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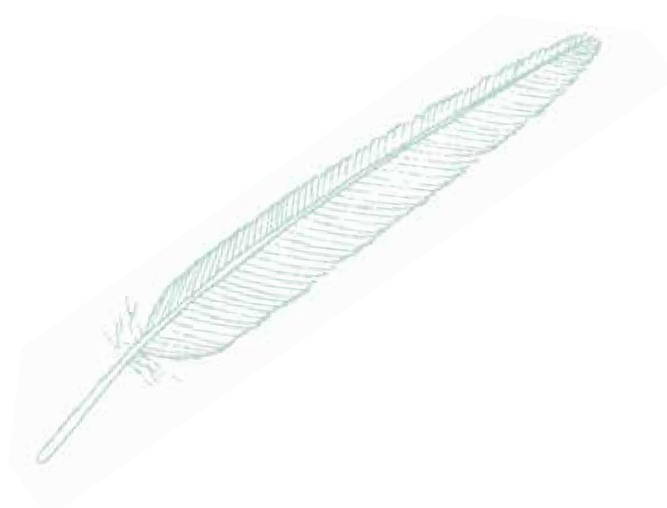
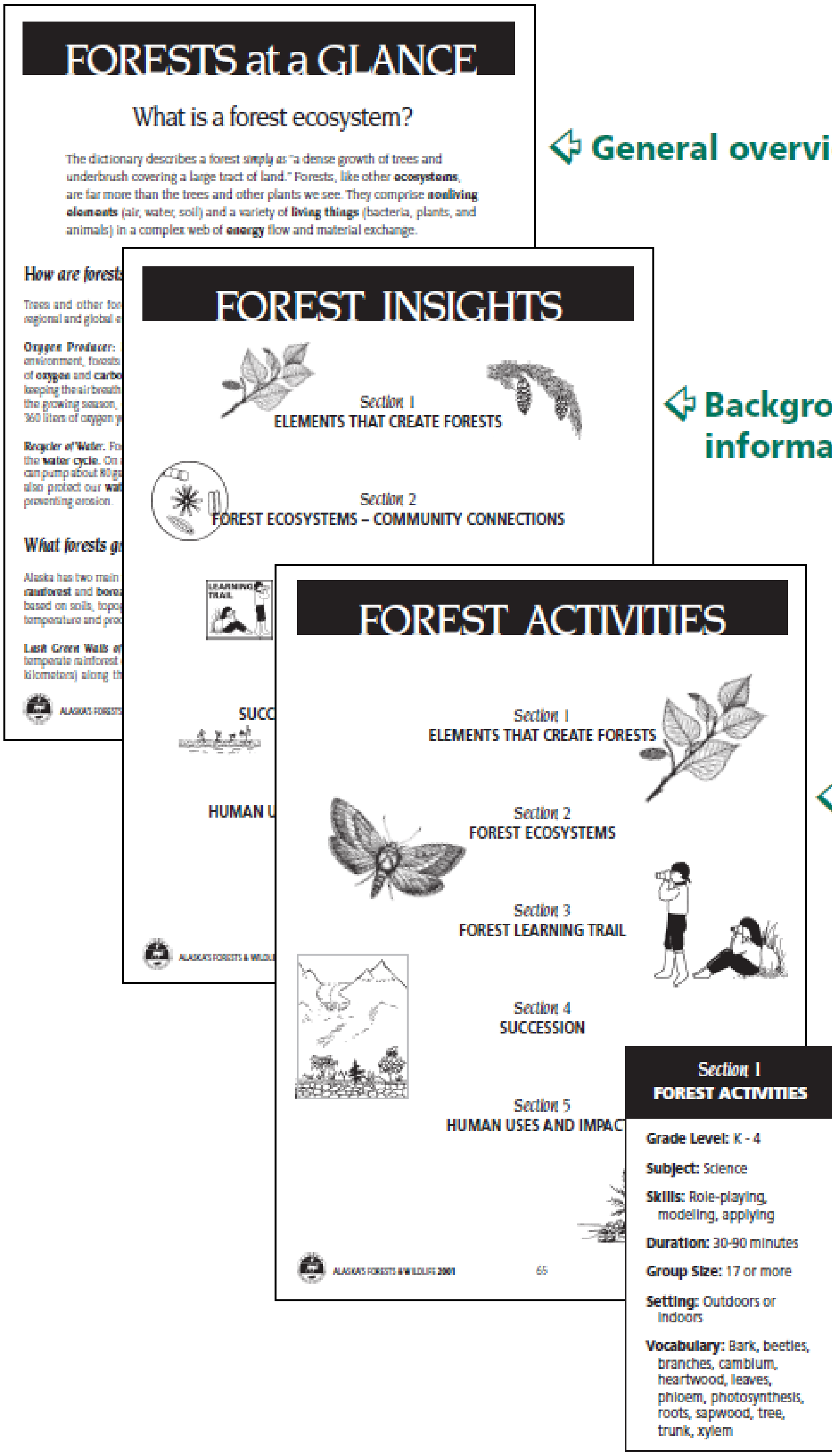
The Alaska Department of Fish and Game has additional information and materials on wildlife conservation education. We revise the *Alaska Wildlife Curriculum* periodically. For information, or to provide comments on this book, please contact us:

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

or visit our web site:
www.adfg.alaska.gov



How to use this curriculum



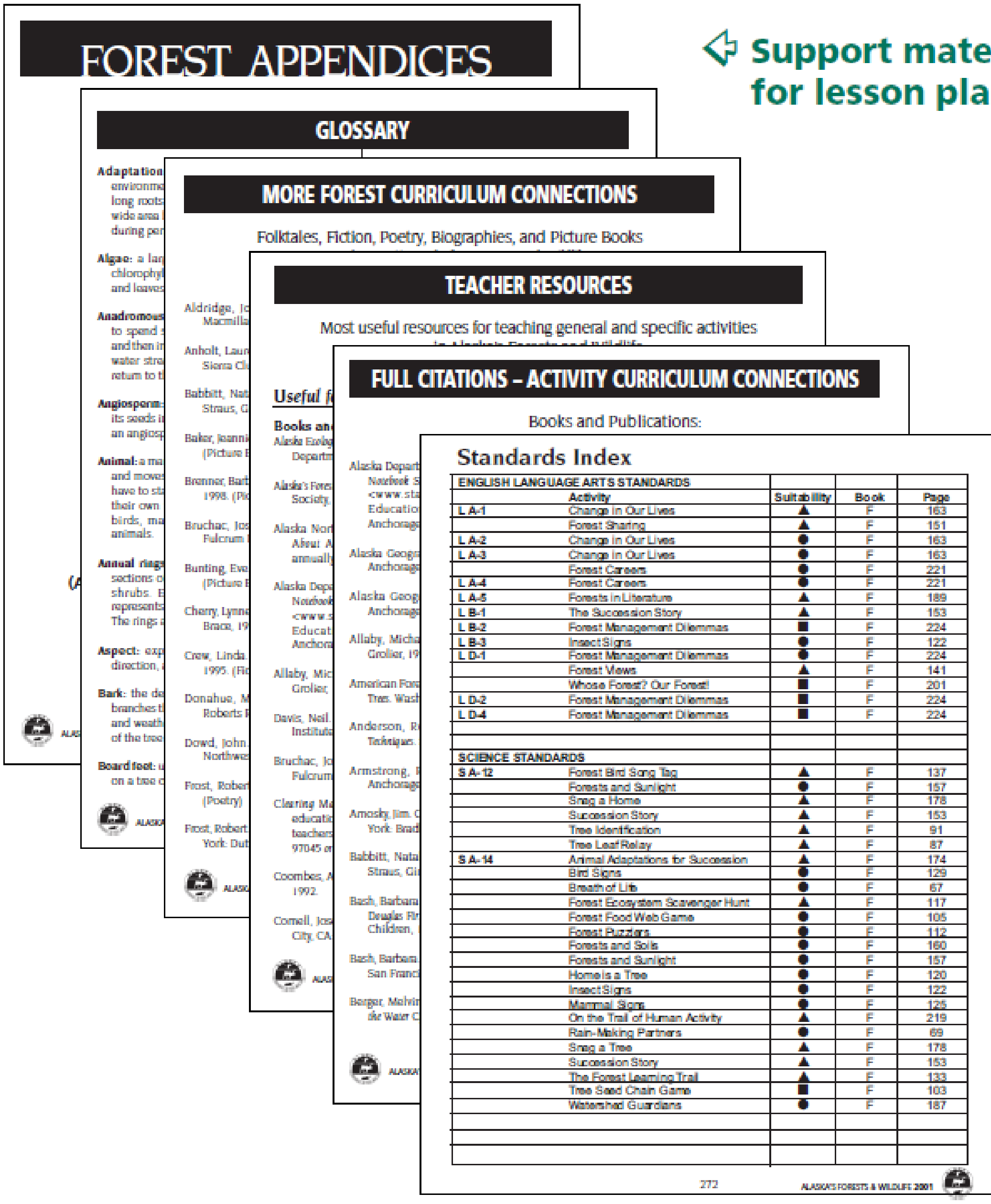
General overview

Background information

Activities

Student activity boxes provide a quick planning reference

How to use this curriculum CONTINUED



ENGLISH LANGUAGE ARTS STANDARDS	Activity	Suitability	Book	Page
L A-1	Change in Our Lives	▲	F	163
	Forest Sharing	▲	F	151
L A-2	Change in Our Lives	●	F	163
L A-3	Change in Our Lives	●	F	163
	Forest Careers	●	F	221
L A-4	Forest Careers	●	F	221
L A-5	Forests in Literature	▲	F	189
L B-1	The Succession Story	▲	F	153
L B-2	Forest Management Dilemmas	■	F	224
L B-3	Insect Signs	●	F	122
L D-1	Forest Management Dilemmas	●	F	224
	Forest Views	▲	F	141
	Whose Forest? Our Forest!	■	F	201
L D-2	Forest Management Dilemmas	■	F	224
L D-4	Forest Management Dilemmas	■	F	224
SCIENCE STANDARDS				
S A-12	Forest Bird Song Tag	▲	F	137
	Forests and Sunlight	●	F	157
	Snag a Home	▲	F	178
	Succession Story	▲	F	153
	Tree Identification	▲	F	91
	Tree Leaf Relay	▲	F	87
S A-14	Animal Adaptations for Succession	▲	F	174
	Bird Signs	●	F	129
	Breath of Life	●	F	67
	Forest Ecosystem Scavenger Hunt	▲	F	117
	Forest Food Web Game	●	F	105
	Forest Puzzlers	●	F	112
	Forests and Soils	●	F	160
	Forests and Sunlight	●	F	157
	Home is a Tree	●	F	120
	Insect Signs	●	F	122
	Mammal Signs	●	F	125
	On the Trail of Human Activity	▲	F	219
	Rain-Making Partners	●	F	69
	Snag a Tree	▲	F	178
	Succession Story	▲	F	153
	The Forest Learning Trail	▲	F	133
	Tree Seed Chain Game	■	F	103
	Watershed Guardians	●	F	187

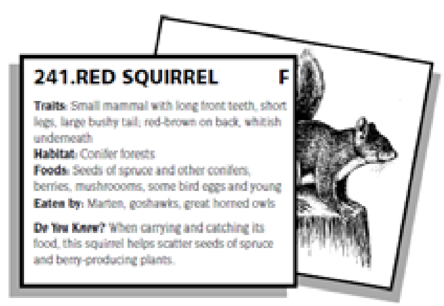
Support materials for lesson planning

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



*** TO ADVANCE DIRECTLY TO THE START OF A UNIT CLICK ON BOLD TEXT IN TABLE OF CONTENTS ***

Alaska's Forests & Wildlife

TABLE OF CONTENTS

Alaska's Forests & Wildlife
TABLE OF CONTENTS

Alaska's Forests & Wildlife
TABLE OF CONTENTS

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.

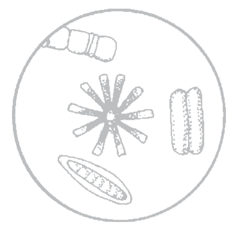
FOREST INSIGHTS

Section 1

ELEMENTS THAT CREATE FORESTS

Section 2

FOREST ECOSYSTEMS – COMMUNITY CONNECTIONS



Section 3

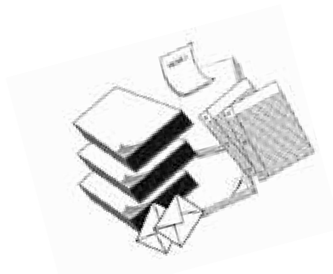
FOREST LEARNING TRAIL

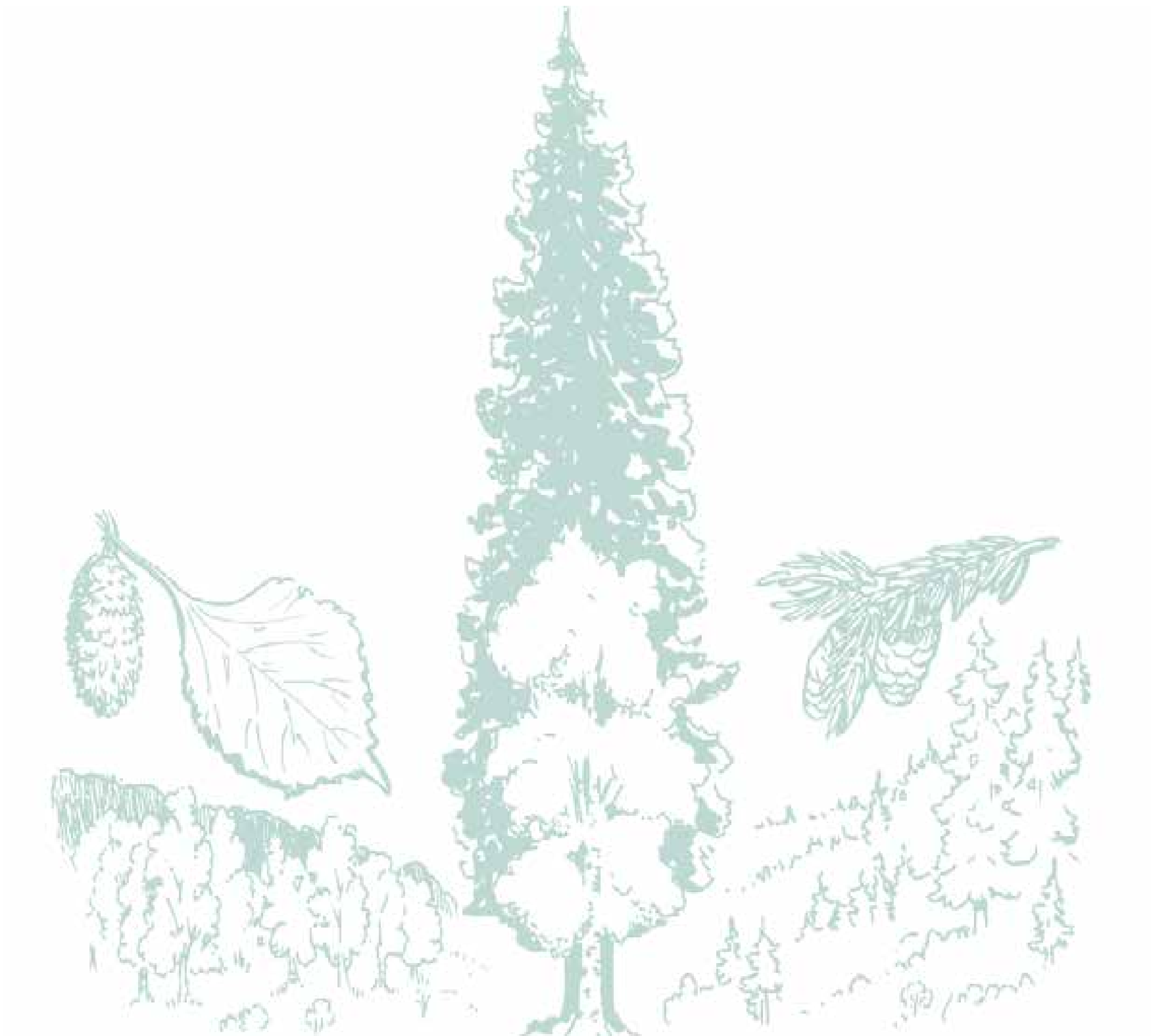
Section 4

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.

Section 1
FOREST INSIGHTS

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.

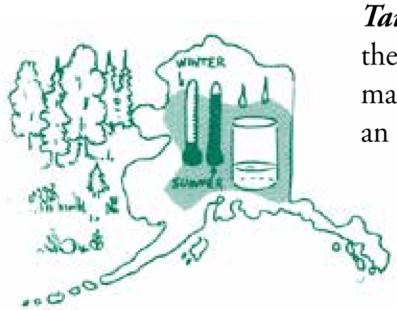
SOILS. Typically, soils in the coastal rainforest are relatively thin. Some glaciers are still receding and making way for future forests.

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 tre 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.

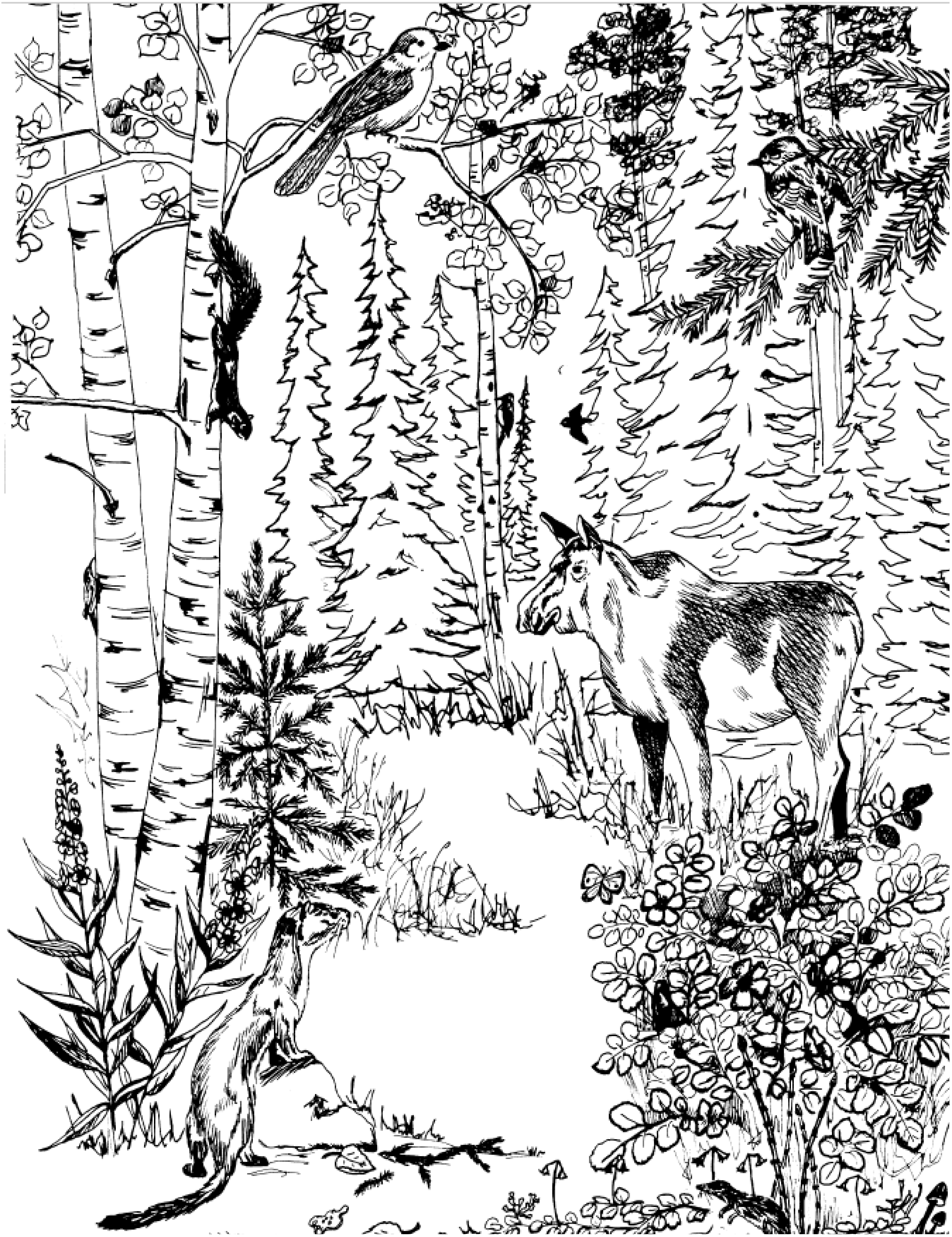
TOPOGRAPHY. Slope and aspect provide micro-climates of warmth and wind protection where the trees of the boreal forest can grow to their greatest potential.

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.

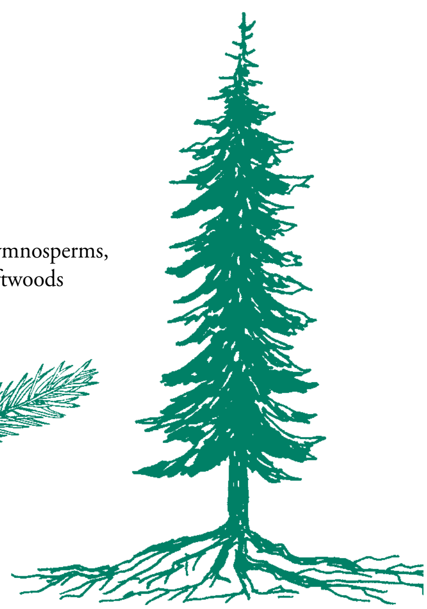
PARTS OF TREES

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).

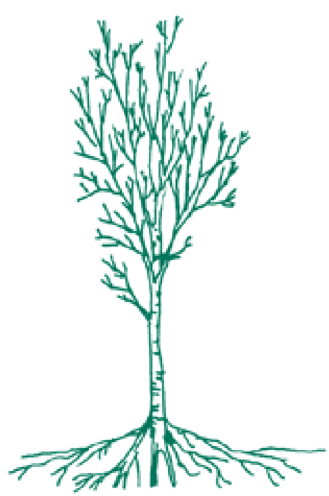
• If the leaves look like needles – just picture a Christmas tree – the tree is called a **conifer, gymnosperm**, and **softwood** (although some have wood that is quite hard).

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.

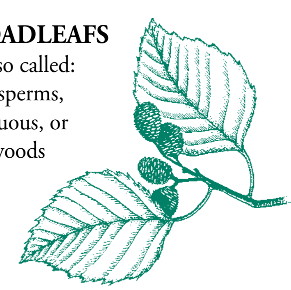
Broadleaf trees in Alaska are **deciduous**, losing their leaves in the fall. They become **dormant** as an **adaptation** to the cold and reduced daylight. (Some broadleaf trees in tropical areas keep their leaves all winter.)

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.

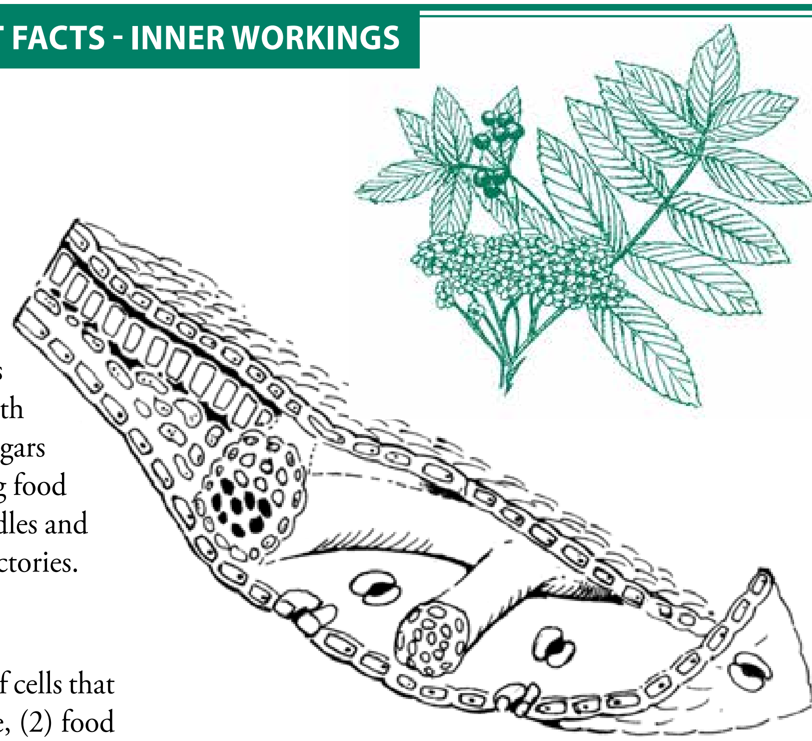
Beneath the phloem is the only growing layer of the trunk, the **cambium**. The cambium produces both the phloem cells and the next inner ring of cells called the **xylem**. New xylem cells carry water and dissolved minerals from the roots *up* to the leaves and other parts of the tree. Sometimes these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

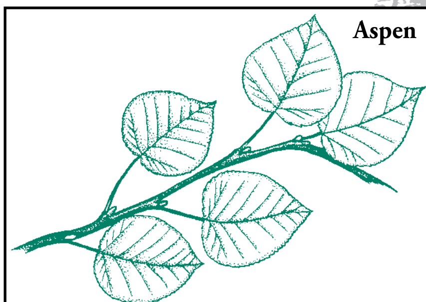
Look at the leaves.

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

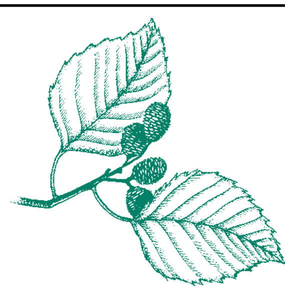
Broadleaf trees have flowers as well as broad, flat leaves. Flowers on a majority of Alaska's broadleaf trees are small and green and do not look like a typical flower petal.

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

Birch



Aspen

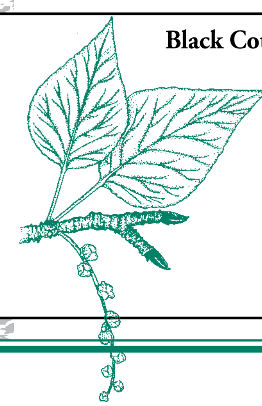


Alder

Mountain Ash

Willow

Balsam Poplar



Black Cottonwood

FOREST FACTS - CONIFER TREES

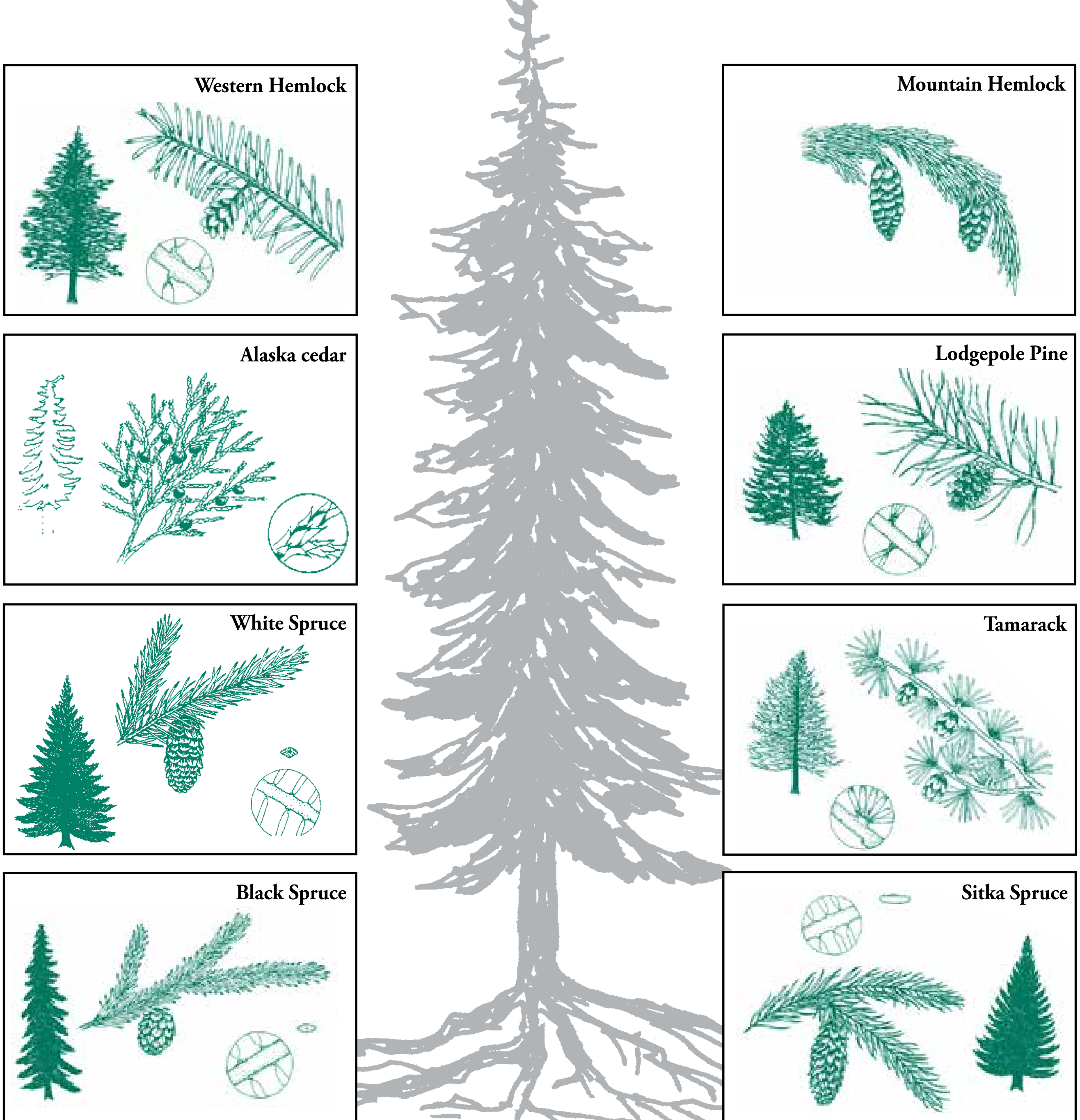
ALASKA'S CONIFER TREES

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.

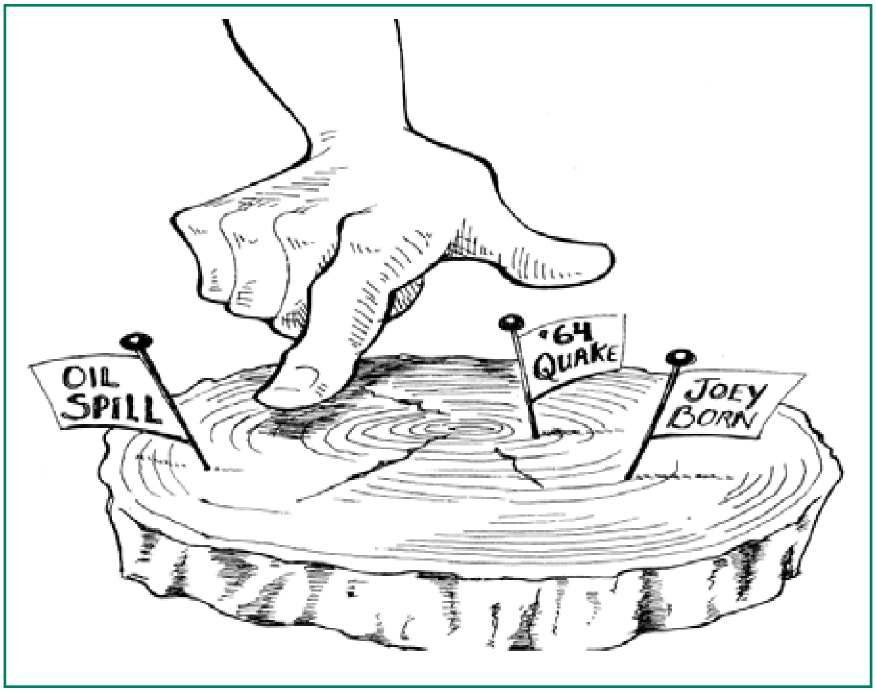
Global water cycle.
When scientists looked for the source of rain and snow clouds, they discovered the **water cycle** and the important role of trees in returning moisture to the atmosphere. Forests recycle water that falls to earth in two ways:

(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 <u>living tree</u> 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.

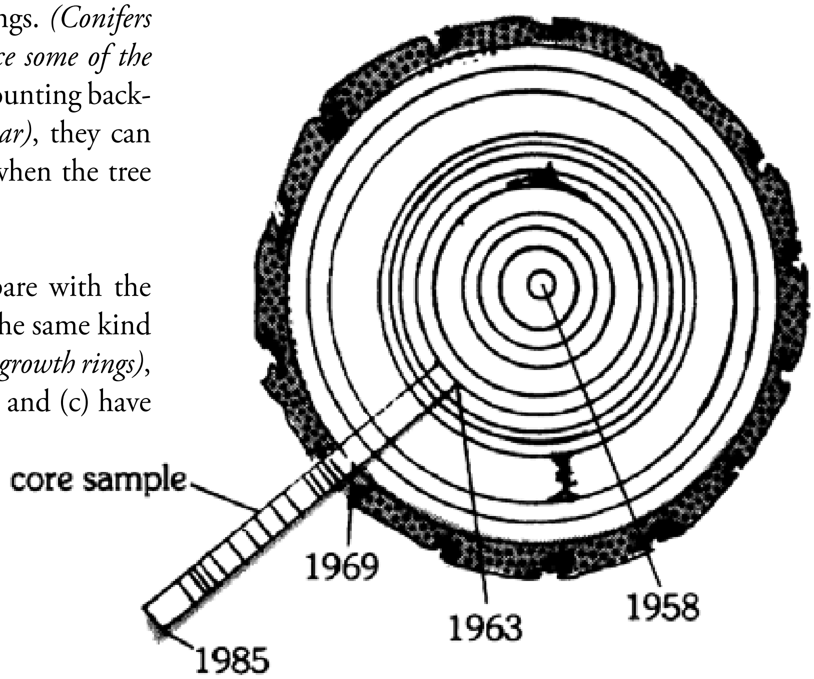
(In cross-dating, scientists often use stumps, logs, beams in old building, or any part of a tree trunk that clearly shows the annual rings.)

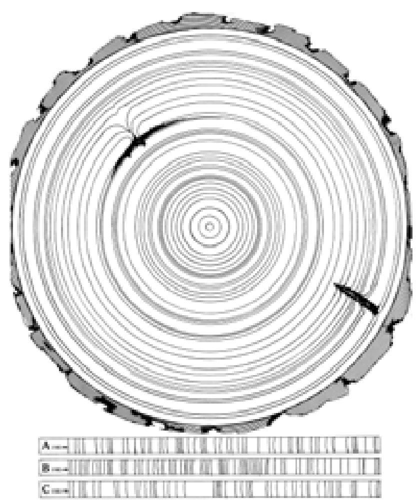
3. Dendrochronologists then compare the inner *(oldest)* rings of the core sample with the outer *(youngest)* rings of the stump or log to find a section where the ring patterns match *(see diagram)*.

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.

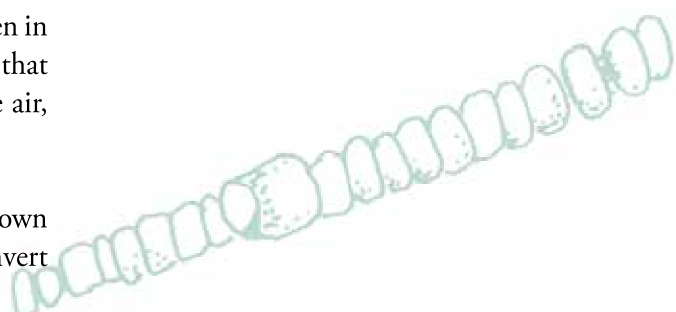
A Nest Cavity for Free. Woodpeckers dig holes in trees for nesting and winter roosting, but they use them only for a year or two. Owls, which cannot dig holes in trees, are able to use the abandoned woodpecker holes as nest sites.

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.

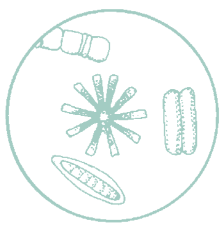
PARASITISM – a win/lose situation

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.

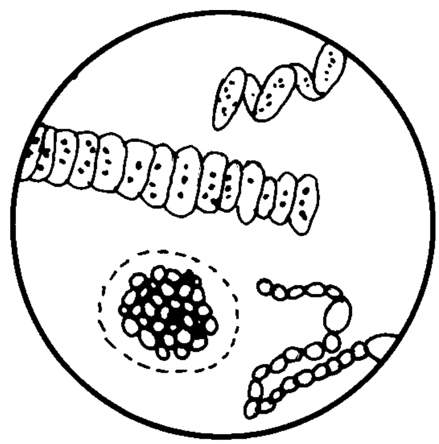
Given Their Own Kingdoms. Some not only make their own food, like plants, but also move around and catch and eat other living things. Additionally, their cell structure is quite different from those of either plants or animals.

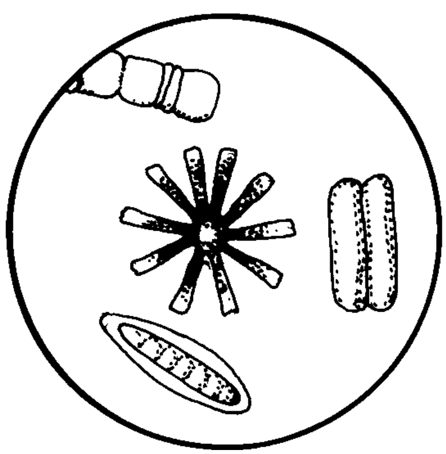
MONERANS, the smallest microscopic organisms, do not have nuclei in their cells. **Bacteria** and **cyanobacteria** (or **blue-green algae**) are examples of monerans. *A million monerans would fit on the head of pin.*

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.

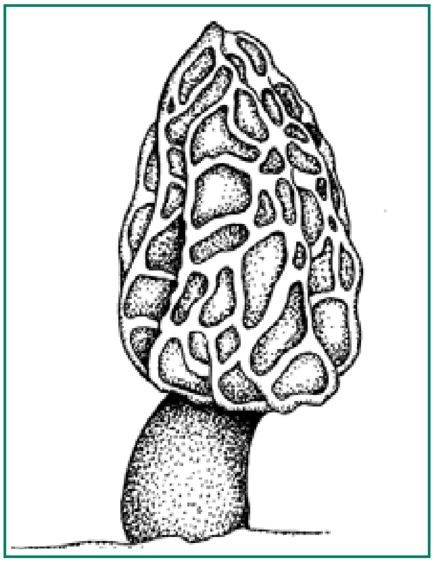
Fungi are similar to plants in that they are immobile. In fact, scientists used to consider them to be plants. But fungi are very different from plants in cell structure and in the ways they live, so scientists now place them in a separate kingdom of living things.

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

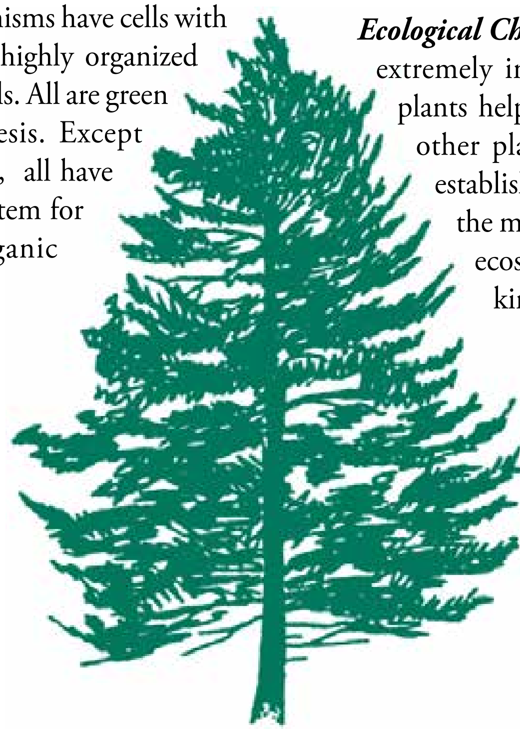
From small to tall

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

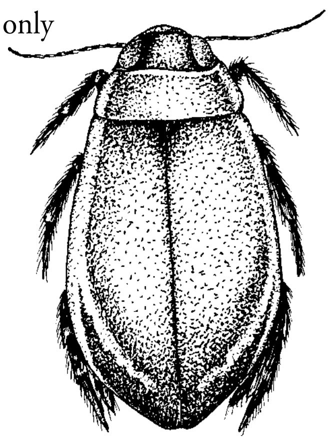
Invertebrates animals are multicellular organisms that lack a backbone or spinal column. They make up the majority of the animal kingdom, both in number of species and in populations.

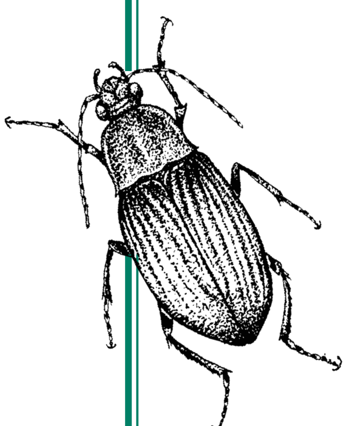
Like other animals, invertebrates obtain energy and minerals by eating other living things – plants, fungi, or other animals. They are **consumers**. Many also function as **detritivores**, helping to recycle the minerals and nutrients in dead organic material.

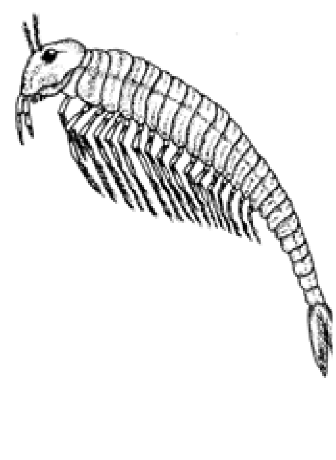
Need External Warmth. Invertebrates need external warmth to function. Forest invertebrates are only active during the warmer months which in the boreal forest is limited to a few summer months. Even then, despite their numbers, few humans notice them.

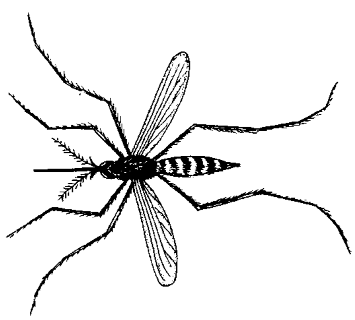
Mosquitoes and Other Buzzing. Arthropods *(spiders, centipedes, millipedes, and insects)* are the most conspicuous. Flying insects include butterflies, bumblebees, moths, ichneumonid wasps, crane flies, and midges. Mosquitoes, blackflies, and other biting flies can occur in great abundance.

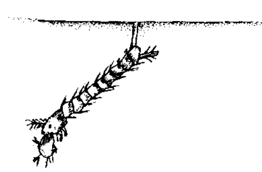
Look Under Bark, Logs. Forest invertebrates also include segmented worms, snails, and slugs. Sawflies, aphids, bark beetles, carrion beetles, and ground beetles are among the insects that live on plants or in the leaf litter. *For a more complete list and illustrations, see the Alaska Ecology Cards.*

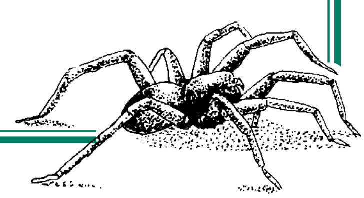






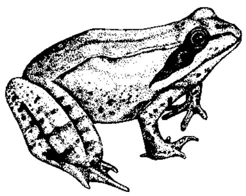


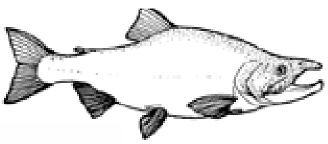


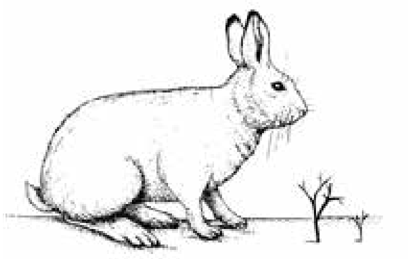


5B – ANIMALS (Vertebrates)

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.

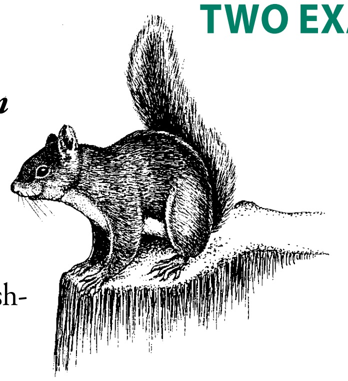
Fruiting fungi – Many fungi grow on trees. Their threadlike mycelium spreads beneath the bark, hidden from view. Only the fruiting bodies of fungi such as shelf fungus are easy to spot.

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.

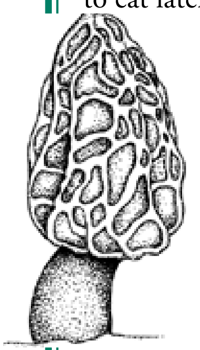
TWO EXAMPLES



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.**

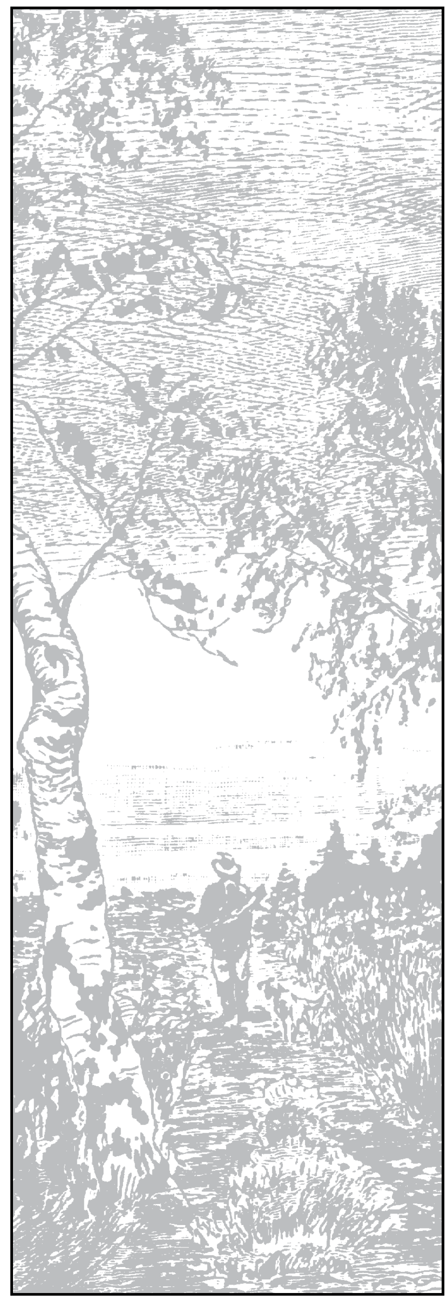
A year or two later, that nest hole made by the woodpecker will become home for other cavity-nesting animals such as swallows, boreal owls, or flying squirrels.

Who all helped make that nest hole for the owl?

FOREST Learning Trail

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

Section 4
FOREST INSIGHTS

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.

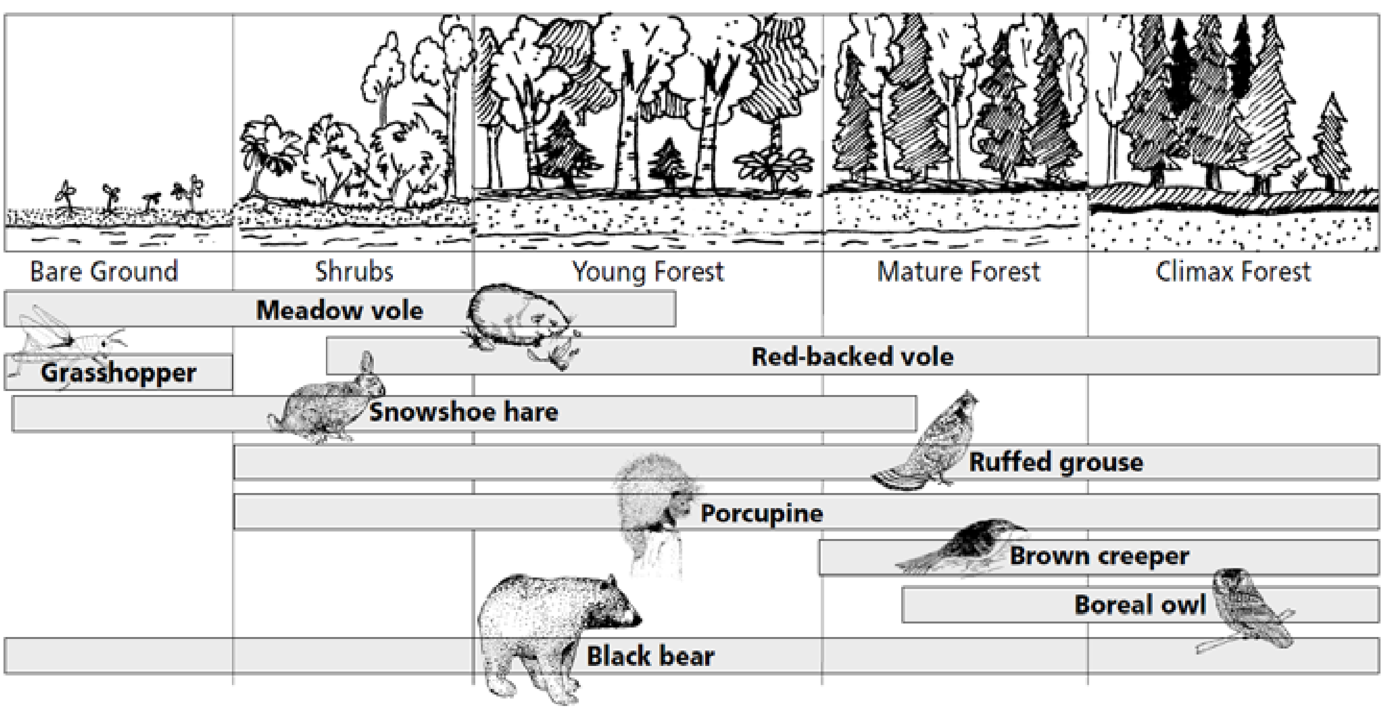
Succession describes the *patterns of change* in ecosystems when a new environment is formed or after an existing environment is disturbed. Succession occurs in all types of ecosystems, from oceans and wetlands to tundra, deserts, and forests.

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.

<u>COASTAL RAINFOREST</u>
Regrowth Stage
Second-Growth Forest
Old-Growth Forest

<u>BOREAL FOREST</u>
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.

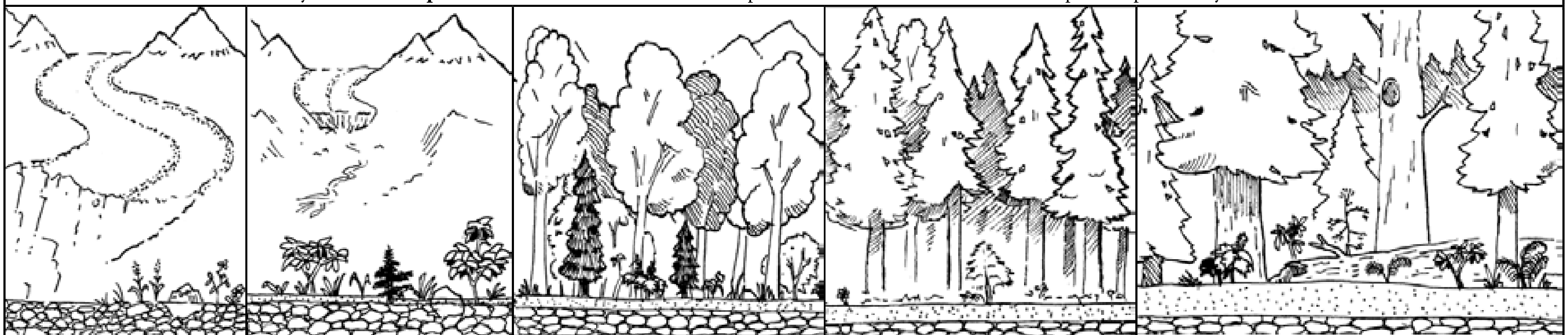
Fire Thrives in Mature Forests

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):

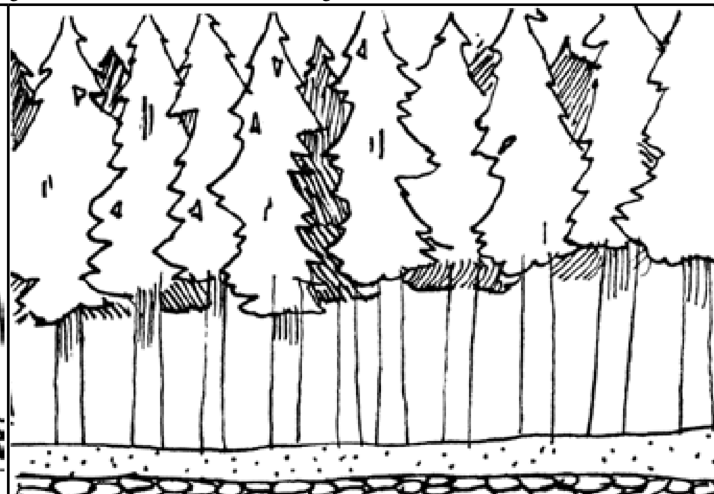
The length of time required varies, but some scientists estimate **250 to 600 years**. On well-drained sites the **canopy** trees are hemlock and Sitka spruce. Many large old conifers have died and fallen. Sunlight reaches the forest floor. Trees of all ages (seedlings, saplings, young trees, and old 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.

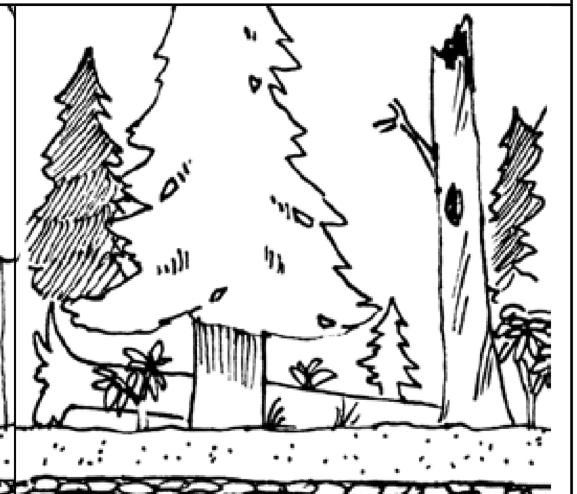
REGROWTH STAGE:

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:

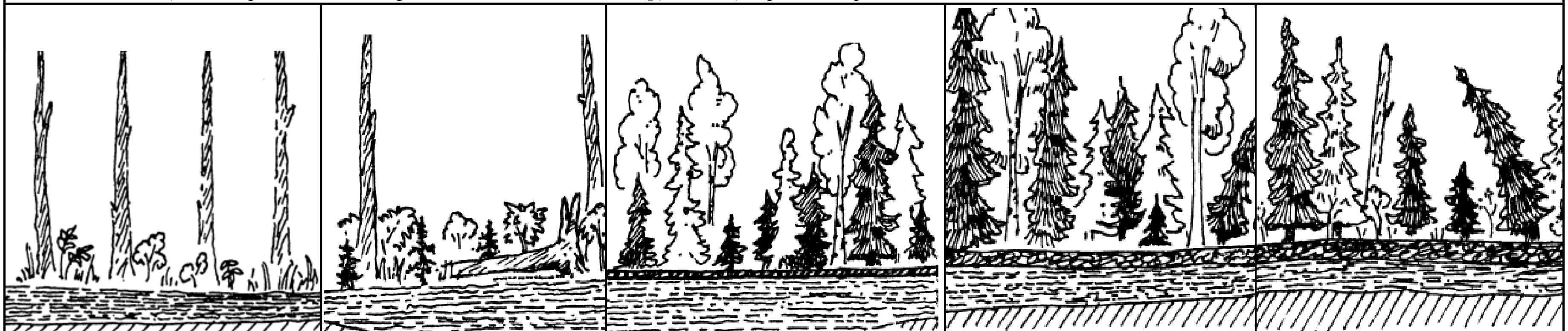
From **45 to 150 years** after fire, **organic soil** is several inches thick. A mixture of broadleafs and white spruce form the forest **canopy**. The abundance of white spruce varies among sites. The canopy is more open, so some birch and aspen seedlings and saplings grow in the **understory**. High-bush 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.

Section 5
FOREST INSIGHTS

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.

FOREST FACTS - WOOD IN OUR LIVES

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

COTTONWOOD/POPLAR

Cabinets	Bridges
Pulp	Pallets
Old-fashioned fruit baskets	Veneer

SPRUCE

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

WESTERN HEMLOCK

Pulp	Veneer
Lumber	Railroad ties
Cabinets	Flooring
Furniture	Broom handles
Poles	

ALASKA YELLOW CEDAR

House construction	Cabinets
Decking	Trail planks
Poles	Bridges
Boats	Furniture

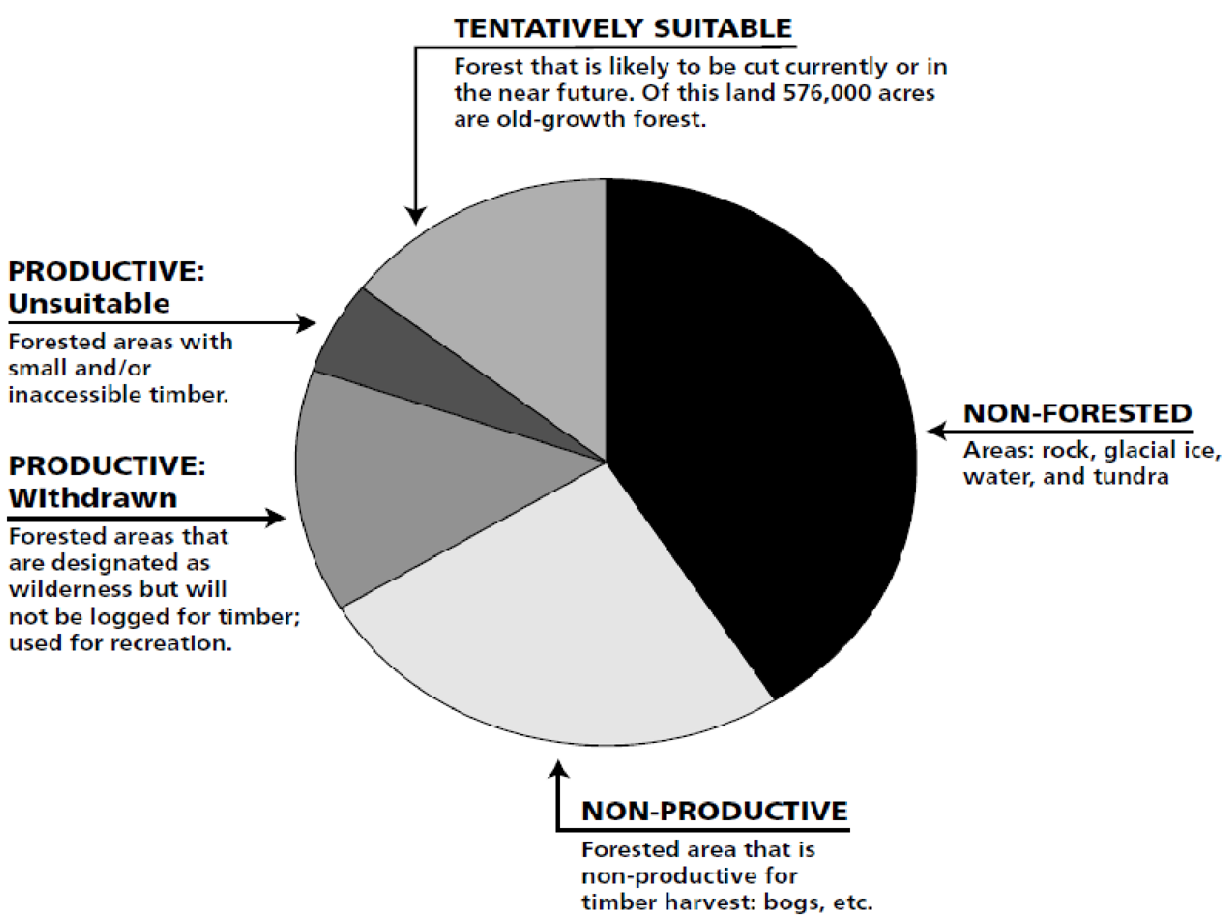
WESTERN RED CEDAR

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

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.

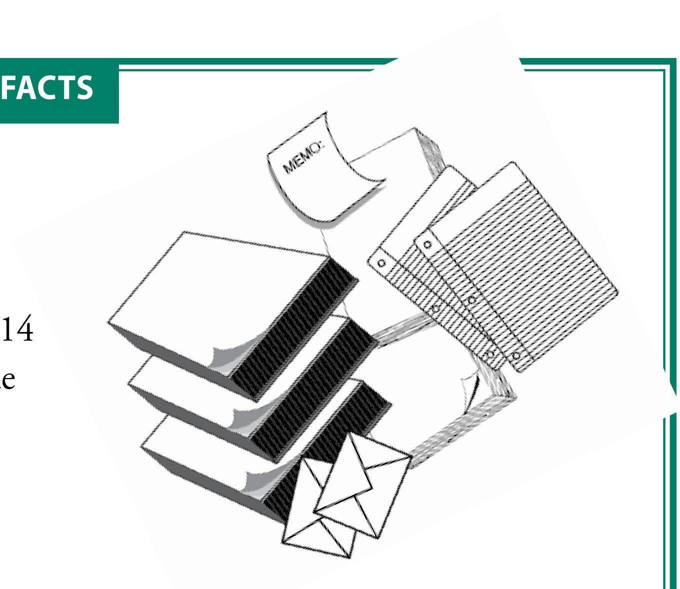


****Values are in million of acres***

FOREST FACTS

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?

FOREST FACTS - PLANT A TREE

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 FACTS

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.