREST ACTIVITIES

Grade Level: 4 - 12

State Standards: S A-14
NGSS: 4-LS1-1.

Subjects: Science, math, art

Skills: Observing, measuring, identifying, drawing

Duration: 1 class period

Group Size: Individuals

Setting: Outdoors & indoors

Vocabulary: Alternate branching, broadleaf, compound leaves, conifer, opposite branching, simple leaves, twigs, whorled branching

Objectives:

Students will identify and illustrate characteristics of various Alaska trees.

Complementary Activity:

OUTDOORS or INDOORS: "Tree Leaf Relay" *in this section. OUTDOOR:* "Champion Trees" *in Section 4, Succession.*

Materials:

Clipboards and writing paper or field note books, pencils or pens. Tree Identification Science Cards *(following)*. Small ruler; hand lens; crayons (brown, black, and green); *Alaska Ecology Cards* or a field guide to tree identification such as *A Golden Field Guide: Trees of North Americ*a, or *The Audubon Society Field Guide to North American Trees.*

Background:

See *INSIGHTS Section 1, Elements that Create Forests: "Alaska's Broadleaf Trees," "Alaska's Conifer Trees"* and *"Profiles of Alaska's Forests" Fact Sheets.*

Procedure:

IN ADVANCE, find an outdoor site where there are examples of the different trees in the area.

1. *IN CLASS,* discuss the activity. Depending on grade level, lead the children through the steps on the "Science Card" or ask them to complete the activity independently.

Classroom Follow-Up:

1. Students use their field notes and the *Alaska Ecology Cards* or a field guide to trees to identify the trees they saw. They write the name in the column "Species."

2. Below the tree's name, students write one trait that will help them separate it from similar trees.

EXTENSION:

Compile a mural of bark and leaf rubbings. Students take rubbings from the variety of local trees and leaves and create an artistic mural for the classroom or hall. Label each rubbing with the name of the tree, but conceal the name under another flap of paper. Fellow students try to guess the tree's name and lift the flap to see if they guessed correctly.

Curriculum Connections:

(See appendix for full citations)

Books:

Alaska Trees and Shrubs (Viereck)

Field Guide to Western Trees (Petrides)

Golden Field Guide to North American Trees (Brockman)

National Audubon Society Field Guide to North American Trees: Western Region (Little)

National Audubon Society First Field Guide. Trees (Cassie)

Tree (Coombs)

Websites:

Audubon On Line Field Guides <www.enature.com>

Teacher Resources:

(See appendix)

Tree Identification Task Card

1. Look at the "Tree Identification Chart." It shows some of the different shapes and characteristics of Alaska trees and their parts. Notice the different types of tree shapes, branching arrangements, and leaf shapes.

2. Turn your notebook so that the long side of the page is facing you. Write the heading "Alaska Trees" along the new top edge of the page. Write these headings across the page to form columns as shown :

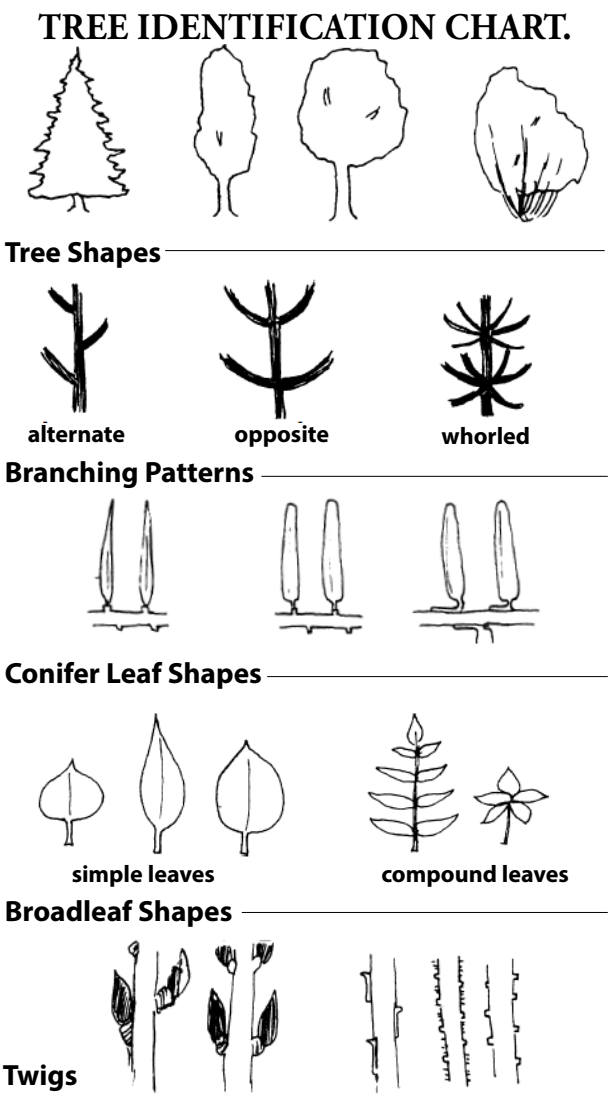
TREE SHAPE BRANCHING LEAVES TWIG BARK SPECIES

3. Look at the nearest tree and fill in your Alaska Trees chart with drawings of the shape and branching of this tree. Make a crayon rubbing of the bark by holding your paper against the bark and rubbing a crayon over the top of the paper. Make a rubbing of the leaf by placing the leaf under the paper, then rubbing the crayon over it.

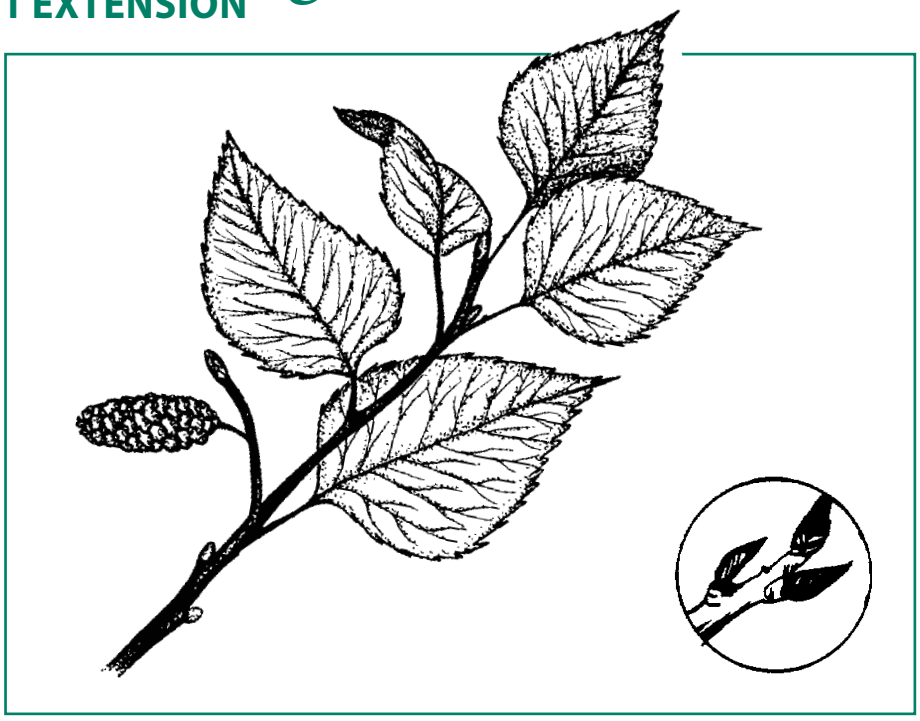
4. Measure the length of a leaf using a ruler and write this measurement below your crayon rubbing.

5. Look at a twig at the end of a tree branch. Draw the twig. Examine it with the hand lens. Is it covered by small hairs, or is it smooth? Write hairy or smooth under your drawing of the twig.

6. Draw a line under these drawings, then find a different kind of tree and repeat Steps 3-5. Complete your chart so it includes information on all the kinds of trees in this area. Use a second page if you need it.



Tree Twig Growth Rate
1 EXTENSION



Section 1
FOREST ACTIVITIES

Grade Level: 7 - 12

State Standards: S A-15, SB-1, SB-5
NGSS: MS-LS1-5 MS-LS2-1.

Subjects: Science, math

Skills: Observing, comparing, analyzing, mapping, graphing

Duration: 30-60 minutes

Group Size: Whole class

Setting: Indoors or outdoors

Vocabulary: Dormant, terminal bud

Objectives:
1. Students will determine the growth rate of a tree based on the number of terminal bud scars.

2. Students will infer environmental conditions based on varying lengths of annual growth as depicted by terminal bud scars.

Teaching Strategy:
Students will identify terminal bud scars on a deciduous tree or bush by locating closely spaced, fine lines encircling twigwood.

Complementary Activities:
OUTDOOR: "Tree Identification " *and* "Tree Trucks" *in this section, and* "Forests and Sunlight" *in Section 4, Succession. INDOOR:* "Build a Tasty Tree" *and* "Tree History – Your History" *in this section.*

Materials:
If the activity is conducted outside, students can use live specimens. If in the classroom, samples of twigwood must be collected. Magnifying lenses, measurement devices, and record sheets.

Background:
See INSIGHTS, *Section 1, Elements that Create Forests.*

Procedure:
1. Explain to students that many trees produce buds at the end of the summer growing season. These buds remain **dormant** during the winter until warmer weather causes the buds to open in the spring.

The location of a **terminal bud** on the twig creates a discoloration on the tree bark and leaves a scar of several closely-spaced, fine lines that encircle the twig. Each terminal bud scar marks the end of a year's growth.

2. Students will examine twigwood, beginning at the end of the branch and moving back toward the trunk, noting each bud scar to determine the growth rate of that twig. *As the twigwood becomes a branch, the thicker bark obscures the end of a year's growth.*

3. Students will use measurement devices to determine growth patterns as indicated by the spacing of the bud scars. *These growth patterns reflect varying environmental conditions that influenced the growth of the tree through time.*

For example, a growth spurt would be indicative of favorable environmental conditions.

4. If students are conducting this experiment on live specimens, they can compare growth pattern on twigs at different locations on the same tree to determine if environmental conditions, such as greater amount of sun on one side of a tree, affect the twig growth on a single tree.

Evaluation:

Beginning with the most recent terminal bud scar, students will date a twigwood specimen.

EXTENSION:

Map trees studied and graph results. If the activity is conducted outside on live specimens, students will map the location of the trees studied. Working backward from the most recent terminal bud scar, students will graph the rate of growth for each of the twigwoods examined. Students will then examine their data to determine if, within their sample area, environmental fluctuations occurred that affected the annual growth of the trees.

Credits:

Adapted by Jeanne L. Williams, teacher at Kingikmiut School, Wales, Alaska, from *Botany for All Ages – Discovering Nature Through Activities Using Plants,* Jorie Hunken and the New England Wild Flower Society, The Globe Pequot Press, Chester, CT, 1989.

Curriculum Connections:

(See appendix for full citations)

Books:

Science Project Ideas About Trees (Gardner)

Focus on Trees (Ganeri)

Tree (Eyewitness Book) (Burnie)

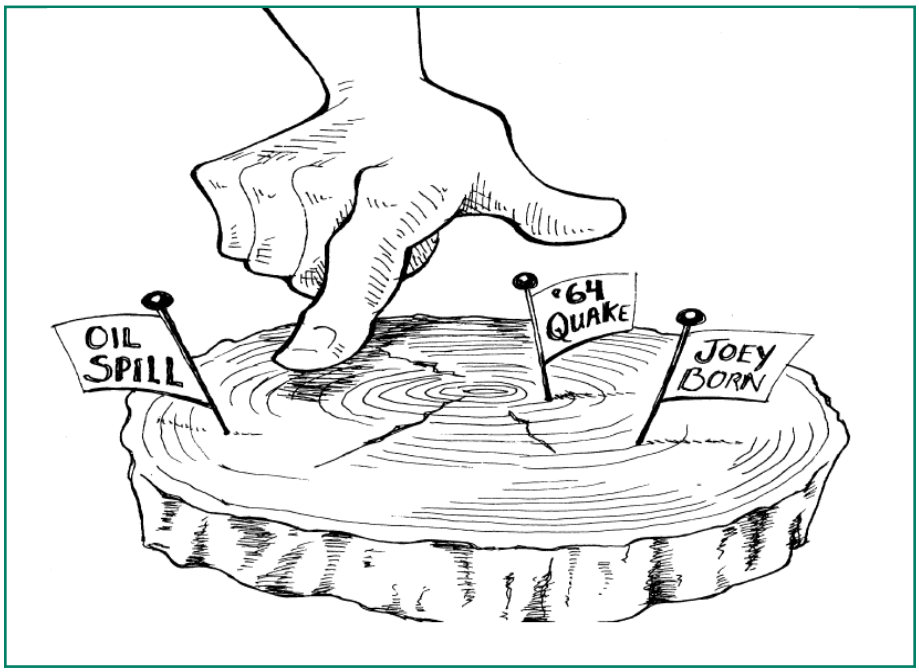
Trees (Eyewitness Explorer) (Gamlin)

Teacher Resources:

(See appendix)

Tree History – Your History

2 ACTIVITIES, 1 EXTENSION



Section 1
FOREST ACTIVITIES

Grade Level: K - 12

State Standards: S A-15, S B-1, S B-5, AC A-2, AC E-2
NGSS: K-LS1-1.K-ESS3-1,K-ESS3-3 2-LS2-1, 2-LS4-1, 2-ESS1-1. 3-LS3-2.,3-ESS2-2,4-LS1-1,5-PS3-1.,5-LS1-1. ,5-ESS3-1. MS-LS1-5.,MS-LS1-6.,MS-LS2-1. , MS-ESS3-2,MS-ESS3-3, MS-ESS3-5, HS-LS1-5,HS-LS2-1. ,HS-ESS3-5.

Subjects: Science, social studies, art, math

Skills: Reasoning, comparing, observing, describing

Duration: 60 minutes

Setting: Indoors

Vocabulary: Annual rings, cambium, core sample, cross dating, cross-section, dendrochronology, drought, earlywood, increment bore

Objectives:

1. Given a cross-section of a tree, students will describe how the annual life cycle of a tree affects the appearance of its annual rings.

2. Given a cross-section of a tree, students will determine the age of the tree.

Teaching Strategy:

Students determine the age of a tree and describe events which may have influenced its appearance. Students could use this method to learn about this history of their community.

Complementary Activities:

OUTDOOR: "Tree Trunks" *in this section; and* "Champion Trees" *in Section 4, Succession. INDOOR:* "Build a Tasty Tree Trunk" *in this section.*

Materials:

Cross-sections of tree trunks from several different trees (can be obtained from students, Division of Forestry, Christmas tree sales lot, firewood, driftwood), T- or large ball-head pins, yarn, scissors, pencils, paper, chalkboard or flip chart, and writing materials. Copies of worksheets "Reading the Rings, Part One," and "Reading the Rings, Part Two" *(following page*s).

Background:

See *INSIGHTS Section 1, Elements that Create Forests: "Reading Tree Rings" Fact Sheets.*

Procedure:

Reading the Rings, Part One

1. *IN ADVANCE,* obtain enough recently-cut tree cross-sections for groups of 2-4 students. If using Christmas tree butts, a short time span will be represented, since most Christmas trees are harvested between 6 and 25 years of age. If saw-marks blur the tree rings, students should sand the butts or re-cut them with a bow saw.

2. *IN CLASS,* explain how tree rings are made and what constitutes one annual ring. Each group of students decides how old its tree was when it was cut. Students calculate what year the tree started to grow.

3. Each group finds the rings that correspond to the years

their classmates were born. Use pins to mark the ring(s), and the yarn to connect the ring to a label outside the cross-section. The label could be glued to poster board or pinned to a bulletin board. Another way to do this is to make a small "flag" with the date and event written on a label attached to a pin. Stick the pin "flag" into the annual ring which corresponds with the date of the event.

4. Use pins to mark other significant dates. For example, how large was the tree when:

(a) students were in first grade?
(b) the school was built?
(c) the community was settled?
(d) Alaska became a state?
(e) other dates corresponding to events students are studying in history.

Attach a label to these or your own important dates with additional yarn (or make more flags).

5. Examine the cross-sections for differences in growing conditions during the years the tree lived. *Christmas tree butts will have fewer variations in ring size, as they are a controlled crop and conditions are optimal for their life span.* Discuss with students the possible reasons for the variations in the patterns of rings.

6. Give each group the cross-sections of four different trees to compare using the information in "Reading the Rings." Review events which might influence tree growth. Ask students to match the cross-sections with possible growing conditions. Review conditions influencing ring width and ring irregularities. The following descriptions refer to the illustrations in worksheet "Reading the Rings, Part One".

• A fallen tree leaning against the growing tree might cause wider rings on one side and tighter rings on the other side of the cross-section. Growing on a slope may have the same result. (Illustrated cross-section A)

• A forest fire causes scars. (Illustrated cross-section B)

• A branch broke off, or was cut off, and the tree grew over the break. (Illustrated cross-section C)

• Drought, damage from insect attack, or construction may cause narrow rings. Loss of leaves results in little food production. Root damage results in reduction of water and mineral supplies. (Illustrated cross-section D)

7. Students apply their understanding and come up with three other events which might limit the growth of a tree.

Procedure:

Reading the Rings, Part Two

Note: In the following part of the activity, we have adapted cross-dating techniques. Dendrochronologists look at the pattern of rings to cross-date trees. To make it easier for students, we've instructed them to lay the core samples on top of the cross section to match the over-lapping sections. With real trees the distances between the rings would never match perfectly. Dendrochronologists also core many trees in one area to get an accurate representative sample of the growth rings in similar trees.

1. Distribute copies of *"Reading the Rings, Part 2"* worksheet to each person.

2. Explain that the large cross section at the top of the page is from a tree that was used to build a cabin along the Iditarod trail. They must find out when the cabin was built by finding out when the tree started growing and when it was cut down. *(The students can assume that the cabin was built the same year the tree was cut.)* They can also discover when some events happened during the life of the tree. To find out, they must study the core samples at the bottom of the page.

3. Explain what a core sample is and how a core sample is taken. Have the students cut out each core sample, making sure they leave the lettered tabs attached.

4. Describe how dendrochronologists cross-date trees by matching similar ring patterns in a core sample with those in an unknown-age cross-section. Explain that only one of the three cores is from a tree that grows in the same area where the log (cross-section) once grew. It has an interval of rings that over-laps with a section of the tree trunk at the top of the page. The students must first decide which core matches the trunk cross-section.

5. To do this, they should take one of the core samples and try to match its pattern of lines with a section of the rings on the round cross-section. *(See the "Cross-dating technique" illustration for how to do this. Remind them that core samples go no farther than the center of the tree, so they should not extend the core sample across the center of the cross-section.)*

6. When they've discovered which core sample overlaps the cross-section *(core sample B)*, they should count backward on the core sample to find the dates when the core sample matches the cross-section. Remind them that the line closest to the letter on their tab is the annual ring from 1985.

7. Once they determine the dates, they can figure out when the tree was cut and when it first started growing. *(It was cut in 1930 and started growing in 1896.)* Tell them that historical records kept during that time indicate that the cabin was abandoned in 1933 only three years after it was built. What was happening along the Iditarod trail during this time that might have caused people to abandon their cabin? *(The Iditarod gold mining was a bust and newcomers probably learned quickly that they couldn't get rich.)*

8. Then have the students assign dates to some of the events in the tree's life. What year did fire scar the tree? *(1915)* How many years did it take for the tree to grow around the remains of a dead branch? *(10 years)* How long did the drought that began in 1912 last? *(2 years)*

9. Wrap up the activity by asking the students for ideas on other things that cross-dating can reveal.

Evaluation:

1. Students name the parts and functions of the rings in a cross-section of a tree.

2. Students observe a cross-section of a tree and list events which might cause differences in the width of tree rings. They describe how each event might influence the size of the ring.

EXTENSION:

Use tree rings as a basis for local history research. If available, use rings taken from recently cut, local trees. Repeat the above activity and then have students gather information about the history of their community corresponding with the life of their tree. Historic photographs and oral histories are an excellent source of information for this extension.

Credits:

Adapted with permission from the American Forest Foundation, "Tree Cookies," *Project Learning Tree Activity Guide for Grades K-6*, 1994. Reprinted with permission of National Wildlife Federation, *Trees are Terrific!* (Ranger Rick's NatureScope), 1992.

Curriculum Connections:

(See appendix for full citations)

Books:

Be a Friend to a Tree (Lauber) K-3

Crinkleroot's Guide to Knowing the Trees (Arnosky) K-5

Focus on Trees (Ganeri)

Once There was a Tree (Romanova) K-3

Outside and Inside Trees (Markle)

Science Project Ideas About Trees (Gardner)

Shrinking Forests (Tesar) 7-12

Tree (Eyewitness Book) (Burnie)

A Tree is Growing (Dorros)

Media:

Once There was a Tree (Video) (Reading Rainbow)

Teacher Resources:

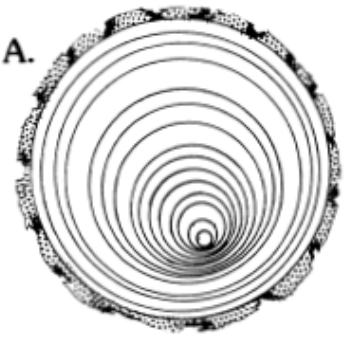
(See appendix)

Reading the Rings, Part One

NAME _____

What events have influenced the growth of these trees? Draw a line from each cross-section to a matching event. (*More than one event can explain the growth pattern!)*

A.



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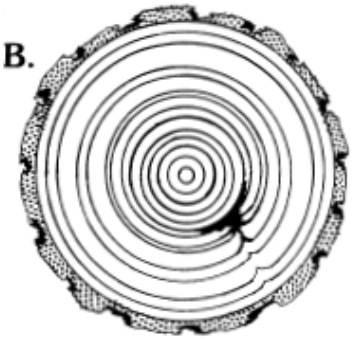

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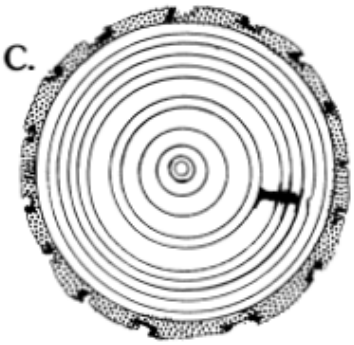

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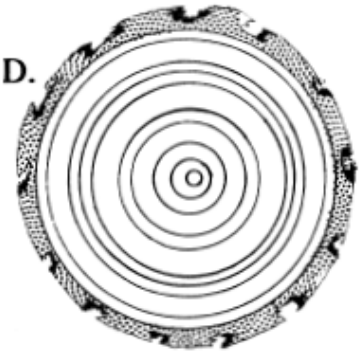
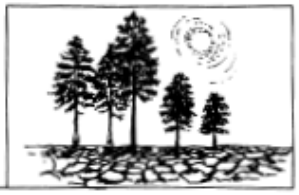


1. *Fallen tree* _____

2. *Fire* _____

3. *Drought* _____



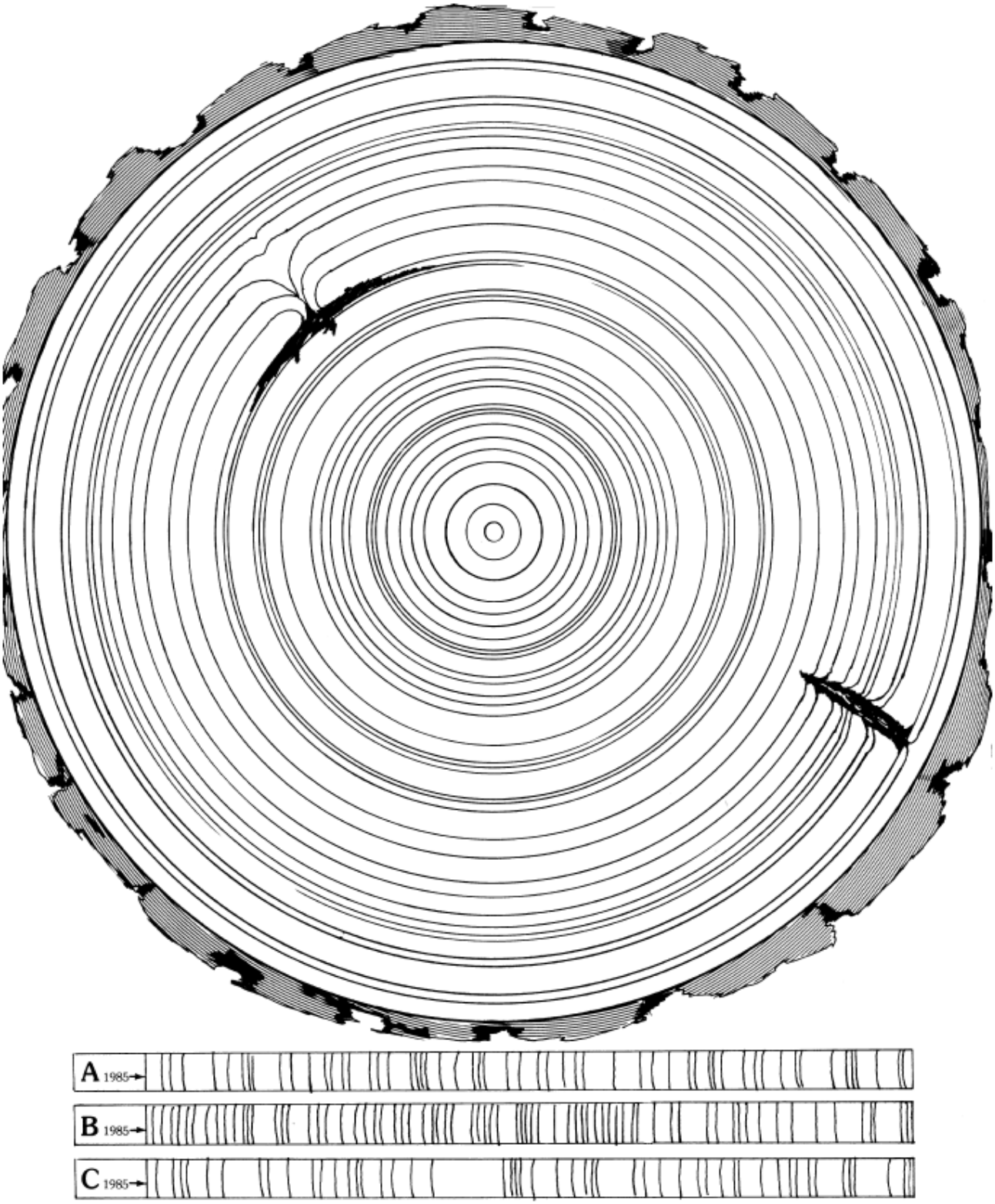
4. *Insect attack* _____

5. *Construction* _____

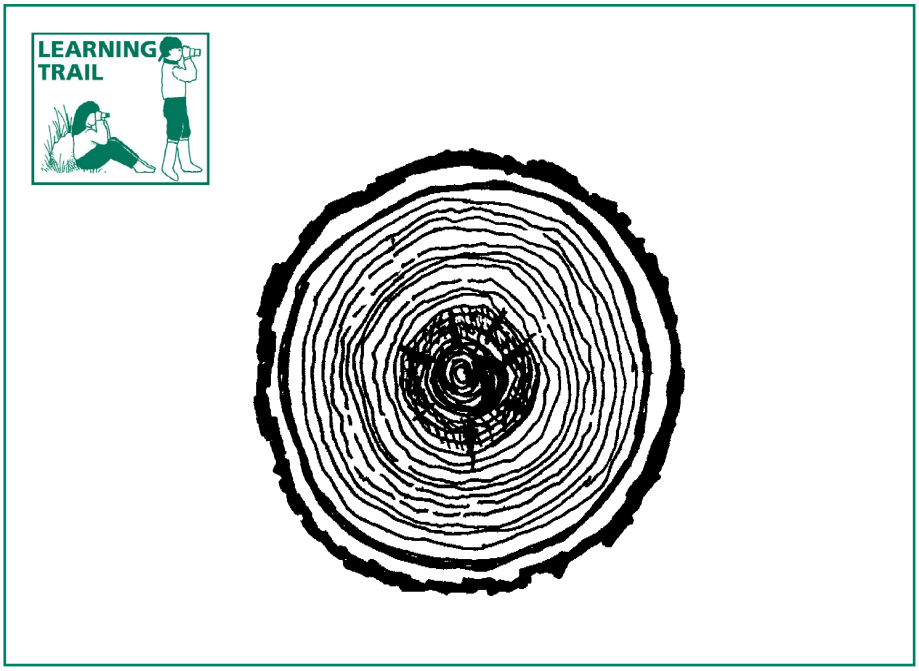
6. *Growing on slope* _____

7. *Dead branch* _____

Reading the Rings, Part Two



Tree Trunks



Section 1
FOREST ACTIVITIES

Grade Level: 4-12

State Standards: S B-1, S B-5, S B-6
NGSS: 4-LS1-1., 5-PS3-1.,5-LS1-1. 5-ESS3-1.MS-LS1-5.,MS-LS1-6. MS-LS2-1.,MS-ESS3-3.,HS-LS1-5. HS-LS2-1.,HS-ESS3-5.
Subjects: Science, math

Skills: Observing, measuring, counting, estimating

Duration: 1 class period

Group Size: Individuals

Setting: Outdoors & indoors

Vocabulary: Annual rings, bark, cambium, circumference, heartwood, phloem, sapwood, xylem

Objectives:

Students will use a cross-section of a tree trunk to identify the function of the tree rings and infer environmental conditions that affected the growth rate of the specimen.

Complementary Activities:

OUTDOORS: "Champion Trees" *in Section 4, Succession. INDOORS:* "Tree History – Your History" *and* "Build a Tasty Tree," *both in this section.*

Materials:

Clipboards and writing paper or field note books, pencils or pens. Yard or meter stick; length of string.
OPTIONAL: Increment borer *(contact local foresters with the USDA Forest Service or State Division of Forestry if you want to use one of these tools*).

Background:

See *INSIGHTS Section 1, Elements that Create Forest: "Inner Workings - Tree Trunks" and "Reading Tree Rings" Fact Sheets.*

Procedure:

IN ADVANCE, locate an outdoor site where trees have been cut recently so that the annual rings are still visible. Or place a cross-section of a tree trunk cut elsewhere at a convenient site with a variety of other age trees.

If you have access to an increment borer, you could take a core from a living tree. Ask a forester for specific instructions on boring trees safely.

IN CLASS, discuss the activity. Depending on grade level, lead the children through the steps on the "Science Card" or ask them to complete the activity independently.

Classroom Follow-Up:

1. Students estimate the age of each unknown tree at the Tree Trunk site by using the following formula:

$$\text{Age of Unknown Tree} = \frac{\text{Age of Known Tree} \times \text{Circumference of Unknown Tree}}{\text{Circumference of Known Tree}}$$

2. Did the ages of the trees vary at the site? By how many years? What factors might cause this method of estimating tree ages to give incorrect estimates?

Inaccurate estimates may result because different trees may have grown at different rates. Other trees may have lived through more bad or good years than the sample tree, and thus have a relatively smaller or larger trunk. Comparisons of different tree species would also cause errors; different species grow at different rates.

Curriculum Connections:

(See appendix for full citations)

Books:

Outside and Inside Trees (Markle)

Science Project Ideas About Trees (Gardner)

Tree (Eyewitness Book) (Burnie)

Teacher Resources:

(See appendix)

SCIENCE CARD

Tree Trunks

1. Write the heading "Tree Trunks" across the top of a page in your notebook. Record your answers to the questions below, and make any calculations on this page.

2. Look at the cross-section of tree trunk and try to identify the various layers: the **heartwood** (center), the **sapwood** or **xylem**, the **cambium**, the **phloem**, and the **bark**. Measure each part and record its thickness (inner to outer edge).

3. Can you see the **annual rings**? Count the very center as one, then count the number of dark rings to find out how old the tree was when it was cut. Record your answer as: Tree Age = _____.

4. Did you notice that the rings are various distances apart? Find the 2 that seem closest together. These indicate a year when the tree did not grow very much. It may have been a very dry year, or a year when the tree lost many of its leaves to insects or fire. How many years ago did this occur?

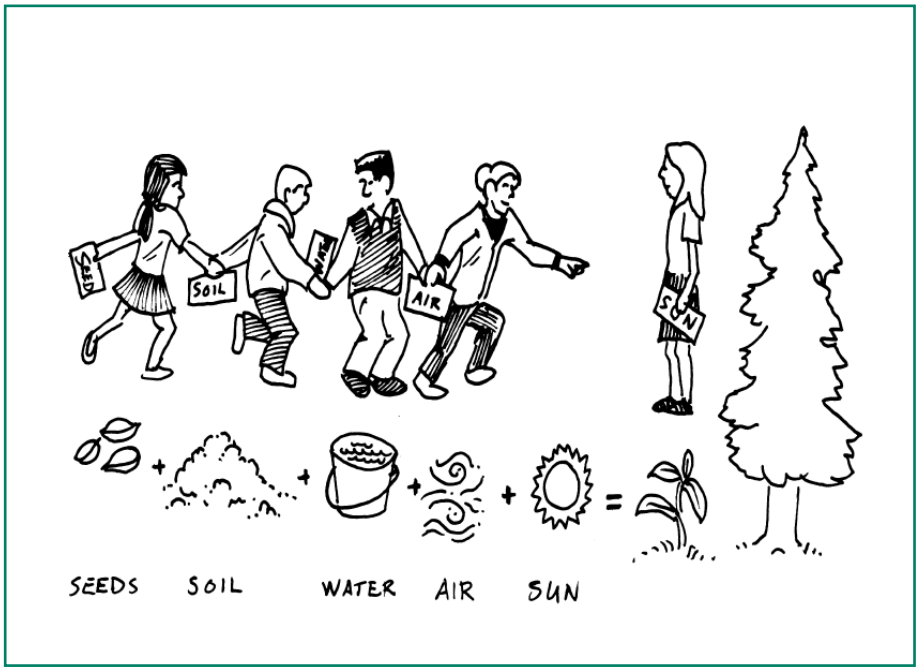
5. Find 2 rings that are spaced furthest apart. These indicate a year that the tree grew well. This was probably a year with plenty of moisture, few insects, and warm temperatures. How many years ago did this occur?

6. As you know, even if this tree were alive and standing, only the cambium layer would be growing. The heartwood, sapwood, phloem, and bark do not grow. If the bark is dead and doesn't grow, how does the tree trunk manage to get larger as the tree gets older?

7. You will later be able to estimate the ages of other trees in this area by comparing their trunk measurements to the measurement of this tree whose age you know. *First* measure the **circumference** of this tree by measuring the length of string that is needed to go all around the trunk at the height of a person's shoulders. *Record* this measurement next to the tree's age. *Then* measure and record the circumferences of 10 other trees in this area. You'll want to select both large and small trees.

Tree Seed Chain Game

1 EXTENSION



Section 2
FOREST ACTIVITIES

Grade Level: K - 3

State Standard: S A-14

NGSS: K-LS1-1.,K-ESS3-1.,3-LS4-3.

Subjects: Science, physical education

Skills: Classifying, memorizing

Duration: 30 minutes

Group Size: Whole class

Setting: Outdoors (or gym)

Vocabulary: Living, non-living, germination

Objective:

Students will sequentially demonstrate the elements of a forest food web required for the survival of a tree.

Teaching Strategy:

In a game, students race to collect the nonliving requirements for seed germination.

Complementary Activities:

OUTDOOR: "Fungi" *and* "Detritivores" *in this section.*

Materials:

For a class of 30 students: six seed cards (labeled "SEEDS need soil, water, air, and sun"), six soil cards (labeled "SOIL"), six water cards (labeled "WATER"), six air cards (labeled "AIR"), six sun cards (labeled "SUN"). Alternately, you can fill Ziploc bags with seeds, dirt, water, sun cutouts and air (nothing). The seed bags also contain the sentence: "SEEDS need soil, water, air, and sun."

Background:

See INSIGHTS, *Section 2, Forest Ecosystems.*

Procedure:

1. Divide the class into two groups of equal size, each divisible by 5. If there are extra students, they can become judges at the finish line or markers for the playing field.

2. Hand out one card (or Ziploc bag) to each student, and tell the students to keep their identities a secret (except for seeds). Set the boundaries of the playing area.

3. Tell the students that the goal of the game is for seeds to obtain all the nonliving parts of the ecosystem they need to germinate, **in the order** they need them *(soil, water, air, sun)* and to be the first to cross the finish line. *Without soil, water, air, and sunlight, seeds will not grow.*

4. Begin the game with the seeds at the end of the field opposite the finish line. Divide the nonliving things equally along the two other sides of the field. *Caution students not to run into another tree seed chain.*

5. The seeds will run from one side of the field to the other, asking **only one** person per side if he is soil (or the next requirement on the list). Nonliving requirements (soils, waters, airs, suns) can only answer "yes" or "no." They

should not tell what they are. Seeds may need to consult with the teacher for the next item on the list, depending on reading-skill level.

6. When a seed finds soil, the seed and the soil join hands to form a chain and head for the opposite side of the playing area to look for the next requirement on the list. This process keeps going until the seed has, in order, all the requirements she needs to survive as a tree. A completed chain proceeds to the finish line. Continue the game until all the seeds have found all their nonliving requirements.

Evaluation:

Students name (in order) the four essential nonliving requirements for tree growth.

EXTENSION:

Experiment with seeds and nonliving elements. Divide the class into four groups to conduct scientific experiments on plants, observing their need for soil, water, air, and sun. Assign a group to each of the following: 1) soil problems, 2) water problems, 3) air problems, 4) sunlight problems.

Using green beans, or other fast-growing plants, students design a growth experiment that demonstrates what happens if there is a missing nonliving component in an ecosystem. Each group should have an experimental and a control plant and design its own tests. Students keep records in daily logs and present their findings to the class.

Credits:

Adapted from Rocky Rohwedder, "Tree Chain Game," Project Learning Tree, Leaflet No.15, 1991.

Curriculum Connections:

(See appendix for full citations)

Books:

Ancient Ones, The World of the Old-Growth Douglas Fir (Bash)

The Big Tree (Hiscock)

Crinkleroot's Guide to Knowing the Trees (Arnosky)

Mighty Tree (Gackenbush)

One Small Square: Woods (Silver)

The Tremendous Tree Book (Brenner)

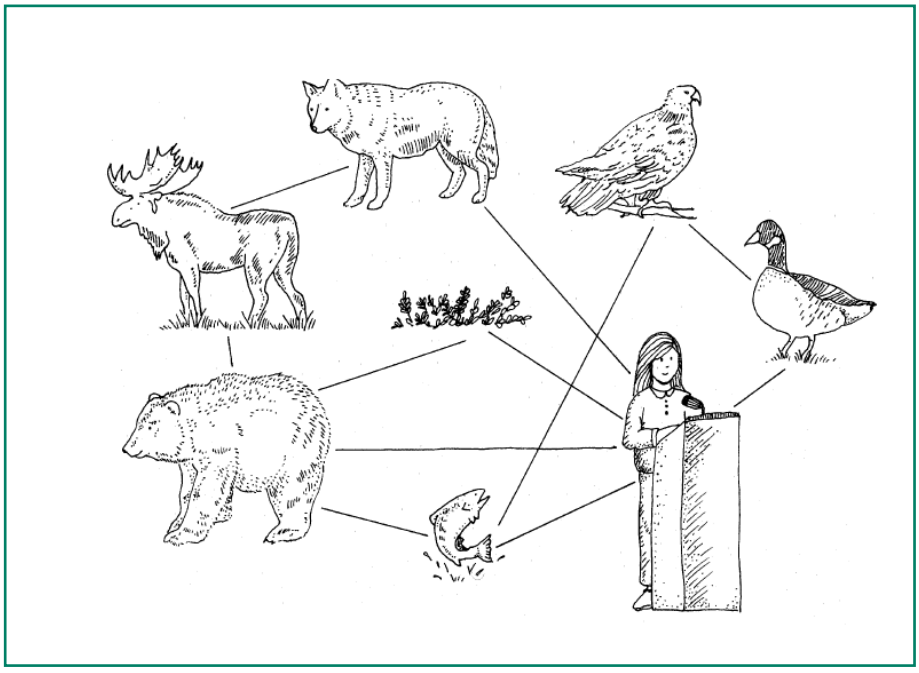
Teacher Resources:

(See appendix)

Conifers take a long time to produce and release their seeds compared with broadleafs. Black spruce cones may hang on branches for many years.

Forest Food Web Game

1 EXTENSION ***ALERT: ALASKA ECOLOGY CARDS REQUIRED***



Section 2
FOREST ACTIVITIES

Grade Level: 5 - 12

State Standard: S A-14

Subjects: Science

Skills: Classifying, predicting

Duration: 60 minutes

Group Size: Whole class

Setting: Indoors

Vocabulary: Carnivores, consumers, detritivores; ecosystem, energy, food chain, food web, fungi, habitat, herbivores, minerals, omnivores, producer

Objective:

Using pictures, students will construct and describe food webs that include the nonliving elements of a forest ecosystem.

Teaching Strategy:

Students introduce themselves as elements of a forest ecosystem and link with the other elements they need to form a forest food web.

Complementary Activities:

OUTDOOR: "Fungi," "Detritivores," and "Forest Ecosystem Scavenger Hunt," *all in this section.*

Materials:

Selected *Alaska Ecology Cards* (list follows) or other pictures of coastal and boreal forest plants and animals, lengths of yarn 6 inches to 3 feet long, chalkboard and chalk.

Background:

See INSIGHTS, *Section 2, Forest Ecosystems.*

Procedure:

1. Separate the *Alaska Ecology Cards* for either the boreal or coastal forest (list follows).

2. Review your students' prior knowledge about **food webs**.

3. Brainstorm the components of an Alaska forest. Encourage students to name a mixture of **nonliving things**, kingdoms of **living things** *(plants, animals, fungi, etc.)*, specific organisms *(flying squirrels, woodpeckers, insects, etc.)* and roles of living things *(**producers**, **consumers**, etc.)*. List whatever they mention on the board.

4. Students divide the list into living and nonliving things. Students then divide the living things into ecological roles *(producer, consumer, **herbivore**, **carnivore**, **omnivore**, and **detritivore**).*

5. Explain the classification of living things by their ecological roles is important in understanding how a forest **ecosystem** works. *If an ecosystem is to survive changes, then all of the ecological roles must be conserved. For example, if an herbivore disappears then the carnivore that eats it will be*

affected. Explain that the *Alaska Ecology Cards* represent a sample of some of the living things found in Alaska forests.

6. Depending on which forest you have chosen to study, distribute the following *Alaska Ecology Cards* in the following order (to assure that all organisms will interconnect):

BOREAL FOREST	**COASTAL FOREST**
Sunlight	Sunlight
Air	Air
Water	Water
Rocks and soil	Rocks and soil
White spruce tree	Sitka spruce
Red squirrel	Red squirrel
Goshawk	Goshawk
Carrion beetle	Carrion beetle
Bacteria	Bacteria
Gilled mushroom	Gilled mushroom
Bark beetle	Bark beetle
Hairy woodpecker	Red-breasted sapsucker
Sharp-shinned hawk	Sharp-shinned hawk
Birch tree	Hemlock tree
Moth	Sawfly wasp
Chickadee	Chickadee
Truffle	Truffle
Bacteria	Bacteria
Springtail	Springtail
Flying squirrel	Flying squirrel
Low-bush cranberry	Trailing raspberry
Vole	Moth
Great horned owl	White-footed deer mouse Weasel
Marten	
Polypore or shelf fungi	Polypore or shelf fungi
Protozoans	Protozoans
Lichen	Lichen
Moose	Deer
Grouse	Grouse
Hare	Crossbill
Lynx	Wolf
Algae	Algae

If few students are doing this activity, students hold more than one card from the same ecological role. For example, one student could hold all of the nonliving cards, or all the producer cards.

7. Students circulate around the room and introduce themselves to each other. They give the name of the item they represent, their type (nonliving, producer, consumer), and what they eat or use to survive. *For example, "I am the minerals in rocks and soil. I am nonliving. I do not eat;" or "I am a spruce tree. I am a producer. I make my own food using sunlight, water, minerals, and air;" or "I am a moose. I am an herbivore that eats twigs of birch, willow, and other plants."*

8. Whenever a student meets something that it eats, that eats it, that uses it (in the case of producers), or that is used by it (nonliving things), those students should join together by holding pieces of yarn. Students who are connected by yarn move together as a group. Students in groups can introduce themselves individually, or the top consumer in each group can do the introductions. Other students will join this group whenever appropriate. *Several separate groups will form at first, but eventually, the whole class should become interconnected.*

9. Congratulate the class on becoming a forest food web! Explain that a food web contains all the **food chains** of an ecosystem.

10. Ask what would happen to the ecosystem if one of the organisms in the food web was removed. Tug on one player as if to remove her. Tell her to pass the tug on to all the organisms she connects. Ask those who feel the tug to raise their hands. Discuss the effects. If desired, repeat this step by removing different kinds of organisms. Which causes the most effects – removal of a producer, herbivore, carnivore, or detritivore?

Evaluation:

1. Students describe the ecological role of producers, consumers, herbivores, carnivores, detritivores.

2. Students draw a food chain of at least 4 living things from the forest environment.

EXTENSION:

Color the posters and find the wildlife. Students color the boreal and coastal forest posters from the *Section 2* INSIGHTS, *Forest Ecosystems – Community Connections.* Can they find the following:
COASTAL FOREST: 14 animals? 9 plants? 3 fungi?
BOREAL FOREST: 12 animals? 7 plants? 3 fungi?
How are they connected in the ecosystem?

Curriculum Connections:

(See appendix for full citations)

Books:

Alaska Wildlife Notebook Series (ADF&G)

Ancient Ones, The World of the Old-Growth Douglas Fir (Bash)

Biomes of the World (v.1) (Allaby) 7-12

One Small Square: Woods (Silver)

Taiga (Kaplan)

Taiga (Sayre)

U-X-L Encyclopedia of Biomes (v.3) (Wigel) 7-12

What are Food Chains and Webs? (Kalman)

Who Eats What? (Lauber)

Website:
Alaska Science Forum
<www.gi.alaska.edu/AlaskaScienceForum>

Teacher Resources:

(See appendix)

Fungi

1 EXTENSION

ALERT: ALASKA ECOLOGY CARDS REQUIRED

Section 2
FOREST ACTIVITIES

Grade Level: 5 - 12

State Standards: S B-1. S B-5
NGSS: MS-LS1-5, MS-LS1-6. MS-LS2-2., MS-LS2-3., HS-LS2-4. S-LS2-5.

Subject: Science

Skills: Observing, identifying

Duration: 50 minutes & follow-up several days later

Group Size: Individuals

Setting: Outdoors & indoors

Vocabulary: Consumer, detritivores; ecosystem, energy, food chain, food web, fungi, habitat, hyphae, minerals, photosynthesis, producer

Objective:

Students will identify and describe forest fungi.

Complementary Activities:

OUTDOOR: "Detritivores" *and* "Forest Ecosystem Scavenger Hunt" *in this section;* "Snag a Home" *in Section 4, Succession. INDOOR:* "Forest Food Web Game" *in this section.*

Background:

See INSIGHTS, *Section 2, Forest Ecosystems.*

Materials:

Fungi cards from the *Alaska Ecology Cards*. Clipboards and writing paper or field note books, pencils or pens. Plastic bags, hand lens, plastic wrap, several small dishes or disposable muffin tins, ingredients for agar mixture *(made by combining 2 cups boiling water, 2 teaspoons sugar, 2 teaspoons beef or chicken bouillon powder, and 4 teaspoons of gelatin).* Copies of Science Card *(following page).* OPTIONAL: Field guides on mushrooms and other fungi.

Procedure:

IN ADVANCE, look for a forested site that has dead leaves and dead trees to conduct the fungi investigation.

Make an agar mixture *(recipe in Materials list).* Fill small dishes or disposable muffin tins with agar mixture and allow it to set so they are ready when the students return from the forest.

1. *IN CLASS,* discuss the role of **detritivores** in a forest ecosystem. Where would you find them *(in leaf litter and on dead things).* Review the concept of **food chains**. Where are detritivores in forest food chains? Fungi are one of the many kinds of detritivores.

2. Tell the students they will go in search of forest fungi. Review the fungi cards from the *Alaska Ecology Cards* series before going to the forest site.

Classroom Follow-Up:

1. Students place their fungi samples in separate dishes filled with agar, a medium that contains **energy** and **minerals**. Cover these with plastic wrap and place them in a

warm, dark place.

2. Ask students to predict what will happen. For example, will anything grow?

3. Wait a few days, then see if anything has grown. If something does grow, is it more likely to be a **producer** or a **consumer**? *NOTE: If the growth in their sample is fuzzy, it is probably a fungus (mold). If it is slimy, it is probably a yeast (a type of fungi) or bacterial growth (a type of moneran). Students should recognize that the organisms that grow are unlikely to be producers since they did not receive any light, and light is needed for* ***photosynthesis****.*

EXTENSION:

1. **Research forest fungi and create a display.** Students use the *Alaska Ecology Cards* or other "Curriculum Connections" resources (*following*) to find out more about forest fungi. They use this information along with sketches or samples to make a poster or display of this seldom noticed forest life.

Curriculum Connections:

(See appendix for full citations)

Books:

The Big Tree (Hiscock)

Fungi (Silverstein)

Fungi (Tesar)

Taiga (Sayre)

Website:

Alaska Science Forum
<www.gi.alaska.edu/AlaslaScienceForum>

Teacher Resources:

(See appendix)

SCIENCE CARD

Fungi

1. Write "Forest Fungi" at the top of a page in your field notebook.

2. Look at the pictures of fungi on the cards, then look around this area carefully and try to locate as many kinds of fungi as you can. Draw pictures of those you see in your notebook.

3. Can you see any evidence that fungi are **detritivores**? Write down any evidence you notice.

4. Probably the first fungi you see are large fruiting bodies of mushrooms or shelf fungi. These visible parts of fungi are minor in comparison with the major, harder to see feeding parts called **hyphae**, long but tiny or microscopic hair-like threads that can be hundreds of feet long. Look closely at the dead leaves and decayed wood in this area with a hand lens. Can you see any hair-like fuzz or strands?

5. Based on what you know about fungi, select two items from this area that you think might have some kind of fungi growing on them. Place a sample of each in plastic bags. Label the bags *Fungi Sample 1* and *Fungi Sample 2*. Record in your notebook everything about them. Take these samples back to the classroom with you.

Detritivores

1 EXTENSION

ALERT: ALASKA ECOLOGY CARDS REQUIRED

Section 2
FOREST ACTIVITIES

Grade Level: 5 - 12

State Standards: S B-1, S B-5
NGSS: HS-LS2-4., HS-LS2-5.
5-LS2-1.,MS-LS1-5,MS-LS1-6
MS-LS2-2.,MS-LS2-3.,HS-LS2-4.
HS-LS2-5.

Subject: Science

Skills: Observing, inferring, predicting

Duration: 30 minutes & follow-up several days later

Group Size: 2

Setting: Outdoors & indoors

Vocabulary: Consumer, detritivores; ecosystem, energy, food chain, food web, fungi

Objective:

Students will identify, categorize, and compare detritivores based on the type of food they eat.

Complementary Activities:

OUTDOOR: "Fungi" *in this section,* "Snag a Home" in Section 4, Succession. *INDOOR:* "Forest Food Web Game" *in this section. Also* "Forests and Soil" *an* outdoor *and* indoor *activity in Section 4 comparing forested and non-forested sites for detritivores and their work in soil formation.*

Background:

See INSIGHTS, *Section 2, Forest Ecosystems.*

Materials:

Small net bags, rotten meat, rotten fruit, string, labels, forceps or tweezers, magnifying glass or hand lens, *Alaska Ecology Card*s, clipboards and writing paper or field note books, pencils or pens. Copies of Science Card *(following page).*
OPTIONAL: field guides to forest invertebrates.

Procedure:

IN ADVANCE, choose a site anywhere in a forest.

One day or more before class, tie 2 small net bags for each team at nearby spots on the forest floor. One should be filled with rotten meat and the other filled with rotten fruit.

1. *IN CLASS,* discuss the role of **detritivores** in the forest **ecosystem.** Are detritivores **consumers**? What do they consume? Where are they represented on a forest **food chain**? What kind of wildlife will the students be looking for at the outdoor site?

2. Tell the students they will be looking for forest detritivores in action. Review the detritivore cards from the *Alaska Ecology Cards* series before going to the forest site.

Classroom Follow-Up:

1. Students look through the *Alaska Ecology Cards* or field guides of forest invertebrates and insects to find pictures of the organisms that they observed in the field.

2. Students label their field drawings. Be sure to look up carrion beetles, blow flies, springtails, and molds.

3. Discuss student answers to the questions on the Science Card. *Students will likely find more animals around the meat and more fungi around the fruit. Like other organisms, detritivores eat specific kinds of food. Some eat plants; others eat meat. Rotten smells are evidence of microscopic detritivores. Without detritivores, the forest would be overflowing with dead plants and animals.*

EXTENSION:

Research forest detritivores and create a display. Students use the *Alaska Ecology Cards* or other "Curriculum Connections" resources (*following*) to find out more about forest detritivores. They use this information along with sketches or samples to make a poster or display of these seldom seen forest wildlife.

Curriculum Connections:

(See appendix for full citations)

Books:

Fungi (Tesar)

Taiga (Kaplan)

Taiga (Sayre)

Website:

Alaska Science Forum
<www.gi.alaska.edu/AlaskaScienceForum>

Teacher Resources:

(See appendix)

SCIENCE CARD

Detritivores

1. In your field notebook, label a page "Forest Detritivores." Record your answers there to the questions below.

2. Look carefully at the small net bags that are tied to the forest floor in this area. Divide your page in half with a line and label one side as *Bag 1* and the other side as *Bag 2*. Below the label, record what each bag contains *(either rotten meat or rotten fruit).*

3. Look carefully in, on, and immediately around each bag using the magnifying glass or hand lens. Draw a picture of any organisms or animal signs that you find in your notebook below the appropriate bag label. Look for insects, other invertebrates, and fungi (fuzz or furry coatings or mushrooms).

4. Use the forceps or tweezers to carefully pick up each bag and look underneath it. Use the hand lens to examine anything you find. Draw pictures of any detritivores you find.

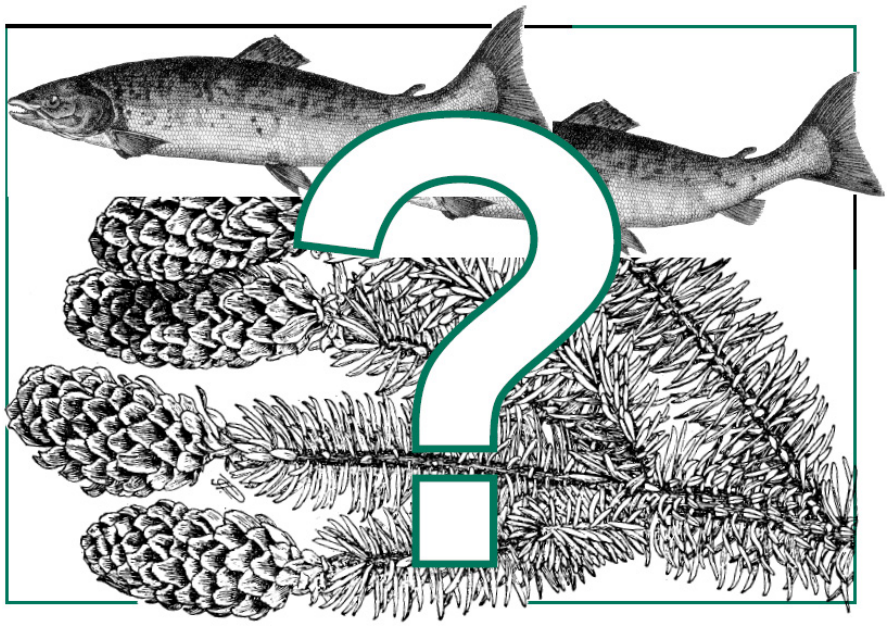
5. Compare the kinds of detritivores you find on each type of rotting material. Are they the same or different? What differences did you notice? Why might there be differences?

6. Do you see evidence of any microscopic detritivores?

7. What would the forest look like if all these invertebrates, fungi, and microscopic detritivores weren't around?

Forest Puzzlers

1 EXTENSION *ALERT: ALASKA ECOLOGY CARDS OPTIONAL*



Section 2
FOREST ACTIVITIES

Grade Level: 5 - 12
State Standard: S A-14
NGSS: 5-LS2-1., MS-LS2-2. MS-LS2-3.,MS-LS2-4,HS-LS2-2. HS-LS2-6.
Subjects: Science, social studies
Skills: Reading, reasoning, analyzing
Duration: Two 40 minute lessons
Group Size: Small and whole class
Setting: Indoors
Vocabulary: Carnivore, commensalism, conifer, competition, detritivore, ecology, herbivore, herbicide, invertebrates, mutualism, parasitism, pesticide, population explosion, predation, predator, symbiotic/ symbiosis

Objectives:

1. Students will describe the effects and consequences of forest ecosystem changes.

2. Students will apply their knowledge of forest ecology to real ecological problems.

Teaching Strategy:

Students analyze forest ecology problems and present possible solutions.

Prerequisite:

Students should understand and be able to apply the concept of "habitat" before starting this activity. *For more background and teaching activities about wildlife habitat, refer to another book in this curriculum set,* Alaska's Wildlife Conservation, *Section 1, Home Sweet Habitat. Additional activities that teach habitat concepts are available in* Project WILD.

Materials:

Copies of "Forest Ecology Puzzlers" *(following pages)*.

Background:

See INSIGHTS, *Section 2, Forest Ecosystems.*

Procedure:

DAY ONE:

1. Divide the class into three groups and give each a different puzzler.

2. Review the vocabulary words with the class. Ask students to read definitions from the glossary or dictionary and list them on the board.

3. In small groups, students read the facts given, then solve the puzzle at the bottom of the page. Each group makes a summary of the problem, the possible cause, and possible solutions.

4. If time allows, each group trades puzzlers.

DAY TWO:

1. Each group presents its puzzler and the possible solutions.

2. Students read the corresponding "What Ecologists Discovered" and compare their ideas to the ecologists' ideas.

3. Discuss the precautions people need to consider before changing an ecosystem.

Evaluation:

Students write a paragraph summarizing possible consequences of human changes to ecosystems. Students should also summarize ways to avoid or resolve problems that arise from changes.

EXTENSION:

Research local forest issues. Students research local forest issues and present them to the class. Each problem should have a student-designed solution. Students submit their final solution to a local forest agency.

Credits:

Adapted from Western Regional Environmental Education Council, Project WILD and Project WILD Aquatic Education Activity Guides, 1992. *For information on Project WILD, contact the Project WILD Coordinator, Alaska Department of Fish & Game (Address: 333 Raspberry Rd, Anchorage, AK 99518).*

Curriculum Connections:

(See appendix for full citations)

Books:

Alaska's Forest Resources (Alaska Geographic Society)

Alaska Wildlife Notebook Series (ADF&G)

Ancient Ones, The World of the Old-Growth Douglas Fir (Bash)

Journey Through the Northern Rain Forest (Pandell)

My Side of the Mountain (George)

Shrinking Forests (Tesar)

Taiga (Sayre)

Websites:

Alaska Science Forum
<www.gi.alaska.edu/AlaskaScienceForum>

Staff-written Alaska newspaper articles: Anchorage *Daily News* Archives <www.adnsearch.com> or Fairbanks *Daily News-Miner* <www.newsminer.com>

Forest Ecology Puzzler

ALDERS AND CONIFERS

The Facts:

• Nitrogen is a mineral element needed by all living things, because it is a basic building block of the chemicals that form cells. Nitrogen is passed from the nonliving environment to plants and other **producers** and then through **food chains** and **food webs**.

• Most of the nitrogen available on earth is in a gas form in the atmosphere. In fact, 78% of the air we breathe is nitrogen.

• Plants cannot use nitrogen from the air; they must obtain it from the soil.

• **Symbiotic** fungi living in the roots of alders are able to take nitrogen from the air and change it to a form plants can use. The alders use this converted nitrogen to build alder leaves.

• When alder leaves are decayed by soil **detritivores**, the nitrogen in the leaves again becomes part of the soil and can be reused by alders or other plants. As a result, soil that is poor in nitrogen becomes enriched with nitrogen after several years of alder growth.

The Puzzler:

Forest researchers want to grow **conifer** trees more quickly. They know that conifers grow quickly if they have good supplies of minerals, sunlight, and water. They notice that slow-growing conifers are often shaded by faster-growing alders. So they decide to reduce the **competition** for sunlight by spraying some experimental sites with **herbicides** to kill alders without harming conifers. For a few years, all the conifers grow faster, but then, those growing on sites with less soil, begin to wither. What do you think caused these results?

Forest Ecology Puzzler

WOLVES, BEAVERS, AND SALMON

The Facts:

• In order to reproduce successfully, salmon require spawning grounds with gravel of a certain size, water with a particular temperature range and oxygen content, and aquatic **invertebrates** to feed their offspring. These conditions are only met in certain locations in a stream.

• Salmon must have clear access up streams in order to travel between the ocean and their spawning areas. Large waterfalls, log jams, or beaver dams can prevent salmon from reaching their spawning locations.

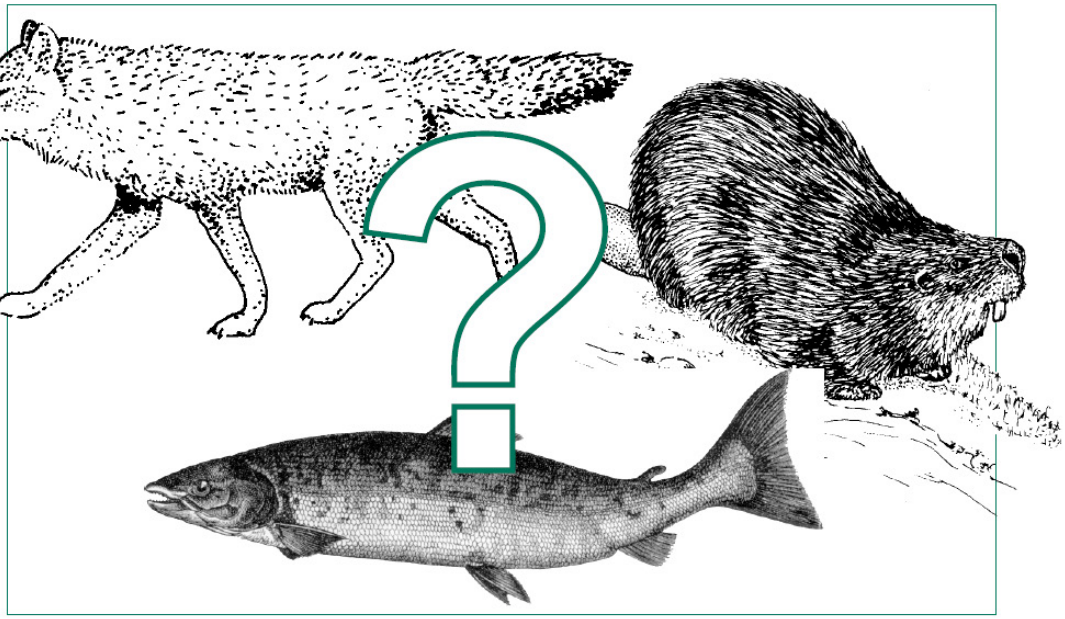
• Wolves prey on a variety of **herbivores**. In most areas, moose and caribou are their primary prey. But, when these prey are scarce, wolves switch to smaller prey such as spawned-out salmon, beaver, or muskrat.

• The **population** – number – is usually limited by a combination of factors, including **predators**, **parasites**, food supplies, and weather. The relative importance of these factors changes from year to year and place to place. For example, **predation** may be the most important factor limiting numbers in one place and time, while shortages of food may be the most important at another place and time.

The Puzzler:

In one part of Alaska several years ago, populations of deer were low and biologists wanted to do something to help the deer population. They determined that predation by wolves was an important factor limiting the deer population.

So, biologists put poison in some beaver carcasses and placed these as bait for the wolves. Because other prey were in short supply, the wolves readily fed on the carcasses and many died. With this reduction in wolf numbers, the deer population began to increase. A few years later, fisheries biologists were puzzled when salmon numbers dramatically decreased. What happened?



Forest Ecology Puzzler

FORESTS WITH ONLY ONE KIND OF TREE

The Facts:

• The numbers of insects feeding on the leaves or other tissues of trees normally goes up and down. In a natural forest, sometimes their numbers go way up. This is called a "**population explosion**." Such outbreaks are usually controlled by a combination of **predators**, **parasites**, food supplies, and weather.

• The numbers and kinds of animals living in a forest depend on the variety of habitats available. Generally, forests with many vegetation layers and a mixture of species of live and dead trees provide habitat for more kinds of animals.

• Just as some people do not become sick when a flu hits, some individual trees are better able to resist certain insect pests.

• The number of **carnivores** is always much smaller than the number of the **herbivores** they eat. Certain **pesticides** (such as DDT) are passed through food chains just like nutrients. Carnivores retain most of the pesticides stored in the bodies of all the **prey** they consume. As a result, carnivores accumulate higher doses of pesticides than do herbivores.

• Genetic variation in individuals in a population of insects or trees means that some individuals may be more resistant to a poison, disease, or parasite. This resistance is often passed to offspring.

The Puzzler:

In the past, when people wanted large, healthy trees suitable for timber harvest, they planted a forest of only the species desired. Foresters first selected a few individual trees that were tall, straight, fast-growing, and of high value for their wood. They collected seeds from these trees, cultivated seedlings, and planted a new forest. To reduce **competition** for sunlight and minerals , they removed other trees and shrubs.

The planted trees grew quickly at first, and it looked as though there would be plenty of timber to harvest when the trees were full-grown. Then one year, the forest was attacked by a mob of insects that ate the leaves of the trees. In some cases, nearly all the planted trees were attacked and began to die.

In order to save their forest, the owners sprayed DDT or other pesticides to kill the insects. This helped at first. The numbers of insect pests dropped, and the trees began to recover. Then, without warning, insect pest numbers rose higher than before. The pesticide used originally no longer worked. Most of the trees in the planted forest died.

Explain why the insect outbreak occurred, why nearly all the trees were killed, and why this would rarely happen in a natural forest.

Forest Ecology Puzzler

WHAT ECOLOGISTS DISCOVERED

Alders and Conifers

When the alders were killed, all the nitrogen in their leaves was returned to the soil. That recycled nitrogen and the nitrogen already present filled the needs of the conifers for a few years. With plenty of nitrogen and more sunlight, the conifers grew faster.

Eventually, those growing on sites with little soil took most of the nitrogen from the soil and stored it in their needles. Unable to use nitrogen from the air, and without alders and their **symbiotic** bacteria to enrich the soil, these conifers were unable to get the nitrogen they needed to grow. Indirectly, the conifers needed the alders, even though the alders competed with them for sunlight.

Wolves, Beavers, and Salmon

Without many large animals to eat, wolves turned to beavers for food. Soon there were fewer beavers. When the biologists poisoned the wolves, the beaver population grew. More beavers built more beaver dams and blocked fish passage to important spawning areas. Because salmon could not reach spawning areas, they could not reproduce. When the adults died, there were few young to replace them.

Forests With Only One Kind of Tree

Today, forest scientists know that the method of growing new trees described in the puzzler actually encourages outbreaks of insects and diseases that kill trees. Here's why.

With only a couple kinds of trees, all of the same age in this planted forest, only a few animals can find what they need to live. With fewer predators and parasites, insect populations are more likely to explode, given good weather and abundant food.

By planting tree seedlings from just a few selected trees, growers created a forest likely to get sick. If the trees were not immune, any insect or disease had an abundant, undefended, food supply. When weather conditions were right, the insect populations (no longer limited by food, predators, or parasites) exploded and overwhelmed the trees.

Spraying **pesticides** at first reduced the numbers of problem insects – and any natural predators and parasites present. If some of the insects survive, they're "resistant." They will pass on to their babies the ability to survive this kind of pesticide. Then that pesticide will no longer kill them.

The natural predators and parasites recover more slowly, if at all, because there were fewer of them before the pesticide was sprayed. Without natural controls, the next problem insect explosion occurs quickly. This explosion cannot be reduced with the same pesticide.

Forest Ecosystem Scavenger Hunt

ALERT: ALASKA ECOLOGY CARDS OPTIONAL

Section 2
FOREST ACTIVITIES

Grade Level: 5 - 9
State Standards: AC E-2, S A-14, S B-1
NGSS: 5-LS2-1,MS-LS2-2.,MS-LS2-3. HS-LS2-4.,HS-LS2-5.
Subjects: Science
Skills: Observation, inferring, application
Duration: 45 minutes or more
Group Size: 3-5
Setting: Outdoors
Vocabulary: Broadleaf, carbon dioxide, carnivore, commens-alism, conifer, consumer, detritivore, ecosystem, erosion, fungus, herbivore, interdependence, invertebrate, mammal, microscopic organism, oxygen, mutualism, nonliving element, omnivore, parasitism, photosynthesis, predation, producer, recycle, respiration, symbiosis

Objective:
Students will identify concepts and components of a forest ecosystem.

Teaching Strategy:
Students participate in a scavenger hunt to identify and review roles of organisms in a forest ecosystem.

Complementary Activities:
OUTDOOR: "Insect Signs," "Mammal Signs," *and* "Bird Signs" *in this section. Also* "Track Casting" *in Section 3, Forest Learning Trail;* "Snag a Home" *in Section 4, Succession.*

Materials:
Copy of the scavenger hunt list for each group *(following pages)*.
OPTIONAL: *Alaska Ecology Cards.*

Background:
See INSIGHTS, *Section 2, Forest Ecosystems.*

Procedure:
1. Before distributing the scavenger hunt list, add specific animals, plants or other items which represent your local area.

2. Review the list of items together. Help students define unfamiliar terms.

3. Explain that some items on the "Forest Scavenger Hunt List" require creative thinking. *For example, students may not see specific animals, but they could find animal signs such as droppings, browse marks or tracks. Similarly, students will not see* ***carbon dioxide****, but they can deduce its presence by their own presence or the presence of animals that breathe it out, or by plants which use it in* ***photosynthesis*** *and* ***respiration****.*

Evidence of ***symbiosis*** *might include a* ***parasitic*** *growth on a plant, a deer or moose (which requires* ***microscopic organisms*** *to digest its food), a swallow (which must have holes in trees made by woodpeckers or fungi to survive), or seeds that stick to someone's socks.*

4. Explain the rules:
   - Although students can review the *Alaska Ecology Cards* or the Glossary, they may not write anything down until the hunt begins. (b) When students find an item, they are to **write each "find" on their list rather than collecting it**.
   - Students can use the same item more than once on the list as long as the item fits more than one category.
   - The search ends when any team finds one example of each item on the list, or at the end of a specified time.

5. Once the class is outside, set clear boundaries for the hunt. Remind students to respect wildlife and the forest ecosystem by leaving plants as they find them.

6. When the search ends, the first team finished reads aloud its list, explaining why their items are examples or evidence. Other teams follow with items that they found which were different from the first team's list.

7. All teams cross from their list anything that another team also listed. Any incorrect answers must also be crossed off. Each team then adds the number of allowed items remaining on its list and scores one point per item. The team with the most points wins.

Evaluation:

Students write a description of the forest ecosystem using the scavenger hunt list. Students explain the interconnections.

Curriculum Connections:

(See appendix for full citations)

Books:

Ancient Ones, The World of the Old-Growth Douglas Fir (Bash)

Dead Log Alive (Kittinger)

A Dead Log (Green)

One Small Square: Woods (Silver)

Shrinking Forests (Tesar)

Teacher Resources:

(See appendix)

Forest Scavenger Hunt List

Find examples or evidence of the following and list them in the space at the right or on another sheet of paper:

a producer
a carnivore
a symbiosis
photosynthesis
parasitism
an insect
a detritivore
an herbivore
mutualism
predation
commensalism
an omnivore
an animal
a fungus
a plant
microscopic organisms
a nonliving element
an invertebrate
a mammal
interdependence
a broadleaf
a consumer
a tree
water
erosion
a bird
oxygen
humans
carbon dioxide
conifer
recycling of minerals
a tree or plant that tolerates shade
a tree seedling
a tree that died
a tree that is dying
a place where two different kinds of trees grow next to each other
moss on a tree

Home is a Tree

ALERT: ALASKA ECOLOGY CARDS REQUIRED

Section 2
FOREST ACTIVITIES

Grade Level: K - 3

State Standards: S A-14, S A-5, S B-1, A A-1
NGSS: K-ESS3-1

Subjects: Science, art

Skills: Analyzing, drawing, recording

Duration: 2 30-minute classes

Group Size: Whole class

Setting: Indoors

Vocabulary: Broadleaf, evergreen, habitat, names of forest animals

Objectives:

Students will describe why trees are important to wildlife by making a mural with pictures of wildlife peeking out from their homes in trees.

Materials:

Copies of forest wildlife from the *Alaska Ecology Cards*, scissors, crayons or markers, butcher paper for mural, tape.

Background:

See INSIGHTS, *Section 2, Ecosystem Connections: "Home is in a Tree" Fact Sheet;* and *Alaska Ecology Cards.*

Procedure:

1. Ask students to brainstorm animals that depend on trees as part of their **habitat**. What role do trees play in each animal's life? Record their observations on the board.

2. Distribute copies of appropriate *Alaska Ecology Cards* and explain that these animals use trees or the areas around them for shelter, food, or nesting sites. *The animals wouldn't necessarily all use the tree at the same time because different animals use trees for different reasons during different times of the year.*

3. Ask the students to draw and color a large **evergreen** tree and a large **broadleaf** tree on the butcher paper. Add a fallen log. Students also color the animals on the copies of the *Ecology Cards*. If an animal that the students' brainstormed is not represented on the cards, the students should draw their own.

4. Decide where each animal would live in and around the trees. Draw with pencil a box at that spot smaller than the *Ecology Card* picture. (Perhaps make a template for younger students.)

5. Using scissors, cut three sides of the box on the murals. Then fold the flap back along the uncut side. The cut flaps should work like little doors.

6. Make a tab for each door by cutting a small piece of paper 1 inch long by $^1/_2$ inch wide. Tape half of the piece of paper to the back of the door so that $^1/_2$ inch hangs free and forms a tab. Be sure to tape the piece of paper to the

back of the door edge opposite the uncut side. You can use the tabs to keep the doors closed by tucking them under the cut edges.

7. Place the animal *Ecology Cards* behind their proper "doors" on the mural and glue or tape in place.

8. Open the doors to see what is underneath the leaves and bark and around the roots and under the rotting log.

Credits:

Adapted by Jeanne L. Williams, teacher at Kingikmiut School, Wales, Alaska, from National Wildlife Federation, *Home is Where the Habitat Is — National Wildlife Week Educator's Guide*, 1995.

Curriculum Connections:

(See appendix for full citations)

Books:

Alaska Wildlife Notebook Series (ADF&G)

The Big Tree (Hiscock)

The Gift of the Tree (Tresselt)

In a Tree (Schwartz)

Look Closer: Tree Life (Greenaway)

Once There was a Tree (Romanova)

A Tree in the Ancient Forest (Reed-Jones)

Tree Trunk Traffic (Lavies)

Media:

Once There was a Tree (Video) (Reading Rainbow)

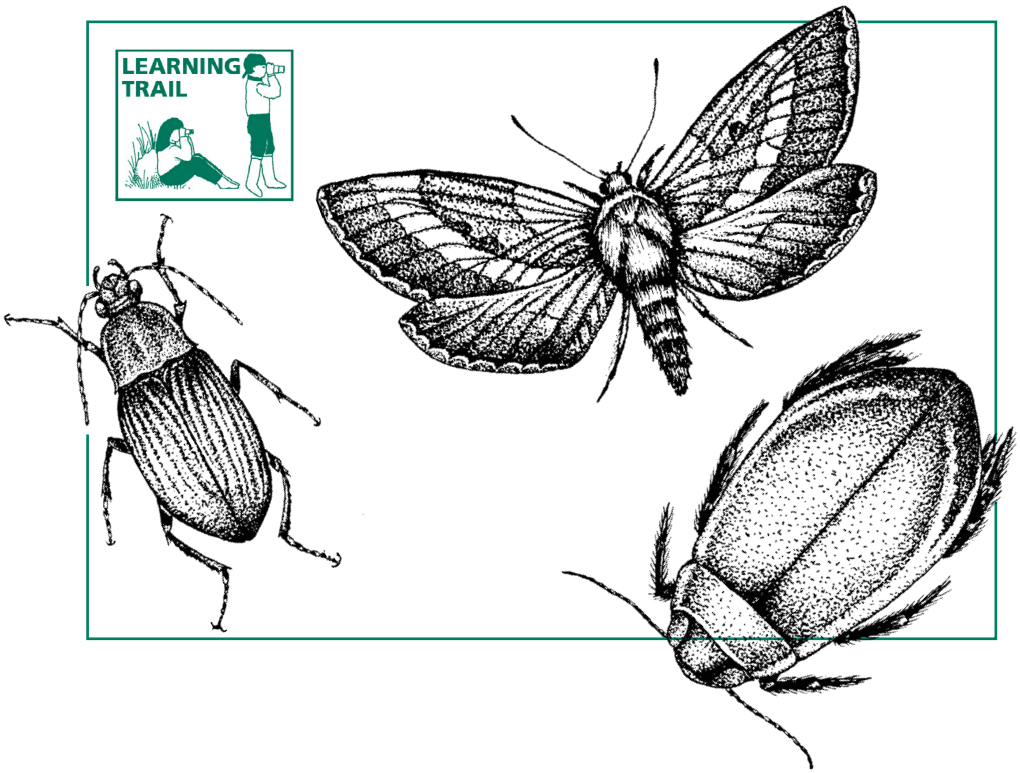
Teacher Resources:

(See appendix)

Insect Signs

1 EXTENSION

ALERT: ALASKA ECOLOGY CARDS REQUIRED



Section 2
FOREST ACTIVITIES

Grade Level: K - 12

State Standards: A A-1, L B-3

NGSS: K-LS1-1., K-ESS3-1.,2-LS4-1 3-LS4-3., 4-LS1-1, 5-LS2-1. MS-LS2-3.

Subject: Science

Skills: Observing, comparing, inferring, identifying

Duration: 50 minutes

Group Size: Individuals

Setting: Outdoors & indoors

Vocabulary: Cambium, consumer, food chain, gall, habitat, larvae, names of insects, predator, prey, sap

Objective:

Students will identify signs of insect activity and determine the role of insects in a forest food chain.

Complementary Activities:

OUTDOOR – "Detritivores," "Forest Ecosystem Scavenger Hunt," "Mammal Signs," *and* "Bird Signs" *in this section;* "Snag a Home" *in Section 4, Succession. INDOOR* – "Forest Food Web Game" *in this section.*

Materials:

Copies of "Insect Signs Chart" and "Insect Signs Science Card" *(next page*) for each student, hand lens, clipboards and writing paper or field note books, pencils or pens. *Alaska Ecology Cards* of forest insects.

Background:

See INSIGHTS, *Section 2, Forest Ecosystems.*

Procedure:

IN ADVANCE, locate a forest site with a variety of live plants (trees, shrubs, and groundcover) and dead leaves. Look for a spot that shows galls *(see illustration on Insect Signs Chart)* on plants, or a tree with bark engravings or reddish brown sawdust at its base. Record the number and location of insect signs you find for later comparison with student notes.

1. *IN CLASS,* discuss the role of insects in the forest ecosystem. Are insects **consumers**? What do they consume? Where are they represented on a forest **food chain**?

2. Using the information on the *Alaska Ecology Cards* of forest insects, review some of the traits, **habitats**, **prey**, and **predators** before going to the forest site.

3. Discuss and compare student findings. Where do the found insects fit in the food chain? Students can use the *Alaska Ecology Cards* to illustrate information and enhance the discussion.

4. Pose the following questions: Will you find more or less insect signs at other seasons of the year. Why? How does this affect decomposition in the forest?

5. If they have studied other ecosystems (tundra, rainforests, wetlands, etc.), students compare what they found

in their local forest to the work and abundance of insects elsewhere.

EXTENSION:

Research forest insects and create a display. Students use the *Alaska Ecology Cards* or other "Curriculum Connections" resources (*following*) to find out more about their forest insects. They use this information along with sketches of the insect signs they found to make posters or a display of forest wildlife.

Curriculum Connections:

(See appendix for full citations)

Books:

Insects: A Guide to Familiar American Insects (Cottam)

Insects and Diseases of Alaskan Forests (Holsten)

National Audubon Society Field Guide to North American Insects and Spiders (Milne)

Website:

https://www.gi.alaska.edu/AlaskaScienceForum/

Teacher Resources:

(See appendix)

SCIENCE CARD

Insect Signs

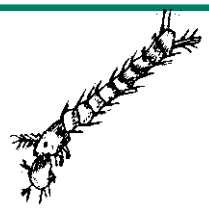
Insects are some of the most important **consumers** in forest ecosystems. The "Insect Signs Chart" shows some of the evidence insects leave behind. How many of these signs can you find in this area?

1. Write the heading "Insect Signs" on a page in your field notebook. Record the number of different types of insect signs you find in this area.

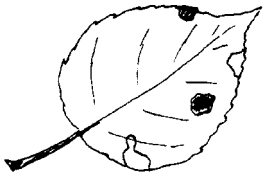
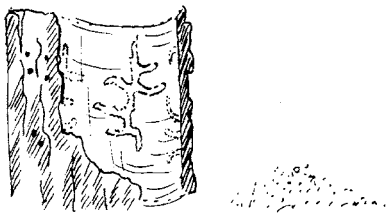
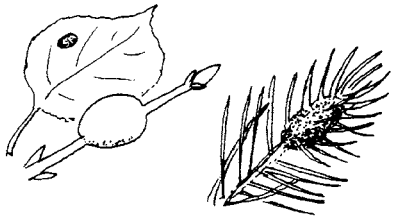
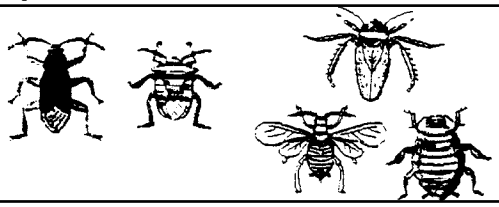
2. List each type of insect for which you find evidence. Draw a sketch to remind you what its sign looked like. Your sketch or its label should include the leaf or type of wood where you found the sign – the insect's **habitat**.

3. Where do the insects whose evidence you found fit in the food chain? Would another kind of forest have different insects? Record your answers in your notebook.

4. If you find the insects themselves, draw a picture of them in your notebook to help you identify them later.

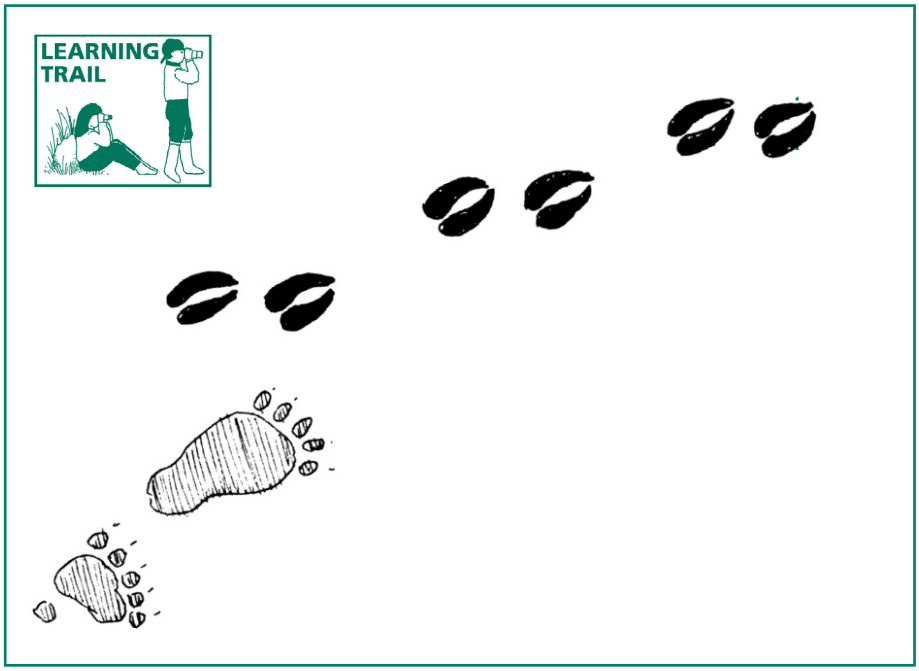


Insect Signs Chart

FEEDING METHOD	SIGNS	EXAMPLES OF INSECTS THAT LEAVE THESE SIGNS
Leaf-chewing Insects		 Larvae of moths, butterflies, sawflies, and beetles
Leaf-mining Insects		 Tiny larvae of moths, beetles, flies, and wasps
Leaf-rollers and Tent Caterpillars		 Larvae of moths
Cambium-eating Insects		 Larvae of bark beetles, a few moths, and some flies
Gall-making Insects		 Wasps, flies, sawflies, gall-making aphids, and spruce aphid
Sap-sucking Insects		 Adult Insects

Mammal Signs

1 EXTENSION ***ALERT: ALASKA ECOLOGY CARDS OPTIONAL***



Section 2
FOREST ACTIVITIES

Grade Level: 5-12

NGSS Standards: 5-ESS3-1. MS-LS2-1.,MS-LS2-2.

Subjects: Science, language arts

Skills: Observing, identifying, inferring, comparing, descriptive writing

Duration: 50 minutes

Group Size: Individuals

Setting: Outdoors

Vocabulary: Animal names, carnivore, consumer, food chain, habitat, herbivore, predator, prey

Objective:

Students will use a variety of signs to identify the presence of specific mammals and determine their diet.

Complementary Activities:

OUTDOOR – "Forest Ecosystem Scavenger Hunt," "Insect Signs," *and* "Bird Signs" *in this section.* "Track Casting" *in Section 3, Forest Learning Trail.* "Snag a Home" *in Section 4, Succession.* INDOOR – "Forest Food Web Game" *in this section.*

Materials:

Copies of "Mammal Signs Chart" *(following)* and "Mammal Signs Science Card" for each student, clipboards and writing paper or field note books, pencils or pens.
OPTIONAL: *Animal Tracks of Alaska* and *Alaska Ecology Cards.*

Background:

See* INSIGHTS, *Section 2, Forest Ecosystems.

Procedure:

IN ADVANCE, locate several forest sites where you find evidence of two or more mammals. Good choices may be near open water, sites with snow, and areas with a variety of shelter. Record the number of signs you find on the instruction card below as an incentive for students. Make a separate record of the mammal signs at these sites for later comparison with student notes.

If desired, you can have students make a plaster track prints of what they find. See *"Track Casting"* in Section 3, *Forest Learning Trail.*

1. *IN CLASS,* brainstorm what kind of mammals live in a forest. Discuss what these animals obtain from a forest *(food, shelter, water, space — **habitat**)* and why forest habitat is important for their survival. Review **predator** and **prey** relationships.

2. Tell the students they will go in search of forest mammals. Students may not see specific animals, but they could find animal signs such as droppings, browse marks, or tracks.

3. Give each student the "Mammal Signs Science Card" and the "Mammal Signs Chart."

Classroom Follow-Up:

1. Students discuss and compare their findings. Based on what they found, where do their animals fit in a forest **food chain** and forest **food web**?

2. Ask if they think they might find more or less mammal sign at other seasons of the year. Why?

3. Where might they go to find signs of mammals on the chart that were not found during class? What does that habitat offer that the class forest does not offer?

EXTENSION:

Research forest mammals and create a display. Students use the *Alaska Ecology Cards* or other "Curriculum Connections" resources (below) to find out more about their forest mammals. They use this information along with sketches of tracks and signs to make posters or a display of forest wildlife.

Curriculum Connections:

(See appendix for full citations)

Books:

Alaska Mammals (Smith)

Alaska Wildlife Notebook Series (ADF&G)

Animal Tracks of Alaska (Sheldon)

Animal Tracks of Alaska (Stall)

Mammals of Alaska (Alaska Geopgraphic)

Teacher Resources:

(See appendix)

SCIENCE CARD

Mammal Signs

1. Write "Forest Mammals" at the top of a page in your field notebook. Record the number of mammals whose evidence you find in this area.

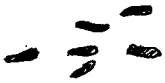
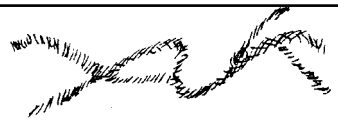
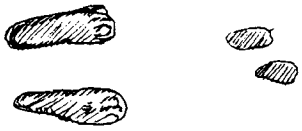
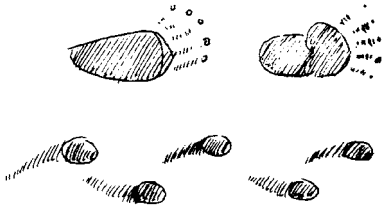
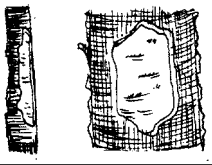
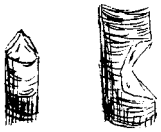
2. List mammals whose evidence you find along the left side of your page.

3. Write what you think they eat based on the signs you find on the right side of the page. Decide whether they are **herbivores** or **carnivores.**

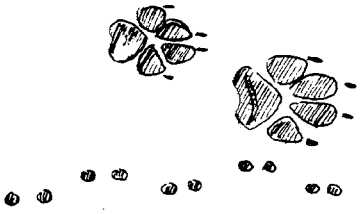
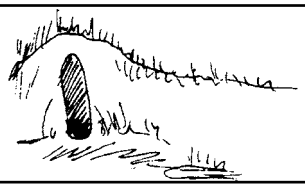
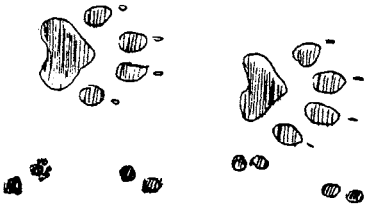
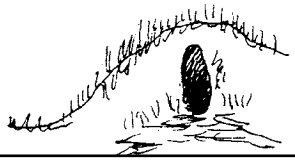
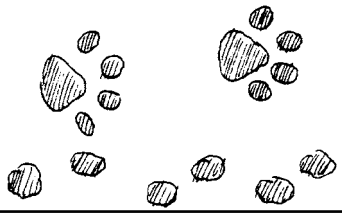
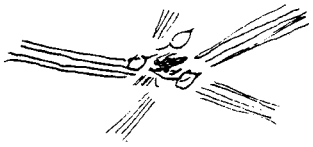
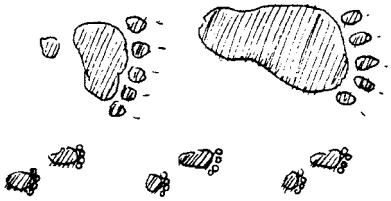
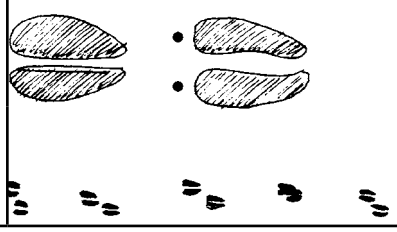
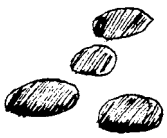
4. Write a short description of the signs next to each animal's name. Try to compare each sign to something familiar. Make a rhyme, or a humorous statement in order to help you remember which sign is evidence of which animal. *(For example: Deer droppings look like big chocolate chips. Hare-browsed willows are sharp. Ow!)*

5. If you find signs of other mammals while walking to or from this site, make notes of your findings on the page. The "Mammal Signs Chart" shows evidence of mammals that you might find in this forest. There are signs of at least ____ kinds of mammals in this area. Can you find these signs and identify them?

Mammal Signs Chart

ANIMAL	TRACKS	DROPPINGS	OTHER SIGNS
Shrew			
Vole, Mouse, or Lemming			 Tunnels under the snow or, after the snow melts, small piles of grasses lying in patterns like tunnels.
Squirrel			 Middens or large piles of cones, cone scales, and cone cobs. Also, mushrooms hanging in trees.
Snowshoe Hare			 Willows, birch, rose, aspen, or other plants with stems neatly clipped.
Porcupine			 Large strips or patches of bark missing from a tree trunk.
Beaver			 Tree stumps or branches with gnawing marks; lodges or dams of sticks and branches.
River Otter			 Strong odor; trampled grasses and plants, dens under tree roots, and sledding trails on small slopes.

Mammal Signs Chart

ANIMAL	TRACKS	DROPPINGS	OTHER SIGNS
Marten			
Fox or Coyote			 **Dens**
Wolf			 **Dens**
Lynx			 **Scraping around droppings**
Bear			 **Grasses and sedges that have been grazed or clipped off. Skunk cabbage that is torn or dug up.**
Deer			 **Huckleberry or other shrubs with stems that appear to have been chewed off.**
Moose			 **Birch, aspen, willow, or other plants with stems roughly browsed (not neatly clipped).**

Bird Signs

2 EXTENSIONS *ALERT: ALASKA ECOLOGY CARDS OPTIONAL*

Bird landing and walking in snow

Section 2
FOREST ACTIVITIES

Grade Level: 5 - 12

NGSS: 5-ESS3-1., MS-LS2-1. MS-LS2-2.

Subject: Science

Skills: Observing, identifying, inferring

Duration: 50 minutes

Group Size: Individuals

Setting: Outdoors

Vocabulary: Bird names, food chain, food web, habitat

Objective:

Students will recognize bird signs and identify the species and behavior of any birds in the area.

Complementary Activities:

OUTDOOR – "Forest Ecosystem Scavenger Hunt," "Mammal Signs," *and* "Insect Signs" *in this section;* "Snag a Home" *in Section 4, Succession. INDOOR* – "Forest Food Web Game" *in this section.*

Background:

See INSIGHTS, *Section 2, Forest Ecosystems.*

Materials:

"Bird Signs Chart" and "Bird Signs Science Card" for each student, clipboards and writing paper or field note books, pencils or pens.
OPTIONAL: Field guides to animal tracks and birds, binoculars, and *Alaska Ecology Cards.*

Procedure:

IN ADVANCE, locate several forest sites where you can find evidence of several birds. Good choices may be near open water, sites with snow, and areas with a variety of shelter. *It is okay to salt the area you choose with a feather or raptor casting.* Record the number and kinds of bird signs you find for later comparison with student observations and notes. Fill in the number of signs on the "Bird Signs Science Card."

1. *IN CLASS,* brainstorm what kind of birds live in a forest. Discuss what these wildlife obtain from a forest *(food, shelter, water, space — **habitat**)* and why forest habitat is important for their survival. Review the concept of **food chains**. Where are birds on the forest food chain?

2. Tell the students they will go in search of forest birds. Students may not see specific birds, but they could hear birds or find bird signs such as feathers, nests, whitewash (droppings), or tracks.

3. Give each student the "Bird Signs Science Card" and the "Bird Signs Chart."

Classroom Follow-Up:

1. Students discuss and compare their findings. Based on what they found, what do their birds need in the forest ecosystem? Where do they fit in the forest **food web**?

2. Ask if they think they might find more or less bird sign at other seasons of the year. Why?

3. Where might they go to find the birds or their signs illustrated on the Chart that were not found during class? What does that habitat offer that the class forest does not offer?

EXTENSIONS:

A. **Research forest birds and create a display.** Students use the *Alaska Ecology Cards* or other "Curriculum Connections" resources (*following*) to find out more about their forest birds. They use this information along with sketches of tracks or signs to make posters or a display of forest wildlife.

B. **Set up a winter bird feeding station visible from the classroom.** If a wooded area is near your classroom window, depending on grade level, students set up a winter bird feeding station after researching the best devices, food, and location through their local Alaska Fish and Game office, Audubon Chapter, or "Curriculum Connections" *(below).* Students keep a class chart of the kinds of birds that come to their feeding station, how often they are seen, and note their behaviors. Before the school year ends, students calculate the results and discuss the seasonal changes in bird visits.

Curriculum Connections:

(See appendix for full citations)

Books:

Alaska Wildlife Notebook Series (ADF&G)

Guide to the Birds of Alaska (Armstrong)

The National Audubon Society North American Birdfeeder Handbook (Burton)

Teacher Resources:

(See appendix)

SCIENCE CARD

Bird Signs

You have heard of mammal tracks. Did you know birds leave signs too? Open your eyes and look carefully, you will be able to find ____ bird signs that are in this area.

1. Write "Forest Birds" at the top of a page in your notebook.

2. Record the number of birds whose evidence you find at this site. Then list them by name along the left side of the page.

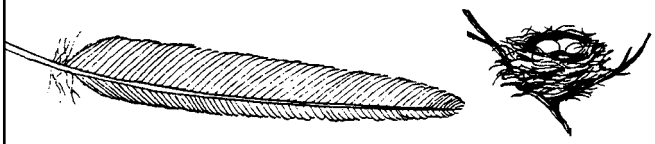
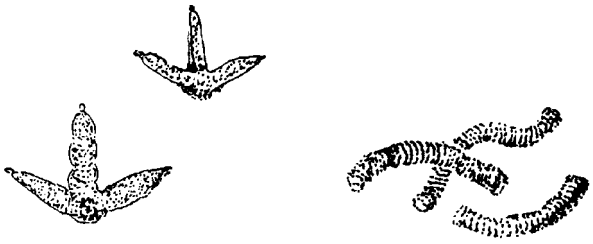
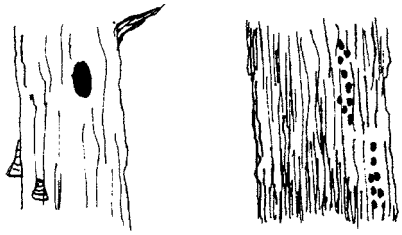
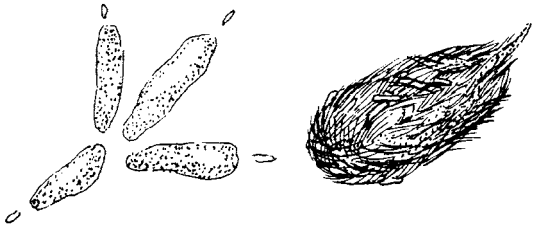
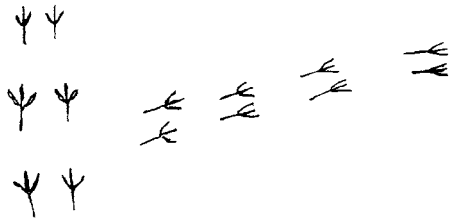
3. Listen and look carefully, for these birds may still be nearby. Have one person in your group repeatedly make a shhh, shhh, shhh sound. Sometimes birds will move or call when they hear this sound.

4. If you see birds, watch them. Can you identify them using the guide book? Watch and record their behavior. What trees do they like most? Are they eating? Gathering sticks? Record what you see in sketches or words.

5. If you found signs of grouse or woodpeckers, look for these groups in a field guide to birds. Based on the season and the habitat you are in, can you figure out which kind of grouse or woodpeckers might be in this area? List the species you think are most likely to have made the signs.

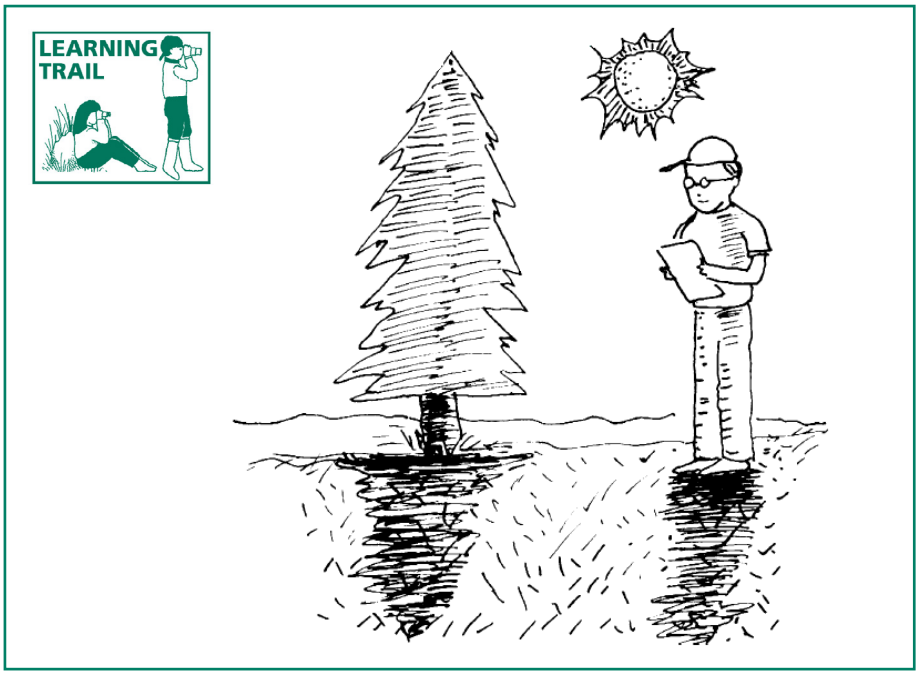
6. If you find signs of other birds enroute to the site, make notes of your findings in your notebook.

Bird Signs Chart

BIRD	SIGNS	
Signs Left by Many Birds		**Feathers, sticks or grass nests**
Grouse		**Grouse make 3-toed tracks on solid snow or wet soil, but in deep soft snow they make a trail that looks like a ditch in the snow. Their droppings seem dry and are shaped like fat worms. Listen for their hooting or low drumming calls.**
Woodpeckers		**Listen for tapping or drumming sounds. Look on live and dead trees for small or large holes that look like something drilled into the bark of the tree. Also look for flakes of bark around the base of trees.**
Raven		**Droppings and tracks around a dead animal.** **Hoarse croaking sounds.**
Hawks and Owls		**Hawks and owls regurgitate pellets of fur, feathers, and other indigestible bits of the prey. These pellets are cleaned of all meat, so that they smell and feel clean.**
Songbirds		**Listen for twittering, chirping, or other calls and songs.**


LEARNING
TRAIL

The Forest Learning Trail:
HOW TO SET UP STATIONS



Section 3
FOREST ACTIVITIES

Grade Level: K - 12
State Standards: S A-14, S A-15, S B-1, Geo E-5, A A-1
Subjects: Language arts, social studies, science, math, art
Skills: Write, read, speak, listen, compare, concentrate, count, draw, estimate, follow instructions, identify, imagine, infer, measure, observe, paint, predict, sensory awareness, work together, value clarification
Duration: Periodic, half day, or full day
Group Size: Small groups, several classes at a time, pairs, individuals, whole class
Setting: Outdoors

Objectives:
Students will reinforce and expand their knowledge of the forest ecosystem.

Teaching Strategy:
The Forest Learning Trail uses some or all of the 20 cross-curriculum, hands-on student-directed activities in a forest environment.

Materials:
Clipboards and writing paper or field note books, pencils or pens. Copies of each activity's "Science Card(s)" giving students directions to follow and questions to answer.
Note: Wear clothing suitable to your area.

Trail Setup:
IN ADVANCE, set up a *Forest Learning Trail* with several other teachers or individually in an area accessible to your school. Several classes can use the same *Forest Learning Trail,* so it only needs to be set up once.

Place learning stations in sets of 3-4. Divide your class into small groups. In this way, one leader can monitor the activities of 3-4 student groups at one time. Encourage parents and others in your community to attend, participate as leaders, and share their knowledge of the forest with students.

Trail Stations:
Each of the trail's 20 activities has a description to help you select and set up the site (3 activities have 2 stations each to compare and contrast forested and non-forested sites).

Copy the "SCIENCE CARDS." These can be given directly to students or placed at the stations for students to follow.

You may choose to include all the cards at once for a half-day or day-long trail, or use different groups of cards to set up different trails for use on separate days. You can also select those activities most relevant to your forest study or those most usable with your students.

Many other trail activities can be found in sections noted with this Trail Marker.

Tips for Success

Before hitting the trail:

Prepare the students' for a successful experience by using first two of the following activities. ***"Forest Bird Song Tag"*** will help use excess energy and calm students enough to pay attention along the trail. ***"Sensing Forest Mysteries"*** will help students focus on discovering the forest.

Keeping warm on the trail:

Consider planning an active game at the start, middle, and end of the trail to help students stay warm and interested. Tie any game into the forest by naming the teams using forest terms, forest wildlife, or ecosystem concepts.

After the Learning Trail:

"Forest Sharing" station ends the trail. The entire class gathers to share impressions of the forest. The "Classroom Follow-Up" section of each activity suggests things to do once students are back in the classroom.

Forest Learning Trail Activities

List and Objectives of Forest Learning Trail Activities
Note: some activities follow, others can be found in Sections 1, 2, 4, and 5.

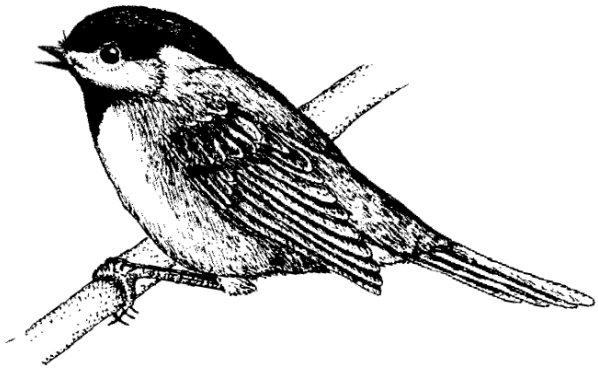
Section #	Activity Name	Learning Objective
3	***Forest Bird Song Tag***	Students will practice listening skills and learn to recognize the songs of forest birds common in their area.
3	***Sensing Forest Mysteries***	Students will use their senses of hearing, seeing, smelling, and touch while identifying items from the forest.
3	***Forest Views***	Students will write about a forest ecosystem from the perspective of an indigenous animal.
3	***Forest Art***	Students will observe and reproduce colors found in a forest environment.
3	***Forest Sounds***	Students will listen for and map forest sounds.
3	***Nosing About***	Students will use their sense of smell to identify a variety of items found in a forest ecosystem.
1	***Forests and Air***	After conducting an identical set of experiments in forested and non-forested sites, students will compare and contrast the results.
1	***Tree Identification***	Students will identify and illustrate characteristics of various Alaska trees.
1	***Tree Trunks***	Students will use a cross-section of a tree trunk to identify the function of the tree rings and infer environmental conditions that affected the growth rate of the specimen.
2	***Fungi***	Students will identify and describe forest fungi.
2	***Detritivores***	Students will identify, categorize, and compare detritivores based on the type of food they eat.
2	***Insect Signs***	Students will identify signs of insect activity and determine the role of insects in a forest food chain.
2	***Mammal Signs***	Students will use a variety of signs to identify the presence of specific mammals and determine their diet in the forest food web.

Forest Learning Trail Activities (cont.)

List and Objectives of Forest Learning Trail Activities
Note: some activities follow, others can be found in Sections 1, 2, 4, and 5.

Section #	Activity Name	Learning Objective
2	***Bird Signs***	Students will recognize bird signs and identify the species and behavior of any birds in the area.
4	***Snag a Home***	Students will look for evidence that dead trees comprise a link in some forest food chains.
4	***Forests and Sunlight***	Students will observe and compare densely forested and open forest sites to determine the role sunlight plays in a forest ecosystem.
4	***Forests and Soils***	Students will describe and compare soil composition found in forested and non-forested sites.
5	***Human Activities***	Students will identify effects of human activities in a forest and classify them as helpful or destructive to the forest ecosystem.
3	***Forest Sharing***	Students will match descriptive words or phrases to observations made in the forest.

Forest Bird Song Tag



Section 3
FOREST ACTIVITIES

Grade Level: 2 - 12

NGSS: 2-LS4-1

Subjects: Language arts, music, physical education

Skills: Listening, memory, concentrating

Duration: 15 minutes in class; 15 in game

Group Size: Entire class

Setting: Indoors & outdoors

Objectives:
Students will practice listening skills and learn to recognize the songs of forest birds common in your area.

Complementary Activity:
"Forest Sounds" *in this section.*

Materials:
Tape recorder; tape recorded songs of forest birds. There are a variety of records and tapes of bird songs available. Check with local libraries, museums, or bird watchers to borrow a copy, or purchase a copy *(see following Curriculum Connections and Teacher Resources).*

Procedure:
IN ADVANCE, use or make a tape recording of 6-8 songs of common forest birds. Record the songs *(see lists below)* along with the announcements of the birds' names on the tape. This portion of the tape will be used to teach students the bird songs.

Make a second tape recording with several repetitions of these songs in mixed order, without the name announcements. This portion of your tape will be used to play the game outdoors.

1. *IN THE CLASSROOM,* review the bird songs with students. Repeat the review immediately before going outside to play the game. You will want students to recognize the bird songs on your tape.

2. *PLAY BIRD SONG TAG.*
Divide the class into two teams, the Hawks and the Songbirds. Place markers showing the "Home Base of the Hawks," the "Home Base of the Songbirds," and a "Home Free" spot. Place these markers in a triangle at distances apart that are appropriate for your students. Have each team stand on or near its home base. Explain the ***rules of the game***:

(a) Call out the name of a bird that is recorded on the tape.

(b) All students must listen carefully while you play the bird song tape. When the song of the bird you named is played, the Songbirds must run towards the "Home Free" spot, and the Hawks must chase them.

(c) If a Songbird gets to the "Home Free" spot without being tagged by a Hawk, he survives and returns to the Songbird home base. If he is tagged, he becomes a Hawk.

(d) If a Hawk catches a Songbird to eat, she remains a Hawk and returns to the Hawk home base with her prey (who becomes a Hawk). If a Hawk does not catch a Songbird, she dies; her minerals are returned to the soil and are taken up by a plant whose seeds are eaten by a Songbird. In other words, starved Hawks become Songbirds.

(e) If either a Songbird or a Hawk runs out at the wrong song, he returns to his home base and takes two big steps backwards *(that is, moves farther away from the "Home Free" base)*.

(f) The team with the most players at the end of the game wins. The end of the game is whenever you decide it should end.

3. Remind students that when they are on the *Forest Learning Trail* or outside anytime, if they are quiet and listen, they may hear these birds.

NOTE OF CAUTION: If you are doing this activity in late spring as birds set up and defend nesting territories, be respectful if the tape draws an upset songbird trying to chase away the recorded competition.

Curriculum Connections:

(See appendix for full citations)

Books:

Guide to the Birds of Alaska (Armstrong)

Media:

Bird Songs of Alaska (CD) (Peyton)

Western Bird Songs (CD) (Peterson)

Teacher Resources:

(See appendix)

Suggested Songs

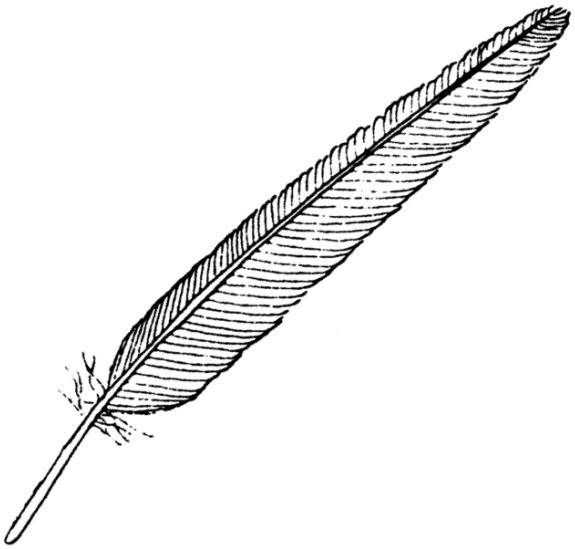
Suggested songs–Boreal Forest

Any woodpecker of Alaska
(chirp and drumming)
Gray Jay
Common Raven
Black-capped Chickadee
Common Redpoll
Pine Grosbeak
Great Horned Owl
Spruce Grouse

Suggested songs–Coastal Forest

Any woodpecker of Alaska
(chirp and drumming)
Common Raven
Northwestern Crow
Steller's Jay
Chestnut-backed Chickadee
Pine Siskin
Winter Wren
Blue Grouse
Varied Thrush

Sensing Forest Mysteries



Section 3
FOREST ACTIVITIES

Grade Level: 2 - 12

Subject: Science
NGSS: 2-LS4-1

Skills: Comparing, memory, sensory awareness

Duration: 40 minutes

Group Size: Small groups, whole class

Setting: Indoors

Vocabulary: Senses

Objectives:

Students will use their senses of hearing, seeing, smelling, and touch while identifying items from the forest.

Materials:

Clipboards and writing paper or field note books, pencils or pens for each student. Small box for **smell** items; large box for **touch** items; tape recorder; small contest prizes *(these awards can be tangible – such as a balloon – or intangible – such as getting to go to lunch first)*.

See: bark of a tree, lichen, twig browsed by a hare, moose, or deer, leaf, a piece of a feather, other animal sign.

Touch: tree bark, conifer branch, shelf fungi.

Smell: conifer branch, leaf litter, poplar or cottonwood branch (if sap running), rotting wood, skunk cabbage.

Hear: short audio tape recording of bird song or call, wind in trees, footsteps in snow, dripping or flowing water.

Procedure:

IN ADVANCE, select mystery items. Select one item for each of the four senses from the list above, or use others that you found while setting up the trail.

Prepare containers for the items that are to be touched and smelled:
(a) Prepare the *small box* for the smell item. Punch holes on all sides. Be sure you put enough of the "smell" mystery item inside so that you smell it instead of the cardboard.

(b) Prepare the *large box* for the tactile items. Cut holes big enough for hands to reach inside. Put cloth covers over the openings to prevent students from looking at the tactile items.

Set up a site in your school for each sensory category. If incorporated as part of the *Forest Learning Trail,* do this no earlier than one day before your field trip.
(a) The **visual** items can be laid out on a table.

(b) Have someone operate the **auditory** station by playing the tape recording for each student or group of students.

(c) Place the **touch** and **smell** boxes where they can be easily handled.

1. *IN CLASS,* tell students they are going to need to use their senses carefully in order to solve several forest mysteries. Explain that there are four (or more) secret items that were brought back from the forest they are going to visit. Students will visit each mystery box or table and observe the secret items carefully.

2. Tell them that when they are in the forest, they should keep their eyes, ears, noses, and hands awake and observe carefully. If and when they come across a mystery item from these sense stations, they should write a note to themselves in their notebook. They should not tell anyone else. Explain that when they return to class later, there will be a contest to see who has solved the forest mysteries.

3. Students travel the *Forest Learning Trail* or take a walk in a forest.

4. Hold a contest to identify the mystery items. Allow students to reexamine the mystery items, if desired. Then they write down what they think each item is on a piece of paper with their names.

5. Ask students what they thought each item was and see if there is a class consensus. Then reveal the item and its correct identity. Repeat the procedure for each item – then give 4th place awards to those who got one item correct, 3rd place to those who got 2 correct, and so on.

Curriculum Connections:

(See appendix for full citations)

Media:

Bird Songs of Alaska (CD) (Peyton)

Teacher Resources:

(See appendix)

Forest Views

ALERT: ALASKA ECOLOGY CARDS REQUIRED

Section 3
FOREST ACTIVITIES

Grade Level: 3 - 12

State Standards: L B-3

Subjects: Science, language arts

Skills: Observing, imagining, creative writing

Duration: 30 minutes

Group Size: 1-4

Setting: Outdoors

Vocabulary: Senses

Objectives:

Students will write or act out the experiences of a wild animal from the forest.

Materials:

Copies of the Science Cards for each student, selected *Alaska Ecology Cards* for each student, notebooks or clipboards and paper, pencils or pens.

Procedure:

IN ADVANCE, select *Alaska Ecology Cards* for animals that occur in the forest in your area. Include one insect and/or small mammal that lives in or on the soil *(ant, springtail, shrew, vole)*, one animal that is fairly close to human height *(deer, moose, bear),* and one animal that lives in the tree tops *(flying squirrel, chickadee)*.

Select a forest site with good places to sit that will provide comfortable places for students to write.

1. *IN CLASS,* tell students they are going to need to use their senses carefully in order to complete this activity. And they will think outside of themselves as if they were forest wildlife.

2. Tell them that when they are in the forest, they should keep their eyes, ears, noses, and hands awake and observe carefully. They will receive their animal identity at the forest site. They should not tell anyone else who they are. Explain that when they return to class, they will see who can guess their identities.

3. Send students outside to travel the *Forest Learning Trail* or to a sit for awhile at a site in the forest.

4. Assign a reasonable length of time for your students to write about their animal or plan their role play. If an example is needed for the writing exercise, read a portion of *Di's Story* from *Alaska's Tundra and Wildlife.*

Classroom Follow-Up:

Students read aloud their essays or (for younger students) act their character and see if their fellow students can guess what kind of forest animal they were pretending to be.

Curriculum Connections:
(See appendix for full citations)

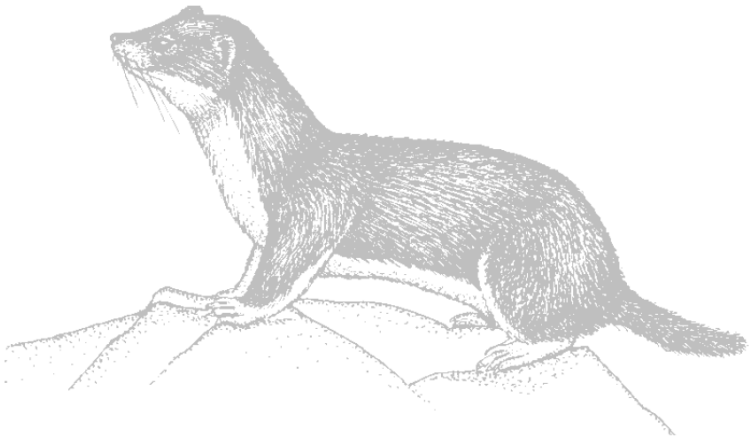
Books:
Faces in the Forest (Hirschi)

Forest Mammals (Kalman)

In the Forest (Cooper)

Look Closer: Tree Life (Greenaway)

Teacher Resources:
(See appendix)



SCIENCE CARD

Forest Views

1. Write the title "Forest Views" at the top of a page in your notebook.

2. Take one *Alaska Ecology Card* and one "Science Card: Forest Views" for yourself. Find a good spot to sit, look carefully at the forest around you, and follow the directions on your Science Card.

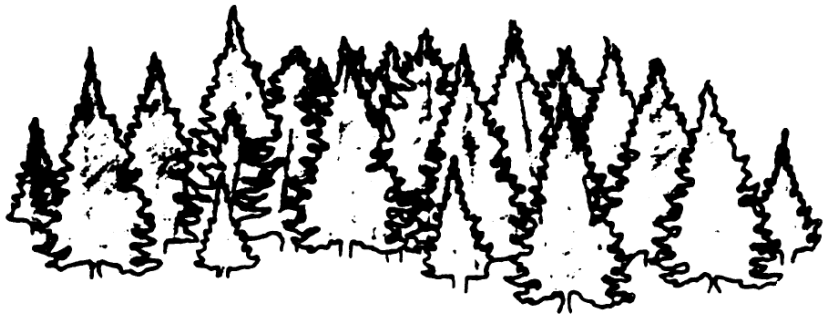
3. Read your *Alaska Ecology Card* to learn something about the animal.

4. Imagine that you are that animal, and you live in this forest. Imagine you are living wherever your animal lives and looking through its eyes as you look around.

5. Write in your notebook: "I am a forest animal."

6. Write one or more complete sentences to answer each of the following questions:
(a) Exactly where are you and what are you doing?
(b) What do you see, feel, smell, or hear within a few inches of your nose, bill, or snout? Describe the sizes of the things around you, their colors, textures, and shapes.
(c) What do you see on all sides of you if you look outward a distance of a few feet?
(d) What do you see if you look out as far as you can see? Describe the distance, colors, and textures of your view.
(e) You just spotted a predator! Describe it. Describe where it was when you spotted it, and how you narrowly escaped it.
(f) Record the name of the animal you imagined yourself to be.

Forest Art



Section 3
FOREST ACTIVITIES

Grade Level: K - 12

State Standards: A A-1

Subject: Art

Skills: Observing, drawing, painting

Duration: 30 minutes

Group Size: 6 to whole class

Setting: Outdoors

Objectives:
Students will observe and reproduce colors found in a forest environment.

Materials:
Jug of water; "Art Kit" for each student in the group containing watercolor paints, paintbrush, small pan or jar for water; clipboards and writing paper or field note books, pencils or pens for each student; "Forest Art Science Card" *(following)*.

Procedure:
IN ADVANCE, prepare "Art Kits." Label each kit by a color, i.e. the "Red Art Kit," the "Blue Art Kit." Other suggested colors as found in nature are yellow, green, black, and brown.

Locate a forested site where students can sit comfortably.

Place a large bottle or jug of water at this site.

IN CLASS, depending on grade level, guide the students through the activity or send them out to follow the instructions on the Science Card.

Classroom Follow-Up:
Set up a display of student artwork. Discuss the difficulty of matching nature's colors. Help students improve their color mixing skills.

Curriculum Connections:
(See appendix for full citations)

Books:
Sky Tree (Locker)

Teacher Resources:
(See appendix)

SCIENCE CARD

Forest Art

1. Arrange yourselves in a circle or line, so it will be easy to see whose turn is next.

2. The first person should point to something in the forest that is *red*. Each person in line must then point to something different that also contains the color *red*. Look carefully. Anyone who can't see something new that contains the color is out of the game until the next round. The last player to point out something red will get the "Red Art Kit."

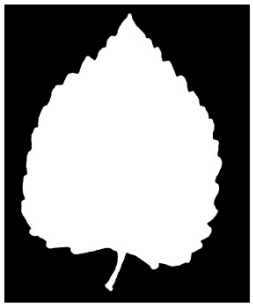
3. Everyone else plays again for the other colors *(yellow, blue, green, black, and brown)*. The winner of each round gets the "Art Kit" of that color.

4. The color of this kit is "your color." Find something from the forest that contains your color.

5. On a page in your forest notebook, draw a picture of the space around this object (the negative space). You may be surprised to find that once you have drawn the negative space, you will have drawn the item!

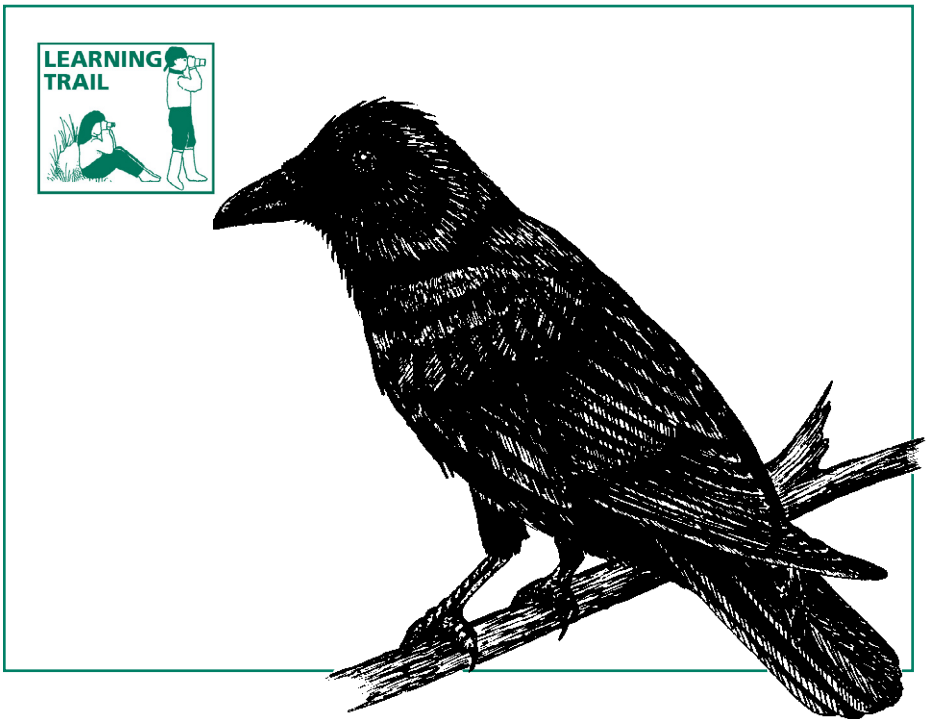
6. Now put some water from the jug in your pan or jar. Use the paintbrush and watercolors to mix a paint that matches as closely as possible the shade and tint of your color that occurs in the natural object. Then paint your color wherever it should go in your negative space drawing of the forest object.

Sample Object



Sample Object in Negative Space

Forest Sounds



Section 3
FOREST ACTIVITIES

Grade Level: K - 12

State Standards: S A-15
NGSS: 2-LS4-1

Subjects: Science, music

Skills: Listening, observing, identifying

Duration: 30

Group Size: 4-6

Setting: Outdoors

Objective:
Students will listen for and map forest sounds.

Complementary Activity:
"Forest Bird Song Tag" *in this section.*

Materials:
Audio tape of recorded bird songs as described in "Forest Bird Song Tag" *in this section.* Clipboards and writing paper or field note books, pencils or pens for each student. Copy of "Forest Sounds Science Card."

Procedure:
IN ADVANCE, select a forest location far from distracting noises of traffic, parking lots, or playgrounds. *Sites that are near open water, contain* ***snags****, or have a variety of vegetation layers (tree canopy, tall and low shrubs, and ground cover plants) attract more birds and will be good choices for this station.*

Place the "Science Card: Forest Sounds" at this site.

1. *IN CLASS,* familiarize students with the calls and songs of common local birds using the audio tape of bird songs before going into the forest.

2. Depending on grade level, guide the students through the activity or send them out to follow the instructions on the Science Card.

Curriculum Connections:
(See appendix for full citations)

Media:
Bird Songs of Alaska (CD) (Peyton)

Teacher Resources:
(See appendix)

SCIENCE CARD

Forest Sounds

1. Write the heading "Forest Sounds" at the top of a page in your field notebook.

2. *Read instructions 3-5 before doing anything else.*

3. Move to a spot where you can still be seen from this station, but you are off the trail, and a little bit out of view. You may want to choose a spot under a tree or on a nice rock or fallen tree. *You must sit at least 10 feet away from anyone else.* Sit so that you face away from other students. Be very quiet, close your eyes, and listen carefully to the sounds of the forest.

4. Listen to the trees, shrubs, snow, ground, birds, and animals for a few minutes. Then, slowly open your eyes. If you were very quiet, a forest animal may just be poking its nose out at you. Keep listening and quietly make a map of the sounds around you in your notebook. Label each sound and place it on your map.

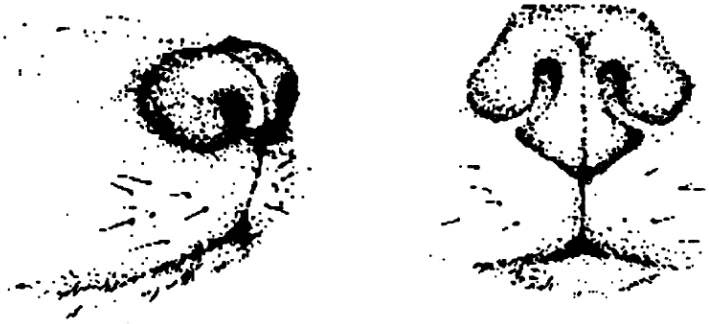
5. Do you hear more students coming? Just think if you were an animal and heard all the noise people often make. Would you stay out where you could be seen? Try to be so quiet that they don't notice you.

Read step 6 only after you have finished steps 1-5.

6. Later, compare the sounds you heard with your group members. Did you all hear the same things? Try to be very quiet so that the next group will be able to hear the forest sounds, and you don't scare any animals that are ahead of you on the trail. You can be somewhat noisy, however, if there are likely to be bears in the area – they will usually move away if warned of your approach.

Now that you know about being quiet, and listening for forest sounds, maybe you'll hear and see more forest wildlife.

Nosing About



Section 3
FOREST ACTIVITIES

Grade Level: 3 - 12

Subjects: Science, social studies

Skills: Using senses, recall, working together

Duration: 20 minutes

Group Size: 2

Setting: Outdoors

Vocabulary: humus

Objective:
Students will use their sense of smell to identify a variety of items found in a forest ecosystem.

Materials:
Clipboards and writing paper or field note books, pencils or pens for each student. "Forest Smells Kit" for each pair of students – containing a bandanna for use as a blindfold, a copy of "Science Card: Nosing About," five plastic bags with clearly labeled forest items, such as: (1) rotting leaf litter or **humus**, (2) a piece of rotten wood, (3) fresh twigs from a shrub or hardwood tree, (4) a conifer branch or cone, (5) a shelf fungus (or other smelly item).

Procedure:

IN ADVANCE, locate a forest site where there are naturally occurring examples of items in the Forest Smells Kit.

Prepare Forest Smells Kits so that each pair of students can have one.

IN CLASS, depending on the grade level, guide the students through the activity or send them out to follow the instructions on the Science Card.

Teacher Resources:
(See appendix)

SCIENCE CARD

Nosing About

1. Count off your group (1, 2, 3, . . .). If you are an odd number, pair with an even-numbered student. *(1, 3, 5, 7 are odd numbers; 2, 4, 6, 8 are even numbers.)*

2. You and your partner take one "Forest Smells Kit."

3. The odd-numbered partner should put on the blindfold and start testing her sniffing abilities, while the even-numbered partner reads instructions 4 and 5.

4. Look at the contents of this kit. Each enclosed bag contains an item from this area. Look for each item in the surrounding area, then carefully lead your partner to item in the wild. Tell her what each item is, then have her smell it. Be very careful leading your partner around because she can't see. You must tell her when to step over a log or rock.

5. After your partner smells each item in the wild, let her sit down. Now, have her smell each bagged item (mix up the order) and see if she can identify it by remembering the smell. How many does she correctly identify?

Read on only after you do steps 3-5.

6. Trade places. The even-numbered partner puts the blindfold on now. The odd-numbered partner asks the blindfolded person only to smell each bagged item. How many can he recognize by smell alone? When he could see the items earlier, did he use his sense of smell or only rely on sight?

7. As you move down the trail, sniff the wind and the trees. Most forest mammals rely more on smell than on sight. They can smell other animals, food, and you. If you use your sense of smell carefully, you can learn to detect some of them by smell too. *River otters and beavers have very distinctive odors. You can sometimes avoid trouble with bears by learning to recognize the smell of a dead animal. Bears are attracted to this smell, and they will fight to guard a carcass.*

Track Casting

Section 3
FOREST ACTIVITIES

Grade Level: 5 - 12

Subjects: Science, art
NGSS: 5-ESS3-1,-LS2-1, MS-LS2-2.

Skills: Observing, following instructions

Duration: 2 40-minute sessions

Group Size: 2-4

Setting: Outdoors & indoors

Objectives:
Students will make a plaster of Paris cast of an animal track.

Complementary Activity:
OUTDOOR: "Mammal Signs" *in Section 2, Ecosystems.*

Materials:
IN THE FOREST – Clipboards and writing paper or field note books, pencils or pens for each student. For each pair of students: 1 /2 cup of plaster of Paris, one jar of water, 1-inch wide lightweight cardboard strip, toothbrush, forceps or tweezers, a pail of wash water, one empty jar.

IN THE CLASSROOM – Playdough (homemade from flour, water, salt, oil, cream of tartar, and food coloring), a flat box, rolling pin, felt tip pens and cards.
OPTIONAL: Sample casting as example.

Procedure:
IN ADVANCE, locate a forest site where tracks of mammals or birds are easy to find and where students will be able to return to the classroom after 20 or more minutes. If you are unable to locate reliable tracks, consider making tracks using a dog or pre-made tracks.

Place the Science Card and the materials at the site. You may want to set up a sample casting as an example.

IN CLASS, depending on the grade level, guide the students through the activity or send them out to follow the instructions on the Science Card.

Classroom Follow-Up:
1. Students make a track display using homemade PLAY DOUGH:
For each track combine 2 cups flour, 1 cup salt, 2 cups water, 3 teaspoons cream of tartar, 2 tablespoons cooking oil, and a few drops of food coloring in saucepan. Cook until stiff.

2. Students roll out a 3/4-inch thick pancake of dough. Press each track print into the dough to make replicas of the tracks found in the forest.

3. Students make labels for their replica tracks and a title sign for their display, such as "Forest Tracks." Display for other students in the school to see.

NOTE: Rubber tracks are available for loan throughout the state. If locating tracks is difficult near your school, you may choose to borrow tracks and "salt" the area with them prior to doing this activity. Contact Wildlife Education at Alaska Department of Fish and Game in Anchorage for more details. (907) 267-2168.

Curriculum Connections:

(See appendix for full citations)

Books:

Animal Tracks of Alaska (Sheldon)

Animal Tracks of Alaska (Stall)

Teacher Resources:

(See appendix)

SCIENCE CARD

Track Casting

Choose a partner to work together.

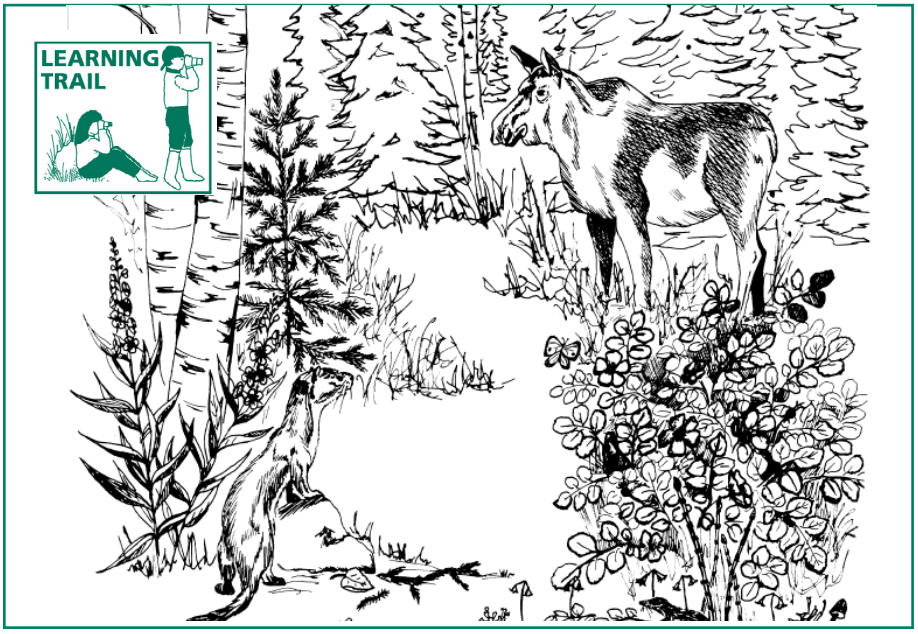
1. Be careful not to step on the animal tracks in this area so that other students will be able to see and use them. Select the track of one animal from this area.

2. Carefully remove sticks and leaves from the animal track with forceps or tweezers. Press a strip of cardboard in the snow or mud around the track.

3. Using the empty jar, mix a half cup of plaster powder with enough water to make a thick batter. If the track is in snow, mix snow with the water before you mix up the batter. This cold batter will be less likely to melt the snow and ruin your track. Pour the batter inside the cardboard strip over your track.

4. It will take about 20 minutes or longer for your track casting to dry. Wash out the mixing jar so others can use it. Carefully pick up your track casting and gently clean off any dirt using the toothbrush. Then take the track casting back to class.

Forest Sharing



Section 3
FOREST ACTIVITIES

Grade Level: 3 - 12

State Standards: LA A-1

Subject: Language arts

Skill: Speaking, writing

Duration: 30 minutes

Group Size: Entire class

Setting: Outdoors

Vocabulary:

Objectives:
Students will match descriptive words or phrases to observations made in the forest.

Complementary Activities:
OUTDOOR: All the other activities of the Forest Learning Trail.

Materials:
Clipboards and writing paper or field note books, pencils or pens for each student. Box or hat to hold cards; cards for each student with a different descriptive word or phrase written on it. *Suggested Terms: most interesting, strangest, ugliest, warmest, coldest, most curious, best smelling, worst smelling, darkest, brightest, most red, darkest blue, brightest yellow, (and other colors), fastest, tallest, smallest, longest, oldest, youngest, most beautiful, loudest, hardest to hear, hairiest, most feathered, most rough, most smooth, most prickly, sharpest. (You may also want to add students' favorite slang terms.)*

Procedure:
1. The box of cards should be placed at the last site along the trail, and the activity conducted with the entire class.

2. Gather the class in a circle. Pass around the box or hat with the cards in it and ask all students to draw one card. Ask all students to think carefully about the things they observed in the forest today. What object best fits the word or phrase listed on the card they drew?

3. Start with any student and ask her to describe what she saw today that fits the description on the card. You may have her state the answer using the word or phrase *(i.e. The prettiest thing I saw today was a spruce tree.)*; OR state what she saw, thought, or felt about it (without using the words on the card – *i.e. I saw a spruce tree. I thought it was beautiful because.....)*, then have the class try to guess what word or phrase the student has listed on that student's card.

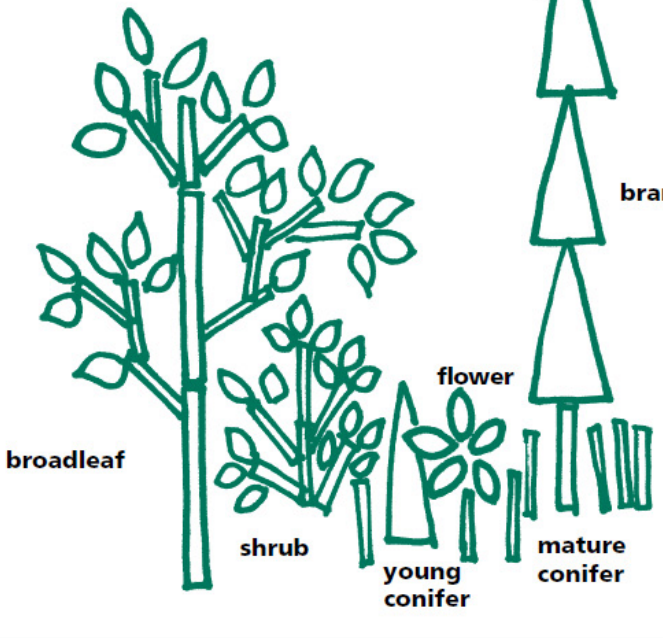
4. Have all students in the class describe one thing that they observed before ending this activity.

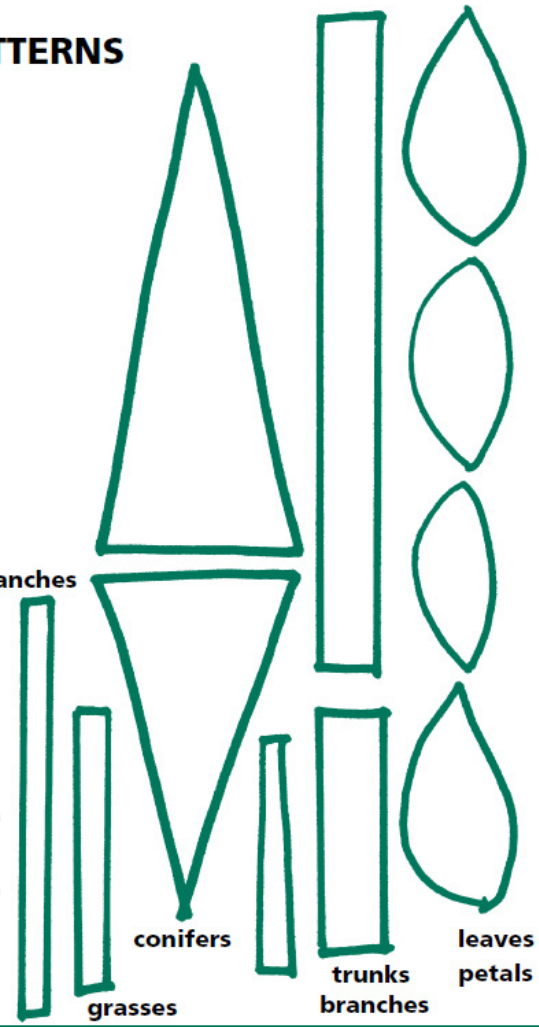
Classroom Follow-Up:
Students write descriptive essays, using adjectives, about their trip through the forest.

Teacher Resources:
(See appendix)

STAMP PATTERNS

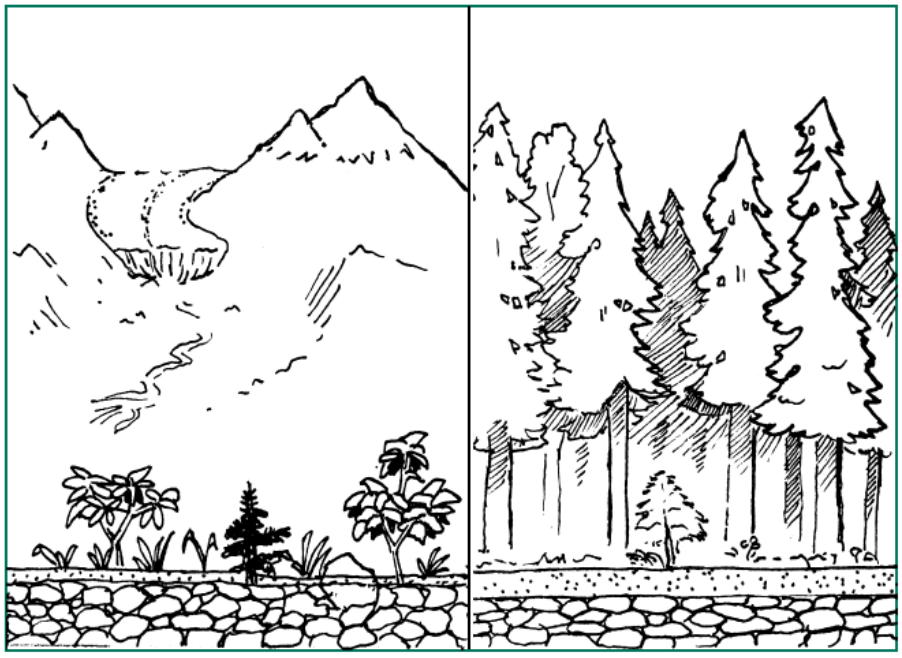
Use your photocopier to enlarge these shapes. You are only limited by the size of your stamping material. Combine shapes to suggest the plants and trees on the succession story timeline.





The Succession Story

2 EXTENSIONS



Section 4
FOREST ACTIVITIES

Grade Level: 2 - 4

State Standards: LA B-1

NGSS: 2-ESS1-1.

Subjects: Science, art, language arts

Skills: Writing, listening, visualizing, observing, drawing, comparing

Duration: Five 20-minute sessions

Group Size: Whole class, individuals

Setting: Indoors

Vocabulary: Pioneer plants, primary succession, timeline

Objectives:
Students will illustrate and write about the process of forest succession.

Teaching Strategy:
Students visualize 1,000 years in the history of a forest and craft a timeline to portray the changes.

Complementary Activities:
INDOOR: "Change in Our Lives" *and* "Animal Adaptations for Succession," *both in this section.*

Materials:
Stamps made from sponges, potatoes, or self-adhesive insulating camper tape; water-based paint or stamp pads; crayons or markers; light blue or white butcher paper cut into 5 sections.

Background:
See INSIGHTS, *Section 4, Succession.*

Procedure:
***(NOTE: For older students**, the following steps can be combined into one or two 30-45 minute classes.)*

1. Prepare stamps, paints, paper. Divide the mural into five sections: Pioneer, Shrub, Young Forest, Mature Forest, Old-Growth Forest.

2. Explain that forests change over a long, long period of time. Tell students that they will mimic that length of time by creating a forest over the course of the week.

3. To set the scene, you may wish to show parts of the video, "Glacier Bay" or "Voices from the Ice" or similar videos.

4. Students prepare for the guided imagery by setting aside all their pens, books, and papers. Students sit or lie down in a relaxed position with their eyes closed.

5. Before you start to read, ask the students to imagine themselves in the story and think about what they are "seeing" as they listen to each part. Set the scene for the mural by dramatically telling the story on the following pages. Speak slowly, allowing students time to create mental images.

6. The years are noted only for your reference for the mural **timeline**. The story is based on the **primary succession** pattern of growth in the coastal forest.

7. When each section of the guided imagery is finished, talk about the images the students created in their minds. List the key words as they verbalize them. That will be the basis for their illustrations and writing.

8. In each section of the mural, students with the appropriate stamps put their patterns on the **succession timeline**. The order of placement is (a) grass and flowers, (b) shrubs, (c) young forest, (d) mature forest. From the story include animals that live in the forest during different stages in succession.

9. After each section of the mural is created, ask students to compare the differences and similarities between stages. Ask students what happened to plants that died during the progression. *(They become soil and nutrients for future plants.)*

10. Ask the students to write about what they drew, using key words that were listed during step 7. Add that writing to the appropriate mural section.

VARIATIONS
A. Students use the story for a book for which they develop illustrations.

B. Tell a succession story that describes a boreal forest after a fire.

EXTENSIONS:

A. **Visit a forest and describe its stage.** Students visit a forested area near the school. Assign students the following question: Where is this forest in the rock's succession story? Students should answer the question using writing, discussion, and/or art.

B. **Create your own story of forest change.** Students find a rock in a forested area near the school. Student should leave the rock as found and show it to a partner or the teacher. Students then create a story for their newfound rock, relating it to forest succession.

Credits:

"Guided Imagery: The Succession Story" written by Donna Matthews, revised by Robin Dublin and Elaine Rhode for this publication.

Curriculum Connections:

(See appendix for full citations)

Books:
The Ever-Living Tree (Vieira)

The Gift of a Tree (Tresselt)

How the Forest Grew (Jasperson)

Teacher Resources:

(See appendix)

Guided Imagery: The Succession Story

[Reading for Day One]
You are a rock that the glacier has been sitting on. Imagine yourself under the glacier. The glacier's ice is very cold and heavy. The glacier moves ever so slowly, scratching you as it moves. Over thousands of years your edges have gotten smoother. Some little crumbles from your edges have been left behind as dust when the glacier rolled you along. You are always wet. You are always cold. The light is a strange blue darkness.

One day the darkness isn't as dark. There is a yellow glow that appears, but it flickers on and off. Three summers later, the blue darkness is gone. The yellow light is bright. You aren't wet all the time. Often you are very warm.
[Years 1 to 3: Pioneer Stage]

You find yourself on the edge of a little pond, surrounded by other rocks. Under you is a huge, flat, scratched rock. There is some dust in the neighborhood, but no soil, and no plants. Not a one. It's like that for another three winters. Then in spring a bird flies over and drops a seed. The seed lands right beside you on the dust. It rains a little and a few days later something green appears. Suddenly it seems there are green sprouts coming up every where there is dust.

Some green things introduce themselves as "moss" and others as "fireweed." They call themselves **pioneer plants** because they are the first green plants to come into the neighborhood. Their roots go down into the cracks in the rock under you.

Each spring there are more of these soft and friendly plants. Each spring their roots go deeper into the rocks around you, starting to make soil. Insects and birds come to visit. They tickle you as they hop on you looking for seeds and flowers. You can see soil now. There are old stems and flowers all mixed in with it. Some of this soil is next to you.
[Years 4 to 9: Pioneer Stage]

[Reading for Day Two]
Ten summers and 10 winters have passed since the blue glacier left you under the sky. Not too far away, there are wavy lines on the ground when the sun shines. Skinny line patterns get longer each spring. You wish you could turn and learn what they are. One day in the fall a pretty yellow leaf drifts by.

Now you know! Willows have joined the neighborhood! The lines are their branches making shadows on the ground. Alder shrubs and other bushy plants have also moved in. They send their roots deeper into the rocky ground. There is real soil here now. You can almost snuggle against it.

Watch out! There's a moose stepping on top of you! Whew. That was scary! Sometimes the snowshoe hares and chickadees sit on top of you. The pretty fireweed doesn't grow here any more. Where did it go, you wonder?
[Years 10 to 99: Shrub]

[Reading for Day Three]
Fluffy white things fall on you. It must be winter again and the snow is falling. But wait. It isn't cold! This must be cotton seeds from a cottonwood tree. You heard that cottonwood and a few spruce trees were in the neighborhood. It's been 100 summers since the glacier slipped away.

You like the way the light changes throughout the year – cool shade in the summer and warm sun in the spring and fall. You feel the ground rumble when the neighborhood bear wakes up and goes looking for roots to eat. Deer walk by and eat the buds of nearby bushes. A tiny shrew runs by you, with an insect in its mouth.
[Years 100 to 199: Young Forest]

[Reading for Day Four]
It's dark again. When there is light, it's green and full of shadows. Is this some strange night? Has the glacier come back? The soil is almost covering you – but not completely. The darkness isn't very cold, wet, or heavy like the glacier used to be.

Those yellow leaves – you haven't seen them for many falls now. Deer don't wander by very often, anymore. Voles don't dig near you like they used to. You notice that the snow doesn't pile up in the winter, either. What could have happened?

Two hundred winters have come and gone since the glacier left. It's a bit colder and dark again. Prickly pointed needles poke you. They don't turn into soil as fast as the colorful leaves did in earlier years. It's quieter here now that the sparrows and grouse have moved out of the neighborhood. The warblers still sing high in the tree tops. Wait a minute! That's it! The tree tops are way up in the sky.

Tree trunks are everywhere. There are three big, rough-barked spruce crowding around you. The spruce are crowded so thick that when you look up, you can no longer see the sun!

New plants aren't growing because the sun doesn't shine on them. The animals that used to live near you don't come by. The plants they used to eat are gone. Animals that eat the plant-eaters don't come either. For a rock, you're have seen a lot of changes.

The forest is very quiet now. For a rock as smart as you are, there is not much to watch. Will anything exciting ever happen again? You see hemlock trees among the spruce. Maybe hemlock trees are taking over. They like the shade of the darker forest. KABOOM!
[Years 200 to 250: Mature Forest]

[Reading for Day Five]
KABOOM! Was that an earthquake? No. But the ground is bouncing up and down. The roar is still echoing. At last – there's some excitement in the old neighborhood. Something is tickling you. A large spruce branch is sitting on you and there's dirt all over you, too. A huge old spruce tree must have fallen over. It crashed into other trees when it fell and broke their tops. You can feel the warmth of the sun shining on you.

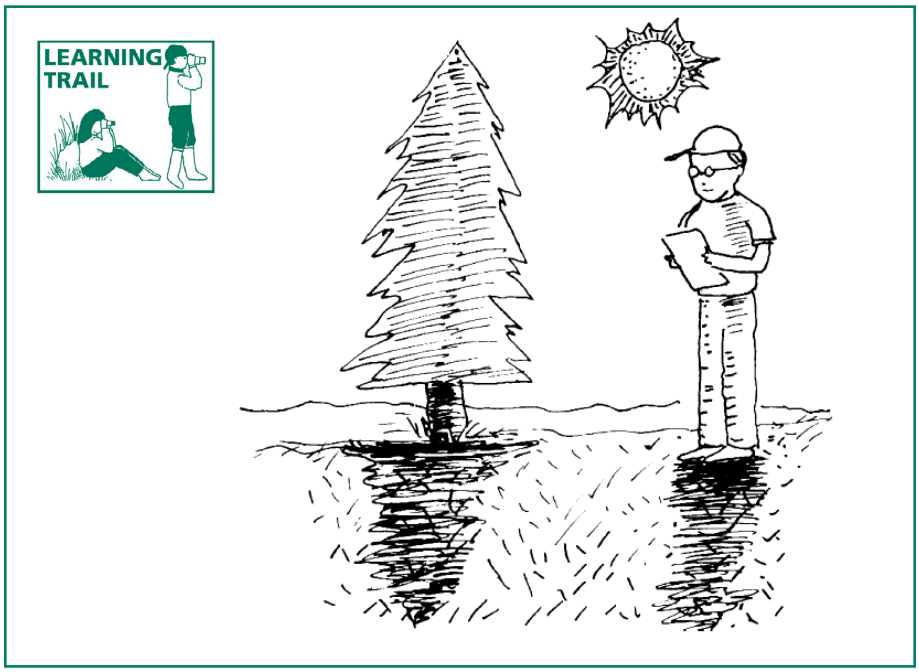
The tree rots away. Lots of little critters help turn the old tree into soft soil. Fungus helps too. You can feel the hairy parts of the fungus working around you. You are shoved by the roots of an elderberry bush as it pushes through the new soil. New willow and alder move in where the old spruce tree stood. They remind you of long ago. Young spruce are back!

Woodpeckers drilled holes in the trees with the broken tops. An owl family is using one of the holes. Deer visit in the winter. You see a little more snow now, but it doesn't slow down the deer. They eat the huckleberry twigs in the neighborhood.

A squirrel just popped its head out of the hole where she stores her spruce seeds for the winter. She tells you that some of the deer would not have survived the winter without those huckleberry twigs.

It's a busy place, this old forest, full of different kinds of plants and animals. It is an exciting place to watch because there is change all the time.
[Years 250 to 1,000 Old-growth Forest]

Forests & Sunlight



Section 4
FOREST ACTIVITIES

Grade Level: 5 - 12

NGSS: MS-LS1-5, MS-LS2-1. MS-LS2-4

Subject: Science

Skills: Observing, measuring, inferring, comparing, drawing

Duration: 60 minutes

Group Size: Individuals

Setting: Outdoors & indoors

Vocabulary: canopy, ground cover, understory

Objective:
Students will observe and compare densely forested and open forest sites to determine the role sunlight plays in a forest ecosystem.

Complementary Activities:
OUTDOORS: "Forests and Soil" *in this section;* "Forests and Air" *in Section 1, Elements (both compare and contrast forested and non-forested sites). INDOORS:* "Tree Seed Chain Game" *and* "Forest Food Web Game," *both in Section 2, Ecosystem Connections.*

Materials:
Clipboards and writing paper or field note books, pencils or pens for each student. Two sets of thermometers, five or more colored pencils, and copies of "Science Cards" for each student *(following pages)*.

Background:
See INSIGHTS, *Section 4, Succession.*

Procedure:
IN ADVANCE, select two sites, one forested or densely forested, and one non-forested or open area.

IN CLASS, explain to students that they will be taking measurements at two forest locations to investigate the interrelationships between forests and the nonliving environment. Tell them they are to look for differences and determine what causes the differences.

Classroom Follow-Up:
Students discuss the two Forest and Sunlight sites.
(a) Which site had the most plants in the shrub and ground cover layers? Was this the site where more or less sunlight reached the ground? Why would the amount of sunlight reaching the ground affect the number of plants growing there?

(b) In which site was the air warmer? How does the air temperature relate to the amount of sunlight reaching the ground?

(c) Which site, the sunny one or shaded one, would provide more food for animals that eat ground cover plants? Which site would provide more food for animals that eat shrubs? Would students expect to find more eaters of shrub and ground cover plants in a dense forest or in an open forest?

Students should conclude that where more sunlight reaches the shrub and ground cover layers, more plants will grow, because plants need sunlight for photosynthesis. Sunnier sites will have more low-growing plants and thus more food for those animals that feed on those plants.

Curriculum Connections:

(See appendix for full citations)

Books:

America's Forests (Staub)

Biomes of the World (v.1) (Allaby) 7-12

Forests and Woodlands (Pipes) K-6

Taiga (Kaplan)

Taiga (Sayre)

U-X-L Encyclopedia of Biomes (v.3) (Wigel) 7-12

Website:

Https://www.gi.alaska.edu/AlaskaScienceForum/administration

Teacher Resources:

(See appendix)

SCIENCE CARD

Forests & Sunlight: Dense Forest

1. Turn to a page of your field notebook and write the heading "Forests and Sunlight." Draw a line down the center of the page. Write a heading that describes this site on the left side of the paper.

2. As you look up, the main plants you will see are trees, if any occur at this site. These form the overstory or **canopy** layer of plants. As you look straight ahead, you may see another layer of plants, the **understory** or shrub layer. As you look down, you will see a **ground cover** layer of plants. Different sites usually have different numbers and kinds of plant layers. Some sites have only one of these layers. Other areas may have more layers – perhaps a tall tree, small tree, tall shrub, low shrub, and ground cover layer will be present.

3. Look around you and draw a picture on the left side of your page that shows the different layers of plants in this area. Use a different colored pencil to draw each layer. The number of lines you draw for each layer should show how many plant stems are in that layer. Draw in many lines to show that there are many plant stems. If there are large spaces between the plants in any layer, then draw just a few lines.

4. Look overhead at the number of leaves and branches. These block sunlight and prevent it from reaching the ground. How much sunlight do you think reaches the shrub layer at this spot: (a) nearly all sunlight, (b) some, but not all sunlight, or (c) very little sunlight? How much reaches the ground? Record your answers in complete sentences below your drawing.

5. Use the thermometer to measure the air temperature. Record this in your notebook below your drawing of this site.

SCIENCE CARD

Forests & Sunlight: Open Site

1. In your field notebook, turn to the "Forests and Sunlight" page that you set up earlier or start a new page. Write a heading that describes this site on the right side of the paper.

2. As you look up, the main plants you will see are trees, if any occur at this site. These form the overstory or **canopy** layer of plants. As you look straight ahead, you may see another layer of plants, the **understory** or shrub layer. As you look down, you will see a **ground cover** layer of plants. Different sites usually have different numbers and kinds of plant layers. Some sites have only one of these layers. Other areas may have more layers – perhaps a tall tree, small tree, tall shrub, low shrub, and ground cover layer will be present.

3. Look around you and draw a picture on the right side of your page that shows the different layers of plants in this area. Use a different colored pencil to draw each layer. The number of lines you draw for each layer should show how many plant stems are in that layer. Draw in many lines to show that there are many plant stems. If there are large spaces between the plants in any layer, then draw just a few lines.

4. Look overhead at the number of leaves and branches. These block sunlight and prevent it from reaching the ground. How much sunlight do you think reaches the shrub layer at this spot: (1) nearly all sunlight, (2) some, but not all sunlight, or (3) very little sunlight? How much reaches the ground? Record your answers in complete sentences below your drawing.

5. Use the thermometer to measure the air temperature. Record this in your notebook below your drawing of this site.

Forests & Soil

Section 4
FOREST ACTIVITIES

Grade Level: 7 - 12

Subject: Science
NGSS: MS-LS1-5, MS-LS2-1. MS-LS2-4, MS-LS1-5, MS-LS2-1. MS-LS2-3, MS-LS2-4,-ESS2-1

Skills: Observing, measuring, comparing, drawing

Duration: two 40 minute sessions 2 days apart

Group Size: Individuals

Setting: Outdoors & indoors

Vocabulary: Diversity, humus, invertebrates, leaf litter, pungent

Objective:
Students will describe and compare soil composition found in forested and non-forest sites.

Complementary Activities:
OUTDOOR: "Forests and Sunlight" *in this section;* "Forests and Air" *in Section 1, Elements (both compare and contrast forested and non-forested sites).* "Detritivores" *and* "Insect Signs," *both in Section 2, Ecosystem Connections. INDOORS:* "Forest Food Web Game" *in Section 2.*

Materials:
OUTDOORS – Clipboards and writing paper or field note books, pencils or pens for each student. At both forested and non-forested sites: thermometer, colored pencils, ruler or yard/meter stick, plastic bag, labels, trowel. Copies of "Science Cards" *(following).*
CLASSROOM – Scale for measuring weights; small paper or aluminum cups; a sunny, dry spot or an oven; a light; funnel; screen; flask; hand lens or binocular microscope. OPTIONAL: Soil core sampler *(contact foresters or soil scientists to see about using one of these tools*).

Background:
See* INSIGHTS, *Section 4, Succession.

Procedure:
IN ADVANCE, select 2 sites – one **forested** (F) and one a **non-forested** (NF) where students can compare the soils.

Prepare each site by digging a 1- to 2- foot deep soil pit or by using a soil core sampler to extract a soil sample.

IN CLASS, explain to students that they will be taking measurements at a two locations, one forested and one without trees. They will investigate the impact of trees on soil formation.

Classroom Follow-Up:
1. Students compare drawings of the two Forests and Soil sites. Which site had the thickest layers of leaf litter and **humus** (*dark organic material*)? Why do they think this difference occurred?

2. Students measure equal amounts by weight of soil samples F-2, F-3 (if collected) and NF-2, NF-3 (if collected) and place them in separate cups. Record the weights and evaluate which smells more **pungent** (*sharper and stronger*).

3. Place the samples in the sunlight or in a low-heat oven to dry them. Then, students reweigh them. Subtract the second weight of each bag from its first weight. This

will tell how much moisture was in each sample. Which sample contained more moisture? Why?

4. Use soil samples F-1 and NF-1 to set up a Berlyse Funnel as shown. Wait 24-48 hours, then examine the contents of each flask using a hand lens or binocular scope.

Which sample contained the greatest number of soil invertebrates? Which sample contained the greatest **diversity** of invertebrates? How do students explain the differences in the samples?

Students should find that the leaf litter and humus layer of soil is deeper in the forested area, and that the soil is darker. They should also find that the forest soil sample smelled more pungent, contained more moisture, and a greater number and variety of invertebrates.

These differences are interrelated. The organic layer of soil is formed through decay of the leaf litter and is mixed with the next soil layer by invertebrates. Organic material smells pungent, holds water, and provides food for invertebrates.

Curriculum Connections:

(See appendix for full citations)

Books:

Biomes of the World (v.1) (Allaby) 7-12

Taiga (Kaplan)

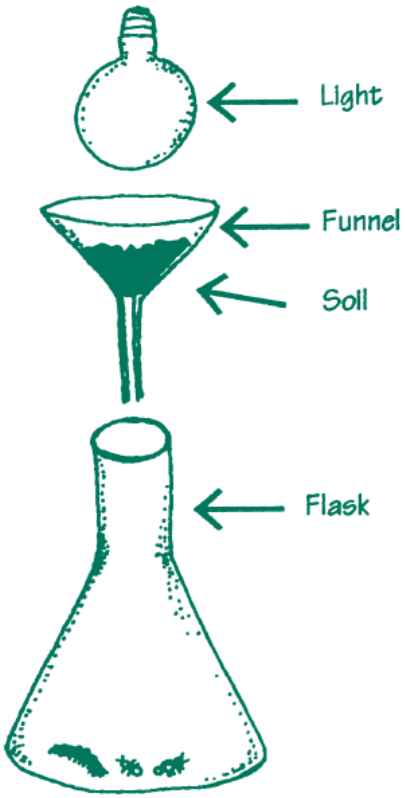
Taiga (Sayre)

U-X-L Encyclopedia of Biomes (v.3) (Wigel) 7-12

Website: Alaska Science Forum
https://www.gi.alaska.edu/AlaskaScienceForum/

Teacher Resources:

(See appendix)



Berlyse Funnel

SCIENCE CARD

Forests & Soil: Forested Site

1. On the top of a page in your field notebook, write the heading "Forests and Soil." Draw a line down the center of the page. Write a heading that describes this site on the left side of the paper. Record your answers to the questions on the left side of the page.

2. Look carefully at the soil pit or core sample. Can you see different layers in the soil? Draw a picture of the different layers in your notebook using the colored pencils to show the differences in color.

3. Measure the thickness of each layer and record it next to that layer in your drawing.

4. Look carefully at each layer of soil. Scrape a small amount of soil from each layer and look at it with the hand lens. What do you think each layer is made of? Record your answers next to your drawing.

5. Collect a trowel full of soil from the top layer of the ground and place it in a plastic bag. The top layer should contain litter and **humus** (*dark organic material*). Seal the bag tightly and label it "Soil Sample F-1."

6. Collect samples from the other soil layers. Place the samples from each layer in a separate plastic bag and label each "Soil Sample F-2" and "Soil Sample F-3," etc. Label your drawing of the soil layers with the same labels you used for your soil samples (F-1, F-2, etc.).

SCIENCE CARD

Forests & Soil: Non-forested Site

1. Use the "Forests and Soil" page of your field notebook that you set up earlier, or write the heading "Forests and Soil" on a new page. Write a heading that describes this site on the right side of the paper. Record your answers to the questions on the right side of the page.

2. Look carefully at the soil pit or core sample. Can you see different layers in the soil? Draw a picture of the different layers in your notebook using the colored pencils to show the differences in color.

3. Measure the thickness of each layer and record it next to that layer in your drawing.

4. Look carefully at each layer of soil. Scrape a small amount of soil from each layer and look at it with the hand lens. What do you think each layer is made of? Record your answers next to your drawing.

5. Collect a trowel full of soil from the top layer of the ground and place it in a plastic bag. The top layer should contain litter and **humus** (*dark organic material*). Seal the bag tightly and label it "Soil Sample NF-1."

6. Collect samples from the other soil layers. Place the samples from each layer in a separate plastic bag and label each "Soil Sample NF-2" and "Soil Sample NF-3," etc. Label your drawing of the soil layers with the same labels you used for your soil samples (NF-1, NF-2, etc.).

Change in Our Lives

1 EXTENSION

Section 4
FOREST ACTIVITIES

Grade Level: 4 - 6

State Standards: L A-1, L A-2, L A-3, Geo A-3, Geo E-5
NGSS: 4-ESS1-1,MS-LS1-5

Subjects: Science, social studies, language arts

Skills: Observing, predicting, comparing, research, interviewing, writing

Duration: Two 45-minute class periods

Group Size: Small groups

Setting: Indoors

Vocabulary: Disturbance, succession, timeline

Objectives:
Students will compare the changes in their own lives to those that occur in forests.

Teaching Strategy:
Students compare pictures of themselves, their school, neighborhood, or community to see that change is a process over time and occurs in all living things.

Materials:
Pictures, photographs of the students, the school, or the community through as many years as possible; forest succession charts from *INSIGHTS, Section 4, Succession.*

Background:
See INSIGHTS, *Section 4, Succession.*

Procedure:
IN ADVANCE, ask students to bring pictures of themselves taken over a number of years.

1. *IN CLASS,* introduce the activity by reading aloud the poem, "Now I Am Six," by A. A. Milne.

When I was one, I had just begun.
When I was two, I was nearly new.
When I was three, I was hardly me.
When I was four, I was not much more.
When I was five, I was just alive!
But now I am six, I'm clever as clever,
I think I'll stay six now for ever and ever!

2. Discuss staying the same always. What would be the advantages or disadvantages of staying the same age forever? Would the situation be the same if you stopped growing, but no one else did?

3. Students individually lay out their pictures in a timeline. And then work in small groups to identify how they've changed over time. Next, students **write** about the differences they see, creating a narrative for their personal photo **timeline**.

4. Students predict what they will look like in one month; in one year; in 20 years (How old will they be?); in 50 years (How old will they be?). Write those predictions on their timelines.

5. Brainstorm with the class which changes students can and cannot control. Discuss the inevitability of change for living things. Explain that change takes place in forests in a pattern called **succession.** Sometimes fire or bulldozers interrupt the pattern and start it over.

6. What do students think the natural area around their school looked like 50 years ago? 20 years ago? 10 years ago? 5 years ago? They should collect as many pictures as possible of the school and/or community from friends, relatives, newspapers, or the local school district office.

7. Students also interview people living and working in the community for verbal descriptions, always recording the dates being described. *(It may be possible for you to obtain archive photos from land management agencies, historic groups, or community councils for use in this activity.)*

8. When all the information is collected, the class constructs a schoolyard or community **timeline**. Illustrate the timeline with pictures that are copies of the photographs or drawings made by students. Emphasize natural growth and change around the school whenever possible.

9. Students compare their personal timelines to the schoolyard or community timeline. What did the area around the school look like before the school was built? Before they were born? What kind of **disturbance** did the school construction cause? What kinds of changes take place slowly? Quickly? What causes the changes? Which of the changes in a forest community can people control to some degree, and which can we not control? Ask the students to predict what the schoolyard will look like in 50 years. In 100 years.

Evaluation:

Students create drawings of themselves through time. Students create drawings of a forest through time. Students compare the two drawings.

EXTENSION:

Plan to enhance schoolyard. Develop a schoolyard habitat project. Students study their schoolyard area, discuss what they can do to invite plant life and wildlife into the area, and plan work projects to enhance the schoolyard. For more information, refer to Project Wild's *WILD School Sites* booklet or contact the National Wildlife Federation.

Curriculum Connections:

(See appendix for full citations)

Books:

Ancient Ones, The World of the Old-Growth Douglas Fir (Bash)

Changing City (Muller)

Changing Countryside (Muller)

Farewell to Shady Glade (Peet)

Window (Baker)

Tuck Everlasting (Babbitt)

Teacher Resources:

(See appendix)

One living tree provides the oxygen needed by one person daily.

Succession's Path
2 EXTENSIONS

Section 4
FOREST ACTIVITIES

Grade Level: 5 - 12

State Standards: Geo C-1, Geo C-2, Geo C-3, Geo E-5
NGSS: 4-ESS1-1,MS-LS1-5, MS-LS2-4., MS-ESS2-2., HS-LS2-6,HS-ESS2-7

Subjects: Science, social studies

Skills: Analyzing, reasoning, classifying

Duration: 30 minutes

Group Size: 2-5

Setting: Indoors

Vocabulary: Climax community, competition, disturbance, mineral soil, organic soil, pioneer, primary succession, secondary succession, sere, snag, succession

Objectives:
1. Students will describe the difference between primary and secondary succession.

2. Students will name 2-10 disturbances that set back succession.

Teaching Strategy:
Students play the "Forest Succession Game" to demonstrate how succession works in our coastal rainforest and the Interior boreal forest.

Materials:
For each group: a copy of the "Forest Succession Game" board, Disturbance Cards 1 and 2, game rules, First Guess markers *(photocopy from following pages),* any type of game markers for each student, a die for each group, scratch paper and pencil for keeping score.

Background:
See INSIGHTS, *Section 4, Succession.*

Procedure:
1. Ask students whether they think ecosystems ever change. Ask for examples. Will the area around the school look different when they are older and have their own children? Did the area look any different when they were born?

2. Discuss the differences between primary and secondary succession. Students list some disturbances that might change a forest. Record their observations in 1 of 2 columns on the board labeled for primary succession and secondary succession. Students decide which disturbances fit under each category.

3. Divide the class into groups no larger than five. Give each group items in the materials list. Play the "Forest Succession Game." Players try to move from the start (Begin Primary Succession) to the end (Old-growth or Climax Forest). They earn points by grabbing the First Guess Marker first and correctly identifying the effects of a disturbance (stating whether it results in primary or secondary succession).

4. After the game, students summarize the possible effects of disturbances on succession. Review the differences between primary and secondary succession.

Evaluation:

1. Students name five disturbances which change the course of forest succession and describe their potential effects.

2. Students decide whether the forest succession would be primary or secondary when the teacher shows pictures or reads descriptions of a variety of momentous events (volcanic eruptions, earthquakes, fires).

EXTENSIONS:

A. **Build shadow box forest succession.** Students build a shadow box example of a primary and a secondary succession forest.

B. **Design questions for new game of succession.** Students work in teams of 2-4 to create and play their own forest succession games.

Curriculum Connections:

(See appendix for full citations)

Books:

Ancient Forests (Siy)

The Ever-Living Tree (Vieira)

Fire: Friend or Foe (Patent)

Fire in the Forest: A Cycle of Growth and Renewal (Pringle)

A Forest's Life (Mania)

How the Forest Grew (Jasperson)

Taiga (Kaplan)

Wildfires (Simon)

Media:

Birth of a Forest: A Forest Grows Old (Video)

Old Growth Forest: an Ecosystem (Video) (National Geographic)

Website:

Alaska Science Forum
<www.gi.alaska.edu/ScienceForum>

Teacher Resources:

(See appendix)

The stiff-scaled cones of the black spruce stay on the tree for many years and are opened by fire or years of drying in the sun.

Forest Succession Game Rules

1. All players start on the square marked **"New Land – Begin Primary Succession Here."** Players each toss the die once to find out who plays first. Lowest number plays first. Play then rotates to the left.

2. A player rolls the die and moves the marker ahead the number of spaces indicated on the die.

3. If the player lands on a blank space, the turn rotates to the next player.

4. Any player who lands on a Disturbance square must draw a card from the **Disturbance Card Pile** indicated on the board (pile #1 or #2). Other players listen as the player reads the kind of disturbance and its effects listed on the card. The player stops reading as soon as any other player grabs the **"First Guess Marker"** *(see next step)* or before reading the line telling the kind of succession that results.

5. When any player draws a **Disturbance Card** and begins reading it, all other players have a chance to earn a game point. All players listen to the type of disturbance described on the card. As soon as any player knows whether this disturbance results in primary or secondary succession, that player should reach for the **"First Guess Marker."** The first player to grab the marker gets a chance to guess. The answer is always either primary or secondary succession. A player who guesses correctly earns one point. Anyone who guesses incorrectly loses one point. Individual points are recorded on the score sheet.

6. The player who drew the Disturbance Card must then move her/his marker as instructed on the card (back a number of spaces or back to the primary or secondary succession squares). Return the Disturbance Card to the bottom of its original pile (#1 or #2). Play rotates to the next player on the left.

7. The game ends when any player reaches the **Climax Forest** square, but the WINNER is the player who earns the most points.

FIRST GUESS MARKER

BEGIN HERE
Primary Succession
New Land:
Rocks and Mineral Soil only

Disturbance!
Take a card
from card pile #1

Disturbance!
Take a card
from card pile #1

Disturbance!
Take a card
from card pile #1

Disturbance!
Take a card
from card pile #1

Secondary Succession Begins Here:
organic soil in place

Disturbance!
Take a card
from card pile #1

Disturbance!
Take a card
from card pile #1

Disturbance!
Take a card
from card pile #1

The Forest Succession Game

Pioneer Stage — Shrub Stage — Young Forest Stage

0 years — Transition — 5-10 years — Transition — 20-40 years

Disturbance! Take a card from card pile #2

Disturbance! Take a card from card pile #2

Disturbance! Take a card from card pile #2

Disturbance Cards 1

Disturbance! Take a card from card pile #2

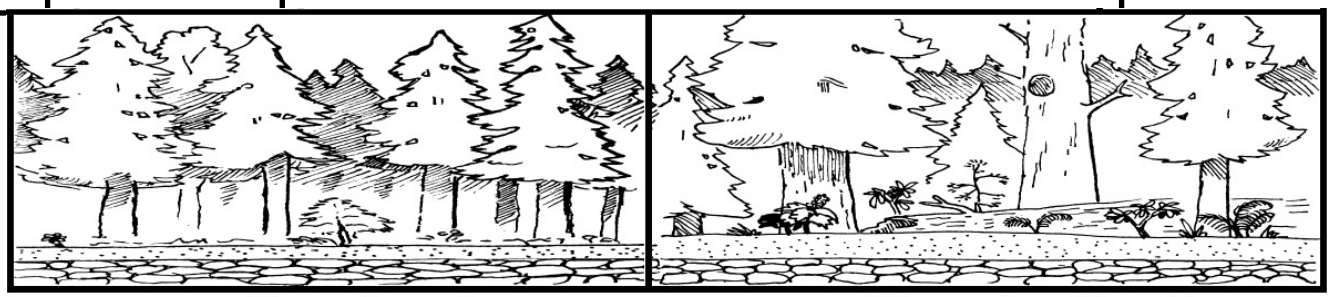
Disturbance! Take a card from card pile #2

Disturbance Cards 2

Disturbance! Take a card from card pile #2

Disturbance! Take a card from card pile #2

Disturbance! Take a card from card pile #2



Mature Forest Stage | Old-growth or Climax Forest

Transition | 50-70 years | 100-200 or more years

DISTURBANCE CARD #1

VOLCANO ERUPTS

New land is created; all previous inhabitants are destroyed.
Go back and begin Primary Succession again.

(Primary Succession)

DISTURBANCE CARD #1

GLACIER ADVANCES AND THEN RETREATS

All organic soil is removed; new rocks and mineral soil are deposited; all previous inhabitants are gone.
Begin Primary Succession again.

(Primary Succession)

DISTURBANCE CARD #1

EARTHQUAKE UPLIFTS NEW LAND

New land is created.
Go back and begin Primary Succession again.

(Primary Succession)

DISTURBANCE CARD #1

FLOOD ERODES SOIL AND DEPOSITS IT IN A NEW PLACE

New land is created.
Begin Primary Succession again.

(Primary Succession)

DISTURBANCE CARD #1

INSECT OUTBREAK KILLS TREES

Soil and other plants remain, along with some live trees.
Go back 5 spaces.

(Secondary Succession)

DISTURBANCE CARD #1

TIMBER HARVEST REMOVES TREES

Trees are harvested by selective cutting, so only some are removed. Many remain on the site, along with other live plants. The soil is disturbed and many plants are killed.
Go back 6 spaces.

(Secondary Succession)

DISTURBANCE CARD #1

LAND CLEARED BY HUMANS

All organic soil is removed to allow mining of rocks beneath.
Go back and begin Primary Succession again.

(Primary Succession)

DISTURBANCE CARD #1

WILD FIRE!

This fire burns moderately hot, so some organic soil remains along with many roots, seeds, and live plants.
Go back and begin Secondary Succession again.

(Secondary Succession)

DISTURBANCE CARD #1

WILD FIRE!

This fire burns moderately hot, so some organic soil remains along with many roots, seeds, and live plants.
Go back and begin Secondary Succession again.

(Secondary Succession)

DISTURBANCE CARD #1

LANDSLIDE

All organic and mineral soils are eroded, leaving a rubble of rocks and bedrock.
Go back and begin Primary Succession again.

(Primary Succession)

DISTURBANCE CARD #1

INSECT OUTBREAK KILLS SAPLINGS

Mineral and organic soils remain, along with roots, seeds, some healthy young trees, and other plants.
Go back 4 spaces.

(Secondary Succession)

DISTURBANCE CARD #1

AVALANCHE

Mineral and organic soils remain, along with roots, seeds, and live shrubs.
Go back 5 spaces.

(Secondary Succession)

DISTURBANCE CARD #2

VOLCANO ERUPTS

New land is created; all previous inhabitants are destroyed.
Go back and begin Primary Succession again.

(Primary Succession)

DISTURBANCE CARD #2

GLACIER ADVANCES AND THEN RETREATS

All organic soil is removed; new rocks and mineral soil are deposited; all previous inhabitants are gone.
Begin Primary Succession again.

(Primary Succession)

DISTURBANCE CARD #2

EARTHQUAKE UPLIFTS NEW LAND

New land is created.
Go back and begin Primary Succession again.

(Primary Succession)

DISTURBANCE CARD #2

FLOOD ERODES SOIL AND DEPOSITS IT IN A NEW PLACE

New land is created.
Begin Primary Succession again.

(Primary Succession)

DISTURBANCE CARD #2

INSECT OUTBREAK KILLS TREES

Most old trees are killed, but soil and a variety of other plants remain, along with many young trees.
Go back 7 spaces.

(Secondary Succession)

DISTURBANCE CARD #2

TIMBER HARVEST REMOVES TREES

Some organic soil is lost through erosion, but much remains, along with many seeds, roots, and live plants.
Go back and begin Secondary Succession.

(Secondary Succession)

DISTURBANCE CARD #2

LAND CLEARED BY HUMANS

Some mineral and organic soil remains.
Go back and begin Secondary Succession again.

(Secondary Succession)

DISTURBANCE CARD #2

WILD FIRE!

This fire burns very hot, so all organic soil is burned and nearly all roots, seeds, and live plants are killed.
Go back and begin Primary Succession again.

(Primary Succession)

DISTURBANCE CARD #2

WIND STORM BLOWS DOWN TREES

Mineral and organic soils remain, along with roots, seeds, and live plants.
Go back to Begin Secondary Succession again.

(Secondary Succession)

DISTURBANCE CARD #2

LANDSLIDE

All organic and mineral soil are eroded, leaving a rubble of rocks and bedrock.
Go back and begin Primary Succession again.

(Primary Succession)

DISTURBANCE CARD #2

DISEASE OUTBREAK KILLS TREES

Mineral and organic soils remain, along with roots, seeds, live young trees, and other plants.
Go back and begin Secondary Succession again.

(Secondary Succession)

DISTURBANCE CARD #2

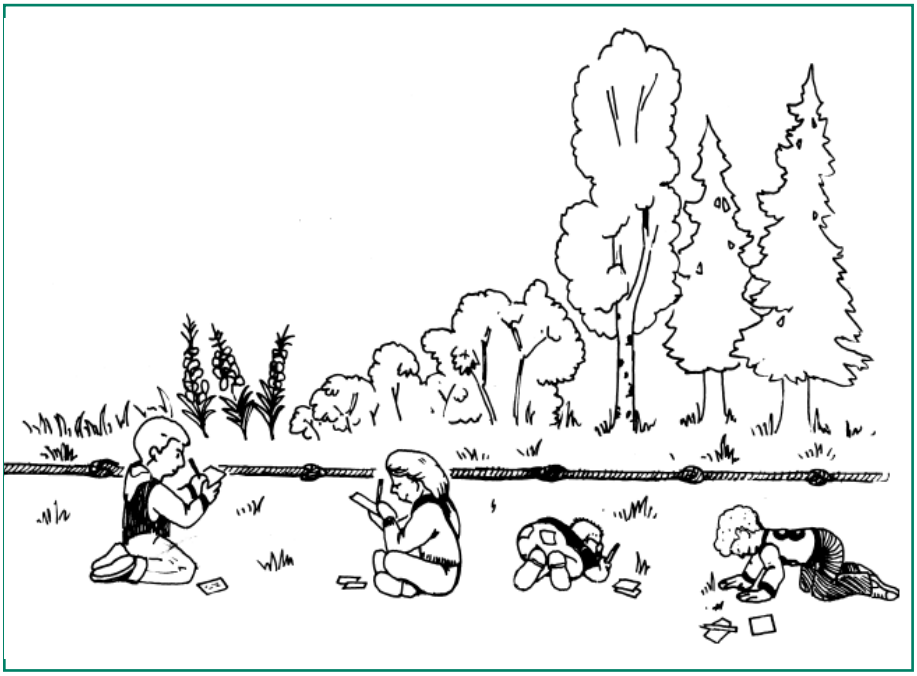
AVALANCHE KNOCKS DOWN TREES

Mineral and organic soils remain, along with roots, seeds, and live plants.
Go back and begin Secondary Succession again.

(Secondary Succession)

Flipbook Succession

1 EXTENSION ***ALERT: ALASKA ECOLOGY CARDS OPTIONAL***



Section 4
FOREST ACTIVITIES

Grade Level: 4 - 8

NGSS: 4-ESS1-1, 4-ESS1-1
4-ESS1-1

Subjects: Science, social studies, art

Skills: Observing, recording, drawing

Duration: 50-100 minutes

Group Size: 1-3

Setting: Outdoors and indoors

Vocabulary: Herbs, pioneer, sere, shrubs, succession, successional stage, transect

Objective:

Students will identify and record the successional stages of a local forest.

Teaching Strategy:

As students walk (or crawl) along a transect line, they will observe differences in the types and abundance of plants, draw these changes, and make a flipbook to show stages of succession along a transect.

Materials:

Enough 3 x 5 cards (or 5 x 7) for each student to have at least 10 cards, two brass fasteners per student, one clipboard or cardboard for drawing surface per student, pencils, hole punch, rope long enough to signify a transect from pioneer stage to climax forest (several hundred feet maximum).

OPTIONAL: *Alaska Ecology Cards*, separate cards or construction paper for booklet covers.

Note: This activity works well if you familiarize yourself with local plants prior to doing the activity with students. You may also invite a botanist, forester, naturalist, knowledgeable community member, or elder into class to assist you with this activity.

Background:

See INSIGHTS, *Section 4, Succession.*

Procedure:

IN ADVANCE, locate an area with plants ranging from **pioneer** stage through as many **successional stages** as possible to **climax** forest. Spring, summer, or fall will give more successional clues. *Look for such areas where gravel pits, dirt parking lots, or abandoned fields meet a forest.*

1. *IN CLASS,* review your forest's (coastal or boreal) **succession charts** *(see* INSIGHTS, *Section 4*) with students before making a visit to the site. Explain that students have new jobs as foresters, botanists, or biologists. Their first assignment is to describe the **successional stages** at a nearby site.

2. *AT THE OUTDOOR SITE,* students number the cards to match the number of knots/markers on the transect line.

3. Set up the **transect** by laying the rope along the ground across the area. *For example, start one end of a 100-foot trope on the edge of an abandoned dirt parking lot and stretch it into the adjacent woods.* The rope becomes a visual cross-section.

4. Make knots in the rope at spots where you want students to draw a picture of the successional stage, *OR* put flagging tape or other marker at the observation spots.

5. Students draw as much as they can on an index card at each station. Encourage students to observe all the kinds of herbs, shrubs, and trees at each spot, and to make their drawings in profile, as if they were lying on the ground looking head-on at the plants *(as in the succession charts)*.

6. *As students move along the rope, they will notice that the numbers and kinds of low growing annual plants like fireweed decrease. As they move into the forest, small trees may begin to appear. By the time they reach the forest, they might find tall spruce, hemlock, or birch with thick sphagnum moss on the ground.*

7. *BACK IN CLASS,* give students time to complete the details in their drawings.

8. Students arrange the cards in successional order, punch holes in the cards, and fasten them with the brass fasteners. Covers are optional. Students may work in groups of 2 or 3.

9. Students refer to their succession charts to label the various stages or **seres** they observed.

10. Practice flipping through the stages of succession, and watch the forest grow!

Evaluation:

1. Students put a new set of pictures in successional order and label the stages.

2. Students arrange a set of written forest descriptions in successional order, adding a drawing, and label to each one.

EXTENSION:

Make puzzles out of the succession cards. Students cut their succession cards into puzzle pieces for classmates to reassemble.

Curriculum Connections:

(See appendix for full citations)

Books:

The Gift of a Tree (Tresselt)

How the Forest Grew (Jasperson)

Taiga (Kaplan)

Teacher Resources:

(See appendix)

An ancient tree still lives in Alaska. Fossil records tell us that the plant, horsetail or *equisetum*, was once a mighty tree. It grows about a foot tall now and is no longer a true tree. You can see horsetail in many disturbed areas. (#25 of *Alaska Ecology Cards*)

Animal Adaptations for Succession

ALERT: ALASKA ECOLOGY CARDS REQUIRED

Section 4
FOREST ACTIVITIES

Grade Level: 3 - 8
State Standards: Geo E-5
NGSS: 3-LS4-3, 3-LS4-4,4-LS1-1 MS-LS1-5, MS-LS2-1MS-LS2-2. MS-LS2-4, MS-ESS2-2, HS-ESS2-7
Subjects: Science, art, language arts
Skills: Comparing, differentiating, analyzing, reasoning, reading, writing
Duration: 2 or 3 50-minute sessions
Group Size: Whole class
Setting: Indoors
Vocabulary: Adaptation, cambium, conifer, deciduous, ground cover, habitat, predator, shrub, snag, succession, successional stage

Objective:
Students will match wildlife species to the forest successional stage where they are most likely to be found.

Teaching Strategy:
Students draw a mural of plant successional stages and list the appropriate wildlife beneath each stage.

Complementary Activities:
OUTDOOR/INDOOR: "Flipbook Succession" *and* "Snag a Home," *both in this section.*

Materials:
*Alaska Ecology Cards; c*opies of succession charts (*from* INSIGHTS, *Section 4, Succession*); butcher paper; ruler or yard stick; pencils; crayons, markers or paints; tape or paste. Copies of forest-organism list *(following page).* Worksheets: "Who Lives Where?" and "Where's Home?" *(following pages*).

Background:
See INSIGHTS, *Section 4, Succession.*

Procedure:
1. Divide the class into several groups, if desirable, or have everyone work on one large mural.

2. Students draw a line dividing the butcher paper into an upper and lower section. Use the top portion to draw plants of the successional stages in your area *(from charts in* INSIGHTS, *Section 4)*. The drawing should fill all the space above the line. Label the stages. Leave the bottom portion for the following steps.

3. Referring to the lists below, students use the *Alaska Ecology Cards* that feature species from either the **boreal forest** or Pacific **coastal rainforest** to find clues to where the animals will be found.

4. Students start drawing a line where an animal would *first* appear and continue the line under each successional stage that the animal can use *(see illustration).* Label the line with the animal's name.

5. Students draw or paste pictures of the animals on the line with its name and/or in the mural scene at the appropriate stage(s).

6. Discuss with students what effects disturbance of a forest by fire, timber harvest, or insect outbreak might have on wildlife. *(They should conclude that the effects depend on the animal and the successional stage of the forest after each event. Disturbances benefit some wildlife species while decreasing the numbers of others.)*

Evaluation:
1. Students answer the worksheets: "Who Lives Where?" and "Where's Home?"

2. Students write a short report comparing and contrasting the animals and their adaptations in the early pioneer and climax stages of succession. Students should note any similarities and detail the differences among the animals' adaptations.

Curriculum Connections:

(See appendix for full citations)

Books:

A Dead Log (Green)

Alaska Wildlife Notebook Series (ADF&G)

Dead Log Alive (Kittinger)

How the Forest Grew (Jasperson)

Log's Life (Pfeffer)

Media:

Old Growth Forest: an Ecosystem (Video) (National Geographic)

Teacher Resources:

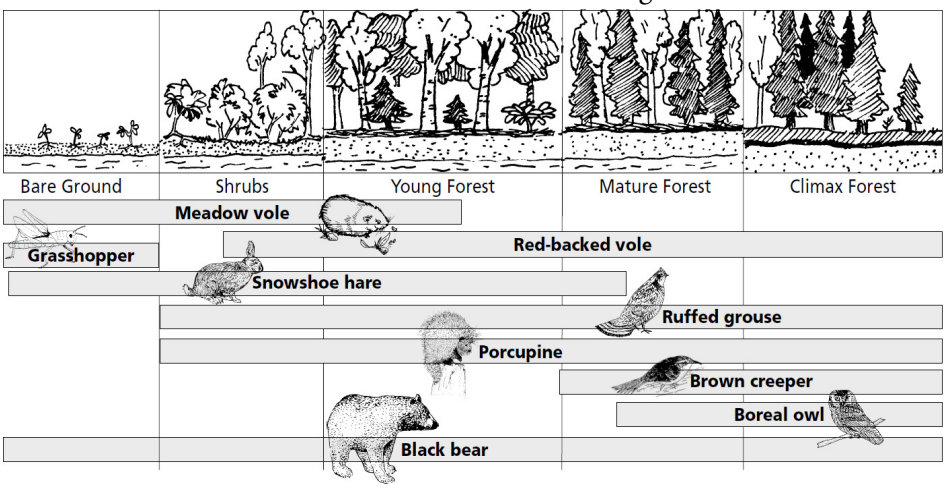
(See appendix)

BOREAL FOREST

Sunlight
Air
Water
Rocks and soil
White spruce tree
Red squirrel
Goshawk
Carrion beetle
Bacteria
Gilled mushroom
Bark beetle
Hairy woodpecker
Sharp-shinned hawk
Birch tree
Moth
Chickadee
Truffle
Bacteria
Springtail
Flying squirrel
Low-bush cranberry
Vole
Great horned owl
Weasel
Polypore or shelf fungi
Protozoans
Lichen
Moose
Grouse
Hare
Lynx
Algae

COASTAL FOREST

Sunlight
Air
Water
Rocks and soil
Sitka spruce
Red squirrel
Goshawk
Carrion beetle
Bacteria
Gilled mushroom
Bark beetle
Red-breasted sapsucker
Sharp-shinned hawk
Hemlock tree
Sawfly wasp
Chickadee
Truffle
Bacteria
Springtail
Flying squirrel
Trailing raspberry
Moth
White-footed deer mouse
Marten
Polypore or shelf fungi
Protozoans
Lichen
Deer
Grouse
Crossbill
Wolf
Algae



Dead trees are valuable in the forest. Standing dead trees called snags are soft enough to be drilled by woodpeckers. Birds adapted for cavity-nesting such as boreal owls appreciate these homes in the sky.

Who Lives Where?

Which successional stage of the **boreal forest** is home for each of these animals? Compare the animal's needs to the description of secondary succession to figure this out. Fill in the number(s) of the successional stage(s) in which you think each animal could survive best.

A ___ ___

Flying squirrels eat fungi, berries, and seeds. They need standing live or dead trees to glide between. They escape predators by hiding among the branches of live trees. They need holes in snags to nest and rest.

B ___ ___ ___

Voles eat seeds, berries, and fungi. They need many fallen logs, shrubs, and small plants to hide under.

C ___ ___

Crossbills eat only the seeds of conifers and the insects that live in the tops of conifers. They also nest in conifer trees.

D ___ ___ ___ ___

Three-toed woodpeckers feed on insects that bore into the bark of dead and dying spruce trees. They need large snags to dig holes for nesting and resting places.

E ___

Moose eat the branches and leaves of birch, aspen, and willow. They cannot reach the branches of old trees, so they need saplings and tall shrubs.

F ___ ___

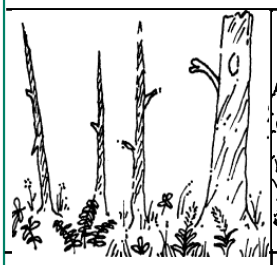
Boreal chickadees eat seeds and insects that feed on conifers. For nesting, chickadees dig holes in large snags. They hide from predators in the branches of conifers.

G ___ ___

Ruffed grouse live in broadleaf forests. They feed mainly on the buds of birch and aspen trees. They often rest in conifer trees, but they nest on the ground under shrubs.

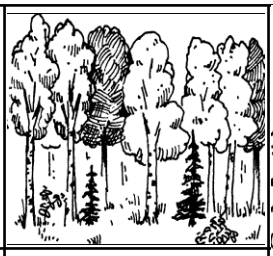
H ___ ___ ___

Red foxes eat voles and can only live in places where many voles live. Foxes dig dens under fallen logs, or into the ground under trees or shrubs.

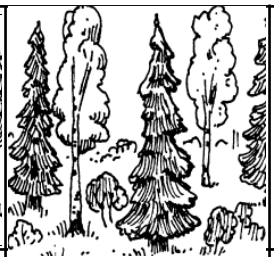


1. Regrowth Herb Stage: Fire releases many stored nutrients. Plants and fungi begin growing soon after the fire. There are standing dead and dying **snags** of spruce and broadleaf trees. Few have fallen to the ground.

2. Regrowth Shrub Thicket: Within 3 to 15 years, the site is covered by tall shrubs and saplings (willow, aspen, birch). A variety of non-woody plants (herbs) are growing. Dead trees lie on the ground, but many large snags remain.



3. Young Forest: In 30 to 50 years, birch, aspen, and willows have grown into young trees. Slow-growing spruce are still small. Few snags remain. Fewer shrubs and ground cover plants grow in this stage than in other successional stages.



4. Mature Forest: In 75 to 100 years, the spruce are taller than the broadleafs. The forest is more open because many broadleafs have died. A few broadleaf snags have nest holes in them. Fungi and seed- and berry-producing shrubs and herbs grow here.

5. Old-Growth Forest: By 150 to 200 years, mainly spruce remain. The forest is fairly open and contains many large, dead spruce and broadleaf trees with holes. The forest floor is covered by fallen logs, and mosses, and berry plants.

Where's Home?

Which successional stage of **coastal rainforest** is home to each of these animals? Compare the animal's needs to the descriptions of secondary succession to find the answer. Fill in the number(s) of the successional stage(s) in which you think each animal could best survive.

A ___ ___

Flying squirrels eat fungi, berries, and seeds. They need standing live or dead trees to glide between. They escape **predators** by hiding among branches of live trees. They need holes in trees for dens.

B___ ___

Porcupines eat the **cambium** layer of live hemlock and spruce trees, along with the branches and leaves of shrubs and ground cover plants. Their quills protect them from most predators.

C ___ ___

Crossbills eat only the seeds of **conifers** and the insects that live in the tops of conifers. They also nest in conifer trees.

D ___ ___

Red-breasted sapsuckers feed on insects that bore into the bark of dead and dying spruce trees. They need snags to dig the holes for nesting and resting places.

E ___

Sitka black-tailed deer eat a variety of **ground cover** plants, lichens, and the twigs of **shrubs** such as huckleberry. They need areas without deep snow to find food and escape predators in winter.

F ___

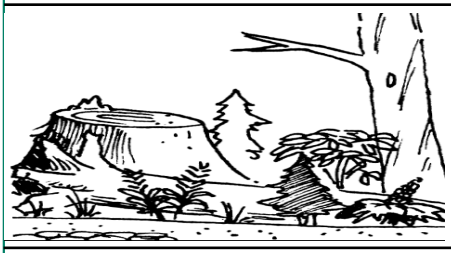
Chestnut-backed chickadees eat seeds and insects that feed on conifers. To make nests, they dig holes in large snags. They hide from predators in the branches of conifers.

G ___ ___

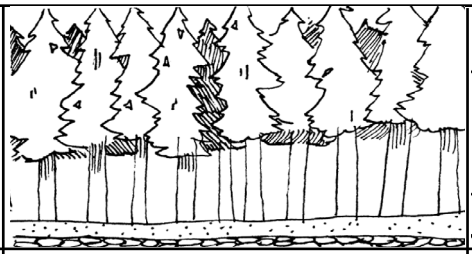
Dark-eyed juncos eat insects and the seeds of ground cover plants and insects. They nest on the ground under logs, branches, or shrubs.

H ___

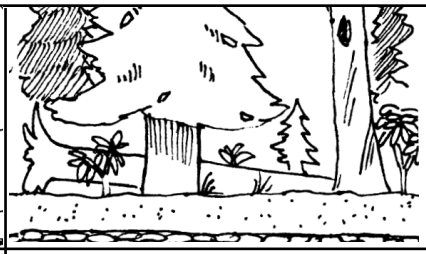
Bald eagles eat fish and dead animals. They build huge stick nests in large, old conifers and **deciduous** trees (cottonwoods and poplars).



1. Regrowth Stage: Many plants begin growing soon after timber harvest. Within 3-5 years, the site is covered by tall shrubs and saplings (alder, huckleberry, spruce, hemlock). Their shade forces out many sun-loving ground cover plants. Branches, stumps, and logs cover the ground, making travel through here difficult. A few standing dead trees (**snags**) remain. In hard winters, 6-8 feet of snow may cover the ground.



2. Second-Growth Forest: Within 15-30 years, the site is thickly covered by hemlock and Sitka spruce. These conifers shade the forest floor so very few shrubs or ground cover plants can grow. No large snags remain. The conifer branches catch the snow, keeping ground snowcover light even in severe winters.



3. Old-Growth Forest: By 250-600 years, very large trees as well as young seedlings and saplings grow here. Openings in the canopy allow sunlight to reach the forest floor, so a variety of shrubs and ground cover plants can grow. There are many large snags, hollow trees, and fallen logs. Branches of the large trees prevent snow from covering shrubs and ground cover plants even in severe winters.

Snag a Home

Section 4
FOREST ACTIVITIES

Grade Level: 5 - 12

NGSS: 5-LS2-1, MS-LS2-2., MS-LS2-3.,HS-LS2-4

Subjects: Science, social studies

Skills: Observing, inferring, predicting

Duration: 50-100 minutes

Group Size: Small or individuals

Setting: Outdoors & indoors

Vocabulary: Detritivores, food webs, habitat, photosynthesis, predator, prey, snags

Objective:
Students will look for evidence that dead trees are habitat for forest wildlife.

Complementary Activities:
OUTDOOR: "Fungi," "Detritivores," "Bird Signs," *and* "Animal Signs," *all in Section 2, Ecosystems;* "Bird Song Tag" *in Section 3, Forest Learning Trail. INDOOR:* "Forest Food Web Game" *in Section 2, Ecosystems; and* "Animal Adaptations for Succession" *in this section.*

Materials:
Clipboards and writing paper or field note books, pencils or pens for each student. Hand lens; field guide such as *Peterson Field Guides: Ecology of Western Forests.* Copies of "Snag a Home Science Card" *(following).*

Background:
See INSIGHTS, *Section 2, Ecosystems – Community Connections;* and *Section 4, Succession.*

Procedure:
IN ADVANCE, locate forest site with a standing dead tree and a fallen dead tree, preferably one that fell several years ago and pulled up its roots when it fell.

1. *IN CLASS,* discuss the concept of **habitat** and remind students that forests can provide habitat even when some trees are dead. At what stages in forest succession are snags present? *(Coastal rainforest — in regrowth after floods, avalanches, timber harvest, beetle kills, or other disturbance; also in old-growth stage. Boreal forest – in regrowth after fire, shrub thicket stage, and in old growth stage.)*

2. Students will use their detective skills to find as many signs as possible of wildlife living in **snags** and fallen trees. Ask them to be on the lookout for links in the forest food web.

3. Give each student or group the "Snag a Home Science Card."

Classroom Follow-Up:
1. From their collective field observations, students compile a master list of wildlife that use dead trees. Students may need to identify evidence of organisms drawn earlier in their notebooks by using a field guide or other reference.

2. Using the list, students build at least 3 forest food chains that include dead trees.

3. Discuss how the removal of all dead trees might affect a forest? *Students should think carefully about which living things use dead trees, and how minerals are cycled.*

Curriculum Connections:

(See appendix for full citations)

Books:

Ancient Forests (Siy)

Ancient Ones, The World of the Old-Growth Douglas Fir (Bash)

Journey Through the Northern Rainforest (Pandell)

A North American Rain Forest Scrapbook (Wright-Frierson)

Teacher Resources:

(See appendix)

SCIENCE CARD

Snag a Home

1. Turn to a page in your field notebook and label it "Snag a Home." Record your notes and answers to the questions below on this page.

2. Standing dead trees are called **snags**. Look carefully at the snag at this site and see if you can find evidence that living things are using it, or have used it in the past *(see "Signs of Life..." for hints*). List in your notebook, under the heading, "Life on a Snag," evidence of organisms that you find. If you don't know the name of the evidence you find, draw its picture in your notebook so that you can identify it later.

3. Look at the fallen dead tree at this site and try to discover what living things are using or have used it. List evidences you find in your notebook under the heading "Life on a Fallen Tree." If you don't know the name of the evidence, draw its picture in your notebook so you can identify it later.

4. Much of the sunlight energy which a tree stores through **photosynthesis** is stored in the wood of the tree trunk. Is this energy lost, or is it used by other living things after the tree dies?

5. Many of the minerals that a tree takes up from the soil are stored in its trunk. Look at the fallen dead trees in this area carefully. What evidence do you see that suggests the minerals in tree trunks are returned to the soil?

6. Nurses are people who help other people. Why do you think fallen dead trees are often called "nurse trees"?

Signs of Life on a Dead Tree

MICROSCOPIC ORGANISMS: Look for rotten and crumbly wood or slimy coatings on any part of the tree.

FUNGI: Examine mushrooms, shelf fungi, fuzz or furry coatings on any part of the tree.

PLANTS: Are any small plants growing in cracks?

ANIMALS:

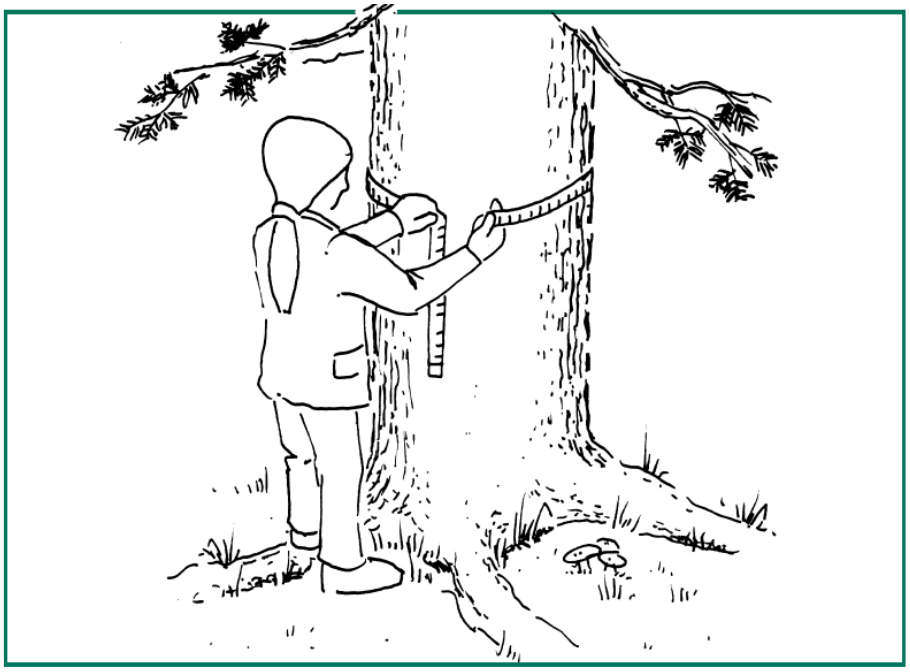
Invertebrates: Look closely at any crumbly wood, in the cracks and crevices of the wood, and at any reddish brown sawdust. Carefully remove a few pieces of loose bark or crumbly wood to see if anything is underneath them. Use a hand lens so you won't miss tiny invertebrates. Be sure to replace the wood pieces so that any animals that live there will still have a home.

Mammals: Look for hair, droppings, tooth and claw marks on the tree. Look in hollow places where an animal might hide.

Birds: Look for drill holes in the bark or a round hole into the trunk. These were likely made by woodpeckers. These birds feed on beetles that eat wood. Look for feathers, whitish droppings, or raptor pellets on or beneath the tree.

Champion Tree

3 EXTENSIONS



Section 4
FOREST ACTIVITIES

Grade Level: 5 - 12

State Standard: M A-3

NGSS: 5-ESS3-1.

Subjects: Math, science

Skills: Measuring, computing, observing

Duration: 45 minutes

Group Size: 2-4

Setting: Outdoors

Vocabulary: Circumference, crown, height

Objective:

Students will use math skills to determine the size of trees.

Teaching Strategy:

Students measure the circumference, height, and crown of trees, and use those measurements in a formula to find the largest tree.

Complementary Activities:

OUTDOOR: "Tree Identification" *in Section 1, Elements that Create Forests. INDOOR/OUTDOOR:* "Tree Leaf Relay" *and* "Tree History – Your History, " *both in Section 1.* "Succession's Path" *and* "Flipbook Succession," *both in this section.*

Materials:

Copies of "Champion Trees" worksheet *(following pages)*. Pencils, measuring tapes, yardsticks (meter sticks), string, clipboards, tree identification guides or "Alaska Trees" worksheet *(see* "Tree-Leaf Relay" *Section 1*).

Background:

See following *Champion Trees Worksheet.*

Procedure:

1. Review the "Champion Trees" worksheet with the class. Discuss each step and brainstorm some predictions about the investigation. Practice solving one or more examples.

2. Divide the class into small groups of 3-4 students. Equip each group with a tape measure, some string, and a yardstick. Each group will measure three trees. *You may wish to limit each group of students to a separate area for measuring their trees. Alternately, groups may measure the same trees and compare results.*

3. Distribute the worksheets. Demonstrate how to measure tree height, circumference, and crown.

4. Allow groups time to measure three trees and record their data.

5. Students should draw a mural/map of their area and note the location and size of the trees that were measured. Share the map with other students at your school.

6. Identify the species using tree-identification guides or the

Conifer and Broadleaf fact sheets in INSIGHTS *Section 1*.

Evaluation:

Students write a paragraph or draw a diagram describing the steps that they would take to measure a particular tree.

EXTENSIONS:

A. **Locate largest local tree.** Give students one week to find the largest tree in their neighborhood, town, or village and collect its measurement data. Compare student findings to determine the champion tree.

B. **Set criteria and locate smallest tree.** Challenge student teams of 2-4 to design a formula and criteria to determine the smallest trees – "mini-champions." Students gather the information and determine the winner.

C. **Survey largest trees on schoolyard.** Students survey the largest trees on the school property (or some other convenient location) to find the champion tree. Award a prize!

Credits:

Adapted from the American Forest Foundation, "How Big Is Your Tree?" *Project Learning Tree Environmental Education Activity Guid*e, Pre K-8, 1993. Adapted with permission of National Wildlife Federation, *Trees are Terrific!* (Ranger Rick's NatureScope), 1992.

Curriculum Connections:

(See appendix for full citations)

Books:

Grand Trees of America: Our State and Champion Trees (Jorgenson)

National Register of Big Trees (American Forestry Association)

Website:

Tree Guide <www.tree-guide.com>

Teacher Resources:

(See appendix)

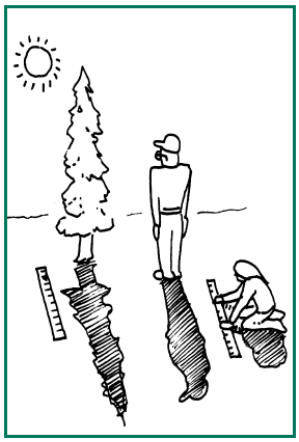
Alaska's champions include a Sitka spruce that is 185 feet tall, 358 inches in circumference, and has a 50 foot crown spread. Its total point count is 556. The champion Alaska birch has 181 points. It is 67 feet tall, 103 inches around, and has a 42 foot spread.

Champion Trees

Measurements of the largest trees of many species are kept by the American Forestry Association. In Alaska, the Cooperative Extension Service publishes a list of the "champion" trees. To find champion trees, foresters measure three aspects of tree size: the **height**, the **circumference** (distance around the trunk), and the average **crown** spread (the distance the branches spread). The numbers are used in a formula to determine the total points awarded a particular tree.

The formula is: ***Point total = height + circumference + 1/4 crown***

For example: 33 Points = 24 feet + 6 inches + 1/4 (12 feet)



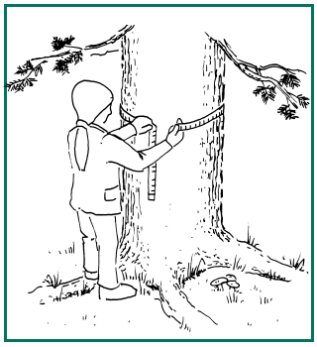
1. Measure the height of the tree

To determine the height of a tree, measure the length of the tree shadow and the shadow of a stick of known length. A yardstick or a student may be used as a "stick." After measuring the shadow cast by your "stick," measure the tree's shadow by laying a tape measure (or some other measuring device) along the length of the tree's shadow. Use the following formula:

$$\text{TREE HEIGHT} = \frac{\text{length of tree shadow}}{\text{length of stick shadow}} \times \text{length of stick}$$

Height Measurements in feet:

Tree #1 _____ Tree #2 _____ Tree #3 _____



2. Measure the circumference of the tree

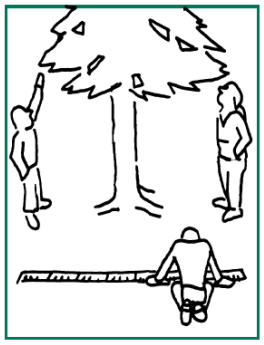
To measure the circumference of a tree, hold one end of a tape measure or yardstick at the base of a tree, and measure up **4 1/2 feet** (the forestry standard). Wrap the measuring tape around the tree at 4 1/2 feet and record this measurement. If the tree is too large to use the measuring tape, use string and measure its length afterward. If there are branches at 4 1/2 feet up or if you are too short to reach that height, measure near there where you can reach.

Circumference measurements in inches:

Tree #1 _____ Tree #2 _____ Tree #3 _____

3. Measure the tree's crown:

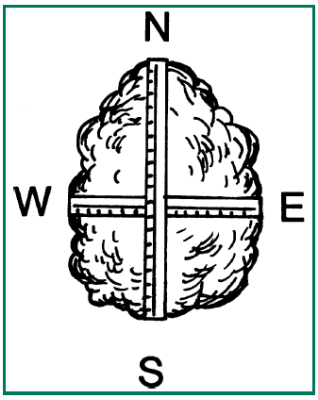
To measure the size of a tree's crown, find the branches which stick out farthest from the main tree trunk. One person should stand under the tip of one of these branches and another person should stand under the tip of the branch on the opposite side of the trunk. A third person should measure the distance between them. Repeat this procedure, but measure the branches at a 90 degree angle from the first measurement. For example, if during the first measurement the twp people stood below branches pointing north and south, the next measurement should be below branches pointing east and west. To find the average crown spread, add the two measurements together and divide by 2.



(Continued on next page)

_____ + _____ ÷ 2 =

First crown measurement + Second Crown measurement (divided by) 2 = _____
Average crown spread



Crown spread measurements in feet:
Tree #1 _____ Tree #2 _____ Tree #3 _____

7. Record tree information for each tree as follows:

Tree # 1
Point total: = height + circumference + 1/4 crown
Height _____feet of height
Circumference: +_____inches of circumference
Average crown spread feet x 1/4 +_____ adjusted crown
=_____ Point total Tree # 1

Tree # 2
Point total: = height + circumference + 1/4 crown
Height _____feet of height
Circumference: +_____inches of circumference
Average crown spread feet x 1/4 +_____ adjusted crown
=_____ Point total Tree # 2

Tree # 3
Point total: = height + circumference + 1/4 crown
Height _____feet of height
Circumference: +_____inches of circumference
Average crown spread feet x 1/4 +_____ adjusted crown
=_____ Point total Tree # 3

Record the point totals for each of your trees:

Tree #1 _____ Tree #2 _____ Tree #3 _____

Champion Trees

"Trees are the earth's
endless effort
to speak to
the listening heavens."

Rabindranath Tagore

We All Use Forests

ALERT: ALASKA ECOLOGY CARDS OPTIONAL

Section 5
FOREST ACTIVITIES

Grade Level: K - 3

State Standards: A A-1

NGSS: K-ESS3-1.

Subjects: Science, art

Skills: Comparing, contrasting, applying, drawing, writing

Duration: 30-60 minutes

Group Size: Whole class

Setting: Indoors

Vocabulary: Forest, names of forest wildlife, wood

Objectives:

1. Students will identify the different ways animals use trees.

2. Students will identify the different ways people use trees.

3. Students will use a Venn diagram to compare and contrast animal and human use of trees.

Teaching Strategy:

Students will compare and contrast the uses of trees by forest animals and people.

Complementary Activities:

OUTDOOR: "Plant a Tree" *in this section. INDOOR:* "Home is a Tree" *in Section 2, Ecosystem Connections.* "Forests in Literature," "Voices in the Woods," "Wood in Our Lives," *and* "Paper Making" *in this section.* "Breath of Life" *and* "Rain-Making Partners" *in Section 1, Elements that Create Forests.*

Materials:

Chart paper or whiteboard, markers, magazines, glue, twigs, yarn or twine.
OPTIONAL: *Alaska Ecology Cards.*

Background:

See INSIGHTS, *Section 5, Human Uses and Impacts in Forest Ecosystems.* Also INSIGHTS, *Section 1, Elements: "The Giving Forests" and* INSIGHTS, *Section 2, Ecosystem Connections.* And *Alaska Ecology Cards.*

Procedure:

1. The teacher will record student observations as they brainstorm ways trees are used by forest animals.

2. Students will individually, or in groups, draw pictures and write captions illustrating how animals use trees. These pictures will be combined to form a classroom big book.

3. Students will cut pictures from magazines that show ways people use forests and wood.

4. The pictures will then be glued onto heavy construction paper. Yarn or twine will be attached to the pictures and used to hang them from twigs to form a forest-use mobile.

5. Students will use Venn diagrams to compare and contrast the use of trees by animals and people. Shared uses, such as the use of trees for shelter, will be written in the area where the two circles intersect.

Evaluation:

Students will name three ways animals use forests and three ways people use forests.

Credits:

Adapted by Jeanne L. Williams, teacher at Kingikmiut School, Wales, Alaska, from *Uses of Trees,* Amy Shirley and Edie Watson, Oklahoma State Department of Education, 1990.

Curriculum Connections:

(See appendix for full citations)

Books:

Alaska Wildlife Notebook Series (ADF&G)

Forests and Woodlands (Pipes)

In the Forest (Cooper)

In the Woods (Krupinski)

Timber (Jasperson)

A Tree in the Ancient Forest (Reed-Jones)

Look Closer: Tree Life (Greenaway)

Tremendous Tree Book (Brenner)

Teacher Resources:

(See appendix)

Watershed Guardians

Section 5
FOREST ACTIVITIES

Grade Level: K - 12

State Standards: Geo E-5

NGSS: K-ESS2-2-ESS3-3,2-ESS2-1. 3-ESS3-1, 4-LS1-1.,4-ESS2-1. 4-ESS3-2,5-ESS3-1,MS-LS2-4. MS-LS2-5,-ESS3-3.,HS-LS2-7

Subjects: Science, language arts

Skills: Observing, note-taking, applying, analyzing, writing

Duration: 30 minutes and periodic observation

Group Size: Pairs or small groups

Setting: Indoors

Vocabulary: Erosion, germinate, habitat, watershed

Objectives:

Students will conduct an experiment to demonstrate how plant roots affect the rate of erosion.

Complementary Activities:

OUTDOOR: "Forests and Soils" *in Section 4, Succession (compares forested and non-forested sites). INDOOR:* "Rain-Making Partners" *in Section 1, Elements that Create Forests.*

Materials:

Potting soil; grass seeds or seeds of other quickly-growing plants; plastic wrap or two large, clear plastic bags; a sprinkling can; two paint pans or similar sloping containers with catch trays.

Background:

See INSIGHTS, *Section 5, Human Uses and Impacts in Forest Ecosystems.* Also, INSIGHTS, *Section 1, Elements: "The Giving Forests."*

Procedure:

1. Students keep a daily log of the experiment. Each page should include the date, the subject, a drawing of it, and 2-3 sentences describing changes.

2. Fill the sloping parts of two paint pans with very moist potting soil. Spread the seeds of the grass or other plants thickly over the soil in one pan only. Cover both pans with plastic wrap or a large plastic bag and place in a warm, sunlit place or under grow-lights.

3. Ask students to predict what they believe will happen over the next several days. Students record their observations and note any changes. If you have more than one station, label them and ask students to consistently monitor one of them. When the seeds begin to **germinate** (sprout), ask students to define this process and write it in their journals.

4. After the grass is well established in one paint pan, explain that the grass in the pan represents a **watershed**, the forest of trees and other plants on a hillside. Students demonstrate the effects of rainfall by sprinkling water over the two pans and observe what happens to the soil. Less soil should be **eroded** or washed down the "hillside" in the "forested" pan. What if there were a stream at the bottom of the hill? How would it be affected by a clear-cut? How could a change of **habitat** affect the fish living in the streams?

5. Students compare their experiments to the world around them. How did the "forest" protect the soil of the hillside? What might happen to the soil if forests on steep hillsides are removed? Can new trees grow if the soil is washed away?

Evaluation:

1. Pairs or groups of students write an analysis of the experiment and the discussions.

2. Students compare their experiments to real forest issues such as reforestation on sloped land. Students present their experiment and their comparisons to another class.

3. Students design other experiments to demonstrate the possible complications of deforestation.

Credit:

Adapted from American Forest Foundation, "Growin' Seeds and Savin' Soil," *Project Learning Tree Supplementary Activity Guide for Grades 7-12*. 1987.

Curriculum Connections:

(See appendix for full citations)

Books:

Ancient Forests (Siy)

Deforestation (Owens) K-4

Shrinking Forests (Tesar) 7-12

Website:

Alaska Science Forum
<www.gi.alaska.edu/AlaskasScienceForum>

Teacher Resources:

(See appendix)

Forests in Literature

Section 5
FOREST ACTIVITIES

Grade Level: K - 6

State Standards: L A-5, Geo E-1, Geo E-4, A A-1
NGSS: K-ESS3-1., 4-ESS3-1

Subjects: Language arts, social studies

Skills: Writing, listening, listing, evaluating

Duration: 30 minutes

Group Size: 1 and whole class

Setting: Indoors or outdoors

Vocabulary: Values

Objectives:
1. Students will list three things we obtain from forests.
2. Students will identify the forest values portrayed in juvenile fiction books.

Teaching Strategy:
Students listen to a story, list things we use from trees, and write a thank-you note to a tree.

Complementary Activities:
INDOOR: "Papermaking" *and* "We All Use Forests," *both in this section.*

Materials:
The Giving Tree by Shel Silverstein, chalkboard or flip chart paper, chalk or markers, paper, pencils.

Background:
See Curriculum Connections *for resources.*

Procedure:
1. Have students read, or read to them, Silverstein's *The Giving Tree.*

2. Discuss the gifts the tree gave the boy. List the gifts on the chalkboard or flip chart. Did the boy initially give anything to the tree? How did the boy's attitude toward the tree change as he got older? In what other ways might the boy have treated the tree? How does this story show our society's attitude toward forests?

3. Have students write a thank-you note to a tree for one gift it gives to people. The note may include a picture of the child and a tree.

4. Compile the thank-you notes into a class book. If desired, send it to the USDA Forest Service, Resource Education, P.O. Box 21628, Juneau, AK 99802-1628 or the Alaska Division of Forestry, Project Learning Tree, 505 W. 7th Avenue, Suite 1450, Anchorage, AK 99501.

VARIATION FOR YOUNGER GRADES
A. Students draw a picture of the gift instead of writing a note.

B. Following the direction of the younger students, older students write the note.

VARIATION FOR OLDER STUDENTS
Students read several books and analyze how trees or forests are portrayed in the books. Use the following questions:

1. How was the forest portrayed in the story? *(dark and forbidding? friendly and interesting? important or unimportant?)*

2. What did the story tell us about the relationship between humans and the forest?

3. Was the forest in the story imaginary or realistic?

4. How was the forest in the story valued? According to the story, which value or values were most important?

Evaluation:

1. The students name one gift from trees in a thank-you note or drawing.

2. Students write their own *Giving Tree* type of story including at least three "gifts" from the tree(s) and a forest value statement.

Curriculum Connections:

(See appendix for full citations)

Books:
Giving Tree (Silverstein)

The Life and Times of the Apple (Micucci)

Once There was a Tree (Romanova)

Tremendous Tree Book (Brenner)

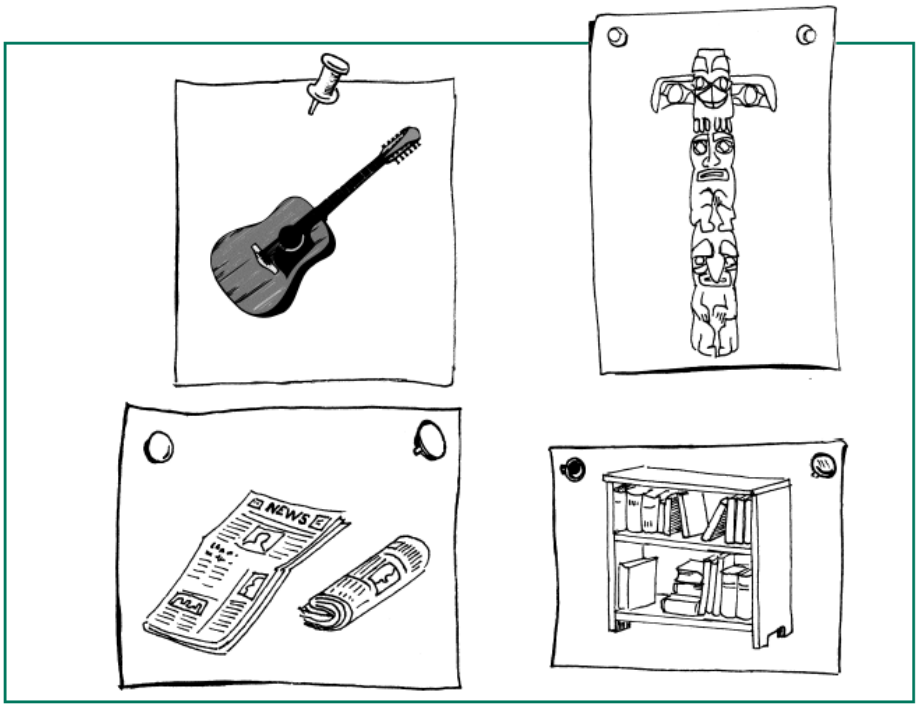
Media:
Once There was a Tree (Video) (Reading Rainbow)

Teacher Resources:

(See appendix)

"I think that I shall never see
A poem lovely as a tree."
Thus begins "Trees"
by poet Alfred Joyce Kilmer
who lived from 1886-1918.

Wood in our Lives
5 EXTENSIONS



Section 5
FOREST ACTIVITIES

Grade Level: K - 6

State Standard: Geo E-1

NGSS: K-ESS3-1.,4-ESS3-1. MS-ESS3-4

Subjects: Social studies, language arts

Skills: Decision-making, observing, comparing, classifying

Duration: 30-60 minutes

Group Size: Small group followed by whole class

Setting: Indoors

Vocabulary: Cellophane, rayon, renewable resource

Objectives:
Students will name at least 10 ways that we use wood in our lives.

Teaching Strategy:
Students search their school and home environments to find ways that wood is used. Students find samples and pictures and make a display board.

Complementary Activities:
INDOOR: "Paper Making" *and* "Voices of the Woods" *in this section*

Materials:
For each group of older students: paper, pencils, tagboard or large pieces of paper. *For younger students:* bulletin board, magazines for cutting pictures, scissors.

Background:
See INSIGHTS, *Section 5, Human Uses and Impacts: "Wood in Our Lives: Alaska Trees – Wood Products"* fact sheet.

Procedure for younger students:
1. Conduct a class discussion about forest products, focusing on where wood is found in nature. Discuss why trees are important to us as part of our natural environment.

2. Students look around the classroom and note things that are made of wood. Create a list of all of the things in the classroom made from wood or wood products. *Add things to the list that perhaps are not as obvious, such as paper, pencils, and boxes.*

3. Ask students to look around their home and identify one item made from wood and used frequently. They can bring a sample of the wood product, draw a picture of it, or cut a picture from a magazine.

4. The next day, collect the items and pictures and make a display showing the ways that wood is used in our lives. *As an extension*, students classify their products into groups of similar items.

Procedure for older students:
1. Discuss the importance of trees as part of our natural world.

2. Discuss how trees provide many products that we use every day. Students may think of lumber, but remind them that wood pulp is another form. Discuss uses for wood pulp such as **rayon**, **cellophane,** and additives in food products.

3. The class lists items in the classroom that are made from wood. Model the skill of classifying these items into such categories as school supplies, furniture, etc.

4. Assign small groups to find the many ways wood is used in our lives. Provide magazines and have students create a collage poster of the varied uses of wood. On the back of the posters ask them to list the uses in categories *(furniture, houses or shelters, etc.)* Encourage the use of encyclopedias or alternate resources to find additional unusual uses.

5. Students present the posters to the class. See how many categories of uses for wood the class can create.

6. Conclude the lesson with a discussion of other resources that could be substituted for wood. For example, could we build our houses effectively out of other resources? Is there a substitute for paper products?

Evaluation:

Students name at least 10 ways in which we use wood.

EXTENSIONS:

A. **Research wood substitutes.** Students research other products that replace wood in our lives. For example, explore the idea of building homes out of adobe, cement, or straw bales.

B. **List ways to reduce personal wood consumption.** Students list all the ways they can replace wood products used at home (for example, using cloth napkins instead of paper napkins).

C. **Compare historic and current uses of wood.** Using Eric Sloane's *Reverence for Wood* or Cameron Miller's *Woodlore* compare the ways we use wood today with the ways people used wood 100 years ago.

D. **Research local use of recycled wood products.** Students visit the grocery store in search of recycled wood products, finding and recording as many items as they can that use recycled packaging.

E. **Rank wood items on a scale of importance.** Students evaluate categories of wood products commonly used in their lives, rating each in terms of necessity for human survival on a scale of 1-10.

Curriculum Connections:

(See appendix for full citations)

Books:

Apple Trees (Patent)

Christmas Tree Farm (Jordan)

From Tree to Paper (Davis)

The Life and Times of the Apple (Micucci)

Lorax (Seuss)

Timber (Jasperson)

Woodlore (Miller)

Media:

The Lorax (Video)

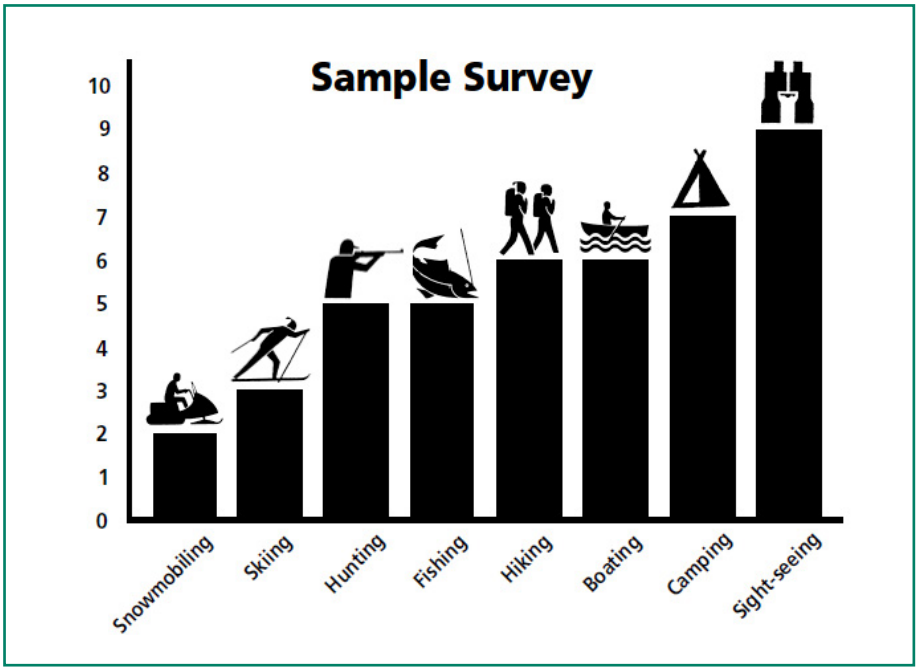
Teacher Resources:

(See appendix)

Historically, forests have been used for objects that we wouldn't recognize today. Early versions of chewing gum and rubber tires both came from trees. Today we use other materials.

Forests for People

5 EXTENSIONS



Section 5
FOREST ACTIVITIES

Grade Level: 5 - 12

State Standards: Geo E-1, Geo E-4, M A-4, M A-6
NGSS: MS-ESS3-4

Subjects: Social studies, math, language arts

Skills: Writing, analyzing, evaluating, graphing, interviewing, speaking, synthesizing

Duration: 3-4 hours

Group Size: Whole class and small group

Setting: Indoors and/or outdoors

Vocabulary: Values

Objective:

Students will understand that people go to forests for a variety of purposes.

Teaching Strategy:

Students devise and conduct a survey of the school to discover how individuals spend their time in forests.

Materials:

Questionnaire devised by students, pencils.
OPTIONAL: tape recorder and cassette tape.

Background:

See INSIGHTS, *Section 5, Human Uses and Impacts in Forest Ecosystems.*

Procedure:

1. Discuss techniques of surveying groups of people to gather information.

2.Introduce the idea of creating a survey about forest use and discuss the merits of such a survey. People spend time in forests for a variety of reasons and place a **value** on forests. Explain that the class will make a survey about Alaska forest use to determine how students and their families use the forest.

3. Explain the difference between open-ended and close-ended questions. The class assignment is to gather information on how students, teachers, and school staff spend time in the forest. Questions could include:

(a) Do you go to any forest areas. If so, which ones?
(b) If you go to forest areas, did you go in the past year? If so, how often?
(c) What kind of activities do you do in a forest area?
(d) Do you pay any fees to participate?
(e) How do you get to the areas you use?
(f) What is your favorite forest area? Why?
(g) Do you know who "owns" the forest?
(h) What do you think are the most valuable things in forests?
(i) Do you think forests have other important values, and if so what are they?
(j) How would you measure the value of an acre of forest?

4. As a class, construct a questionnaire using the questions students want answered.

5.Work with students to create a data log or organizational chart that will lend itself to easy information gathering and later tabulation. *Using a computer to create the log or chart is excellent practice. The chart may include a choice of responses and/or levels of agreement and disagreement.*

6. Practice asking the questions and recording the data in class before going out into the school community to gather actual data.

7. Working in small groups or pairs, conduct the survey of school staff and students. If feasible, conduct part of the survey outside the school to gather information from a wider range of ages. Assign a minimum number of interviews per student team.

8. Ask each team to make a table or graph to show the kinds of answers obtained. A computer works well for this task.

9. Discuss the answers obtained. Were the people interviewed from a variety of backgrounds? How might the answers change if the respondents were from other parts of the state? What kinds of values do people have about forests? What kinds of activities do people do most frequently? How important do forests appear to be to the community surveyed?

Evaluation:

Students write 1-3 paragraphs describing the results of the survey as if it were to be published in a newspaper. Use a "compare and contrast" format for their compositions. *If possible, print the best paragraphs as articles in the school or community paper.*

EXTENSIONS:

A. **Calculate outdoor recreation costs.** Use outdoor magazines and catalogs for outdoor gear to calculate the cost of outfitting a family trip to a forest area to go fishing, hunting, backpacking, hiking, camping, wildlife viewing, skiing, snowshoeing, or snowmobiling.

B. **Invite forest users as guest speakers.** Ask community members who log, carve, fish, hunt, gather plants, backpack, ski, guide, or create forest crafts to speak to the class on forest use.

C. **Display survey results.** Make a mural or bulletin board display showing the kinds of forest uses students found in their survey.

D. **Create media announcements.** Students design a public service announcement about using a local forest.

E. **Debate uses of a forest.** Use the Section 5 Student Activity "Whose Forest? Our Forest" as a follow-up activity.

Credits:

Adapted from American Forest Foundation "Local Recreation Preferences," *Project Learning Tree Supplementary Activity Guide for Grades K*-8, 1987.

Curriculum Connections:

(See appendix for full citations)

Books:

Alaska's Forest Resources

Alaska Wildlife Notebook Series (ADF&G)

Forests for the Future (Parker)

Shrinking Forests (Tesar) 7-12

Websites:

Alaska Department of Natural Resources <www.dnr.state.ak.us/forestry>

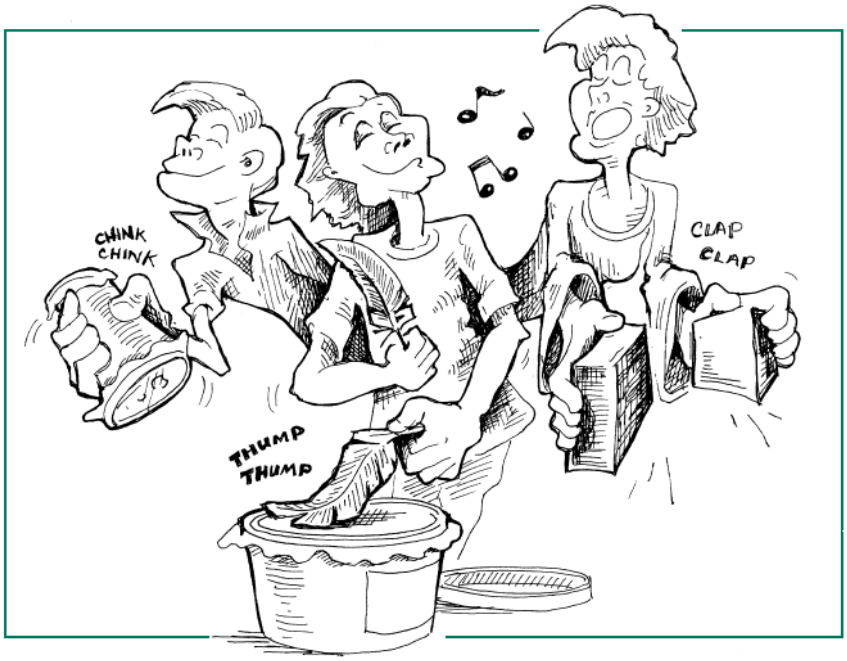
Alaska Statewide Databases <sled.alaska.edu>

Staff-written Alaska newspaper articles: Anchorage *Daily News* Archives <www.adnsearch.com> *or* Fairbanks *Daily News-Miner* <www.newsminer.com>

Teacher Resources:

(See appendix)

Voices of the Woods
5 EXTENSIONS



Section 5
FOREST ACTIVITIES

Grade Level: K - 3

State Standards: A A-1, A A-5

NGSS: K-ESS3-1.
Subjects: Music, art

Skills: Cutting, pasting, inventing, problem-solving

Duration: 30-60 minutes

Group Size: Whole class and individual

Setting: Indoors or outdoors

Vocabulary: Percussion, woodwinds

Objective:
Using forest products, students will create and use musical instruments.

Teaching Strategy:
Students make instruments of new or recycled forest products and play the instruments in class or outdoors.

Complementary Activities:
INDOOR: "Forests in Literature" *and* "We All Use Forests," *both in this section. Also, science lessons on pitch and volume.*

Materials:
New or recycled materials: 2x2s or 2x4s of any wood in varying short lengths *(up to about 10 inches);* sandpaper; glue; round, straight sticks, twigs, or straw; round cardboard containers *(ice cream, oatmeal, corn meal);* cardboard tubes *(wrapping paper, paper towel, toilet tissue);* small cardboard boxes *(up to shoe box size)* or pieces of corrugated cardboard; twine; rubber bands; waxed paper or cellophane; other natural objects such as dried elderberry or cow parsnip canes which are hollow.
OPTIONAL: tape recorder and cassette tape.

Background:
See also *INSIGHTS, Section 5, Human Uses and Impacts.*

People have made musical instruments out of forest products for thousands of years. Solomon Islanders still use the wind to play bamboo cane "pipes" of varying lengths set up on a beach. Australian aborigines use a long, hollow stick to make the droning didgeridoo.

Northern and western Alaska Natives, living where no trees grow, used driftwood to make the rim of their skin drums. Modern instrument makers use trees to make stringed instruments, **woodwinds**, and drums.

Procedure:
1. Ask students how long ago people made music. What might they have used in addition to their own voices? How might they have made instruments?

2. Give students suggestions for making different types of instruments from new or recycled materials:

(a) ***Wind Instruments.*** Tubes of different lengths become "wind instruments" with a piece of waxed paper or

cellophane stretched over one end and held in place with a rubber band. Hum against the waxed paper, or poke a hole in the side of the tube and blow into it, or blow across the open end of the tube. Although they are easily crushed, the dried elderberry or cow parsnip canes can be used the same way.

(b) ***Rattles.*** Tubes can also be rattles. Cover one end of the tube with waxed paper and secure with a rubber band. Put a small handful of wood chips, bark, small pebbles or sand in the tube. Cover the other end of the tube with waxed paper and secure with a rubber band. To play, tip the tube back and forth slowly, then quickly to make the chips "rain" down the tube.

(c) ***Stringed Instruments.*** Pieces of cardboard with twine or rubber bands stretched tightly between notches on opposite sides turn into stringed instruments. Pluck the strings gently. Small cardboard boxes of varying sizes can be used the same way for a variety of sounds.

(d) ***Percussion.*** To make percussion instruments, tap sticks together or clap blocks of wood. Glue sandpaper to some blocks, let dry; then rub two blocks together for another type of sound. Make a xylophone by securing sticks of different sizes to two parallel boards and striking them with two other sticks.

(e) ***Drums.*** Use cylindrical containers (ice cream, oatmeal, cornmeal) to make drums by covering the open end with cellophane or waxed paper held in place with twine, rubber bands, or glue from a hot glue gun. To beat the drum (gently!) using small twigs, sticks, straw, or even feathers.

3. Each student constructs an instrument from the materials available. Let dry, if necessary.

4. Play the instruments together in the class. The teacher can be the conductor at first, then let students take a turn directing when each group plays. You may wish to record the "music" so the class can listen to itself later.

5. Invite your music teacher to share this project with your class. This lesson also coordinates well with science lessons on pitch and volume.

Evaluation:

1. Students construct instruments and play them.

2. Students make the same instruments with different woods and compare the different sound qualities.

EXTENSIONS:

A. **Invite Native musicians to share music and culture.** Invite local Native musicians to class who can share their music and cultural traditions with students.

B. **Locate and play instruments of many cultures.** Locate instruments made of forest products by other cultures. Let the students try playing the instruments, if possible. Analyze the materials with which the instruments are made.

C. **Muse to the music.** Students listen to music while making a picture or painting of their listening thoughts.

D. **Invite guest instrument maker.** Invite an instrument maker to class to tell how the instrument is made and what materials are used.

E. **Invite guest musician.** Invite a musician to class to play her/his instrument and discuss its origin.

Credit:

Adapted from American Forest Foundation, "Musing on Music," *Project Learning Tree Supplementary Activity Guide for Grades K-6 and/or 7-12,* 1987.

Curriculum Connections:

(See appendix for full citations)

Books:

Music Crafts for Kids: the How-to-do Book of Music (Fiarotta)

My First Music (Drew)

Songs are Thoughts: Poems of the Inuit (Foa)

Woodlore (Miller)

Media:

Drums Along the Tundra: Music of the Yup'ik Eskimo (McIntyre)

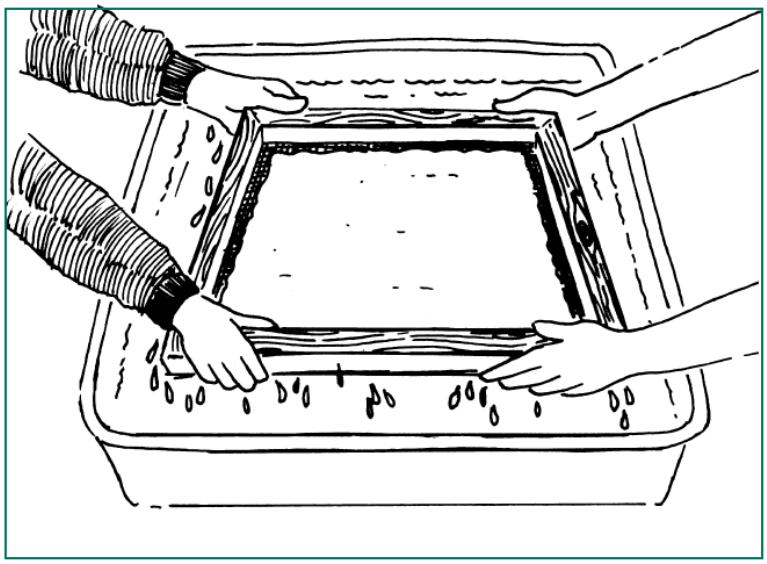
My First Music Video

Teacher Resources:

(See appendix)

Paper Making

2 EXTENSIONS



Section 5
FOREST ACTIVITIES

Grade Level: K -8

Subjects: Science, social studies, math, art

Skills: Gaining information, small motor coordination

Duration: 2 sessions, 10 and 45-minutes

Group Size: Small groups

Setting: Indoors or outdoors

Vocabulary: Deckle, recycle

Objectives:
Students will make their own paper with recycled materials.

Teaching Strategy:
Students use wire screening to form paper from old, torn up paper and other materials.

Complementary Activities:
INDOOR: "Forests in Literature" *and* "How Much Paper Do We Use?" *in this section.*

Materials:
Wire screening (30 mesh); old paper of different types (newsprint, cardboard, tissue paper, notebook or copy paper); thread or yarn; water; wash basins or large pans like kitty litter trays; eggbeater or old blender; newsprint, blotting paper, or old sheets.
OPTIONAL: dried flowers or leaves, rolling pin or pipe, sponges, laundry starch (not spray variety), frame **(deckles)** to hold screening.

Background:
See INSIGHTS, *Section 5, Human Uses and Impacts in Forest Ecosystems.*

Procedure:
DAY ONE
1. Ask students where have they have seen the symbol for **recycled** paper recently? *Probably on documents, packaging, and catalogs. Recycled paper is also used for tissue papers, ticket stubs, insulation, animal bedding, and the "hard" in hardcover books.*

2. Tell students that paper cannot be recycled indefinitely into new paper products. Paper fibers eventually decompose.

3. Explain to the students that they will recycle paper products to make stationery.

4. Have students tear paper or cardboard into small pieces about the size of a quarter. Put the pieces in the basin or pan and cover with water.

DAY TWO (at least 24 hours later)
5. Make a pulp by covering scraps of paper in the basin with a mixture of water and laundry starch. *(Use one tablespoon starch to one cup of water.)* Beat with egg beater or buzz in small batches in the blender until mixture is pulpy and like gravy. *Pulp can be made of only water and paper scraps if obtaining laundry starch is a problem.*

6. Slide the framed screening into the mixture until it is entirely covered with the pulp mixture.

7. Lift the framed screen straight out of the mixture and decorate the new sheet of paper with threads, yarn, dried flowers or leaves, or very small pieces of bright construction paper.

8. Make a sandwich of screen, new paper, and another piece of screening. Press gently. Put this sandwich between several layers of newsprint or blotting paper, or on top of a sponge and press. Remove blotter and put the sandwich between several *fresh* layers of newsprint and step on it, or use the rolling pin or pipe to press out extra water.

9. Remove top screen. Then turn over the rest of the sandwich (new paper face down) on a piece of damp cloth such as an old sheet, or felt. The screen can be removed or left overnight. Remove the dried paper by gently brushing from the edge of the screening.

VARIATION FOR OLDER STUDENTS:
Students design and make a wooden **deckle** (frame) for the screening from lath and tacks.

Evaluation:
Students display their handmade paper and explain how it was made.

EXTENSIONS:
A. **Experiment with a variety of materials.** Make paper and add different materials – rags, thread, yarn, flowers and leaves. Compare the resulting recycled paper to see which is the strongest, the most water resistant.

B. **Write a special note.** Use the recycled paper to write a note to someone, perhaps a poem or thank-you note to a tree!

Credit:
Adapted by Shayla Dobson, art teacher, Anchorage School District, who has used this method with multiple special needs students and all grades.

Curriculum Connections:
(See appendix for full citations)

Books:
Arnold Grummer's Complete Guide to Easy Papermaking (Grummer)

How Paper is Made (Curtis) K-3

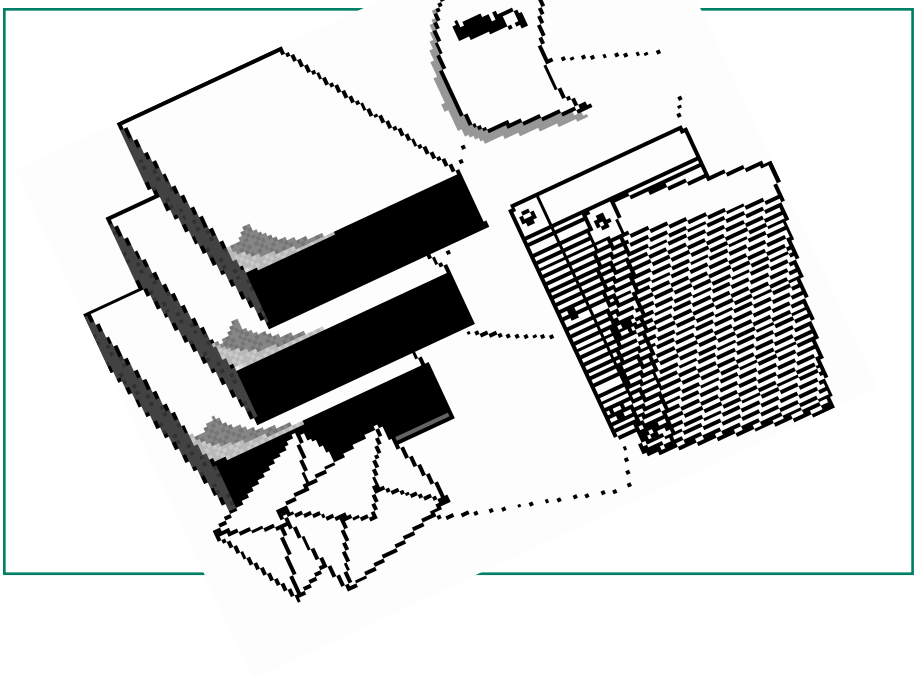
Papermaking for Kids (Wilkenson)

Teacher Resources:
(See appendix)

Reduce, Reuse, Recycle

How Much Paper Do We Use?

4 EXTENSIONS



Section 5
FOREST ACTIVITIES

Grade Level: K - 6

State Standards: M A-3, M A-4, M A-6, Geo E-1, Geo E-2, Gov E-6

NGSS: K-ESS3-1.,4-ESS3-1, 3-5-ETS1-2, MS-ESS3-3. MS-ESS3-4, HS-LS2-7

Subjects: Social studies, math

Skills: Measuring, comparing, analyzing, graphing

Duration: 30-60 min.

Group Size: 1 and whole class

Setting: Indoors

Vocabulary: Recycle, reuse, reduce

Objectives:

1. Students will determine the amount of paper they use daily as individuals, as a classroom, as a school.

2. Students will understand that they can contribute to paper recycling.

3. Students will develop a plan for reducing the volume of paper waste in their classroom and/or school.

Teaching Strategy:

Students keep records of their paper use for one day and calculate the amounts used daily by their classroom and school. Students work in groups and as a class to make a plan for reducing paper use.

Complementary Activities:

INDOOR: "Paper Making" *and* "We All Use Forests" *in this section.*

Materials:

Large box for collecting paper from the classroom, a scale to weigh paper, pencil, paper.

Background:

See INSIGHTS, *Section 5, Human Uses and Impacts in Forest Ecosystems: "How Much Paper Do We Use?"* fact sheet.

Procedure:

1. List and discuss which classroom materials are made from trees.

2. Review daily class activities that use paper. Tell students that they will be keeping track of paper use for each day of one week. Ask them to deposit their paper in a central location such as a marked box. At the end of each day, weigh the paper. At the end of the week, calculate an average daily amount.

3. Divide the paper into two categories: "paper that can still be used," *(perhaps only one side has been used)* and "paper that has been used completely."

4. Discuss ideas for reusing paper. Ask the class to make a simple paper recycling plan and put it into action. Ask the children to determine at least three ways to reduce paper waste in the classroom.

5. After the plan has been in effect for a week, weigh the waste paper again to see if progress has been made.

VARIATION FOR OLDER STUDENTS
Use math to equate the percentage of paper saved over the course of the week. If the amount of paper saved were added up over the course of the year, how much paper, by weight, would be saved?

Evaluation:

1. Students name three ways to reduce paper waste in the classroom.

2. Students develop, carry out, and monitor a plan to reduce paper waste in the classroom or school.

EXTENSIONS:

A. **Research own paper use.** Students collect the paper individually at their own desks and determine their average personal use over a period of time.

B. **Estimate consumption of paper by school.** Estimate the amount of paper used by the school on a daily and weekly basis.

C. **Estimate how many trees supply school paper needs.** Estimate the number of trees used each year by the classroom and school (1 tree = about 300 lbs. of paper).

D. **Create and monitor plan for school paper reduction.** Create a waste reduction plan for the school and include ideas to help teachers and others who work in the school reduce their use. Monitor and follow the plan by weighing waste initially, and then periodically weighing after the plan has been in effect. The results can be recorded on a graph.

Alaska Recycling Sources

Citizens for Recycling Solutions (Anchorage, Alaska) <www.citizensrecycling.com> (907) 566-2405

ALPAR (Alaskan's for Litter Prevention and Recycling), P.O. Box 200393, Anchorage, AK 99520 *or* (907) 274-3266

RurAL CAP (Rural Alaska Community Action Program), 731 E. 8 th Ave., Anchorage, AK 99501 *or* <www.ruralcap.com>

Alaska Inter-Tribal Council, 431 W. 7th Ave., Anchorage, AK 99501 *or* (907) 563-9334 <www.AITC.org>

Anchorage Recycling Center, 6161 Rosewood St., Anchorage, Alaska 99518 <www.anchoragerecycling.com/>

Credit:

This activity was originally contributed by the late Val Chalbot. Val taught elementary school in Eagle River, Alaska.

Curriculum Connections:

(See appendix for full citations)

Books:

Just a Dream (Van Allsburg)

Lorax (Seuss)

Remake It! Alaska: Anchorage Businesses Remake, Recycle, Reuse (Citizens for Recycling Solutions)

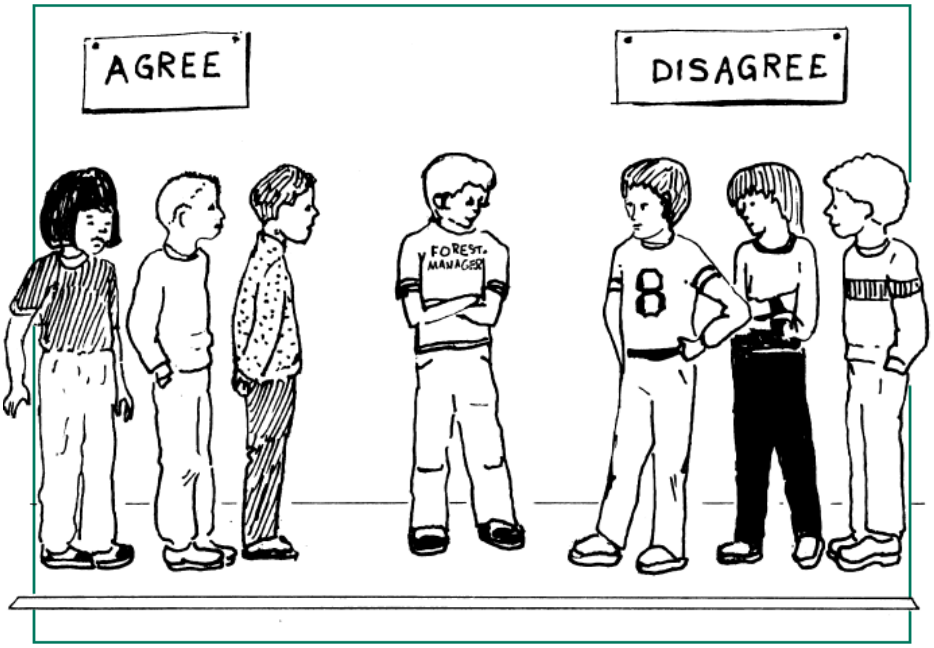
Teacher Resources:

(See appendix)

The average American uses two trees worth of paper each year.

Whose Forest? Our Forest!

2 EXTENSIONS ***ALERT: ALASKA ECOLOGY CARDS OPTIONAL***



Section 5
FOREST ACTIVITIES

Grade Level: 7 - 12
State Standards: L D-1, D4, Geo E1, E4, Gov C1, C7, E7
NGSS: MS-LS2-1.,MS-LS2-4, MS-LS2-5, MS-ESS3-3.,MS-ESS3-4,HS-LS2-2.,HS-LS2-7, HS-ESS3-2,HS-ESS3-3, HS-ETS1-3.
Subjects: Science, social studies, language arts
Skills: Reading, writing, speaking, listening, decision-making, analyzing, synthesizing, role-playing
Duration: 60 minutes research, 60 minutes role-play
Group Size: Whole class
Setting: Indoors
Vocabulary: Conservation, preservation, management goal, multiple-use

Objectives:

1. Students will name three reasons why forest management is necessary.

2. Students will describe at least two problems related to managing a forest.

Teaching Strategy:

Students participate in an imaginary public forum regarding forest use in order to come to a consensus on managing the forest.

Complementary Activities:

OUTDOOR: "On the Trail of Human Uses" *in this section. INDOOR:* "Forests for People" *and* "Forest Careers" *in this section.*

Materials:

Forest Management Game Role Cards *(see following pages);* Policy Statements *(following*); four large cards with the words "Agree," "Disagree," "No Opinion," and "Need More Information" written on them; chalkboard.

Background:

See INSIGHTS, *Section 5, Human Uses and Impacts in Forest Ecosystems.*

Procedure:

Consider the following: *Resource issues touch all our lives and may be close to the heart of many of your students. In the following activity, students may be asked to represent a viewpoint that differs from their own. Explain to students that this activity may be an opportunity to enhance their understanding of how another person sees a similar situation.*

DAY ONE:

1. Brainstorm with students the ways people use forests and list these on the board. Help students think of logging, mining, camping, developing (homesteading, fish camps, homes), subsistence traditions, hunting, trapping, fishing, mushroom or berry picking, snowmobiling, hiking, skiing, and other forms of recreation. *[See* "Forests for People," *a survey activity in this section.]*

2. When students have run out of ideas, ask them to decide if each activity would change the forest and, if so, what the changes would be. List these effects on the board.

3. Ask students to consider what would happen to a forest and its users if all these activities occurred simultaneously without any controls.

4. Follow by asking students how loss of forests might be prevented. Do they think that we can get by without wood and paper, without minerals, and without land for homes. Explain that the process of balancing use and protection of forests is called **forest management**, and those who practice it are called forest managers or foresters. Explain the difference between **conservation** and **preservation.**

5. Review what forest managers need to know in order to manage forests wisely. Distribute the "Forest Management Role Cards" to students and explain that these roles represent citizens and experts concerned about forests. Give some students two or more cards – for example, a logger can also be a wildlife photographer, a hunter can be a birdwatcher.

6. The teacher or a student can play the role of forest manager. Students can also rotate through this role, having each one try to establish one policy. Students read their role cards carefully. Students should imagine that they are the person described on the card and act and think like (role-play) that person.

7. Provide materials and time for research and preparations for their roles.

VARIATION
You may wish to spend a week on this activity. Focus on 2-3 policies each day.

DAY TWO:
1. Conduct a "Forest Management Simulation." Place the "Agree" and "Disagree" signs on opposite sides of the room and the "No Opinion" sign in the middle between these. [*Optional*: Place the "Need More Information" sign at a separate location.]

2. The forest manager reads aloud a Forest Policy Statement (but not the Possible Modifications, until later). Students are to think quickly, then move to the card that describes their reaction to the policy ***based on the role they are playing.*** Props may be helpful in reminding students of their role.

3. Once students have all arrived at a card, ask those on the "Agree" side who they are and why they agreed with the policy *(that is, as if to testify at a public hearing).* Repeat this step for the "Disagree" side. Then, ask if anyone wants to change places after hearing the opinions of others.

4. If you are using the "Need More Information" sign, students who want more information ask their questions and see if anyone can provide an answer. *(For example, a bird watcher may be uncertain how a certain policy would affect birds; the bird expert might be able to tell them.)* If no one can provide an answer, discuss where students might be able to obtain an answer – from a scientist, resource manager, long-time local resident, and/or by doing research or experiments. Explain that a complete answer may take a fair amount of research and interviews.

5. After hearing all the testimony about the policy as stated, the forest manager should take into account what was said, then reword the policy and propose it again in modified form, using as guidelines the "Possible Modifications" on the "Policy Statement" cards.

6. Students then react to the new policy by moving to the sign that represents their opinion. Ask those who still disagree with the policy to state their reasons. Allow other students to change their minds based on the statements of those who disagree with the modified policy.

7. Repeat steps in 5 and 6 until the manager has made a policy with which the majority of students agrees. This process will increase student awareness of compromise in public land policy, the difficult job of a multiple-use land manager, the need for information on how human activities affect a forest, and the need for citizens to speak up for what they want.

8. Discuss how the game differs from real life.

- *Decisions are usually more complicated.*
- *Experts often are not certain of the answers to questions about the effects of change.*
- *People have even more widely varied ideas about forest uses.*
- *Many policies are set not by forest managers but through the political process* (state and federal regulating committees, public input, elected officials, ballot initiatives, for example.) *Forest managers must abide by any laws that relate*

to the forest they are managing. In some cases, laws may limit a forest manager's authority to regulate forest uses or use certain forest management tools.

Evaluation:

Students write an essay that gives at least three reasons for forest management and describes two problems of trying to balance use and protection of forests.

EXTENSION:

1. **Research local forest policies; compare to own.** Students find out the management policies for a forest in their area and compare those to the policies they developed. Encourage them to investigate differences.

2. **Follow forest issue over time.** Students research a local forestry issue, interviewing community members, land managers, industry representatives, etc., and track the public process over the course of the school year.

Curriculum Connections:

(See appendix for full citations)

Books:

Earth's Vanishing Forests (Gallant)

Forest: Identifying Propaganda Techniques (Anderson)

Forests for the Future (Parker)

Saving Our Forests (Hirschi)

Shrinking Forests (Tesar) 7-12

Websites:

Alaska Department of Natural Resources <www.http://dnr.alaska.gov/forestry

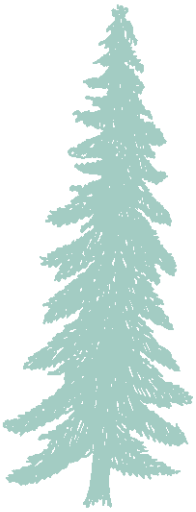
Alaska Science Forum <www.gi.alaska.edu/AlaskaScienceForum>

Alaska Statewide Databases <sled.alaska.edu>

Staff-written Alaska newspaper articles: Anchorage *Daily News* Archives <www.adnsearch.com> *or* Fairbanks *Daily News-Miner* <www.newsminer.com>

Teacher Resources:

(See appendix)



FOREST MANAGEMENT CARD
Fire Expert:

You are concerned about protecting people and property from forest fires. You know that fires near towns or small villages present a more serious threat to people than do forest fires in areas distant from people. Roads and trails can make it easier for you to control forest fires.

You think it is important to monitor all forest fires, and put out those that threaten people. You know that frequent small fires remove dead wood and branches (fuel) in a northern forest. If a fire has decades of fuel, it will burn bigger, hotter and be harder to control. Because it is very expensive to put out fires, you think fires that do not threaten should be watched carefully, but allowed to burn.

You realize that if more people build homes in remote areas, it will become more important to put out fires in those areas. This will make it more difficult to allow wild fires to perform their natural role, and will cost the public much more money.

FOREST MANAGEMENT CARD
Forest Fire Fighter:

You earn your living by putting out forest fires. There may be little work for you in Alaska in some years if there are few fires and if some fires are allowed to burn. You know that forest fires are often difficult to control. Some years your fire crew is sent to fight big fires in the Lower 48 states. Other years, there are many fires in Alaska and you have plenty of work.

FOREST MANAGEMENT CARD
Watershed Expert:

You are concerned about protecting the water supplies for human communities. You are concerned about preventing floods and droughts.

You know that forests are very important in the water cycle. They return moisture to the air, so they help make rain and snow. Forests store and purify water. Forests help keep streams, lakes, and underground water supplies full of clean water.

You know that land clearing, timber harvest, or burning of large areas of forest can cause more frequent and severe flooding and can result in less water in streams during dry periods. You know that small clearings have less impact than large clearings.

FOREST MANAGEMENT CARD
Fisheries Expert:

You are concerned about protecting habitat for fish. You know that forests are important because they help keep streams and lakes full of clean, cool water.

You know that removal of large areas of forest along streams by clearing, mining, timber harvest, or fire can cause soil erosion, destroying fish habitat. Increased sediment (*silt and soil in the water*) raises the water temperature and decreases oxygen levels so fish may not survive.

These activities also can reduce invertebrates in streams that fish eat. You know that small clearings have less impact than large ones. You know that removal of forests along streams has more impact on fish habitat than removal of trees distant from streams. You know that often more soil is eroded as a result of fire and logging trails and roads than as a result of forest fires or timber harvest alone.

FOREST MANAGEMENT CARD
Atmosphere Expert:

You are concerned about the atmosphere and the air we breathe. You know that forests are important in keeping the air clean and breathable because they remove dust, carbon dioxide, and pollutants from the air; and they return oxygen, the gas we breathe.

There is not enough research for you to be certain of the importance of forests on a global scale, but you know that they are important in local areas. You know that removal of trees and forests can lead to dustier, dirtier air. That can bother people with breathing problems.

FOREST MANAGEMENT CARD
Furbearer Expert – Boreal Forest

You are concerned about protecting habitat for furbearing wildlife (*foxes, mink, marten, lynx, weasels, and coyotes*). You know that permanent loss of forest habitat means less habitat for furbearers and therefore fewer furbearers.

You know that small openings in boreal forests, created by fires, timber harvest, insect outbreaks, or other disturbances, can improve habitat for small mammals such as voles, mice, and hares – the main foods of furbearers. But you also know these sites will only be good for small mammals if they have plenty of ground cover and shrubby plants for their food, and many fallen logs and branches for shelter.

You know that large openings in the forest are less valuable than small openings. Some furbearers, such as lynx and marten, need patches of old-growth forest for cover and den sites and can use only edges of large clearings.

FOREST MANAGEMENT CARD
Bird Expert:

You are concerned about protecting habitat for birds. You know that events that set back succession, such as forest clearing, timber harvest, and fire, can sometimes improve habitat for birds that need forest openings and shrub thickets (*sparrows, robins, and certain hawks and owls*). You know that small clearings create better habitat for these birds than large ones.

You know that clearing, timber harvest, burning, or any other activity that changes old-growth forests results in habitat loss for birds requiring this forest type (*spruce grouse, crossbills, warblers, goshawks, boreal chickadees, varied thrushes, three-toed woodpeckers*). Since young forests do not provide habitat for these birds, the only known way to protect these birds is to protect some areas of old forest.

You know that large dead or dying trees (*snags*) provide important feeding and nesting places for woodpeckers, kestrels, swallows, chickadees, owls, and other birds. You know that it takes 100 or more years to form snags suitable for use by some of these birds. You know that many of these birds eat insects and help to reduce the insect populations that harm trees.

FOREST MANAGEMENT CARD
Furbearer Expert – Coastal Forest:

You are concerned about protecting habitat for furbearers so that they will remain abundant in the coastal forest region. You know that most furbearers in the coastal forest use old-growth forests along streams, rivers, and the coast more than any other habitats.

You know that few studies have been done in the coastal forest, but those studies that have been done found that river otters and marten prefer old-growth forests over other habitats when hunting food or places to den.

You also know that furbearers are most abundant in places where their prey are abundant. Their prey are usually abundant along streams, in small clearings, and in old-growth forest; but are rare in mature and second growth coastal forests.

FOREST MANAGEMENT CARD
Commercial Firewood Cutter:

You earn a living by cutting firewood and selling it. The more firewood people need, and the more you can cut, the more money you earn.

FOREST MANAGEMENT CARD
Moose Expert:

You are concerned about protecting habitat for moose so that they will remain abundant. You know that moose feed on tall shrubs and sapling trees. These are most numerous along river banks and in forests that have recently burned or been logged.

You know that putting out all fires may reduce the amount of tall shrub areas available to moose. You also know that in areas with heavy snowfall, such as Southeast Alaska, moose require patches of old-growth forest to find winter food and shelter.

FOREST MANAGEMENT CARD
Deer Expert:

You are concerned about protecting habitat for deer so that they will remain abundant. You know that deer eat small plants and low shrubs. These foods are most abundant in climax (*old-growth*) forests and in forest clearings (*created by insect outbreaks, avalanches, fallen trees, timber harvest, and fire*).

You know that mature and second growth forests contain almost no food for deer. You also know that the most critical season for deer is winter. In winter deer require old-growth forests with very large trees. These trees catch snow in their branches, making travel on the ground much easier and food easier to find.

FOREST MANAGEMENT CARD
Tree-Growing Expert:

You recognize that trees are a renewable resource if they are harvested and regrown carefully. You favor timber harvest when conservation is part of the plan. You do not want activities that increase soil erosion, which some logging practices do. A healthy soil layer is needed for trees to flourish.

You know that forests should not be clear-cut on steep hillsides because the soil will easily erode and then new trees cannot grow. You know that fires and certain wood-eating insects and fungi kill trees. You want to stop the death of trees to these causes. You know that replacing large areas of natural forest with trees that are all the same species and age can lead to outbreaks of insects and disease.

Instead, you favor harvesting trees in small sections and helping a variety of trees to grow back. You know that replanting trees after an area is cleared is very important in some places, but that natural reseeding works better in other areas and is much less expensive.

FOREST MANAGEMENT CARD
Logger:

You make your living by harvesting trees from the forest. You see this as a valuable service to people because everyone uses wood in some form everyday. You know that the company you work for makes more money when it cuts large trees rather than small ones.

You also know that old-growth forests contain a lot of dead and dying trees that are not useful for wood products because they are rotten. You think it would be better to harvest trees when they are mature, but before they grow old and rotten.

You know that it would be easier and safer to harvest trees in remote areas if roads were built into these areas.

FOREST MANAGEMENT CARD
Hunter:

You harvest animals such as moose and deer to feed yourself and your family. You can see these animals in cleared areas more easily than in dense forests. You hunt with your entire family and therefore prefer driving to the area where you hunt.

FOREST MANAGEMENT CARD
Hunter:

You harvest animals such as moose and deer to feed yourself and your family. You like to hunt where you see few other hunters, so you always go by boat or hike to a remote area to hunt.

You do not want roads built to the areas you hunt because then more people will go there. You think that more people will cause animals to become scarce.

You hike everywhere, but don't like to hike in areas where there are a lot of fallen trees and branches, such as clear-cuts and old burns.

FOREST MANAGEMENT CARD
Lumber Mill Worker:

You earn a living by processing the timber harvested from forests in your area. If there are not enough trees to be logged, the mill may have to lay off workers, and you could lose your job. You think wood is the most important benefit we get from forests.

FOREST MANAGEMENT CARD
Angler:

You like to catch fish, especially salmon, to eat. You have always caught more fish in clear, cool streams than in murky ones that have a lot of silt.

FOREST MANAGEMENT CARD
Bird Watcher:

You enjoy hiking in the outdoors and looking for birds. You know that different kinds of birds live in different habitats. Some birds live only in old-growth forests, some only in young forests, and others live only in more open areas. You want to be sure that all birds are around for you and others to watch and hear, so you want to protect all habitats.

You recognize that fire, insect outbreaks, wind, avalanches, and certain human activities (*such as timber harvest*) all create the habitats (*early successional*) needed by some birds, but remove the habitat needed by other birds that live in mature and climax (*old-growth*) forests.

FOREST MANAGEMENT CARD
Firewood Cutter:

You heat your home entirely with wood. Every summer you cut enough trees for firewood for the following winter. Last year's wood has dried and is ready for this winter. You also cut and sell firewood to your neighbors to make money. The amount is minimal, but every dollar helps your family. If you are not allowed to cut firewood, you won't be able to heat your house.

FOREST MANAGEMENT CARD
Gold Miner:

You earn your living by mining for gold. You have found the best places to look for gold are in the banks along rivers. To get the gold out, you must remove the trees or have loggers do this for you. Then you wash away all the soil so you can separate the gold. After you finish mining at a place, all that is left is a pile of gravel. You have noticed that small trees are growing in the places where other miners worked their claims years ago.

FOREST MANAGEMENT CARD
Trapper:

You trap animals to harvest their furs, which are used to make parka ruffs, coats, and other clothing. The more furbearing animals there are in the forest, the more you can harvest. Therefore you are very concerned that their habitat is protected.

You know that if too many people trap or travel in one area, furbearers may become scarce. You think that roads will allow more people to get into the area where your trapline catches the most animals.

FOREST MANAGEMENT CARD
Homesteader:

You homesteaded land in a remote forested part of Alaska. No one else lives within 10 miles of you. After 30 years of hard work, you have a nice house, a big garden, and everything you ever wanted.

Your biggest worry is that a forest fire might sweep through your area and destroy what you have worked so hard to build. You think it is the State's duty to put out all forest fires that occur anywhere near your homestead.

Now that you are older, you would like a road to your area to make it easier to get in and out.

FOREST MANAGEMENT CARD
Alaska Tourist:

You like to drive around and sightsee by car or motor home. You would like to have more roads built through Alaska's forests. You also like to fish, view wildlife, and photograph the spectacular views you see along the roads.

FOREST MANAGEMENT CARD
Alaska Tourist:

You hike and camp in remote forested areas taking pictures of scenery and wildlife. You are amazed at the wildness and beauty of the land and at the variety of plants and wildlife that you see. You think that areas of the earth where human activities haven't changed everything should be left that way. You would like Alaska to stay as wild as possible.

FOREST MANAGEMENT CARD
Commercial Fisherman:

You have been a commercial fisherman since your youth. Your children work alongside you and will inherit your business when you retire. You have always earned your living by catching salmon and other fish. If there are too few salmon, you won't be able to make a living.

You know the importance of healthy forest streams to **anadromous** fish populations. You think all people should be allowed to do what they want to do for a living.

FOREST MANAGEMENT CARD
Wildlife Photographer:

You earn a living by taking photos of wild animals. To do this, you travel to remote, forested areas of Alaska where human impact has been minimal. You fear that if wildlife habitat is further developed (*logging, mining, housing development*), wildlife populations will decline and become more wary of people. It will become much harder for you to photograph wildlife in wild places.

FOREST MANAGEMENT CARD
Hotel Owner:

You rely on tourists who rent rooms from you during the summer months. Without tourists, you would have to close your hotel and lay off your employees. Based on your conversations with your guests, most tourists come to Alaska to see scenery, wild areas, and wildlife.

You think that if the scenery is spoiled by more mining, logging, building, fire, insect infestation or if wild animals become scarce, fewer tourists will come to see Alaska.

FOREST MANAGEMENT CARD
General Store Owner:

You earn a living by selling groceries and supplies people need every day. Tourists are important customers at your store, but local people shop at your store year-round and are vital to your business.

You think that if your neighbors are allowed to log, mine, and build homes in this area, you will have more customers, make more money, and be able to hire more workers.

FOREST MANAGEMENT CARD
Land Developer:

You earn money by buying large sections of land. You divide the land into smaller lots, build roads and houses, and sell these individual houses to other people. You see forested land as open space to be developed, for profit.

FOREST MANAGEMENT CARD
Building Contractor:

You build houses and other buildings using a lot of wood. You know that wood is a renewable resource. The cost of shipping wood from the Lower 48 is expensive. You think it would be cheaper to buy lumber for building if more trees were harvested from local forests.

FOREST MANAGEMENT CARD
Newspaper Publisher:

You publish a newspaper. One of your highest expenses is buying paper. You think that the reason paper costs so much is that not enough trees are harvested.

FOREST MANAGEMENT CARD
Manufacturer:

You manufacture a variety of high-tech goods (*computers, cell phones*). Gold is an important metal used in your manufacturing process. As demand for your product increases, your need for gold rises.

FOREST MANAGEMENT CARD
Truck Driver:

You earn a living by hauling goods from place to place. You and your co-workers haul wood, building supplies, groceries, and many other items. You must have roads to do your business. If there were more roads, you could reach more areas and get more business.

You think that more timber harvesting and building will create more things for you to haul in your truck, so you can make more money. On your days off, you like to hike in wild areas.

FOREST MANAGEMENT CARD
Local Resident:

You moved to Alaska because you thought it was the land of opportunity – a frontier where everyone could still do whatever they wanted. You do not like restrictions of any kind. You think this place is big enough that people should be able to cut wood wherever they want, build where they want, and do as they please.

FOREST MANAGEMENT CARD
House Renter:

You are renting a house because land on which to build is scarce and few houses are for sale in your area. When you look at all the forest land around, you dream about having your own house. You think that land should be given or sold to people who want to build homes.

FOREST MANAGEMENT CARD
Recycling Center Owner:

You own a recycling plant where people can bring old papers, glass, and metals. These materials are processed, then recycled for a second use. You think that if people would recycle more, you could provide more jobs for people, and it won't be necessary to harvest trees or mine as much as we currently do.

FOREST MANAGEMENT CARD
Local Resident:

You moved to Alaska to get away from the crowds and development in the Lower 48 states. You like wild areas and seeing wild animals. You appreciate Alaska's clean fresh air and water. These things seem wonderful to you after growing up in a crowded city with few trees and lots of pollution problems.

FOREST MANAGEMENT CARD
Corporation President:

You are the president of a corporation that owns large tracts of forest. Your corporation harvests timber for profit. You find that it is difficult to make a profit in this business in Alaska for several reasons: (1) It is expensive to operate because so many areas are remote, and you have to pay high wages, (2) Many of the forested areas contain only small trees that are not profitable to harvest, and (3) accident insurance is high — the risk is high that someone will be cut by a saw or crushed by a falling tree. *(The standing dead snags are particularly dangerous.)*

You can make the most money if you are able to clear-cut large areas that contain the biggest trees and are near roads. Building roads to these sites makes it easier and cheaper to harvest the wood. With roads, loggers are safer, because, if accidents happen, they can be evacuated easier. This reduces insurance costs.

FOREST MANAGEMENT CARD
Librarian:

You think books are wonderful and you realize that we need lots of paper to have books. You know that we wouldn't have any paper unless we harvested trees from forests.

You also enjoy wildlife and the outdoors and want to keep Alaska a nice place to live.

FOREST MANAGEMENT CARD
Wilderness Advocate:

You see Alaska as one of the few places in the northern hemisphere that still contains large areas of pristine forests, almost untouched by human activities. You think that humans need wilderness areas if for no other reason than to keep some areas wild and untamed for the future.

You think it would be a tragedy if logging and mining turned Alaska's wild forests into managed, heavily impacted areas. If people used less wood products by reducing, reusing and recycling, the tree farms of the Lower 48 could produce enough wood. This would keep Alaska's wild places wild.

FOREST MANAGEMENT CARD
Traditional Carver:

You carve traditional items of beauty and symbolism from wood. You go into the forest to select the tree that speaks to you for your work. Your family has done this for centuries.

The forest has great meaning to you and sometimes your family and friends hold special ceremonies among the largest trees. You have found ancient tools and artifacts that show Alaskans have used this forest for several thousand years.

FOREST MANAGEMENT CARD
Traditional Gather/Artisan:

You and your grandmother go into the woods many times from spring through fall to gather greens and berries. You are learning basket-making from your grandmother. She knows just where in the forest to get the best materials for baskets. The trees must meet special standards and be just the right age. The baskets you are making are so fine they can hold water, just as the baskets of your ancestors.

You want these woods protected so in the future you can take your own children and teach them where to find the most delicious berries and how to make fine baskets from the forest.

FOREST POLICY STATEMENT:
Wood is the most valuable material we get from forests, so all trees in our forests should be harvested.

POSSIBLE MODIFICATIONS:
- wood is one of many benefits of forests.
- except on steep slopes where soil might erode.
- except along streams.
- only in parts of the forest, while other forest areas should be reserved for other values.

FOREST POLICY STATEMENT:
More roads should be built in Alaska's forests.

POSSIBLE MODIFICATIONS:
- but roads should never be allowed in some areas of forest.
- only if they are carefully designed to prevent soil erosion.
- if roads are built with methods that protect fish, wildlife, and streams.

FOREST POLICY STATEMENT:

All forest fires should be put out.

POSSIBLE MODIFICATIONS:

– fires that threaten human lives or property should be put out.
– controlled fires can be used to create habitat for wildlife in areas where uncontrolled wild fire might threaten lives or property.

FOREST POLICY STATEMENT:

Mining should be allowed anywhere in a forest that minerals are found.

POSSIBLE MODIFICATIONS:

– only in parts of the forest, while other forest areas should be reserved for other values.
– except along streams.
– only if erosion is prevented and the soil is restored after mining ends.

FOREST POLICY STATEMENT:

Timber harvest should not be allowed in any Alaska forests.

POSSIBLE MODIFICATIONS:

– in some Alaska forests
– in some parts of Alaska forests

FOREST POLICY STATEMENT:

In public forests only activities like camping, photography, viewing, hiking, bird watching, berry picking, motorized travel (snow machines, four wheelers), fishing, and hunting should be allowed everywhere.

POSSIBLE MODIFICATIONS:

– all activities in parts of the forest
– certain activities in certain areas of the forest
– certain activities at certain times during the year

FOREST POLICY STATEMENT:

Loggers and firewood cutters should be allowed to cut only dead trees.

POSSIBLE MODIFICATIONS:

– not be allowed to cut dead trees.
– be allowed to cut only certain dead trees.
– be allowed to cut certain age/diameter living trees.
– allowed to cut any tree in certain areas of the forest, while other forest areas should be reserved for other values.
– allowed to cut dead trees in certain areas of the forest, while other forest areas should be reserved for other values.

FOREST POLICY STATEMENT:

People should be allowed to cut as much firewood as they need from wherever they want in the forest.

POSSIBLE MODIFICATIONS:

– only commercial firewood cutters.
– only non-commercial cutters for private use.
– firewood cutting should be allowed only in certain areas.

FOREST POLICY STATEMENT:

Forest lands should be sold to private individuals, and then they can decide what they want to do with these lands.

POSSIBLE MODIFICATIONS:

– some lands.
– only lands near roads.
– only if other forest lands are protected as wildlife habitat, for watershed protection, timber production, and other values.
– only if restrictions requiring forest protection or renewal are placed on the land before selling it to private individuals.

FOREST POLICY STATEMENT:

People should be required to recycle paper because that would reduce our need to cut so many trees.

POSSIBLE MODIFICATIONS:

– government agencies will purchase recycled paper and recycle used paper.
– private recycling groups will be supported by the government for community recycling programs.
– citizens will receive **incentives** to recycle (*tax breaks, cheaper trash removal costs*).
– citizens will recycle voluntarily and not be required by law to recycle.

FOREST POLICY STATEMENT:

People should be required to use air-tight stoves with catalytic converters to reduce use of firewood and air pollution.

POSSIBLE MODIFICATIONS:

– in areas where wood is scarce.

– in areas where air pollution is a problem, citizens will receive **incentives** (*tax breaks, rebates after purchases of converters*).

FOREST POLICY STATEMENT:

People should be allowed to build private cabins on public forest lands.

POSSIBLE MODIFICATIONS:

– not be allowed.

– public use cabins should be built and made available to the public.

FOREST POLICY STATEMENT:

Whenever trees are harvested from forests, people should go in and replant trees.

POSSIBLE MODIFICATIONS:

– in areas where trees would not come back naturally.

– trees should only be harvested from areas where they will come back naturally.

FOREST POLICY STATEMENT:

Insects and fungi kill trees so pesticides and fungicides (poison chemicals) should be used to get rid of them.

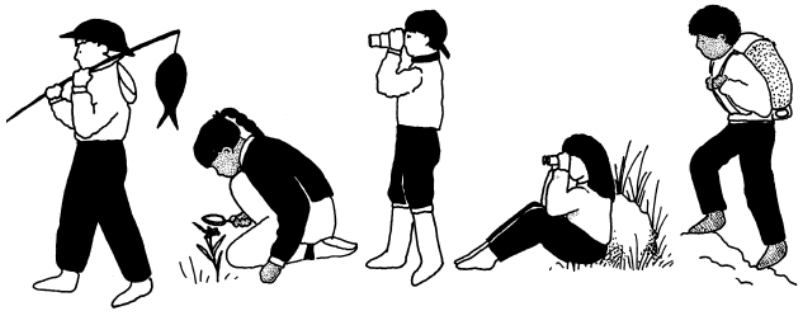
POSSIBLE MODIFICATIONS:

– used on certain insects and certain fungi.

– only in places where producing trees for harvest is the main use of the forest.

– never be used.

On the Trail of Human Activities



Section 5
FOREST ACTIVITIES

Grade Level: 5 - 12

NGSS: 5-ESS3-1, MS-LS2-1.

MS-LS2-4, MS-ESS3-4,HS-LS2-2.

HS-ESS3-3

Subjects: Science, social studies

Skills: Observing, predicting, values clarification

Duration:

Group Size: 1-4

Vocabulary: Succession

Objective:
Students will identify effects of human activities in a forest and classify them as helpful or destructive to the forest ecosystem.

Complementary Activities:
INDOOR: "Forests for People" *and* "Whose Forest? Our Forest!" *in this section.* "Succession's Path" *and* "Animal Adaptations for Succession" *in Section 4, Succession.*

Materials:
Clipboards and writing paper or field note books, pencils or pens, and "Science Card" *(following)* for each student. Chalkboard.

Background:
See INSIGHTS, *Section 5, Human Uses and Impacts in Forest Ecosystems.*

Procedure:
IN ADVANCE, locate a site where humans have altered the forest.

1. *IN CLASS,* brainstorm changes humans can make in a forest. List them as students say them. Discuss if or how these changes might affect forest wildlife.

2. Ask students to predict what human influences they might find in the forest they are about to enter. Remind them to use all their senses.

Classroom Follow-Up:
1. Make a class list on the board of human activities students observed in the forest.

2. Compare the predictions to what was found. Did students find some signs they hadn't expected?

3. Write the following headings across the top of the board:
"Harmed Most Wildlife"
"Harmed Wildlife That Need Old Forests"
"Harmed Wildlife That Need Early Successional Stages"
"Harmed People's Enjoyment of Forest"
"Other Harm To Forest"

"Helped Most Wildlife"
"Helped Wildlife That Need Old Forest"
"Helped Wildlife That Need Early Successional Stages"
"Improved People's Enjoyment of Forest"
"Other Benefits to Forest"

"Overall Effects"

3. Review each activity and place a +, -, or 0 in all the columns that apply. Then, based on the number of check marks on the positive side versus the number on the negative side, assign an overall +, -, or 0 (neutral) symbol in the "Overall Effects" column.

4. Ask students to discuss how the overall effects of each activity might differ if only one person did it, or 10, 50, 1,000, or everybody – or, if it occurred in only a few areas of the forest, or in most areas of the forest.

Curriculum Connections:

(See appendix for full citations)

Books:

Alaska's Forest Resources (Alaska Geographic Society)

Forests for the Future (Parker)

Pharmacy in the Forest: How Medicines are Found in the Natural World (Powledge)

Shrinking Forests (Tesar) 7-12

Media:

Ancient Forest: Rage Over Trees (Video) (National Audubon Society)

Websites:

Alaska Statewide Databases <sled.alaska.edu>

Staff-written Alaska newspaper articles: Anchorage *Daily News* Archives <www.adnsearch.com> *or* Fairbanks *Daily News-Miner* <www.newsminer.com>

Teacher Resources:

(See appendix)

SCIENCE CARD

Human Activities

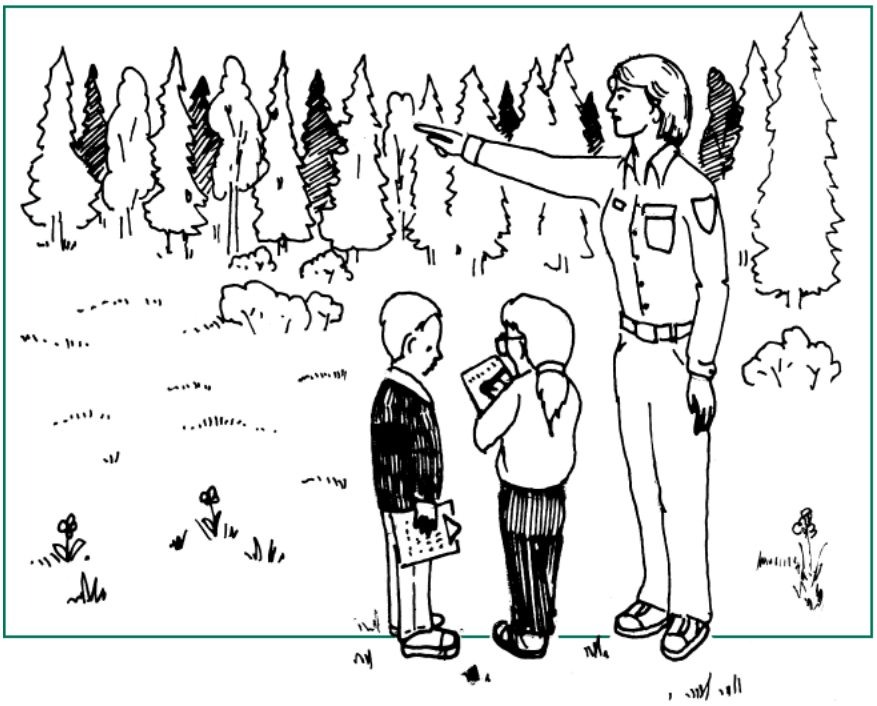
1. Turn to a page in your field notebook and label the page "Human Activities and the Forest."

2. Use your seeing, hearing, and smelling senses as you examine this area carefully. Record any evidence of human activity that you find. Don't forget that past human activities may have disturbed the site and caused this area to be at a different stage of **succession** than nearby sites.

3. List the signs of humans that you found, and put a plus mark by those you think improved the forest, a minus mark by those you think harmed the forest, and a "0" by those you think changed the forest but had mixed effects. *(Remember, a change in the forest may benefit some living things and harm others.)*

4. Add to your notes any evidence of humans you find elsewhere along the trail to or from the site.

Forest Careers
4 EXTENSIONS



Section 5
FOREST ACTIVITIES

Grade Level: 7 - 12

State Standards: L A-3, L A-4

Subjects: Language arts, humanities, social studies

Skills: Vocabulary development, interviewing, writing

Duration: 4 to 5 hours

Group Size: 1 and whole class

Setting: Indoors

Vocabulary: Ecologist, entomology, forest management, horticulture, hydrology, lobbyist, pathology, silviculture

Objectives:
1. Students will name and describe several careers related to forests.

2. Students will find information on one occupation and present it to the class.

Teaching Strategy:
Students create a list of forest-related careers, find information by interviewing or writing a letter, and compile a file of forest-related jobs.

Complementary Activities:
INDOOR: "Whose Forest? Our Forest!" *in this section.* "Workers for Wildlife" *in Alaska's Wildlife Conservation.*

Materials:
Forest Careers Interview sheet *(see following pages)*, writing materials, telephone directory, computer with internet access.

Background:
See INSIGHTS, *Section 5, Human Uses and Impacts in Forest Ecosystems: "Forest Organizations and Careers."*

Procedure:
1. Explain to students that use and protection of forests is called **forest management**, and the professionals who practice it are called **forest managers** or **foresters**.

2. Forest managers work to protect forests from harmful human actions and prevent the loss of valuable forest resources. Forest managers make decisions about timber harvest, air quality and watershed protection, fish and wildlife habitat, and a variety of other benefits that people desire.

3. As a class, brainstorm possible jobs relating to forest uses and conservation. Also list agencies, businesses, or organizations that might have forest-related jobs *(see* INSIGHTS, *Section 5,"Forest Organizations and Careers" fact sheet for ideas).*

4. Each student selects a career to investigate and an

organization or agency related to the career.

5. Students brainstorm questions they could ask about the career, or use the following "Forest Careers" interview worksheet.

6. Each student selects one agency or organization. The student checks the organization's website or calls for printed information to be better prepared to ask questions.

7. The student then writes or phones the organization. Students explain their assignment and ask to speak to a knowledgeable staff person who has the career they are investigating. Students use their questions or the "Forest Careers Interview" worksheet as a guide for learning about the career.

8. Each student presents the information about the occupation to the class. They use whatever methods and props are needed to convey the tasks of the job.

9. Ask students to compile their research results into a file on forest-related careers. This can serve as reference material on forest careers for all students in the class, as well as for other students in your school.

10. Students write short thank-you notes to the professional they interviewed.

Evaluation:

1. Students name five types of work related to forest use or conservation and the kinds of training required for those jobs.

2. Students write advertisements for forest-related jobs. They include requirements and responsibilities for each position.

EXTENSIONS:

A. **Hold a natural resource job fair.** Combine the material collected for this activity with the results of "Workers for Wildlife" student activity in *Alaska's Wildlife Conservation* to start a "Natural Resources Job Fair" or career day.

B. **Invite forest career speakers.** Invite forest resource workers to the class and have students ask them questions. Add this information to the class file or booklet on forest careers.

C. **Work a day in a forest-related job.** Students spend part of a work day with an individual in a forest career.

D. **Role-play and video forest-related job.** Using a video camera, students role-play and tape a day's work in the life of a forest-related worker. Each student or group of students should create at least 2 roles.

Credits:

Adapted from American Forest Foundation, "Careers in Forestry," *Project Learning Tree Activity Guid*e, 1987. Adapted from Western Regional Environmental Education Council, "Wildwork," "Workers for Wildlife," *Project WILD*, 1992.

Curriculum Connections:

(See appendix for full citations)

Books:

Bull Whackers to Whistle Punks: Logging in the Old West (Nelson) Gives a historical perspective of logging.

Websites:

See the websites listed on the "Forest Organizations and Careers" fact sheet in *INSIGHTS, Section 5*.

US Forest Service fire links page
https://www.fs.fed.us/fire

Teacher Resources:

(See appendix)

Forest Careers
INTERVIEW

DIRECTIONS: Investigate a career related to forests. Contact an individual in a career that relates to forests and use this interview form. You may ask additional questions or add other information that the person provides on the backside of the paper. Print neatly or type your final copy so others will be able to read it.

Career/Occupation Title: _____

1. What is the function or purpose of this job and how does it relate to forests?

2. How does a person in this occupation spend his/her time? What proportion is spent at a desk, in a lab, indoors, outdoors, traveling, in meetings, etc.?

3. In conducting this job, what skills are used? (*writing, speaking, working with computers, numbers, measuring, physical labor, using specialized equipment*)

4. What training is needed for this job? Academic or vocational? What types of classes are needed and what level of education is required?

5. Where is training available? Does this person recommend a particular school or program for training?

6. What employers might hire people in this occupation? Be specific.

7. What are the typical benefits of this occupation?

   Monetary: $_____/ hour or _____/ year

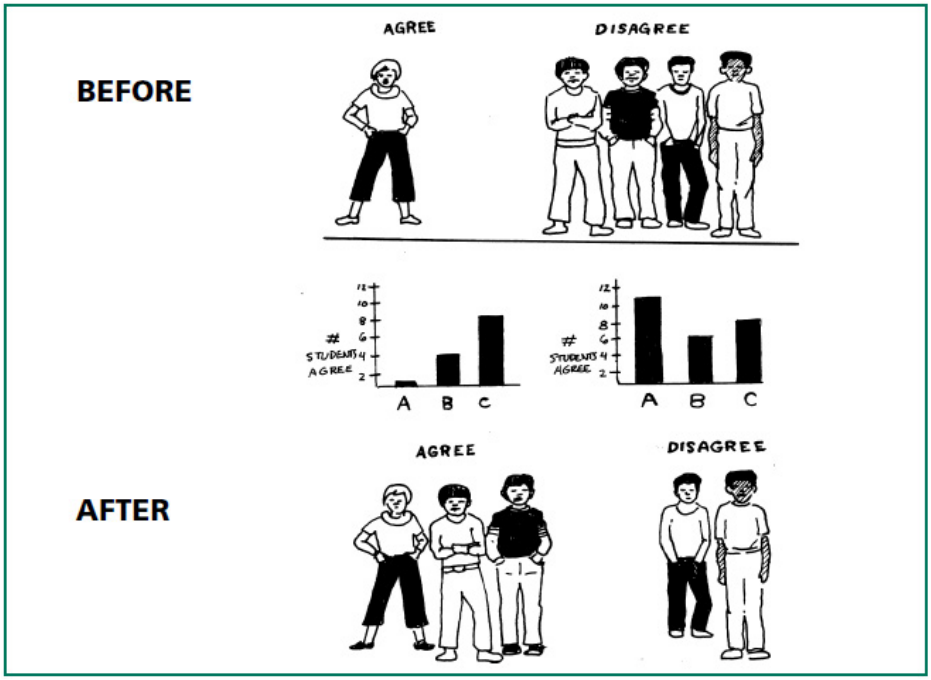
   What are the personal rewards? – *knowledge of doing something worthwhile, value to the community, to the future, chances for travel, security, prestige*?

8. Will there be a greater or lesser need for people in this occupation in the future? Specify where jobs are most likely to be available.

9. Will more training be needed in the future than is needed at present?

Forest Management Dilemmas

1 EXTENSION



Section 5
FOREST ACTIVITIES

Grade Level: 5 - 12
State Standards: L B-2, L D1, L D2, L D4, Geo E-1, Geo E-4, Geo E-5, Geo F-3, Gov C-1, Gov C-7, Gov G-2, Gov G-3
NGSS: 5-ESS3-1,MS-LS2-4, MS-LS2-5,MS-ESS3-3.,MS-ESS3-4,HS-LS2-2.,HS-ESS3-2,HS-ESS3-3 HS-ETS1-3.
Subjects: Science, social studies, language arts
Skills: Analyzing, synthesizing, gathering statistics
Duration: 3-50 minute class periods over several days
Group Size: Whole class
Setting: Indoors
Vocabulary: Dilemma, epidemic, logging slash, management goal, mandate, multiple-use, pitch, resin, seral stage, stands, suppression

Objectives:

1. Students will explain why decisions about forest management are often difficult.

2. Students will describe how to become informed on forest management issues.

Teaching Strategy:

Students model decision-making by beginning with little information on an issue; then researching the issue; and finally, reconsidering their decisions.

Complementary Activities:

INDOOR: "Succession's Path" *and* "Animal Adaptations for Succession," *both in Section 4, Succession.*

Materials:

Large cards labeled "YES" and "NO," Dilemma Background Sheets *(following pages*), newspaper and magazine articles on the specific issues.
OPTIONAL: masking tape.

Background:

See INSIGHTS, *Section 5, Human Uses and Impacts in Forest Ecosystems.*

Just as forests are complex, so is the process of managing them. The purpose of this activity is to encourage **students to obtain information before forming an opinion** and to acquaint themselves with current forest issues. Teachers should stress that there is NO right or wrong opinion about these **dilemmas**.

Opinions about the issues using logic, emotion, or philosophy are valid as long as they are supported by accurate information.

Procedure:

1. Tell students that just as forests are complex, so is the process of managing them. As citizen students they will be asked to form an opinion about several current forest issues.

2. Stress that there is NO right or wrong opinion about these **dilemmas**.

3. Explain to them that opinions about the issues using logic, emotion, or philosophy are valid as long as they are supported by accurate information.

4. Place the "YES" card at one end of the room and the "NO" card at the other. Ask students to imagine a line on the floor connecting these two cards, or put masking tape on the floor.

5. Tell the students that after you read aloud the following forest dilemmas, they are to stand along the imaginary line in a place that reflects their opinion – before they know anything more about the issue. The closer to the end of the line they stand, the more they agree with the decision card at that end.

DILEMMA 1:
Fires are an important, natural ingredient of the boreal forest ecosystem in Interior Alaska. Forest fires can also threaten human lives, properties, and marketable timber and reduce the amount of habitat for wildlife needing old-growth forests. **Your question: Should forest fires in the boreal forest be put out whenever possible?**

DILEMMA 2:
To be profitable, the timber industry must have access to large areas of commercially valuable trees. The most profitable is old-growth forests on public lands such as the Tongass National Forest in Southeast Alaska. Other parties say that Alaska's old-growth forests are more valuable for fish and wildlife habitat, watershed protection, subsistence, scenic beauty, and recreation. **Your question: Should the timber industry continue to log public old-growth forests in Alaska?**

6. Draw a bar graph of this "uninformed" class opinion. Repeat for each dilemma.

7. Divide the class into two or four groups to further examine these issues. Assign each group one of the dilemmas and ask them to find more information about the issue.

8. Ask them to find articles from newspapers, magazines, and the internet; read the "Dilemma Background" information sheets *(following pages);* and contact experts and representatives of various groups concerned about the issue.

9. They could invite these experts to come to class to speak or be interviewed by students. They could obtain brochures, reports, or other information from these individuals. Stress the importance of contacting experts and representatives of groups with different views on their dilemma.

10. Ask each group to divide in half. One subgroup will evaluate the YES position, and one group will evaluate the NO position. **Their evaluations should be structured in terms of both positive and negative consequences.**

11. Present each dilemma to the class again, but before students choose their places along the decision line, ask the group examining that issue to present its findings. Each group should present the positive and negative consequences of the decision assigned to them.

12. After the consequences of the positions have been presented, have the entire class (including the study group) find places along the line that best describe their opinions about the dilemma.

13. Draw another bar graph, this time of "informed" student opinions. Repeat for each issue.

14. Compare the bar graphs of the "uninformed" and "informed" student opinions: Did the students' opinions about these forest management issues change after they learned more about the issues? Ask how many students changed their personal opinions in either direction. Discuss the importance of becoming informed about all sides of an issue before making a decision or forming an opinion.

15. Read aloud "What is being done?" for each issue if the students did not find experts to give the current status. *(Keep in mind that the information provided with this activity is only up-to-date as of this publication. Changes may have occurred since that time.)* How do the decisions made by the government, with public input, compare to the opinions of the class?

16. Discuss the importance of public participation in decision-making through voting, attending and testifying

at hearings, becoming a representative on an advisory board, letters-to-the-editor, or other methods. What are the values of having a variety of people express their opinions? Are opinions based on facts more convincing than opinions based on misinformation? Discuss the responsibility for becoming informed that comes with our right to participate in decision-making.

Evaluation:

Evaluation in this activity is based on students' role-playing rather than expressing their personal opinions.

1. Given a new forest management dilemma, students write a paragraph describing their initial opinion of how it should be handled, and what resources they would use to become better-informed about the issue.

2. Students write or demonstrate why it is important to become well-informed on an issue before defending an opinion.

EXTENSION:

For older students: Attend a public hearing on a forest- or wildlife-related issue. Ask students to select one individual that they will focus on during the hearing. Students record the testimony of that person and any responses made towards their comments. Students then introduce themselves to the person they observed, explain their assignment and ask to talk with them then or at a later date.

Students meet *(by phone or in person)* to clarify any questions they have and to learn more about the person's experience and opinions. Students write up a summary including a profile of the person, their perspectives, and position on the issue. Papers are presented in class with a discussion to follow.

Curriculum Connections:

(See appendix for full citations)

Books:

Alaska's Forest Resources (Alaska Geographic Society)

Alaska Wildlife Notebook Series (ADF&G)

Ancient Forests (Siy)

Earth's Vanishing Forests (Gallant)

Forest: Identifying Propaganda Techniques (Anderson)

Forests for the Future (Parker)

Saving Our Forests (Hirschi)

Shrinking Forests (Tesar) 7-12

Media:

Rage Over Trees (Video) (National Audubon Society)

Websites:

Alaska Department of Natural Resources <www.http://forestry.alaska.gov/

Https://www.gi.alaska.edu/AlaskaScienceForum/administration

Alaska Statewide Databases <sled.alaska.edu>

Tongass National Forest <https://www.fs.usda.gov/tongass/>

US Forest Service fire links page <https://www.fs.fed.us/fire

Teacher Resources:

(See appendix)

Forest Dilemma One

BOREAL FOREST FIRES – *Background*

QUESTION: Should all forest fires in the boreal forest be put out, or should some be allowed to burn?

PAST: Lightning-caused fires are thought to have occurred in the boreal forest since the last ice age, 10,000 years ago. In addition, humans have both accidentally and purposefully caused forest fires since arriving in the boreal forest.

RECENT: We set fire to small areas of forests to clear land for homes, mining, and livestock pastures. Under dry, windy conditions, fires can easily escape control and spread. Some scientists estimate that from 1900-1940, 1.5 to 2.5 million acres of boreal forest burned each year in Alaska. From 1940-1969, about 1 million acres of forest burned each year. During the 1970s the number of acres burned per season varied from less than 8,000 to 2.2 million acres.

CURRENT DATA: Due, in part, to fire control efforts, fewer acres have burned in recent years. (For fire records from 1990 to the present, refer to the Alaska Department of Natural Resources, Division of Forestry website <www.dnr.state.ak.us/forestry/> and search "fire management programs" for "annual fire season statistics.")

SMOKEY THE BEAR: Until about 1970, forest fires were believed to be bad. The Smokey the Bear campaign successfully created a fear of fires. People thought all fires threatened human life and property and destroyed commercial timber and wildlife habitat.

TRUE CONFESSIONS: Forest fires do kill trees, burning timber that might have been logged. Some forest fires change watersheds, kill wildlife, and endanger human life or property. Forest fires that burn in mature and old-growth forests can reduce that habitat for certain wildlife. But is fire so bad that we should suppress it? Read on . . . .

DETECTIVE WORK: Researchers studying boreal forest ecosystems now have proved that forest fires are a natural ingredient in this northern forest. Fires help recycle minerals and in some locations improve water drainage and soil fertility.

Alaska fires leap and dance across a forest, burning some trees to charcoal and barely touching others. That creates a greater mixture of forest habitats than before the fire. Although some boreal forest wildlife need mature or old-growth forest sites, other species find better living conditions in shrub thickets and young forests.

ANIMAL PREFERENCES: Moose and snowshoe hares love the abundant shrubs and saplings that fires foster. Fires create openings in the forest needed by some sparrows, owls, hawks, swallows, and other birds. Trees killed by fire provide homes for wood-boring insects and the woodpeckers that eat them. Lynx and others may survive best in areas with a mixture of **successional stages**.

Some wildlife, however, require mature and climax stages of forest to survive. Flying squirrels, spruce grouse, crossbills, goshawks, and boreal owls do poorly after fire because fire removes their nesting habitat and food sources.

DISAPPEARING FORESTS: Old-growth forest sites are becoming less abundant because: (1) They are the most profitable forests to log. (2) Many exist on prime land where people want to live, so they are cut to make way for roads and houses.(3) If there is a fire, mature forests are much more likely to burn than younger forests with less fuel to burn.

Allowing old-growth forests to burn and harvesting trees from other mature forest sites could eventually lead to a shortage of old-growth and mature forest habitat. Wildlife that depends on this habitat would have no where to go.

WHO FIGHTS FIRES? WHO PAYS? The federal Bureau of Land Management, USDA Forest Service, and Alaska Department of Natural Resources work together to detect, monitor, and control forest fires in Alaska. The ability of these agencies to do this work is limited in part by the amount of money they receive.

CONTINUED

Forest Dilemma One

BOREAL FOREST FIRES – *Background*

QUESTION, Continued

Current federal and state budgets are not large enough to allow these agencies to control all fires in the boreal forest. The costs of fire-control programs are ultimately paid by taxpayers, either through higher taxes, or reductions in other government services.

HUMAN-CAUSED FIRES: Some, but not all forest fires, threaten human lives and property. Human-caused fires are more common along Alaska's road systems and near human habitations. That makes them more often a threat to people and property than lightning-caused fires.

SMOKEY AIR: Smoke from forest fires can interrupt aircraft flights and the travel plans of residents and tourists. Smoke can cause health hazards for persons with breathing difficulties downwind of large fires.

PILES OF FUEL: Some foresters and fire scientists worry when fires are prevented. They fear we may be creating a stockpile of dead wood, branches, and undecayed material that will feed an even bigger fire. They say it may be wise to allow more natural fires to burn to prevent the buildup of fuel.

WHAT A MESS: Fire **suppression** efforts include cutting fire lines and trails, applying fire retarding chemicals, and pumping water from streams and lakes to spray on the fire. Sometimes these actions cause more damage to lands, vegetation, and watersheds than uncontrolled forest fires. Concern has prompted some rehabilitation efforts. Fire fighting groups work after a fire to help restore some areas damaged by fire suppression activities.

SOMEONE HAS TO FIGHT: Fire fighting is dangerous, exhausting, sporadic, and seasonal. At times it's one of the few jobs in the village. Several Alaskan villages have contributed members to "Hot Shot" fire suppression crews that fly to fires here and in the Lower 48. Where fire crews are stationed, others gain income from selling goods and services to them and their agencies.

(Refer also to Forests INSIGHTS Section 4 "Succession – Changing Forest Habitats" for more information on fire in the boreal forest and charts on the stages of forest succession after fires)

Forest Dilemma One

BOREAL FOREST FIRES

What Is Being Done?

LETS COOPERATE: In the late 1970s, state, federal, and private land managers joined to form the Alaska Interagency Fire Management Council. This organization plans cooperative fire fighting throughout Alaska. The council treats fire as a natural force with both beneficial and potentially harmful effects.

THERE'S A PLAN: Members wrote the Alaska Interagency Fire Management Plan. The plan sets a priority for fire fighting work. All lands in Alaska have been given one of four fire protection categories. The categories range from an all-out attack when human lives, property, or valuable resources are in danger to allowing a carefully watched fire to burn if no danger is involved.

Four categories of fire management

1. ***Critical Protection Areas:*** In areas where human lives or homes are affected, all fires will be immediately and continuously suppressed to minimize loss of life and damage to property.

2. ***Full Protection Areas:*** Fires occurring on sites with commercially valuable timber stands, historic structures, or other valuable resources, but where people and homes are absent, will be immediately and aggressively suppressed to limit the number of acres lost.

3. ***Modified Action:*** Fires that occur in uninhabited areas and where valuable timber (or other types of resources) are absent will be monitored, but efforts will depend upon a comparison of the costs of fire suppression versus the potential number of acres that will burn.

Greater efforts to control fires in these areas will be made when the risk of large, hot fires is high. Less effort will take place during cool, wet seasons when fires are unlikely to spread. After mid-July, the policy for these lands changes and they are treated like Limited Action sites.

4. ***Limited Action:*** Fires will be monitored but allowed to burn in areas where natural fires are considered beneficial, or where the costs of fighting the fire are greater than the potential fire damage. Suppression efforts will be made only to limit such fires to the designated area, or to protect critical sites within the limited action area.

CONTROLLED FIRES: Even when there are no wild fires, the fire managers work to contain potential fires in safe areas. They will deliberately start a "controlled" fire.

They select a day when weather and fuel (flammable forest debris) conditions are adequate for a burn, but when a fire is unlikely to burn too severely. They make sure firefighters are ready just in case. Then they set the fire, careful to keep it in the desired area.

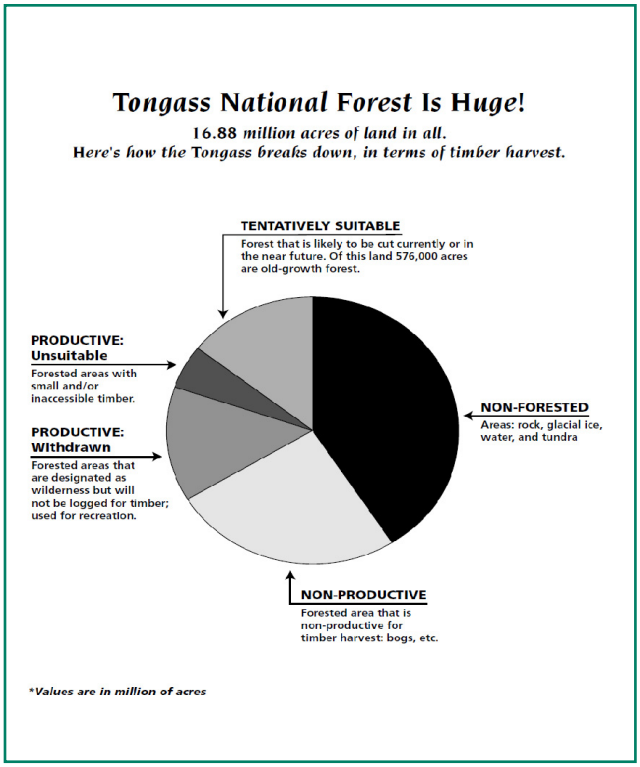
This method is currently being used on an experimental basis to improve habitat for moose which like to eat the tender young branches that grow after fires.

Forest Dilemma Two

OLD-GROWTH MANAGEMENT – *Background*

QUESTION: Should the timber industry continue to log public old-growth forests in Southeast Alaska?

ALASKA CHALLENGES: Harvesting timber in Alaska has always been more costly than in the more productive forests of the Pacific Northwest. The cost of doing business rises with our difficult weather; remote locations of commercially valuable timber stands; lack of roads and expense of building them; and the high cost of labor, equipment, and services.



INTERNATIONAL MARKET: To date, the majority of Southeast timber products has been sold and exported to Japan or other Asian markets because domestic markets buy cheaper supplies from Lower 48 forests. International timber markets change, based on the global economy, making logging a bit of a gamble.

RESEARCH ALL VIEWPOINTS: The issues surrounding timber harvest in the Tongass are clouded by differing viewpoints and differing values. The story you hear depends on the storytellers' experience, values, and knowledge. Research as many as viewpoints possible before you make your own decision.

FORESTS OF TIME: In Southeast Alaska most of the unharvested coastal forest is old-growth. This forest type is the climax stage of **succession**. It includes live trees of a variety of ages, from seedlings to 600-year or older giants, as well as standing and fallen dead trees. Over 200 years are required for old-growth forest to develop after disturbance.

HARVEST VALUES: Old-growth forests vary from scrub stands of noncommercial-quality timber to lots of large trees of great economic value. Noncommercial forests are those with small, widely-spaced trees of little profit to harvest.

"Low-volume" old-growth forests have small or widely-spaced trees which could yield some profit if harvested. The expense of cutting such stands may be greater than the market price of wood obtained, however. Noncommercial and low-volume old-growth stands grow mainly at high elevations and in poorly drained soils.

"High-volume" old-growth forests have huge trees up to 8 feet in diameter and 200 feet tall. Most high-volume stands grow on well-drained soils at low elevations and along rivers that drain watersheds.

LOCAL PROCESSING: National Forest lumber cannot, by law, be shipped out of state without being squared off. **Cant** is minimal processing. Timber from the Tongass National Forest must be milled by Alaska companies prior to export. Cant exports were primarily used for pulp production.

GOOD GROWING: Easily accessible, high-volume old-growth timber stands provide the most wood at the least cost for the timber industry. The land under these trees has the best environmental conditions for growing new trees. Forest planners predict that a new crop of marketable trees could be harvested from these sites in 100 to 120 years.

CONTINUED

Forest Dilemma Two

OLD-GROWTH MANAGEMENT – *Background*

QUESTION: Continued

(To grow commercially harvestable trees on poorer quality sites would require more time.)

Forest managers say that management of high-volume sites for wood production would provide a continual supply of wood for harvest along with logging industry jobs and income for Alaska. Some people believe that this use of the land with high-volume old-growth forest is the best use and say all high-volume sites should be managed for production of wood.

OLD-GROWTH SUPPLY: High-volume old-growth stands suitable for harvest are a relatively small portion of Tongass National Forest. About 2.4 million acres *(14% of the total Tongass)* are classified as tentatively suitable for timber harvest. Of that, 576,000 acres or 20% is old-growth forest.

WILDLIFE NEEDS: Biologists who have studied the wildlife of coastal old-growth forests say that harvest of high-volume old-growth stands and the proposed second logging 100 to 120 years later could mean long-term or permanent loss of habitat for those species of wildlife that need high-volume old-growth forest stands.

The dense shrub thickets and second growth forest that grow back after logging an old-growth forest are quite different from the original old-growth forest. These stands provide relatively poor habitat for many wildlife species that use or depend on old-growth forests.

CONCERN FOR DEER: Biologists from the Alaska Department of Fish and Game (ADF&G) predict that management of high-volume old-growth sites for wood production will lead to a substantial decline in the number of Sitka black-tailed deer on logged lands throughout Southeast Alaska. Deep snows prevent deer from reaching foods in young clear-cuts during winter. Second growth forests provide very little food for deer at any time of year.

EAGLE FUTURE: Bald eagle nest-trees and trees within 300 feet of a nest-tree are officially protected during logging on public lands. Despite the buffer, US Fish and Wildlife Service biologists predict that harvest of high-volume old-growth forest is likely to cause a decline in Southeastern Alaska's bald eagle population for two reasons:

(1) Trees in the buffer zone and the nest trees as well often blow down in wind storms once the surrounding forest is harvested. (2) Eagles depend on fish populations that may be harmed by timber harvest.

CONCERN FOR FISH: High-volume old-growth trees grow along many of the fish-rearing streams in Southeast Alaska. ADF&G fishery biologists admit that the effects of timber harvest are complex and vary from stream to stream, but warn that salmon and trout populations may decline if too much timber harvest occurs along streams or in watersheds that feed into fish-rearing streams.

Harvest of high-volume old-growth forest along streams often changes water temperatures, stream flow, silt loads, and productivity. These changes, in turn, can affect the reproduction and survival of fish.

SIZE AND BUFFERS: Some studies have shown that *small* clear-cuts along streams may increase productivity of the stream and the survival of fish fry. The detrimental effects of clear-cutting on fish habitat may be reduced by leaving buffer strips of forest along the stream — if the buffer strips are wide and stable enough to prevent the wind from uprooting trees during a storm.

In summary, the effects of timber harvest on fish spawning and rearing habitat are uncertain. The impacts depend on how much forest is harvested in each watershed, how it is harvested, and other variables.

Forest Dilemma Two

OLD-GROWTH MANAGEMENT – *Background*

QUESTION: Continued

NO SNAGS: The absence of **snags** *(large dead trees)* in second growth forests will reduce populations of cavity-nesting animals like woodpeckers, chickadees, swallows, owls, and flying squirrels. Even if snags are retained during timber harvest, they eventually decay and fall or are blown down. New large snags will not be created if second growth forests are repeatedly harvested when the trees are 100 to 120 years old.

VARIED WILDLIFE: Research on winter songbirds, river otters, Vancouver Canada geese, mountain goats, and brown bears indicate that these wildlife use old-growth stands in some areas of coastal forest. The impact of old-growth logging on these species is unclear.

TESTING: Some biologists argue that some wildlife may adapt to the changes after logging. They suggest we can modify logging methods and manage second growth forests in ways that reduce the negative impacts on wildlife that depend on old-growth forests. Tests are underway to see the effects of retaining snags, thinning second growth stands, clearing of slash, and other forest management techniques. So far, none of these methods has proven effective or affordable.

SCENIC CONCERNS: The scenic value of various-aged forests has not been thoroughly investigated. Some people argue that the scenic value of Southeast Alaska wilderness will be significantly reduced by timber harvest and its potential to reduce wildlife populations. They predict extensive timber harvest in the coastal forest will cause a decline in tourism, fishing, and guiding.

Other people argue that tourists do not notice or may enjoy the scenic variation of old-growth, clear-cuts, and second growth. They predict that timber harvest will not affect tourism.

IN THE BALANCE: Some foresters agree that extensive harvest of old-growth will reduce the number of deer. They argue that we have enough deer in Southeastern Alaska even at lower population levels. These foresters say we must balance our desire for high deer populations with our desire for jobs and timber. The public must help resource managers choose how to balance competing uses of the forest.

IN SUMMARY: Old-growth forests are unique ecosystems that provide habitat for a variety of plant and animal species They have aesthetic, recreational, subsistence, and economic value to humans. It is challenging to manage public forest lands to meet the variety of public interests while maintaining a long-term, ecologically healthy forest.

Forest Dilemma Two

OLD-GROWTH MANAGEMENT

What Is Being Done?

A TIME OF CHANGE: Changes in the timber industry, markets, social values of the forest, and the Tongass Land and Resource Management Plan have lead the Forest Service to study techniques to find alternative harvesting methods that avoid clear cuts and retain some trees.

LOGGING HISTORY: The Forest Service established long-term timber sale contracts in the 1950s to help stabilize the economy of Southeast Alaska that shifted seasonally with the fish industry and was declining in the mining industry. The 50-year contracts attracted investment for pulp mills and year-round timber enterprises.

MILLS CLOSE: The requirements for timber harvest to satisfy these long-term contracts came to an end in the 1990s when the pulp mills closed in Ketchikan and Sitka.

CURRENT SALES: The Tongass prepares timber sales that allow loggers to harvest a yearly average about 220 million board feet of timber. Many sales are designed so they can be sold to small, local enterprises in Southeast Alaska. The local timber industry is diversifying so it can provide employment for additional local wood processing and take advantage of markets for specialty wood products.

RETHINKING: The Alaska Region of the Forest Service is changing the way it prepares timber sales for several reasons. (1) It is learning more about fish and wildlife habitat needs in the forests. (2) Foresters have also increased their knowledge of how trees grow in Southeast. (3) And the agency is responding to concerned public who say they oppose timber harvesting, particularly clear-cutting.

Plant a Tree
2 EXTENSIONS

Section 5
FOREST ACTIVITIES

Grade Level: K - 12

Subjects: Science

NGSS: K-LS1-1.,2-LS4-1.,5-LS1-1

Skills: Observing, comparing, predicting

Duration: Entire school year

Group Size: 1 and whole class

Setting: Indoors and outdoors

Vocabulary: Seed, seedling, transplant

Objectives:
1. Students will describe the process of growth in trees.
2. Students will help to renew a previously forested area.

Teaching Strategy:
Students grow a tree from seed, make a graph of its growth, then plant it to "renew" a cleared or burned area.

Complementary Activities:
All activities in this book.

Materials:
Tree **seeds** *(birch and alder are relatively easy to grow from gathered seeds),* paper cups or other containers, potting soil, water, fertilizer, trowels or shovels, plastic sandwich bags to cover each container or a plastic sheet to cover many, paper and pencils, "Investment in Tomorrow" certificate *(following)*.

Background:
See INSIGHTS, *Section 5, Human Uses and Impacts in Forest Ecosystems: "Plant a Tree – Arbor Day"* fact sheet.

Procedure:
1. Give each student one or two tree seeds to plant in containers. The containers need a pencil-sized hole in the bottom for drainage. Ask students to mark their containers with their names, the type of seed, and the date.

2. Students put the containers in a sunny window and cover the top loosely with a plastic bag. Care for the tree by watering it until it sprouts, but remember that if it gets too wet, the seed may rot. It may take a while to sprout. If you begin this activity in the fall, you might be able to **transplant** the **seedlings** in the spring.

3. Each student makes a graph of the growth of the seedling over a set period. Compare the graphs, especially if using more than one type of seed.

4. When the seedlings are about 4-6 inches high, transplant them to a location outdoors where reforestation or tree planting for beautification is desired.

5. Award each student an "Investment in Tomorrow" certificate.

VARIATION
Obtain tree seedlings from a local forestry association or other agency, and plant the seedlings instead. Observe growth of the seedlings while caring for them.

Evaluation:

1. The teacher observes student participation in caring for the seedling and in the transplanting activity.

2. Students graph the growth of their seedlings.

EXTENSIONS:

A. **Plant trees on schoolyard or adopt an area.** Conduct a beautification or reforestation project near your school or at some other site in your community.

B. **Problem solve a forestry issue.** Pose a question like this to the class and have students hypothesize a reason for the problem:

"Recently a thousand-acre plot, which was clear-cut two years ago, has been replanted with spruce seedlings. These trees were planted at the same time. The plot is on a northern slope. These trees are not surviving. Why not?"

Students should be able to defend their idea based on what they know about forests. They can base their responses on research. *(*INSIGHTS *sections 1,2, and 4 will provide some answers*.)

Credits:

Adapted from Alaska Cooperative Extension Service "Transplanting Trees Successfully." Anchorage, Alaska: Cooperative Extension Service, University of Alaska, 1990.

Curriculum Connections:

(See appendix for full citations)

Books:

Christmas Tree Farm (Jordan)

Gift of a Tree (Tresselt)

Grandpa Tree (Donahue)

Johnny Appleseed (Kellogg)

Man Who Planted Trees (Giono)

Song of the Trees (Taylor)

Media:

The Man Who Planted Trees (Video, Audio Tape, or CD)

Teacher Resources:

(See appendix)

CERTIFICATE:

Investment in Tomorrow

I have made an investment in tomorrow by planting a tree.

My tree is located at _____

My name _____

Date _____

Teacher's signature _____

Forest official's signature _____

FOREST APPENDICES

WORKSHEET ANSWERS

GLOSSARY

TEACHER RESOURCES

FULL CITATION – ACTIVITY CURRICULUM CONNECTIONS

MORE CURRICULUM CONNECTIONS

Worksheet Answers

Trees Worksheet, Page 79

1. **crown**
2. **Leaves**
3. **trunk**
4. **heartwood**
5. **meristematic tissue**.
6. **Roots**
7. **cross-section**
8. **bark** A
9. **cambium** C
10. **xylem** D
11. **phloem** B

Broadleafs and Conifers Worksheet, Page 89

Broadleafs:
B, E, F, H, K

Conifers:
A, C, D, G, I, J, L

Alaska's Trees Worksheet, Page 90

1 - 1 White spruce 2 - 4 Black spruce
3 - 9 Sitka spruce
4 - 16 Tamarack
5 - 25 Lodgepole pine
6 - 36 Western hemlock
7 - 49 Birch
8 - 64 Aspen
9 - 81 Alaska cedar
10 - 100 Alder
11 - 121 Willow
12 - 144 Mountain ash

Trees that are conifers:
1 - 1
2 - 4
3 - 9
4 - 16
5 - 25
6 - 36
9 - 81

Leaves Worksheet, Page 83

1. **Photosynthesis**
2. **chlorophyll**
3. F. **cuticle**
4. K. **phloem**
5. E. **epidermis**
6. G. **vein**
7. H. **mesophyll**
8. B. **palisade**
9. C. **Chloroplasts**
10. D. **Xylem**
11. J. **Stomata**
12. A. **spongy**

Reading the Rings: Part One, Page 98

Cross section A: factors 1 or 6
Cross Section B: factor 2
Cross Section C: factor 7
Cross section D: factors 3, 4, or 5

Reading the Rings Part Two: Cross Dating Page 99

1. Which core sample matches the tree? Core sample B.
2. The tree was cut in 1930.
3. The tree started growing in 1896.
4. What year did fire scar the tree? 1915.
5. How many years did it take for the tree to grow around the remains of a dead branch? 10 years.
6. How long did the drought that began in 1912 last? 2 years.

Coastal Rainforest and Boreal forest pictures: Pages 15, 17:

The following organisms are pictured:

COASTAL RAINFOREST
Page 15

14 animals:
red-breasted sapsucker
deer mouse
red squirrel
wood frog
Sitka black-tailed deer
red-breasted nuthatch
marten
Steller's jay
owl
hornet
banana slug
beetle
caterpillar
millipede

9 plants:
devil's club
huckleberry
trailing raspberry
bunchberry
ferns
horsetails
skunk cabbage
twisted stalk
spruce

3 fungi:
shelf fungi
mushroom
lichen

BOREAL FOREST
Page 17

12 animals:
gray jay
red squirrel
brown creeper
ermine
beetle
centipede
shrew
butterfly
moose
kinglet
woodpecker
owl

7 plants:
birch
spruce
fireweed
wild rose
twinflower
clubmoss
horsetails

3 fungi:
shelf fungi
mushrooms
lichen

Who Lives Where? Worksheet Page 176

a. 4 5
b. 2 4 5
c. 4 5
d. 1 2 4 5
e. 2
f. 4 5
g. 3 4
h. 2 4 5

Where's Home? Worksheet Page 177

a. 3
b. 2 3
c. 2 3
d. 1 3 (best)
e. 3 (1 in summer only)
f. 3
g. 1 3
h. 3

GLOSSARY

Adaptation: the process of adjusting to the environment. For example, a plant with unusually long roots that enable it to absorb water over a wide area has an adaptation that helps it survive during periods of drought.

Algae: a large group of primitive plants having chlorophyll, but lacking true roots, flowers, stems, and leaves.

Anadromous: a fish with a life cycle that requires it to spend specific parts of its life in fresh water and then in the open ocean. Salmon hatch in fresh- water streams, mature in the open ocean, and return to their river of origin to spawn and die.

Angiosperm: (an-gee-o-spurm) a plant that protects its seeds in some sort of covering. A birch tree is an angiosperm.

Animal: a many-celled living thing that takes in food and moves about. Unlike plants, animals do not have to stay in one place, and they cannot make their own food. Jellyfish, worms, clams, insects, birds, mammals, and human beings are all animals.

Annual rings: the concentric rings seen in cross-sections of the stems (trunks) of most trees and shrubs. Each pair of rings (light and dark) represents a year's growth in the life of the tree. The rings are the previous years' xylem cells.

Aspect: exposure; position facing a particular direction, as in *this slope has a southern aspect.*

Bark: the dead, outer covering of tree trunks and branches that protects the tree from insects, fungi, and weather. Bark is formed as the phloem cells of the tree die.

Board feet: unit of measurement of timber available on a tree or in a forest.

Boreal forest: (bore-ee-ul) the forest of mixed conifers and hardwoods that grows in cold and dry northern areas around the world, including Interior Alaska.

Branches: any woody extension growing from the main stem or trunk of a tree.

Broadleaf: a plant with wide-bladed leaves, such as birch or alder. This term is generally used to describe flowering trees (angiosperms).

Cambium: (kam-bee-um) the living and growing cell layer of a tree trunk that lies just under the bark and phloem layers.

Canopy: the upper layer of a forest where treetops meet.

Cant: logs with one or more squared sides. Cant is the minimal amount of processing required for exported timber harvested from national forests.

Carbon dioxide: a gas that animals exhale (breathe out). Plants and algae use it during photosynthesis to make food.

Carnivore: an animal that consumes other animals.

Cellophane: thin, see-through material made from a mixture that includes the cell walls of plants.

Chlorophyll: (klor-o-fill) a group of pigments that produce the green color of plants, essential to photosynthesis. Found in plant leaves.

Chloroplasts: (klor-o-plast) thin-walled cylindrical cells containing chlorophyll. Found in plant leaves and some algae.

Circumference (of tree): a measurement of the distance around the tree trunk. The standard place to measure is 41 /2 feet up from the ground.

Climate: the average condition of the weather *(temperature, wind velocity, precipitation, sunlight)* at a location over many years.

Climax community: the maximum stage of succession; the mixture of living things that eventually appears on a site if it is not disturbed. Forests and tundra have climax communities.

Coastal rainforest: the coniferous forest that grows along the western coast of North America from Kodiak Island to Northern California.

Colonization: (kol-o-ni-zay-shon) when plants or animals become established in a new territory that they had not previously inhabited.

Commensalism: (co-men-sa-lism) a relationship between two kinds of living things where one benefits and the other is not harmed or helped. It is one form of symbiosis.

Community: all the living things that interact in a certain environment.

Competition: when two or more living things use the same food, water, shelter, or space.

Cone: a structure composed of scales in which seeds are produced. Conifer trees have cones that can hang on some trees for several years.

Cone-scales: overlapping, spirally arranged covers that protect seeds grown by conifer trees. Squirrels open the cone scales to eat the seeds.

Conifer: a type of tree that has needle-like leaves and forms its seeds inside cones. Conifer seeds do not have a thick coating (that's why they need cone-scales for protection). The crown of this tree is cone-shaped or triangular. Most conifers

do not shed their leaves in winter. They are in the gymnosperm class.

Conservation: the use of natural resources in a way that assures their continuing availability for future generations.

Consumer: a living thing that gets energy and minerals by eating other living or dead things.

Cord of wood: a stack of cut wood that measures 4 feet tall, 4 feet wide, and 8 feet long (4x4x8').

Core sample: a piece of wood about the thickness of a soda straw removed from the trunk of a living tree to analyze the tree's growth rings. The tree continues to grow.

Cover: protection from the elements for many purposes including hiding, traveling, resting, and nesting. Also referred to as **shelter**. One of the four elements necessary for survival.

Cross-dating: a technique comparing growth rings of trees (using a core sample of a living tree as a "known") to date wood of unknown age or to analyze past environmental conditions.

Cross-section: a slice *across (not up and down)* the body of something.

Crown: the topmost leaves and branches of a tree.

Cuticle: (cute-e-cul) waxy layer on the epidermal cells (outer wall) of a leaf.

Deciduous: (dee-sid-you-us) a tree that loses all of its leaves during some time of year, usually in fall. Birch trees are deciduous. Spruce trees are not.

Deckle: a movable wooden frame used as an edging for the four sides of paper made by hand.

Dendrochronology: the science of dating past environmental events and changes by looking at tree rings.

Detritivore: (duh-trite-uh-vore) a living thing that eats wastes and other living things that have died. Also called decomposer or scavenger.

Dilemma: a problem involving a difficult choice.

Disturbance: an event that changes an ecosystem or community. Glaciers, volcanoes, earthquakes, floods, fire, and human activities such as timber harvest or land clearing are examples of disturbances.

Drought: a prolonged period of dry weather; a lack of rain.

Earlywood: the cambium layer that grows early in the growing season.

Ecologist: a scientist who studies the interrelationships of living things to each other and to the environment.

Ecology: the study of the interrelationships among living things and between living things and their nonliving surroundings.

Ecosystem: (ee-co-sis-tem) a community of living things and its nonliving surroundings linked together by energy and nutrient exchange.

Energy: a nonliving aspect that can be observed in the form of electricity, heat, light, and motion in living and nonliving things. It has the capacity to move, do work, or change something.

Entomology: the study of insects.

Epidemic: (epp-uh-dem-ick) rapidly spreading among many individuals in a community at the same time; widespread.

Epidermis: (epp-i-dur-mis) outer layers of cells occurring on all parts of the main plant body including the leaf.

Erosion: the wearing away of the land surface by wind or water.

Evaporate: to expel moisture from; to convert into vapor.

Evergreen: a tree that does not lose all its leaves in the autumn, but loses them a few at a time throughout the entire year. A spruce tree is an evergreen.

Food: energy and minerals in a form living things can use. One of the four elements necessary for survival.

Food chain: the transfer of food energy from living things in one nutritional level to those in another. In a simple food chain, for example, a mammal eats a bird that ate an insect that ate a plant.

Food web: many interconnecting food chains.

Forest: any ecosystem that contains many trees.

Forester: a person trained in forestry; one who takes care of trees or a forest; may also be called a forest manager.

Forest management: the balance of using and protecting a forest to ensure that it will continue to provide desired benefits.

Forest manager: a person whose job is to take care of a forest; may also be called a forester.

Fuel: any combustible (burnable) material which will support a forest or tundra fire. Dead and fallen wood and dried leaves and plants in a forest.

Fungi: (fun-jee) one of the five kingdoms of living things. Most fungi do not move around, but live their lives in one place. Most eat dead things and waste materials, but some get food through symbioses with plants or microscopic organisms. Fungi are often white, but may be colorful. (Singular: fungus.)

Gall: A swelling on the tissues of trees and other plants caused by the attacks of certain parasitic insects.

Germinate: when a plant begins sprouting or growing.

Ground cover: small plants that grow on the forest floor except for young trees.

Gymnosperm: (jim-noh-spurm) plants with seeds that aren't enclosed in flowers or fruit. Conifers are the most common type of gymnosperm. A spruce tree is a gymnosperm.

Habitat: the place where an animal lives that provides the food, water, shelter, and space (in a suitable arrangement) that an organism needs to survive.

Hardwood: a type of tree that has flowers and broad, flat leaves and forms seeds with a thick outer coat. A birch tree is a hardwood.

Heartwood: the dead inner part of a tree trunk that gives the tree trunk strength. Each year's xylem cells die and become heartwood, producing the annual rings seen in a cross-section. Sawmills cut heartwood into lumber.

Height (of tree): the measurement from the ground to the top twig of a tree.

Herbicides: chemical substances used to kill plants.

Herbivore: (erb-uh-vor) any living thing that eats producers such as plants and algae.

Horticulture: the science of growing plants.

Hydrology: the science that studies the properties, distribution, and circulation of water on and below the earth's surface and in the atmosphere.

Hyphae: (hi-fee) the tiny hair-like parts that form the main body of fungi. Hyphae are the part of fungi that grow and feed.

Increment borer: the narrow tool used to drill a core sample when analyzing the age of a live tree.

Interdependence: needing each other.

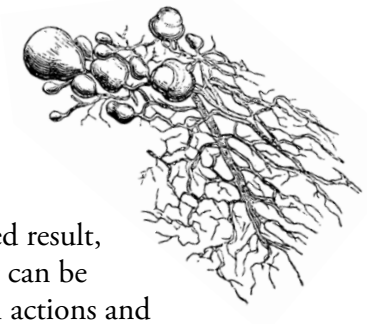
Invertebrate: an animal that lacks a backbone or spinal column.

Larvae: the immature, wingless, and often worm-like form that hatches from the eggs of many insects. (Singular: Larva.)

Leaves: the flat, thin structures, usually green, that grow on a stem or twig of a plant. Leaves are usually where photosynthesis and transpiration occur.

Living thing: something that is able to grow and make new things like itself; an organism. Living things are classified into five great groups called "kingdoms" – monerans, protists, fungi, plants, and animals.

Lobbyist: someone who tries to influence a public official to make an action in favor of a particular cause or issue.



Logging slash: branches, bark, tops, and broken trees left on the ground after logging.

Management goal: a desired result, product, or purpose that can be achieved through certain actions and choices. Natural resource management relies heavily on scientific knowledge and integrates societal values and economical demands in dec

Mutualism: (mute-chew-al-ism) a kind of symbioses; an interaction between two kinds of organisms from which both species benefit.

Mycelium: the mass of thread-like hyphae that forms the major portion of a fungus and is often hidden in the wood of a tree or in decaying leaf litter.

Mycorrhizae: (my-cor-rise-zee) fungi that live in or on the roots of plants and assist the plants in obtaining minerals from the soil.

Nitrogen: an element that is used in the formation of all living things.

Nonliving thing: something that does not, and cannot, move, grow, and make new things like itself. Air, water, soil, rocks, and energy are examples of nonliving things.

Nonrenewable resources: nonliving resources such as petroleum and minerals that are not able to regenerate themselves. Once used, they cannot be replaced.

Omnivore: (ahm-nee-vor) a living thing that eats both producers (plants) and other consumers (animals).

Organic soil: the ideal, fertile medium for plant growth. Composed of decomposed organic *(living)* materials recycled by detritivores. *(See also* **soil formation**.)

Oxygen: a colorless, tasteless, odorless element that most living things breathe and need in order to live. Plants and algae produce this gas during photosynthesis.

Palisade layer: in a leaf, the layer of cylindrical cells that is located just below the upper epidermis. The palisade layer contains the chloroplasts.

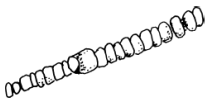
Parasitism: (pair-i-sit-ism) a kind of symbiosis; an interaction between two kinds of living things from which one species benefits and the other is harmed.

Parenchyma: in the growing portion of a tree, the layer of thin-walled cells that helps in photosynthesis and storage of food and water.

Pathology: the study of disease.

Percussion: a musical instrument or other item that is struck to make sound.

Permafrost: soil that is 32ºF (0ºC) or less all year round. Usually lies within a meter of the surface. It may or may not contain ice.



Pesticide: any chemical substance used to kill living things including plants and animals.

Phloem: (flow-em) the layer of cells just under the bark of a tree; a portion of the tube in the vein of a leaf. The phloem carries food from the leaves to other parts of the tree.

Photosynthesis: (foto-sin-this-iss) the combining of sunlight, water, and carbon dioxide to create sugars. Oxygen is a by-product. Photosynthesis takes place in the leaves of plants and in algae.

Pioneer: any kind of living thing that moves into an area of bare rocks and mineral soil, survives, and reproduces; first stage in succession. Pioneer plants help to make soil for other plants that follow.

Pitch: the resin of a tree.

Plant: one of the five kingdoms of living things; includes all the living things that have leaves, roots, and stems. Nearly all plants are green and live their lives without moving from place to place. Nearly all plants are producers. Trees are plants.

Population: the number of people, animals, or plants living in a place.

Precipitation: water that falls to earth in the form of rain, snow, sleet, hail, or mist.

Predator: an animal that kills and eats other animals.

Predict: to declare beforehand based on experience, observation, or scientific reason.

Preservation: protection which emphasizes nonconsumptive values and uses, including no direct use by humans. Contrasted with conservation which emphasizes both consumptive and nonconsumptive values and uses *(see* conservation*).*

Prey: animals that are killed and eaten by other animals.

Primary succession: (suck-se-shun) the orderly change in plant and animal communities that starts on new land that is bare of soil.

Producer: any living thing that can convert nonliving materials *(air, water, soil, rock, and light)* into food for itself and other living things. Plants and algae are examples of producers.

Protist: (pro-teest) one of the five kingdoms of living things; includes microscopic living things called protozoans as well as microscopic and large algae and seaweed.

Rayon: fiber or fabric made from cellulose (from the cells of trees).

Recycle: to reuse the remains of things. Detritivores recycle nutrients for other living things to reuse.

Renewable resource: a living resource which has the capacity to renew itself when conditions for survival are favorable. Trees are renewable resources.

Resin: sticky substance produced by plants, usually clear, yellow, or brown. Resin coats some seed cones of conifer trees. Resin is highly flammable and adds fuel to wild fires.

Roots: the part of a plant below ground that holds the plant in position, absorbs water, and stores food.

Sap: the fluid in a plant that flows in the xylem and phloem.

Sapwood: the layer of cells in a tree trunk that carries water and minerals from the roots to the leaves; also called the **xylem.**

Secondary succession: (suck-se-shun) the orderly change in plant and animal communities that follows a disturbance of an existing environment with organic soil.

Seed: the small object produced by flowering plants or conifers that will grow into a new plant.

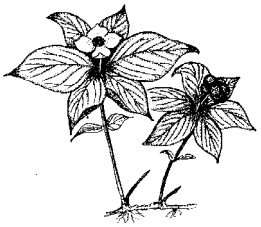
Seedling: any young tree under a meter in height.

Seral stage: (seer-el) successional stage; an identifiable stage in the process of replacing one community of plants and animals with another.

Shelter: protection from the elements for many purposes including hiding, traveling, resting, and nesting. Also referred to as **cover**. One of the four elements all animals need to survive.

Shrub: a low, usually several-stemmed woody plant.

Silviculture: a branch of forestry dealing with the development and care of forests to produce timber crops.



Snag: a standing dead or dying tree.

Softwood: usually refers to coniferous trees. Some deciduous trees such as aspen have relatively soft heartwood.

Soil formation: the making and mixing of small particles of inorganic minerals and organic (formerly living) particles to form the layer of material on the surface of the earth that is the natural medium for plant growth. *(See also* **mineral soil**, **organic soil**, *and* **young soil**.)

Spongy layer: leaf layer that contains loosely packed, differently shaped cells. Exchange of gases – carbon dioxide and oxygen – occurs in this layer.

Stand: a group of trees usually of the same species and age.

Stoma: (sto-muh) a small pore in a plant's leaves and stems that opens to absorb carbon dioxide and release oxygen (plural: **stomata**).

Succession: (suck-se-shun) the gradual replacement of one community by another.

Successional stage: (suck-se-shun) an identifiable stage in the process of replacing one community of plants and animals with another (see **sere**).

Suppression: work done to control and extinguish fires.

Sustained yield: the amount of wood that a forest can produce continually given a pre-determined level of forestry management. The goal of sustained yield management is to extract products while maintaining healthy forest ecosystems.

Symbiosis: (sim-by-o-sis) living together; an interdependence between two kinds of living things that live in close association. It can be harmless, beneficial, or harmful.

Taiga: subarctic forests, dominated by conifers (*spruce and fir*) that begins where the tundra ends. Found in Eurasia and North America. From Russian for *"land of little sticks."*

Temperate rainforest: the coniferous forest that grows along the western coast of North America from Kodiak Island to Northern California. Also called **coastal rainforest.**

Terminal bud: growing at the end of a branch or stem. Usually the start for next year's new growth.

Timeline: a line on which dates and events are shown in chronological order.

Topography: the positions and elevations of natural *(*and human-made*)* features on the landscape.

Transect: a straight line or profile of a cross-section of vegetation that is useful for studying the number and types of plants in an area.

Transpiration: the process by which water evaporates from plants. Ninety percent of transpiration happens through stomata on leaves.

Transplant: a plant (or animal) that is moved to a new location.

Tree: a large woody plant at least 4 meters tall with a single stem (*trunk*) and a crown of leaves.

Tree line: the upper limit of tree growth in mountains or high latitudes because the environment becomes unsuitable. Also called timberline.

Trunk: the large woody stem of a tree.

Understory: the layer of plants *(especially trees* and shrubs) growing between the forest canopy and the ground cover.

Values: the importance or worth of a thing to a human. Different humans often have different values. Values are not factual, but influence management decisions.

Veins: the tubes of xylem and phloem forming the framework of a leaf blade.

Water cycle: water vapor (a gas) in the atmosphere falling to earth as precipitation (a liquid or solid: snow, rain, hail), making its way into rivers, lakes, and oceans where it evaporates (vapor) into the atmosphere to start the process again.

Watershed: drainage area; all the land contributing to the water supply of a river or lake.

Woodwind: a musical instrument (flute, oboe, bassoon, clarinet); breath is used to create the sound. Formerly made of wood.

Xylem: (zzz-eye-lem) the sapwood; a cell layer of the tree trunk or branch that carries water and minerals from the roots up to the leaves. The portion of the tube in the vein of a leaf that carries water and minerals.

Young soil: thin, "pioneer" soil composed of more raw mineral particles (sand, silt, rock bits) than decomposed organic (living) material. Insufficient for large plant or tree growth. (See also soil formation.)

TEACHER RESOURCES

Most useful resources for teaching general and specific activities in Alaska's Forests and Wildlife

Useful for All

Books and Publications:

Alaska Ecology Cards – Alaska Wildlife Curriculum. Alaska Department of Fish & Game, 2000.

Alaska's Forest Resources. Anchorage: Alaska Geographic Society, 1985. (V.12, No.2)

Alaska Northwest Books. *The Alaska Almanac: Facts About Alaska*. Anchorage: Author, published annually.

Alaska Department of Fish and Game. <http://www.adfg.alaska.gov *or* from Wildlife Education, ADF&G, 333 Raspberry Rd., Anchorage, AK 99518.

Allaby, Michael. B*iomes of the World.* Danbury, CT: Grolier, 1999. (9 volumes)

Davis, Neil. *Science Nuggets.* Fairbanks: Geophysical Institute, University of Alaska. Reprinted 1999.

Bruchac, Joseph. *Native Plant Stories.* Golden, Co: Fulcrum Pub., 1995. (Folklore)

Clearing Magazine. A bi-monthly environmental education resource and activity guide for K-12 teachers. Address: P.O. Box 5176, Oregon City, OR 97045 *or* <http://clearingmagazine.org/about>

Coombes, Allen. *Trees*. New York: Dorling Kindersley, 1992.

Cornell, Joseph. *Sharing Nature with Children.* Nevada City, CA: Dawn Publishing, 1998.

Ewing, Susan.. *The Great Alaska Nature Factbook: A Guide to the State's Remarkable Animals, Plants, and Natural Features.* Anchorage: Alaska Northwest Books, 1996.

The Green Teacher. A magazine for inspiration and classroom materials in environmental education. Address: 95 Robert St. Toronto, Canada M5S2K5 *or* <https://greenteacher.com>

Hefner, Christine. *Literature-Based Science: Children's Books and Activities to Enrich the K-5 Curriculum.* Phoenix: Oryx Press, 1995.

Hickman, Pamela. *In the Woods.* Halifax, NS: Formac, 1998. (Activity Book)

Junior Environment on File. New York: Facts on File, 1996.

National Wildlife Federation. *Trees are Terrific!* (Ranger Rick's NatureScope) Philadelphia: Chelsea House, 1999.

Russo, Monica. *The Tree Almanac, A Year-Round Activity Guide.* New York: Sterling Publishing, 1993.

Sheehan, Kathryn. *Earth Child 2000: Games, Stories, Activities, Experiments & Ideas about Living Lightly on Plant Earth.* Tulsa: Council Oak Books, 1998.

VanCleave, Janice. *Janice VanCleave's Ecology for Every Kid: Easy Activities That Make Learning Science Fun.* New York: Wiley, 1996.

Viereck, Leslie and Elbert L. Little, Jr. *Alaska Trees and Shrubs.* Fairbanks: University of Alaska Press, 1986.

Weigel, Marlene. *U-X-L Encyclopedia of Biomes*. Detroit, MI: U-X-L, 2000. (3 volumes)

Media:

Tree. (Eyewitness Video) New York: Dorling Kindersley, 1996. You Tube Eyewitness S211

Websites:

Alaska Department of Fish and Game <www.adfg.alaska.gov

The Alaska Forestry Association <www.dnr.alaska.gov> Represents the forest products industry.

Alaska Department of Natural Resources <www.dnr.alaska.gov/forestry> Manages Alaska State Forests.

Alaska Native Knowledge Network <www.ankn.uaf.edu> *Alaska Standards for Culturally Responsive Schools* and *Guidelines for Preparing Culturally Responsive Teachers for Alaska's Schools* are available on-line. Ordering information for *Curriculum Resources for the Alaskan Environment* and *Inuuqatigiit* (curriculum from the Inuit perspective) are also available. Science Projects are available from <www.ankn.uaf.edu/Alaska_Alive>

Alaska Center for Conservation Science <accs.uaa.alaska.edu> Current status of Alaska's biodiversity, annotated species at risk project, and excellent links to Alaska biodiversity and biology resources.

Alaska Science Forum <www.gi.alaska.edu/ScienceForum> Treasure of new and archive articles written for general audiences answering science questions and highlighting Alaska's natural science phenomena and research.

Alaska Statewide Databases, accessed through your local library website or <sled.alaska.edu > Magazine and newspaper articles from more than 2,000 magazines and journals, 100 newspapers, plus other information.

Anchorage *Daily News* <www.adnsearch.com> Staff-written newspaper articles, current and past. Article citations can be located at no charge. For full text, a fee must be paid.

Fairbanks *Daily News-Miner* <www.newsminer.com> Staff-written newspaper articles, current and past, available on file, no fee.

National Wildlife Federation <www.nwf.org> Has information on environmental education programs.

Project Learning Tree <www.plt.org> Environmental education curriculum K-12 of the American Forest Foundation <www.affoundation.org> Locally supported by the Alaska Department of Natural Resources.

Project WILD <https://www.fishwildlife.org/projectwild> Environmental education curriculum K-12. Association of Fish and Wildlife Agencies. Supported locally by the Alaska Department of Fish and Game.

Tree Guide <www.treeguide.com> Natural history of trees in database format, including identification, ecology, life history, distribution, and use of trees of North America. Features latest news, state trees, and champion trees.

The Tree of Life <www.tolweb.org/tree/phylogeny.htmll> Biodiversity featured in photos and text of members of the Five Kingdoms of Living Things starting with kingdoms and branching through all classifications to individual species. Includes a "treehouse" kids' page on beetles.

USDA Forest Service <www.fs.fed.us> Resource, career, and special issue information and photos including Nature Watch and Woodsy Owl. Alaska Region <www.fs.fed.us/r10> and Tongass National Forests <www.fs.fed.us/r10/tongass> which includes tree identification, plant and wildlife facts for Southeast. Chugach National Forest <www.fs.fed.us/r10/chugach> for South-central Alaska.

US Geological Survey <www.usgs.gov> Resource, career, and special issue information and photos. The *Alaska Biological Science Center* website <www.absc.usgs.gov> includes research on Alaska's wildlife and ecosystems.

Section 1. Elements that Create Forests

Books:

Bleifeld, Maurice. *Adventures with Biology: Biology Experiments for Young People.* Springfield, NJ: Enslow, 1997.

Gardner, Robert. *Science Project Ideas About Trees.* Springfield, NJ: Enslow, 1997.

Harlow, Rosie. *175 Amazing Nature Experiments.* New York: Random House, 1992.

Hunken, Jorie. *Botany for All Ages-Discovering Nature Through Activities Using Plants.* Chester, CT: Globe Pequot Press, 1989.

VanCleave, Janice. *Biology for Every Kid: 101 Easy Experiments That Really Work.* New York: John Wiley, 1989.

Media:

Historical photos are available from the Alaska State Library, your local historical society, the Alaska Museum of History and Art, the University of Alaska, or the State of Alaska Division of Forestry.

Section 2. Forest Ecosystems – Community Connections

Books:

Alaska Women in Timber. *Alaska's Great Green Forest* (Teaching Activities K-4) Address: 111 Stedman St., Ketchikan, AK 99901 *or* (907)247-2948 *or* order online <www.akforest.org>

Armstrong, Robert. *Guide to the Birds of Alaska.* Anchorage: Alaska Northwest Books, 1990.

Cottam, Clarence. *Insects: A Guide to Familiar American Insects.* Golden Books, 1987.

Milne, Lorus. *National Audubon Society Field Guide to North American Insects and Spiders.* New York: Knopf, 1980.

Sheldon, Ian. *Animal Tracks of Alaska.* Lone Pine Publishing, 1999.

Stall, Chris. *Animal Tracks of Alaska.* Seattle: Mountaineers, 1993.

Media:

Once There Was a Tree. (Video) Lincoln, NE: Distributed by GPN, 1994.

Websites:

Alaska Women in Timber. <www.akforest.org/awit>

Audubon On Line Field Guides website <www.enature.com>

Section 3. Outdoor Forest Learning Trail

Books:

Armstrong, Robert. *Guide to the Birds of Alaska.* Anchorage: Alaska Northwest Books, 1990.

Bockman, Christian Frank. *Trees of North America: A Field Guide to the Major Native and Introduced Species North of Mexico.* New York: Golden Books, 1968.

Cassie, Brian. *National Audubon Society First Field Guide: Trees.* New York: Scholastic, 1999.

Cottam, Clarence. *Insects: A Guide to Familiar American Insects.* Golden Books, 1987.

Holsten, Edward. *Insects and Diseases of Alaskan Forests.* Washington, DC: USDA Forest Service, 1985.

Little, Elbert. *National Audubon Society Field Guide to North American Trees: Western Region.* New York: Knopf, 1980.

Milne, Lorus. *National Audubon Society Field Guide to North American Insects and Spiders.* New York: Knopf, 1980.

Petrides, George. *A Field Guide to Western Trees.* New York: Houghton Mifflin, 1998.

Sheldon, Ian. *Animal Tracks of Alaska.* Lone Pine Publishing, 1999.

Stall, Chris. *Animal Tracks of Alaska.* Seattle: Mountaineers, 1993.

Media:

Peterson, Roger Tory. *Western Bird Songs.* (CD) New York: Houghton Mifflin, 1999.

Peyton, Leonard. *Bird Songs of Alaska.* (2 CD set) Order locally *or* from Alaska Bird Observatory, P.O. Box 80505, Fairbanks, AK 99708-0505 *or* email birds@alaskabirds.org. Hear samples from the CD on <birds.cornell.edu/LNS/Comercial-Products/northamerican/alaska.htm>

Website:

Audubon On Line Field Guides website <www.enature.com>

Section 4. Succession – Changing Forest Habitats

Books:

US Fish and Wildlife Service. *The Role of Fire in Alaska – K-12 Curriculum.* Anchorage, AK: Author, 2001.

Media:

Alaska Video Postcards. *Voices From the Ice* (Video) Anchorage, AK: Author, 1991. Address: P.O. Box 112808, Anchorage, AK. 99511

National Park Service. *Glacier Bay, the Grand Design.* (Video) Washington, DC: Author, 1993. (Distributed by Alaska Video Pub.)

Old Growth Forests. (Video) Washington, DC: National Geographic Society, 1994.

Websites:

Glacier Bay National Park & Preserve <www.nps.gov/glba> with photos and resource information.

National Park Service. *Fire in the National Parks, Understanding Fire's Role in Natural Areas.* <www.nps.gov/pub_aff/issues/fire.html >

Section 5. Human Uses and Impacts in Forest Ecosystems

Books:

American Forest and Paper Association. *National Wood Recycling Directory – Wood Recycling Resources, How to Recycle Waste Paper, Youth Action Kit, posters and pamphlets* are available by phone 800-244-3090 or <www.afandpa.org>

American Forest Foundation. *Exploring Envionmental Issues: Municipal Solid Waste.* Washington, DC: Project Learning Tree, American Forest Foundation, 1997. <www.affoundation.org>

Hiebert, Helen. *Papermaking with Plants.* Pownal, VT: Storey Books, 1998.

Moses, S. *Changing Waste in Changing Times: Solid Waste and Natural Resources Issues in Rural Alaska – A Teacher's Guide* (Gr. 9-12). Seattle: Northwest Renewable Resources, 1994. Address: Northwest Renewable Resources Center, 1411 Fourth Ave., Suite 1510, Seattle, WA. 98101-2216 *or call* 202-623-7361

Servid, Carolyn (editor). *The Book of the Tongass.* Minneapolis: Milkweed Editions, distributed by Publishers Group West, 1999. A collection of essays about the Tongass National Forest.

Sloane, Eric. *Reverence for Wood.* New York: Henry Holt, 1995.

Stevenson, Cheryl. *The Art of Handmade Paper and Collage.* Bothell, WA: Martingale, 1998.

Media:

Hardwood Forest Foundation. *The Continuing Forest: Managing our National Forests.* (Video) Memphis, TN: Hardwood Forest Foundation. Address: P.O. Box 34518, Memphis, TN *or* <www.natlhardwood.org>

The Man Who Planted Trees. (Tape or CD) Chelsea, VT: Chelsea Green Publishing.

The Man Who Planted Trees. (Video) DirectCinema Limited, 1987. Available from <www.videoproject.org> *or* 800-475-2638.

Old Growth Forests. (Video) Washington, DC: National Geographic Society, 1994.

Our Vanishing Forest. (Video) Oley, PA: Bullfrog Films. Address for catalog: P.O. Box 148, Oley, Pa 19526 *or* check the on-line catalog <www.bullfrogfilms.com> for a complete description of all their films.

Society of American Foresters. *Forestry: An Intricate Balance.* (Video) Bethesda, MD: SAF, 1992. Address: SAF Sales Orders, 5400 Grosvenor Lane, Bethesda, MD 20814-2198 or <www.safnet.org>

Replanting the Tree of Life (Video) Oley, PA: Bullfrog Films. Address for catalog: P.O. Box 148, Oley, PA 19526 *or* check the on-line catalog <www.bullfrogfilms.com> for a complete description of all their films.

Timber! (Video) Deerfield, IL: Coronet/MTI Film and Video. Address: 108 Wilmont Rd., Deerfield, IL 60015

Websites:

Alaska Cooperative Extension. 2221 E. Northern Lights Blvd., Suite 118, Anchorage, AK 99508 <www.uaf.edu/coop-ext>

Anchorage Recycling Center, 6161 Rosewood, Anchorage, AK 99518 *or* call 907/562-2267. For information on school recycling programs <www.anchoragerecycling.org>

Citizens for Recycling Solutions <www.recyclingsolutions.org> Alaska organization, download publications, links to other recycling projects.

Conservation Organizations:

Alaska Boreal Forest Council <www.ptialaska.net/~abfc>

Alaska Center for the Environment <www.akcenter.org>

Alaska Trappers Association<www.alaskatrappers.org.

Alaska Rainforest Campaign<www.akrain.org>

Alaska Outdoor Council and the Alaska Fish and Wildlife Conservation Fund <www.alaskaoutdoorcouncil.org

National Audubon Society <www.audubon.org>

National Wildlife Federation <www.nwf.org>

The Nature Conservancy <www.tnc.org>

Tongass Conservation Society <tongassconservation.org

Occupational Handbook <stats.bls.gov/ocohome.htm>

FULL CITATIONS – ACTIVITY CURRICULUM CONNECTIONS

Books and Publications:

Alaska Department of Fish and Game. *Alaska Wildlife Notebook Series.* Available to download online <www.state.ak.us/adfg> *or* from Wildlife Education, ADF&G, 333 Raspberry Rd., Anchorage, AK 99518.

Alaska Geographic Society. *Alaska's Forest Resources.* Anchorage, 1985. (Vol. 12, No.2)

Alaska Geographic Society. *Mammals of Alaska.* Anchorage, 1996.

Allaby, Michael. *Biomes of the World.* Danbury, CT: Grolier, 1999. (9 volumes)

American Forestry Association. *National Register of Big Trees.* Washington, DC: Author, 2000.

Anderson, Robert. *Forest: Identifying Propaganda Techniques.* San Diego: Greenhaven Press, 1992.

Armstrong, Robert. *Guide to the Birds of Alaska.* Anchorage: Alaska Northwest Books, 1990.

Arnosky, Jim. *Crinkleroot's Guide to Knowing the Trees.* New York: Bradbury, 1992.

Babbitt, Natalie. *Tuck Everlasting.* New York: Farrar, Straus, Giroux, 1975.

Bash, Barbara. *Ancient Ones, The World of the Old-Growth Douglas Fir.* San Francisco: Sierra Club Books for Children, 1994.

Bash, Barbara. *Tree of Life, The World of the African Baobab.* San Francisco: Sierra Club Books, 1989.

Berger, Melvin. *Water, Water Everywhere: A Book About the Water Cycle.* New York: Chelsea House, 1998.

Bockman, Christian Frank. *Trees of North America: A Field Guide to the Major Native and Introduced Species North of Mexico.* New York: Golden Books, 1968.

Brenner, Barbara. *The Tremendous Tree Book.* Honesdale, PA: Boyds Mills, 1998.

Burnie, David. *Tree. (Eyewitness Book)* New York: Knopf, 1988.

Burton, Robert. *The National Audubon Society North American Birdfeeder Handbook*. New York: Dorling Kindersley, 1995.

Cassie, Brian. *National Audubon Society First Field Guide: Trees.* New York: Scholastic, 1999.

Chambers, Catherine. *Bark.* Austin, TX: Ranitree Steck-Vaughn, 1996.

Citizens for Recycling Solutions. *Remake It! Alaska: Anchorage Businesses Remake, Recycle, and Reuse.* Anchorage, Alaska, 1999. Available to download on <www.recyclingsolutions.org>

Coombes, Allen. *Trees*. New York: Dorling Kindersley, 1992.

Cooper, Ann. *In the Forest.* Denver: Denver Museum of Natural History Press, 1996.

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Curtis Neil. *How Paper is Made.* Minneapolis: Lerner, 1992. (K-3)

Davis, Wendy. *From Tree to Paper.* Littleton, MA: Sundance Publishers, 1996.

Donahue, Michael. *The Grandpa Tree.* Niwot, CO: Roberts Rinehart, 1991.

Dorros. Arthur, *A Tree is Growing.* New York: Scholastic, 1997.

Drew, Helen. *My First Music Book.* New York: Dorling Kindersley, 1993.

Fiarotta, Noel. *Music Crafts for Kids.* New York: Sterling, 1993.

Foa, Maryclare. *Songs are Thoughts: Poems of the Inuit.* New York: Orchard, 1995.

Gackenbach, Dick. *Mighty Tree.* San Diego: Harcourt Brace Jovanovich, 1992.

Gallant, Roy A. *Earth's Vanishing Forests.* New York: Macmillan, 1991.

Gamlin, Linda. *Trees. (Eyewitness Explorer)* New York: Dorling Kindersley, 1997.

Ganeri, Anita. *Trees.* New York: Gloucester Press, 1993.

Gardner, Robert. *Science Project Ideas About Trees*. Springfield, NJ: Enslow, 1997.

George, Jean Craighead. *My Side of the Mountain.* New York: Dutton, 1959.

George, Kristine O'Connell. *Old Elm Speaks: Tree Poems.* New York: Clarion, 1998.

Giono, Jean. *The Man Who Planted Tress.* Chelsea, VT: Chelsea Green Publishing Co., 1985. Full text of this book is available on-line from several websites. Try: <www.horaren.sk/en/man/man.htm>

Green, Jen. *A Dead Log.* New York: Crabtree, 1999.

Greenaway, Theresa. *Look Closer*: *Tree Life.* New York: Dorling Kindersley, 1992.

Grummer, Arnold. *Arnold Grummer's Complete Guide to Easy Papermaking.* Krause Publications, 1999.

Hirschi, Ron. *Faces in the Forest.* New York: Cobblehill, 1997.

Hirschi, Ron. *Save our Forests.* New York: National Audubon Society, 1993.

Hiscock, Bruce. *The Big Tree.* New York: Boyd Mills Press, 1999.

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Jaspersohn, William. *How the Forest Grew.* Econo-Clad Books, 1999.

Jaspersohn, William. *Timber!* Boston: Little, Brown, 1996.

Jeunesse, Gaillimard. *The Tree.* New York: Cartwheel Books, 1992.

Johnson, Sylvia. *How Leaves Change.* Minneapolis: Lerner, 1986.

Jordan, Sandra. *Christmas Tree Farm.* New York: Orchard, 1993.

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Glacier Bay National Park & Preserve <www.nps.gov/glba> For succession images and information triggered by glacial retreat.

Tongass National Forest <www.fed.fs.us/r10/tongass> Forest habitat and wildlife photos and information.

Tree Guide <www.treeguide.com> Natural history of trees in database format, including identification, ecology, life history, distribution and use of trees. trees of North America. Features latest news, state trees, and champion trees.

US Forest Service fire links page <www.fs.us/fire/links.shtml> Topics include fire news, employment, prescribed fire, essays on wildland fire, photos, fire science and research, wildland fire training, and what it's like to be a wildland firefighter.

See also the websites annotated on the "Forest Organizations and Careers" fact sheet in INSIGHTS, *Section 5.*

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