MERIT BADGE SERIES

FORESTRY

BOY SCOUTS OF AMERICA®

How to Use This Pamphlet

The secret to successfully earning a merit badge is for you to use both the pamphlet and the suggestions of your counselor.

Your counselor can be as important to you as a coach is to an athlete. Use all of the resources your counselor can make available to you. This may be the best chance you will have to learn about this particular subject. Make it count.

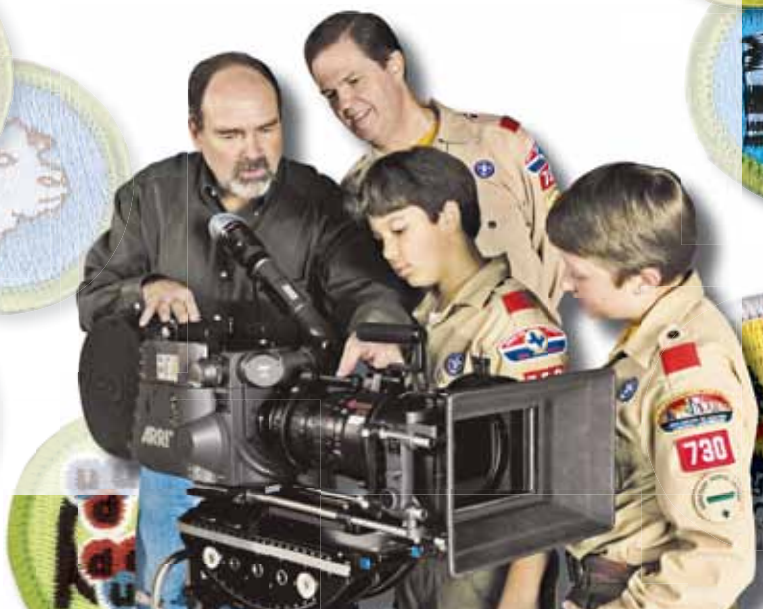
If you or your counselor feels that any information in this pamphlet is incorrect, please let us know. Please state your source of information.

Merit badge pamphlets are reprinted annually and requirements updated regularly. Your suggestions for improvement are welcome.

Send comments along with a brief statement about yourself to Youth Development, S209 • Boy Scouts of America • 1325 West Walnut Hill Lane • P.O. Box 152079 • Irving, TX 75015-2079.

Who Pays for This Pamphlet?

This merit badge pamphlet is one in a series of more than 100 covering all kinds of hobby and career subjects. It is made available for you to buy as a service of the national and local councils, Boy Scouts of America. The costs of the development, writing, and editing of the merit badge pamphlets are paid for by the Boy Scouts of America in order to bring you the best book at a reasonable price.



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Requirements

1. Prepare a field notebook, make a collection, and identify 15 species of trees, wild shrubs, or vines in a local forested area. Write a description in which you identify and discuss the following:
   a. The characteristics of leaf, twig, cone, or fruiting bodies
   b. The habitat in which these trees, shrubs, or vines are found
   c. The important ways each tree, shrub, or vine is used by humans or wildlife and whether the species is native or was introduced to the area. If it is not native, explain whether it is considered invasive or potentially invasive.
2. Do ONE of the following:
   a. Collect and identify wood samples of 10 species of trees. List several ways the wood of each species can be used.
   b. Find and examine three stumps, logs, or core samples that show variations in the growth rate of their ring patterns. In the field notebook you prepared for requirement 1, describe the location or origin of each example (including elevation, aspect, slope, and the position on the slope), and discuss possible reasons for the variations in growth rate. Photograph or sketch each example.
   c. Find and examine two types of animal, insect, or damage on trees. In the field notebook you prepared for requirement 1, identify the damage, explain how the damage was caused, and describe the effects of the damage on the trees. Photograph or sketch each example.

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3. Do the following:
   a. Describe the contributions forests make to:
      (1) Our economy in the form of products
      (2) Our social well-being, including recreation
      (3) Soil protection and increased fertility
      (4) Clean water
      (5) Clean air (carbon cycling, sequestration)
      (6) Wildlife habitat
      (7) Fisheries habitat
      (8) Threatened and endangered species of plants and animals
   b. Tell which watershed or other source your community relies on for its water supply.
4. Describe what forest management means, including the following:
   a. Multiple-use management
   b. Sustainable forest management
   c. Even-aged and uneven-aged management and the silvicultural systems associated with each
   d. Intermediate cuttings
   e. The role of prescribed burning and related forest-management practices
5. With your parent's and counselor's approval, do ONE of the following:
   a. Visit a managed public or private forest area with the manager or a forester who is familiar with it. Write a brief report describing the type of forest, the management objectives, and the forestry techniques used to achieve the objectives.
   b. With a knowledgeable individual, visit a logging operation or wood-using manufacturing plant. Write a brief report describing the following:
      (1) The species and size of trees being harvested or used and the location of the harvest area or manufacturer

(2) The origin of the forest or stands of trees being utilized (e.g., planted or natural)

(3) The forest's successional stage. What is its future?

(4) Where the trees are coming from (land ownership) or where they are going (type of mill or processing plant)

(5) The products that are made from the trees

(6) How the products are made and used

(7) How waste materials from the logging operation or manufacturing plant are disposed of or utilized

c. Take part in a forest-fire prevention campaign in cooperation with your local fire warden, state wildfire agency, forester, or counselor. Write a brief report describing the campaign, how it will help prevent wildfires, and your part in it.

6. Do the following:

   a. Describe the consequences to forests that result from FIVE of the following elements: wildfire, absence of fire, insects, tree diseases, air pollution, overgrazing, deer or other wildlife overpopulation, improper harvest, and urbanization.

   b. Explain what can be done to reduce the consequences you discussed in 6a.

   c. Describe what you should do if you discover a forest fire and how a professional firefighting crew might control it. Name your state or local wildfire control agency.

7. Visit one or more local foresters and write a brief report about the person (or persons). Or, write about a forester's occupation including the education, qualifications, career opportunities, and duties related to forestry.

Contents

Introduction

Forest vegetation helps clean the air by absorbing carbon dioxide and releasing oxygen.

Humans have always depended upon forests. Forests have provided food, fuel, shelter, and many other resources. They have been worshipped, feared, bought and sold, protected, destroyed, and restored. Forested lands are deeply woven into our myths and legends, music, literature, and art. Without forests, our existence would be far less rich. In fact, without forests, we would find it difficult to survive at all.

Today, the forests of the world continue to be among the most interesting and important natural resources on the planet. Nearly 30 percent of the world's land is forested, and a third of the acreage of North America is covered with forests. These great stands of vegetation shield Earth from the forces of wind, rain, and sunlight. They slow erosion, enrich the soil, protect bodies of water, and provide shelter for wildlife. From the equator to near the polar regions, forests are home to plant and animal species that, in many cases, we have yet to fully understand.

Perhaps you have hiked with your troop into a forest and camped under the shade of big hardwoods or in deep stands of pine and fir. You may have seen wildlife among the trees and in nearby meadows. Perhaps you have cast a line into a stream or a lake and had the thrill of catching a couple of fish. When you are in the middle of a forest having such a good time, it is easy to understand the value of the recreational opportunities that forests offer.

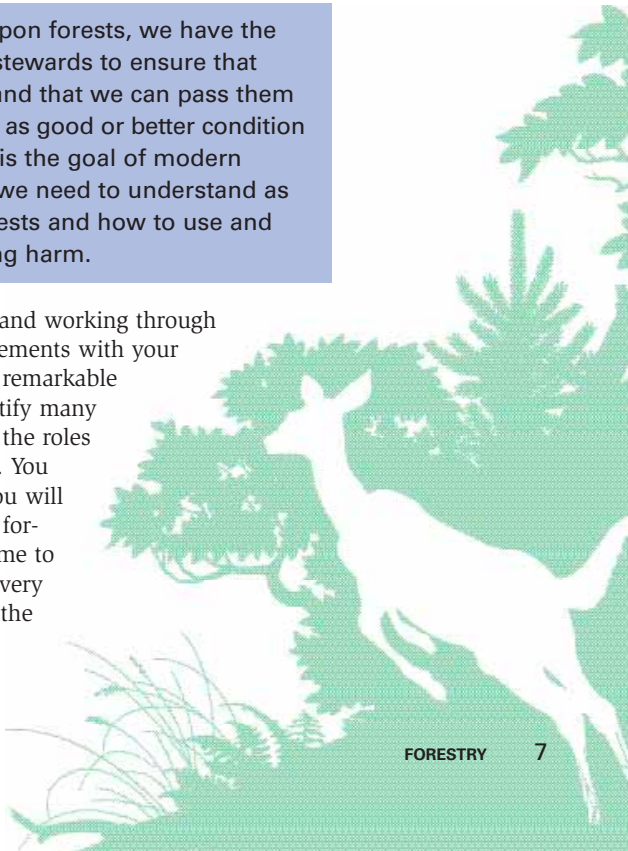
You might not spend much time thinking about the products that come from forests, but they are vital to our way of life. Your home probably has lumber in it that was milled from trees harvested hundreds of miles away. Much of the furniture in your house is made of wood, and so is the paper used to print this merit badge pamphlet. Many of the foods we put on our tables and the drugs in our medicine cabinets have forest origins. In fact, if you wrote down all the forest products you and your family use, the list would be very long.

Forests provide jobs, too. Some people manage timberlands and harvest trees and other forest resources. The wood-products industry is a key industry in many states and the primary economic engine in many rural communities. The outdoor-recreation industry creates tens of thousands of positions as well.

The very land on which forests grow is in demand, too. Forests are still being cleared to make way for homes, farms, and cities.

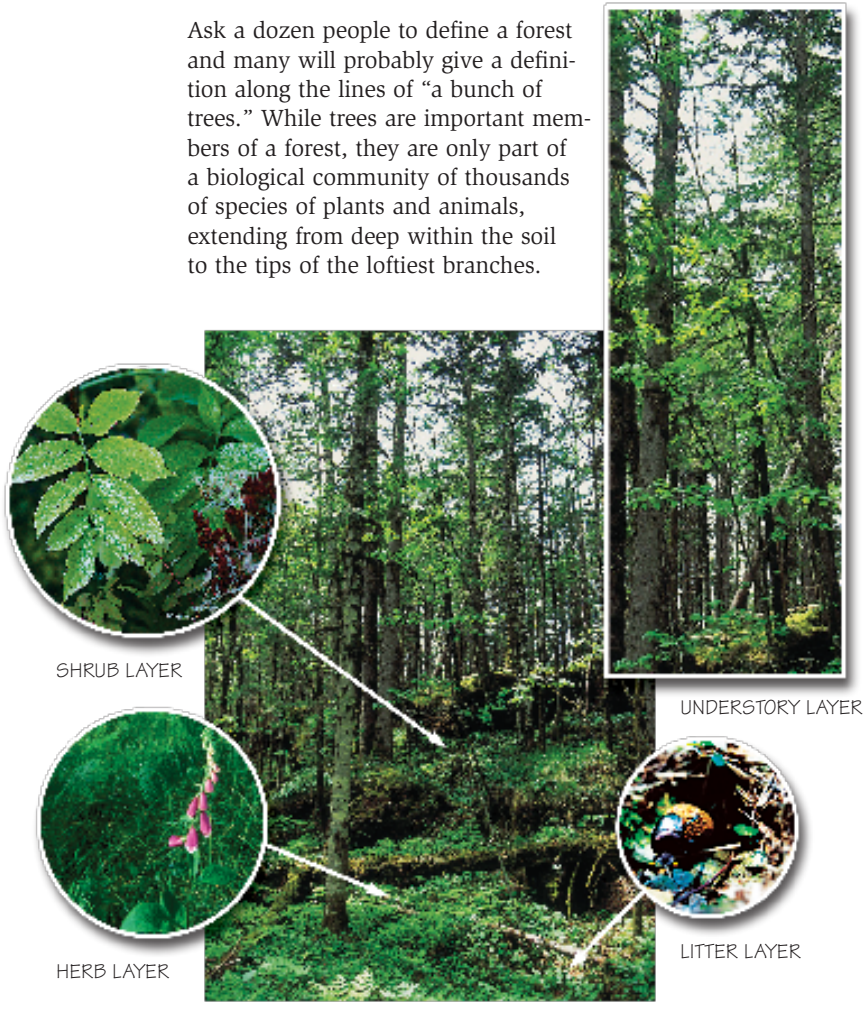
With so many pressures upon forests, we have the responsibility to be good stewards to ensure that forests are healthy today and that we can pass them on to future generations in as good or better condition than we found them. That is the goal of modern forestry. To accomplish it, we need to understand as much as we can about forests and how to use and enjoy them without causing harm.

In studying this pamphlet and working through the Forestry merit badge requirements with your counselor, you will explore the remarkable complexity of a forest and identify many species of trees and plants and the roles they play in a forest's life cycle. You will find that forests change. You will discover some of the resources forests provide to humans and come to understand that people have a very large part to play in sustaining the health of forests.



Understanding Forests

Ask a dozen people to define a forest and many will probably give a definition along the lines of "a bunch of trees." While trees are important members of a forest, they are only part of a biological community of thousands of species of plants and animals, extending from deep within the soil to the tips of the loftiest branches.



Forest Strata

A mature forest consists of levels, or *strata.* Typical forest strata are the canopy, understory, shrub layer, herb layer, and litter layer. All the strata are essential to the health of a forest ecosystem.

Canopy. Branches and leaves that form the highest reaches of a forest are positioned to capture sunlight and to provide shelter and shade for the strata below. Formed by the largest and oldest trees, the canopy is home to birds, climbing mammals, and insects.

Understory. Smaller and younger trees growing in the broken shade and lower light levels beneath the canopy layer form the understory. As canopy trees die and light levels increase, some of the understory trees will grow to take their place.

Shrub layer. Bushes and thickets of plants with woody stems form the *stratum* that rises above the ground up to about 15 feet. It is the shrub layer that can pose a serious challenge to cross-country travelers when dense vegetation makes hiking difficult.

Herb layer. A forest's herb layer is composed of the ground cover of grasses, flowers, ferns, and other soft-stemmed vegetation. Depending on light levels, elevation, and other variations in the environment, this layer may be sparse or dense.

Litter. What foresters call *litter* is as important to a forest as any of its other layers. Made up of organic material including decomposing leaves, needles, branches, tree trunks, and other dead vegetation, litter is home to microorganisms and to beetles, snails, millipedes, and hundreds of other animal species. It protects the soil and provides a moist bed for new plants to take root. As litter decays, phosphorus, potassium, magnesium, calcium, nitrogen, and other nutrients return to the soil where they can be absorbed by living plants.

To plant scientists, *forest* generally refers to land with a tree canopy that covers at least 10 percent of the area. With some species of trees, this percentage may be as low as 5 percent. Included in this definition of a forest are lands that have been recently planted with trees or that are temporarily understocked (recently harvested tree farms, for example) but are not dedicated to another land use.

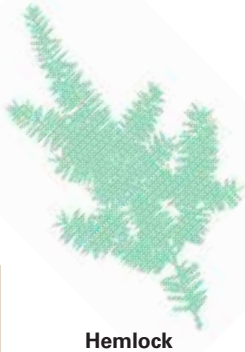
Nurse Logs

Long after their deaths, fallen trees and their stumps continue to play an important role in the life of a forest. Termites, beetles, worms, and other creatures burrow into the wood, allowing moisture to seep in. Fungi and mosses take hold, softening the wood and creating an inviting germination bed for larger plant species. As these old trees, or *nurse logs,* slowly decompose, they return nutrients to the forest floor and become host to young plants that sprout from their surface, thus ensuring the health of future generations of vegetation. They also provide important cover for small mammals, reptiles, and amphibians.

Forests as Ecosystems

A forest is an *ecosystem,* that is, a group of living organisms living in a particular environment that are dependent upon each other and their environment. No two forest ecosystems are alike. Many, however, share general similarities based on their location, elevation, and other factors. Those similarities provide a way of comparing one area with another.

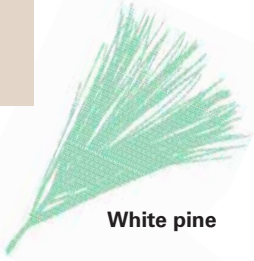
A *population* is a group of the same animal or plant species living together. A *community* consists of all the populations of plants and animals in an area. An ecosystem is made up of those communities plus their physical surroundings—the land, weather, water, amount of sunlight, and everything else that affects it.



Hemlock

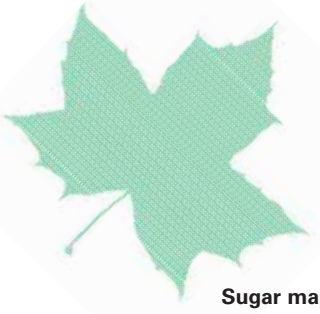
Types of Forests

Broad-leaved forests dominate the eastern United States and Canada, while conifer forests dominate western North America. Forests in the eastern or southern part of the United States include oak-hickory, oak-pine, longleaf pine–slash pine, and spruce-fir forests. Western forests include Douglas fir, western hemlock, Sitka spruce, redwood, ponderosa pine, piñon-juniper, and lodgepole pine forests. There are many hemlock-spruce forests in Oregon and Washington. Hemlock-spruce forests also are the predominant forest type in southern Alaska.



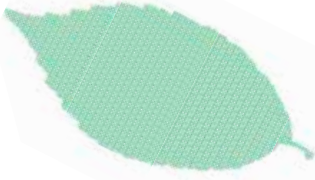
White pine

Douglas fir



Sugar maple

Oak



Elm

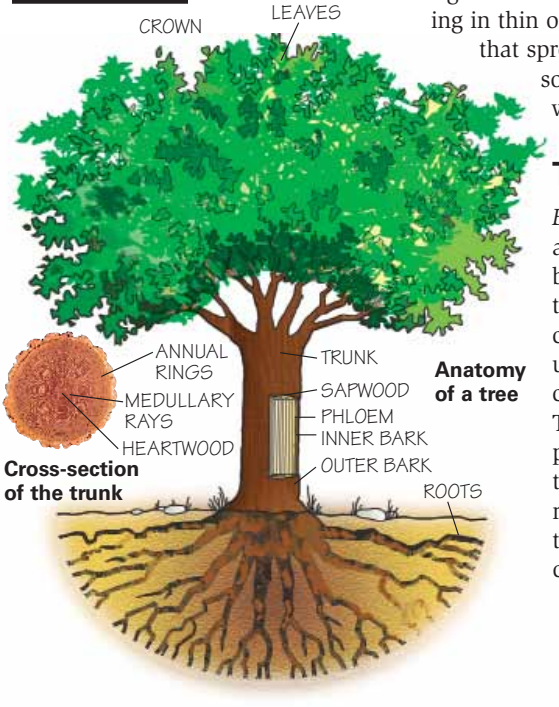
Trees

More than 1,000 species of trees grow in North America, and thousands more flourish in other parts of the world.

Although a forest is an ecosystem composed of many species, trees are the dominant form of forest life. Trees are characterized by their size (usually taller than a person) and by the fact that each usually has a single woody stem, or trunk. Shrubs, on the other hand, have multiple woody stems and seldom grow much beyond 8 to 15 feet high.

Roots

Much of a tree lies beneath the ground's surface. Tiny root hairs absorb moisture and send it up into the tree. A root system is also the anchor that holds a tree upright, even in high winds. Some trees have tap roots that extend deep into the ground. Others, especially those growing in thin or rocky soils, may have roots that spread out just below the surface, sometimes achieving a radius as wide as the tree is tall.



Trunk and Bark

Bark is the nonliving outer armor of a tree's trunk and branches. Under the bark is a thin layer of tissue called the cambium layer, which is made up of two distinct types of cells—the *phloem* and *xylem*. The phloem channels food produced by the leaves into the trunk, branches, twigs, and roots. These cells also form the bark of the tree. The xylem cells make up the *sapwood* that

transports the moisture and nutrients from the roots to the crown of the tree. Sapwood eventually forms the *heartwood* in the center of the trunk that gives the tree much of its structural strength. The yearly growth of xylem cells forms the "annual rings" that tell the tree's age.

The cambium grows a new layer of sapwood and bark around the trunk each year.

Leaves

Chlorophyll, a chemical compound in leaves, absorbs energy from sunlight to convert carbon dioxide, water, and soil nutrients into plant food. This process, called *photosynthesis,* also returns oxygen to the atmosphere. Green plants produce the oxygen that supports all of Earth's animal life, humans included.

Each fall, the foliage of many broad-leaved trees turns from green to brilliant red, orange, and brown. In fact, those bright hues were in the leaves all summer, hidden beneath the green of the chlorophyll. As the growing season comes to an end, a tree's food production drops and so does the amount of chlorophyll in the leaves. The green fades, allowing the fiery colors to show through.

All trees are either conifer trees or broad-leaved trees. Conifers, also known as evergreens, are cone-bearing trees with needlelike or scalelike leaves that may stay on the trees for several years. Broad-leaved trees are flowering trees. They also are deciduous—they generally lose their leaves in the fall.

Another change causes a layer of cells at the base of the leafstalk to cut tissues holding the leaf on the tree. The leaf falls to the ground where it will decompose, returning nutrients to the soil.

Conifers

Conifers are *gymnosperms,* that is, plants with naked (uncovered) seeds tucked inside of cones. Exposed to the elements, conifer seeds are fertilized directly by windblown pollen when their cones open slightly in the spring. Rather than relying on insects to aid in fertilization, conifers release pollen that is carried by the wind from tree to tree. This makes an ideal means of transportation in alpine regions and other environments where there are plenty of breezes but perhaps not many insects. The pyramid shape of pines, firs, spruces, and other conifers helps them shed rain, snow, and wind.

Several *deciduous conifers,* including cypress, dawn redwood, and larch, do lose their leaves in the fall.

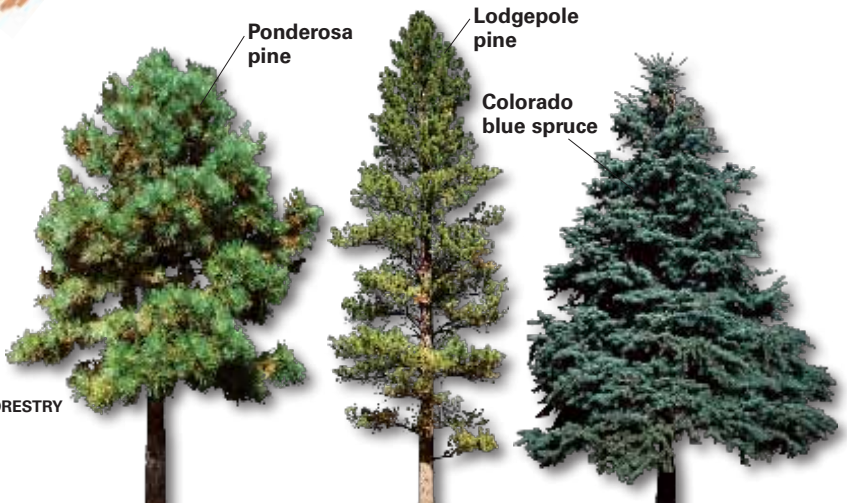
The needlelike leaves of most conifers do not fall off at the end of summer, allowing those trees to spur growth as soon as the days begin to warm in the spring. Although conifers are well-suited to high elevations and northern latitudes where growing seasons are short, there are exceptions. For example, many species of pines—loblolly, longleaf, slash, shortleaf, and Virginia pines—grow well in the South. Also, the coast redwood grows at low elevations near the Pacific Ocean. The fact that redwoods can thrive most of the year helps them attain their great height.

Pines

The white pine is found throughout the Northeast and is the tree shown on the state flag of Maine. It has smooth, tight bark and leaf clusters of five needles each. Other pines common in the eastern states include the pitch pine with three needles per cluster and the jack and red pines with two needles. In the Southeast, the longleaf and loblolly pines have three needles to a cluster, while slash and shortleaf pines display two.

The largest pines grow in the mountains of the West. Sugar pines can reach a height of 200 feet. Look for five needles in each of its leaf clusters. The heavy cones of sugar pines can be up to 18 inches long.

Ponderosa pines have long needles in groups of three. Get close to the bark of a ponderosa and you may smell a pleasant vanillalike aroma. Jeffery and knobcone are other western pines with three-needle clusters. Lodgepole pines, named for the straight, clean trunks once used by some American Indian tribes for constructing tepees and lodges, feature pairs of two needles each.



Spruces

The needles of spruce trees are four-sided. The Engelmann spruce of the Cascade Mountains and Rocky Mountains has soft needles with a blue-green hue. The blue spruce, whose natural home is the Rocky Mountain region, has stiff needles and is widely planted as an ornamental. The tallest American spruce is the Sitka spruce of the rain-drenched Pacific Northwest coastal forests.

Firs

Fir needles are flat, flexible, and appear to be arranged in orderly rows along the sides of branches. The needles are dark green on top, while the undersides show two white lines. Fir cones grow upright on the upper branches of the trees. The balsam fir of the East and the white fir of the West are stately, fragrant representatives of these evergreens.

Larches and Tamaracks

The soft needles of the larch and tamarack grow in tufts out of bumps on the branches. Unlike those of most other conifers, the leaves fall off in the winter. Larches and tamaracks are tall, slender trees with small cones.

Hemlocks

Hemlocks are large evergreens distinguished by short, flat needles with dark green tops and silvery undersides. The small cones hang from branches that can droop in the shape of a graceful pyramid.

Douglas Firs

A close relative of the hemlock is the Douglas fir, a tree found primarily in the western United States. Also known as the Douglas spruce, red fir, and Oregon pine, it is actually not a spruce, fir, or pine but rather a *pseudotsuga,* or false hemlock. Its flat needlelike leaves spiral around the branches, giving branch ends the appearance of bottle brushes or squirrels' tails.

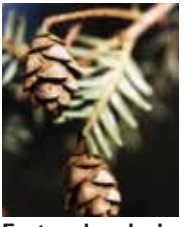
Sequoias and Redwoods

The world's largest trees are the redwoods and giant sequoias of California. Redwoods can grow to more than 300 feet in height, and sequoias can reach a diameter of more than 25 feet. Some of these trees are several thousand years old.

Balsam fir

Larch

Tamarack



Eastern hemlock

Douglas fir

Cedars, Junipers, and Cypresses

The leaves of cedars are tiny, bright-green scales arranged like small shingles on flattened twigs. Eastern red cedar is, in fact, a juniper. Junipers have two kinds of leaves. Some are scaly and flat like a cedar, while others are prickly. Juniper cones look like moldy blueberries. The bald cypress of the South drops its needles each winter.

Some species of cypress grow in swamps. The portions of their roots exposed above the water are called *knees.*

Identifying Firs, Spruces, and Pines

As a quick rule of thumb to determine some of the larger families of evergreen trees, examine their needles and note their shape.

Flat = Fir	Needles in pairs = Pine
Square = Spruce	Shingled, scaly needles = Cedar

Broad-Leaved Trees

Broad-leaved trees are *angiosperms,* or flowering plants. They make *ovules,* or eggs, that develop into seeds after fertilization. Unlike the cones protecting the seeds of conifers, seeds of broad-leaved trees are enclosed in nuts, fruits, or some other form of seed case.

As you may have guessed, most broad-leaved trees have wide, flat leaves. The trunks of many broad-leaved trees branch out into round, airy shapes. Broad-leaved trees do well where conditions during the growing season are not harsh, but they also are found in areas with cold winters and deep snows.

Everything about broad-leaved trees, from leaf shape to the orientation of branches, influences their survival and their ability to adapt to their environments. Losing their leaves in the fall, for example, protects branches from breaking under the weight of winter snows.

Willows and Aspens

The pussy willow takes its name from its furry flower clusters that resemble tiny kittens clinging to the willow's long, straight branches. The sandbar willow is often one of the first plants to grow on newly exposed ground when a river changes course.

Aspens thrive on sunlight. They take root quickly on mountain slopes burned by fire, protecting the soil from erosion and providing browse for deer, elk, moose, and other animals. As slower-growing conifers mature, they tower above the aspens and eventually create so much shade that they replace the aspens.

Pussy willows

Nut Trees

Walnuts and hickories have compound leaves, each made up with a number of leaflets. A hickory leaf has three to nine leaflets, while the leaf of a walnut tree may have more than a dozen. Walnuts and hickory nuts are the seeds of their trees. Both are good to eat, as are the nuts of the pecan tree, which is a type of hickory. Mockernut, bitternut, and pignut have small, bitter kernels. Wood from the walnut is prized for furniture and gun stocks, while hickory wood is used for short-handled tools such as hammers and hatchets.

Bitternut hickory

Walnut

Birch

The Birch Family

This family of broad-leaved trees includes birches, hornbeams, and alders, which are commonly found in the East and Northeast, while the western red alder is a prominent broad-leaved tree found in the West. The oval leaves have jagged edges and shiny surfaces.

American Indians used sheets of white bark from the paper birch to build their canoes. The bark of yellow birch peels away from the trunk in curls. Gray and black birches have much tighter bark.

The wood of the smooth-barked American hornbeam is so tough that the tree is sometimes called an ironwood. The appearance of the trunk and bark of an ironwood tree remind some people of a person's muscular arm.

Alders grow in moist ground throughout the country. They have broad leaves, stalked buds, and small, conelike fruits. Found along the Pacific Coast, red alder is a tremendous source of lumber and other wood products.

American beech

Beeches and Chestnuts

You can identify a beech tree by its smooth, pale gray bark. Beech leaves have a strong midvein and parallel side veins. The beech's burrlike fruit contains two triangular nuts.

The chestnut was once common in forests of the eastern United States until the appearance of chestnut blight, a fungus that killed so many of the trees that you will probably have a hard time locating a chestnut today.

Oaks

Carpenters and cabinetmakers have long prized wood from American oak trees. Oak timbers are slow to rot, even if they get wet. The Revolutionary War ship USS *Constitution* (nicknamed "Old Ironsides") was made of live oak, a species common to the coastal South, and hand-hewn oak beams were used in many Colonial homes.

The acorn is the fruit of an oak. Most oaks have notched leaves. The lobes on the leaves of some oaks are rounded, while those of others come to sharp points. The live oak is an exception. Its evergreen leaves have smooth edges and no lobes at all, but its acorns help identify it as an oak.

Although the edible acorns of American oaks have a bitter taste to humans, squirrels and a number of other animals find them irresistible.

Elms

Elms are large, graceful shade trees once found in towns and cities throughout the nation. Dutch elm disease has killed most large elms in the eastern United States. The leaves of American elms and slippery elms are egg-shaped and lopsided with sawtoothed edges. Leaves of American elms are shiny and smooth. Despite the name, the leaves of the slippery elm have dull, rough surfaces.

American elm

Papaws and Sassafras

The common papaw belongs to the custard apple family. It is found in forests of the East and Midwest. The fruit of the papaw looks and tastes like a chubby, overripe banana. On a single sassafras tree you can find leaves of many shapes—some oval, some like three-fingered mittens.

Magnolias

Magnolia trees are found in the southeastern United States. Their large, distinctive leaves are shiny dark green on top and pale underneath, and the blooms can fill summer evenings with wonderful aromas. One magnolia, the cucumber tree, bears a mass of many small, elongated pods.

Another member of the magnolia family is the tulip tree, named for the tuliplike appearance of its flowers. A very tall tree, it thrives in Southern states but is seldom found where winters are severe.

The magnolia is known for its large blooms, which have a pleasantly sweet fragrance.

American sycamore

Gums and Sycamores

The sweet gum tree has star-shaped leaves that turn brilliant colors in fall. Its fruits look like spiny balls.

The fruit of the sycamore has a similar shape but is without the spines. The bark of a sycamore gives the trunk a distinctive patchwork of large white, green, and yellow blotches.

Plums and Cherries

A dozen varieties of wild plum tree grow in the eastern United States. They are small trees with shiny oval leaves and purple or reddish fruits. The hard pit inside each fruit contains the seed of a new tree.

Wild bird cherries or pin cherries are small trees with tiny red fruits in clusters of two or three. Other wild cherries have fruits arranged in bunches like grapes. The wood of the black cherry is one of the most valuable in the United States, prized for its beautiful color and grain in fine furniture.

Fruit of the plum tree

Wild cherries

Ashes

Ax handles and baseball bats are often made from the hard, smooth wood of the ash tree. Each ash leaf is made up of many leaflets that grow in pairs on either side of the stalk. The leaves are in pairs, as are the branches of the tree.

Ash tree leaves

Maples

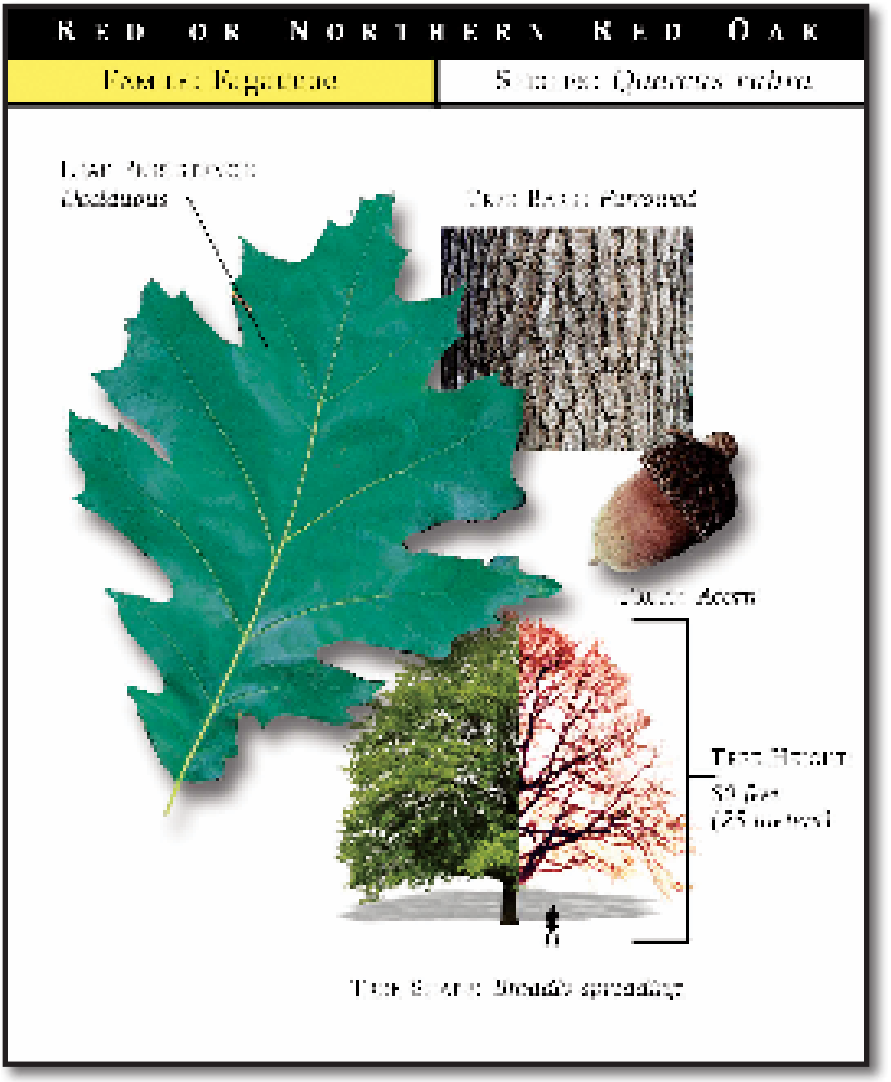
The leaves of maples are arranged in pairs opposite each other on the branch. Their main veins jut out like fingers from the base of the leaf. Fruits of maple trees, called *keys,* each have a "wing" attached that causes them to twirl through the air. Maple wood is used for furniture. Especially valued is bird's-eye maple, named for the circular and dotted patterns of its grain.

Maple syrup is made from sugar maple sap.

Buckeye

Buckeyes

Inside a tough, spiny burr is the fruit of the buckeye. Its size and shiny brown surface make it look something like the eye of a deer, and thus its name. Leaves of the buckeye have five long leaflets.



A plant key can guide you step-by-step to the identity of a plant species.

Identifying and Collecting Plant Species

Identifying trees, shrubs, and vines can be a great deal of fun. It is a tremendous tool for learning about a forest.

The most useful tools for discovering the scientific names of plants and learning something about their range, uses, and growing habits are *plant keys,* available both as books and as interactive Internet Web sites. Each plant key may address specific kinds of vegetation (trees, for example, or mushrooms or wildflowers), and focus on a specific region (the trees of North America, for instance).

Using a Plant Key

Most plant keys are constructed with an either/or format, asking you to make a series of yes-or-no decisions that will steadily narrow your choices until you come upon the specific description of the plant you want to identify. A typical sequence might lead you this way:

- Needlelike leaves or broad-leaf leaves? If broad-leaf, then . . .
- Compound leaves or simple leaves? If compound, then . . .
- Thorns or spines present or absent? If without thorns or spines, then . . .
- Leaves smooth, toothed, or lobed? If lobed, then . . .
- Are the leaves arranged opposite each other on the twigs, or do they alternate? If opposite, then . . .
- Are leaves heart-shaped or oval? If oval, then . . .

Scientific *nomenclature,* or naming, uses Latin terms to describe each tree species. This system allows botanists and others who study plants to share accurate information with one another about particular plant species.

Plant identification is most effective when it is done in a plant's natural setting. There you may have a wide range of clues present such as appearance, aromas, and evidence of the interaction a particular plant has with other species of plants and animals. You can also observe the full array of leaves and notice whether they are in clusters, opposed, or staggered.

Leaves are only one part of a plant. The *context* of the plant—the surroundings in which you find it—is vital to understanding it, too. The following questions can help you begin your exploration of a tree, shrub, or vine and its role in its ecosystem.

- How is it similar to and different from nearby plants?
- How are the leaves or needles shaped?
- Does it bear flowers or fruiting bodies?
- What kind of soil is it growing in? For example, is it sandy, wet, dry, or rocky?
- What animals visit the plant? Do any creatures use it for food or as shelter?
- How does its environment influence the plant? For example, does it grow in sunshine or shade?
- How does the plant affect the environment around it?

Weeds that crowd out native vegetation can create a *monoculture,* an area dominated by a single species. When that happens, plant diversity is lost.

Native, Exotic, and Invasive Species

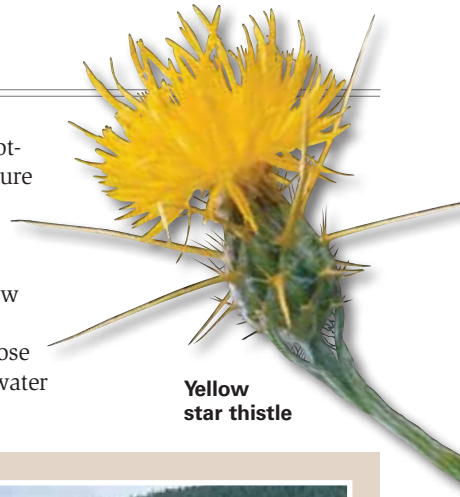
Native species of plants are those that are the natural inhabitants of an area. The fact that they have evolved over many generations in a forest means that each species has a clear niche in the ecosystem. A native plant species interacts with other native species of plants and animals in balanced ways that help an ecosystem maintain a high degree of stability.

A *nonnative species,* also known as an *exotic,* is a species that has been introduced to a forest from somewhere else. Some exotic species have little impact on other species. The ginkgo tree, for example, is a native of China. Imported into the United States more than 100 years ago, it grows well without seriously challenging native plants. Some nonnative species spread aggressively, though. Nonnatives that push out or kill native species are known as *invasive species.*

Noxious weeds are invasive species designated by law as undesirable and requiring control. These plants are usually exotics. Invasive species include the passion flower, Scotch

broom, purple fringe, yellow star thistle, and spotted knapweed. The U.S. Department of Agriculture maintains the Federal List of Noxious Weeds.

Many native plants have fibrous root systems that provide soil cover, stability, and water infiltration, while many exotics have narrow taproots that leave bare soil exposed to erosion. Other weeds have roots more aggressive than those of native plants, allowing them to access more water and thus crowd out native vegetation.



Yellow star thistle

Wind, water, livestock, wildlife, vehicles, and people and their pets can spread weed seeds. Backcountry users traveling with horses, mules, or other livestock often carry hay that is specially treated to prevent the weed seeds it may contain from taking root and competing with native vegetation.

Making Collections

A fun way to increase your ability to identify trees, shrubs, vines, and other forest vegetation is by making collections of leaves and wood samples. For a leaf collection, select small branches that show leaf arrangement and twig traits. You might also gather flowers, fruits, and winter twigs for each tree, shrub, or vine.

Before you begin, get permission from the landowners or land managers of the area where you want to do your collecting.

In the field, you can store collected leaves and small branches between the pages of a phone book and make notes on the tree's name (if you know it), the date, where you found it, and other information about the plant. Use a belt or strap to keep the book pressed shut so the leaves stay flat and do not fall out as you carry it.

When you get home, put each leaf between two sheets of paper, lay the sheets on a board or other flat surface, and then place heavy books or some other weight on top. Allow several days for the leaves to flatten and dry, then mount them in a notebook along with the details of where and when you found them, the identity of each plant, and information you have learned about its natural history and uses.

Leave what you find is among the principles of Leave No Trace, adopted by the BSA as a means for enjoying the outdoors in a responsible manner.

- Allow others a sense of discovery, and preserve what you find.
- Leave rocks, plants, animals, archaeological artifacts, and other objects as you find them.
- Observe, but do not touch, cultural or historical structures and artifacts.

Wood Samples

Pieces of wood are valuable in identifying and understanding the trees from which they came. Appearance, color, grain, texture, weight, general feel, and sometimes even the aroma of a wood all are clues to its growing patterns, strengths, weaknesses, and uses.

Learning About a Tree's History

Each year during the spring and summer, most trees increase their diameter by adding two new layers of wood. The layer formed by the cambium in the spring grows quickly. Because the cells are large, this springwood looks light in color. During the summer, the wood grows more slowly. Because the cells are smaller, this summerwood appears darker.

Your merit badge counselor can provide guidance on where and how you can collect wood samples, leaves, and other items from a forest in ways that will leave no trace and do no harm. For example, your counselor may suggest that, rather than cutting branches in a forest for wood samples, you gather samples of different species of wood from lumberyards and home improvement stores.

When a tree is cut or a core sample taken, the light and dark layers show as alternating rings of light and dark wood. Count the rings of dark wood and you can estimate the age of the tree. Aspects such as soil moisture and fertility, weather, fire, overcrowding, insect attacks, and the ability of the tree's leaves to capture sunlight influence the size and shape of the rings.

As the influencing factors change from year to year, the shape, thickness, color, and evenness of the annual rings also will change. *Dendrochronologists* (scientists who study tree rings) use tree rings to determine past patterns of drought and gather data to predict future periods of dry and wet weather.

The hole made by an increment borer will heal over with next year's growth, but the small (¼ inch) hole in the heartwood remains. Foresters usually core a tree no more than once, thus minimizing injury to the tree.

For requirement 2b, you are asked to sketch or photograph three stumps, logs, or core samples.

Core Samples

Counting the annual rings on a stump of a tree that has been cut down is relatively easy. In order to study the rings of a living tree, foresters rely on a method called *coring.* They begin by using an *increment borer* to drill a hole into the center of the tree trunk. The borer is a hollow tube that, when drawn out of the hole, takes with it a *core sample.* The light and dark bands in the core sample show how many rings the tree has grown. Their distance from one another can indicate years of rapid growth and seasons when growth was sluggish.

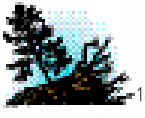
A Tree's Life

1904

The tree—a loblolly pine—is born.

1909

The tree grows rapidly, with no disturbance. There is abundant rainfall and sunshine in spring and summer. The rings are relatively broad and are evenly spaced.

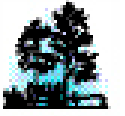


1914

When the tree was 6 years old, something pushed against it, making it lean. The rings are now wider on the lower side as the tree builds "reaction wood" to help support it.

1924

The tree is growing straight again, but its neighbors are growing, too. Their crowns and root systems take much of the water and sunshine the tree needs.



1927

The surrounding trees are harvested. The larger trees are removed and there is once again ample nourishment and sunlight. The tree can now grow rapidly again.

1930

A fire sweeps through the forest. Fortunately, the tree is only scarred, and year by year more and more of the scar is covered over by newly formed wood.

1942

These narrow rings may have been caused by a prolonged dry spell. One or two summers would not have dried the ground enough to slow the tree's growth this much.

1957

Another series of narrow rings may have been caused by an insect like the larva of the sawfly. It eats the leaves and leafbuds of many kinds of coniferous trees.

Animal, Insect, and Disease Damage

The relationships of species in a forest ecosystem are very complex. Various species depend upon one another for shelter and food. Most interactions are harmless or beneficial. Insects that take nourishment from the flowers and fruits of trees may help the trees pollinate. Birds building nests in the branches of trees may eat insects that might otherwise be a threat to forests. Organisms that live in the soil break down dead vegetation so that it can enrich the soil.

Animals

The actions of some species can be damaging to a forest, at least from human's point of view. During a hard winter, for example, deer and rabbits might survive by stripping and eating the bark of young trees. That can keep the animals alive until spring, but it can kill the trees a forester had hoped would grow large enough to harvest.

As you identify trees, vines, and shrubs in the field, make it a point to look for any damage caused by wildlife, insects, or disease. Then, to fulfill requirement 2c, sketch what you have found.

Insects

Forest insects and diseases destroy more trees every year than are consumed by wildfires. Most insects attack only certain tree species or only trees of a certain age. White grubs, for example, eat the roots of young nursery and forest seedlings, making growing trees in nurseries costly. The white pine weevil attacks young white pines in the Northeast, causing them to grow crooked and reducing the amount of lumber that can be made from them.

Epidemics of bark beetles periodically kill tens of thousands of acres of pine in the Southern, Southwestern, and Rocky Mountain regions of the United States. These pests generally attack mature trees.

Insects such as the spruce budworm and larvae of the gypsy moth *defoliate* trees by eating many of the leaves. The spruce budworm damages spruce and fir forests throughout New England, eastern Canada, and Minnesota. In the West, they have weakened some forests and left them open to catastrophic wildfires. The gypsy moth larvae attack hardwoods in the eastern states. Fortunately, foresters that take quick action often are successful in stopping the spread of gypsy moths.

The pinecone beetle can destroy almost the entire yearly seed crop of some western pines. Emerald ash borers, introduced to the United States in shipping pallets coming from China, attack ash trees that have no natural defenses against them.

One of the reasons the gypsy moth has spread is that gypsy moths often lay their eggs on cars and other vehicles, which are then transported across the country by unsuspecting motorists.

The emerald ash borer causes extensive damage to ash trees by destroying their water-supply system.

Diseases

Trees are also subject to many diseases. *Leaf spots, rusts, wilts, blights,* and *cankers* can weaken or kill forest trees. Some tree diseases affect the leaves; others attack the main woody parts (trunk, branches, twigs). Still others damage only the roots. Here are some examples of common tree diseases.

Dutch elm disease is caused by a fungus carried from tree to tree by the elm bark beetle. It is one of the most devastating diseases ever to attack trees and led to the disappearance of most of the elms that once graced streets of U.S. cities and towns.

Wilting in the upper branches of this tree is a telltale sign of Dutch elm disease.

This tree is infected with white pine blister rust.

White pine blister rust kills white pines. Discovered in New York state in 1903, it spread widely among the eastern white pines, and by 1921 was affecting white pines in western states. White pine blister rust cannot spread from pine to pine but must spend part of its life on currant or gooseberry bushes.

Chestnut blight was brought into the United States from Asia about 1900. The blight destroyed nearly all the native chestnut trees in the United States.

Oak wilt attacks oaks, developing most rapidly in red oaks and black oaks. Many infected trees die within a few weeks or months.

Many insects and diseases with the potential of damaging trees in the United States and Canada are native to the forests they inhabit. Because they are a part of the forest ecology and have a niche, they often can be controlled through adjustments of their habitat. Insects and diseases brought to North America from other parts of the world, such as the gypsy moth, the emerald ash borer, and Dutch elm disease, can pose more serious problems because they have no natural controls.

Tree infected with oak wilt

Commercial orchard

A healthy forest with many species of plants and animals can withstand attacks of insects and diseases better than one already under stress. A vigorous forest has the greatest variety of natural defenses. For example, birds, rodents, and other small animals attracted to the lower strata of a forest can control insect populations that could otherwise pose problems for trees.

In commercial forests where trees are raised as a crop, insect infestations are sometimes suppressed with *pesticides* (chemicals for controlling insects and disease). Pesticides also are used in other forests to stop the spread of undesirable insects such as the gypsy moth, which is prevalent in the East but, because of effective control, has not become established in the West. The expense of chemical agents depends largely on the size of the area treated, the cost of the pesticide, the type of equipment used, and the accessibility of the area.

Forest researchers continue to search for alternative methods of minimizing insects and disease outbreaks. For example, artificial scents can be used to confuse the mating habits of certain insects and thus reduce their numbers. In some forests, scientists promote the populations of insects that feed on disease-bearing insects.

Protecting Forests From Threats

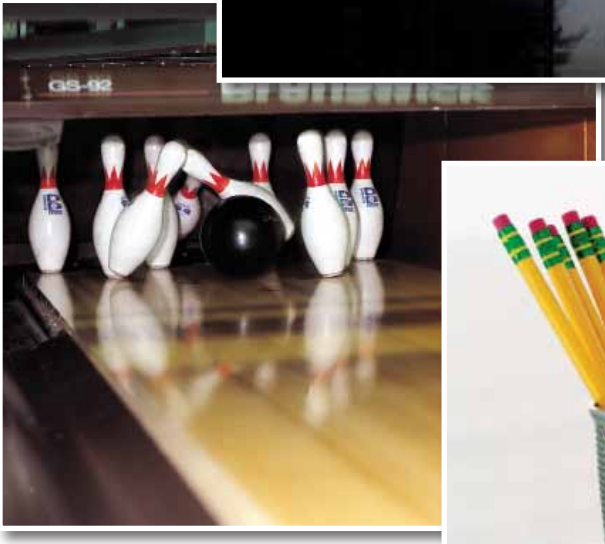
Whatever its origins, damage from certain insects, diseases, fires, and invasive species often can be reduced if the forest is healthy. Some additional preventive actions that encourage healthy forests might include the following.

- Protecting against wildfire
- Fencing woodlands to keep out excessive numbers of cattle, sheep, and other domestic animals
- Making cuttings to promote stands with mixed species of robust trees

Other Dangers to Forests

Trees may be sick because of one of the following reasons.

- Insufficient light, inadequate drainage, or poor soil.
- The trees are not the right species for the site.
- The habitat has been changed by the raising or the lowering of the water table or by a change in exposure to light.
- The trees have been damaged by drought, flooding, frost, or ice.
- Damage from fire, excessive grazing, or pesticides.
- Damage from automobile exhaust, acid rain, or other pollutants.
- The trees are too crowded.


GS-92

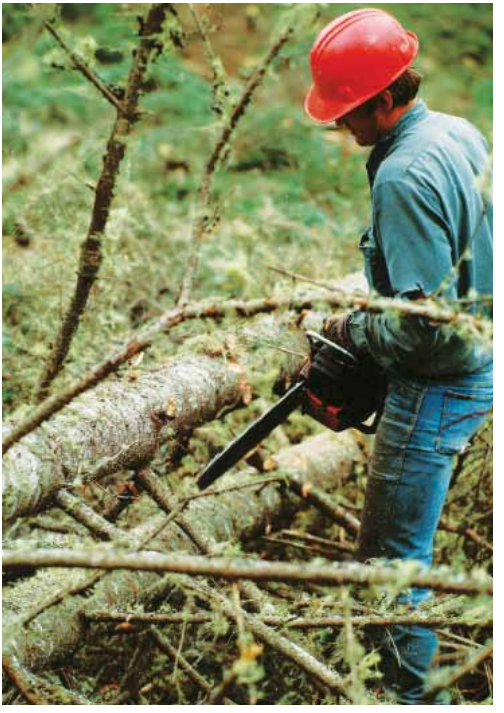
Using Forest Resources Responsibly

Forest resources are materials people use. People use forests for many things, such as wood, water, food, and recreation. As providers of raw materials, forests are vital to our economy.

Trees

The forest resources you probably know the best are trees and the products made from them. We use wood from trees to make furniture and to build homes. Wood also can be used as a fuel. Other products made from wood include paper, pencils, bats, telephone poles, and bowling pins.

Many building materials, including dimensional lumber, plywood, laminated veneer lumber, and I-joists, come from softwood trees. Softwood trees also are used for making paper. Softwood trees include Douglas fir, fir, redwood, white pine, ponderosa pine, hemlock, cedar, and southern pines such as shortleaf, loblolly, and slash. Chips and sawdust left over from the manufacture of wood products are used for making paper, particleboard, and medium-density fiberboard.



Hardwoods are used to make furniture, flooring, paneling, and many other construction materials and certain engineered wood products. Some of the more economically important hardwood species are oak, maple, ash, walnut, cherry, gum, and yellow poplar.

Forest products are essential for tires, aspirin, toothpaste, and the manufacture of clothing, fuels, paints, and many other products.

Recreation

People have long enjoyed visiting forests. Camping, hiking, picnicking, swimming, boating, and winter sports grow in popularity every year. Forest recreation is also an important source of jobs. Businesses near forests can provide food, lodging, and supplies to visitors.

Companies offering instruction in outdoor skills and organized opportunities to enjoy forests hire many seasonal and full-time employees to meet their demands. The manufacture and marketing of outdoor equipment—everything from bird-watching binoculars to camping gear—is a multimillion-dollar business. All this could not exist without healthy forests accessible to the public.

Those who manage public and private lands must balance the needs of the environment with the wishes of its users. To that end, agencies and landowners develop management plans that identify how and when various areas may be used. Their goal is to encourage people to have fun in the outdoors in ways that have little negative impact upon the land.

Protecting forest ecosystems used for recreation is a cooperative effort involving those who enjoy the outdoors and those who manage it. Most forest visitors want to take good care of the areas where they travel and camp and will gladly do so if they know how that can be done.

Leave No Trace, a set of principles familiar to outdoor enthusiasts and to the managers of forested areas, provides understandable, effective ways for everyone to be good stewards of forests while enjoying them. The reward for everyone is a healthy environment that can be used for recreation today and by generations to come.

Leave No Trace Outdoor Ethics

Plan Ahead and Prepare

Travel and Camp on Durable Surfaces

Dispose of Waste Properly

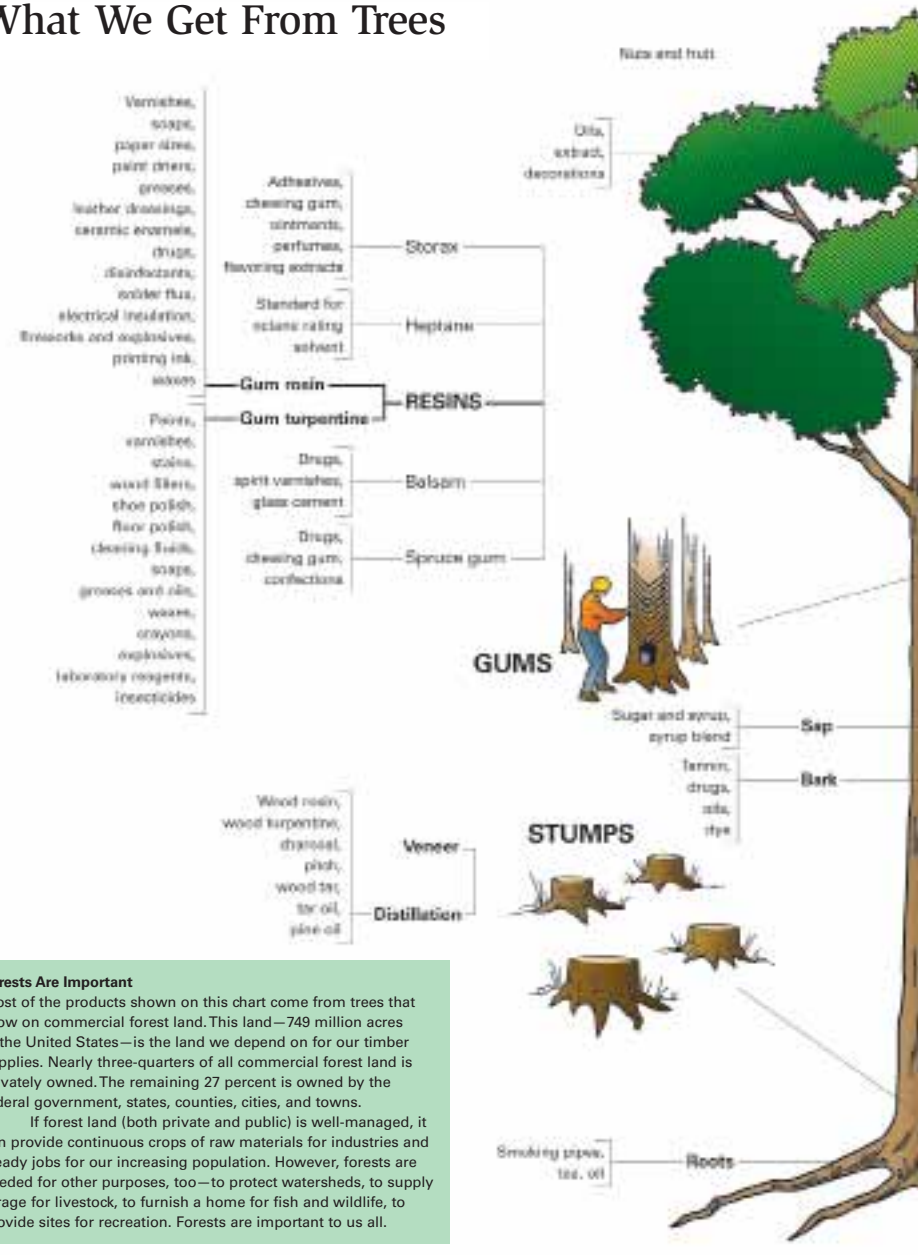
Leave What You Find

Minimize Campfire Impacts

Respect Wildlife

Be Considerate of Other Visitors

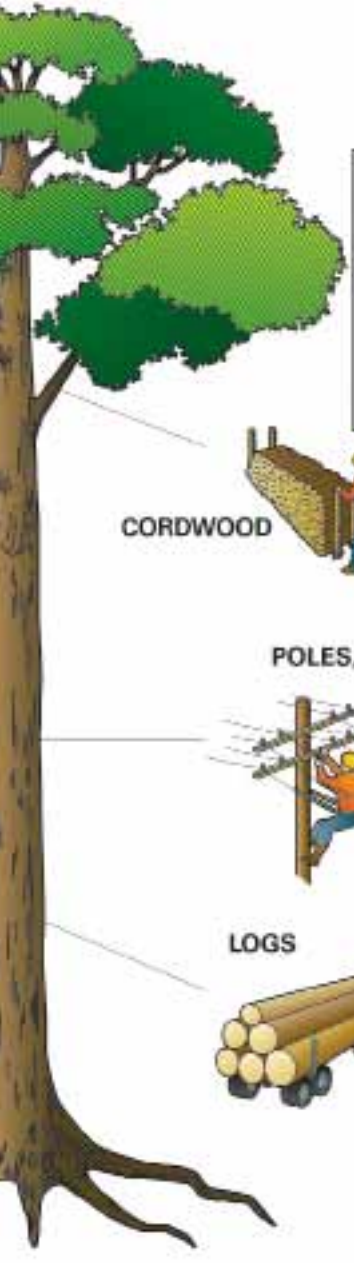
What We Get From Trees



Forests Are Important

Most of the products shown on this chart come from trees that grow on commercial forest land. This land—749 million acres in the United States—is the land we depend on for our timber supplies. Nearly three-quarters of all commercial forest land is privately owned. The remaining 27 percent is owned by the federal government, states, counties, cities, and towns.

If forest land (both private and public) is well-managed, it can provide continuous crops of raw materials for industries and steady jobs for our increasing population. However, forests are needed for other purposes, too—to protect watersheds, to supply forage for livestock, to furnish a home for fish and wildlife, to provide sites for recreation. Forests are important to us all.



CORDWOOD

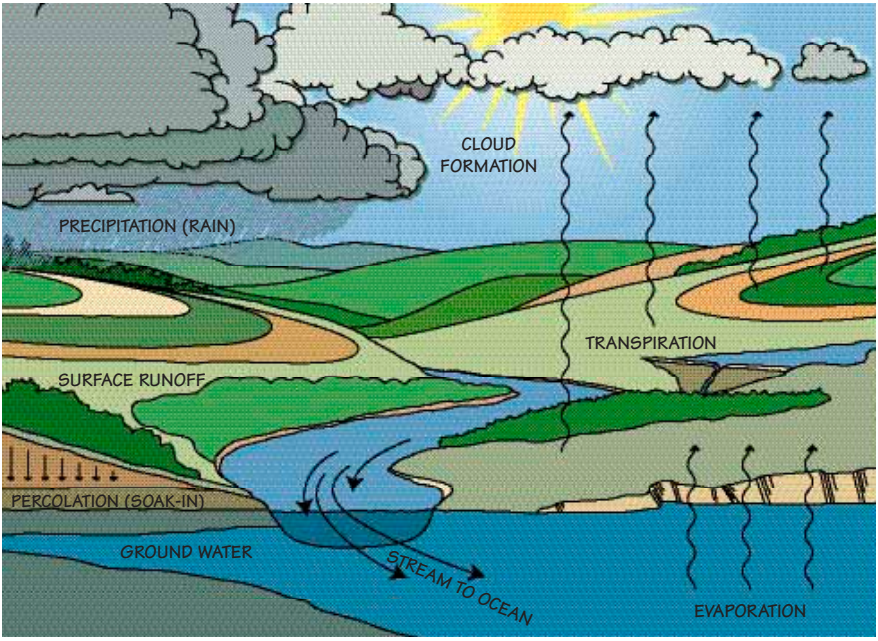
- Pulpwood
  - Lignin — Soil conditioner, plastics, road building materials, hide tanning materials, vanillin
  - Cellulose
    - Chemical products — Rayon, cellophane, sausage casing, collodion, explosives, photo films, celluloid, shatterproof glass, sponges, imitation leather, artificial hair and bristles, solid alcohol, molded plastics, hundreds of other articles
    - Fiber products
      - Paper — Newsprint, wrapping, bag, bank, writing, tissue, absorbent, building, industrial, wall
      - Fiberboard — Insulation board, hardboard, insulation board, wallboard
- Fuel
- Charcoal
- Tannin
- Dye
- Distillation
  - Hardwood — Charcoal, acetate of lime, wood creosote, tar, acetic acid, wood alcohol
  - Softwood — Oils

Pulp and paper products (thousands of different articles)

POLES, PILES, POSTS

LOGS

- Lumber
  - Shop and factory — Boxes, cabinets, caskets, farm implements, flooring, furniture, millwork, musical instruments, parquetry, patterns and flasks, tanks
  - Structural — Heavy joists, planks, sills, laminated wood
  - Yard — Boards, dimension, finish
- Ties
- Veneer — Plywood, furniture, baskets
- Bolts — Barrel staves, handles, shingles, shoe findings
- Mill waste — Slabs (fuel, lath), sawdust and shavings (floor-sweeping compounds, industrial alcohol, stock-feeding yeast, bedding for animals, insulation, oxalic acid, fuel), trimmings (box parts, fuel), edgings (moldings, flooring, furniture squares, mop handles, dowels, particle board, fuel)



The water cycle

The Water Cycle

As important as forests are in providing us with raw materials and opportunities for recreation, they also are vital as watersheds. Forest lands are primary sources of water for most people in this country. In some areas, the amount of water coming from the forest for drinking, irrigation, power, recreation, and navigation is far more important than any other forest resource.

Water circulates through the environment in a cycle that is energized by the sun. Heat from the sun evaporates water from forests, oceans, lakes, and streams. The vapors form clouds that can be carried long distances by the wind. When the air cools or becomes loaded with moisture, the vapor can fall as rain, snow, sleet, or hail.

Much of the precipitation percolates into the soil, where it can be absorbed by the roots of plants. Some of that precipitation finds its way into underground aquifers and other natural reservoirs, then rises again to flow from springs or wells. Small streams join together to form rivers that return water to lakes and oceans and, through evaporation, once again to the atmosphere.

Trees extract water from the soil and *transpire,* or give off water vapor, through their leaves. This water becomes part of our atmosphere and may later fall as rain or snow. The amount of water released into the air through transpiration depends on factors including soil moisture, air temperature, and the speed and direction of the wind.

Forest cover is important, too, in determining how much water *infiltrates* the forest soil and how much runs off the surface to nearby streams. Wise watershed management can help ensure adequate quantities of water at the right times and guarantee that water quality is good.

Watershed dam surrounded by homes

Finding Your Watershed

To find your watershed, locate the stream nearest your home. Follow it uphill (against the current). Notice the other streams joining it. All of those streams and the land feeding water into them form your watershed.

In some cases, water comes to a community through pipelines, aqueducts, or canals. If you consider those to be artificial streams and follow them against their flows, you will eventually find the open country where terrain, moisture, and vegetation meet to create the watershed upon which you and your neighbors depend.

Clean Air

Forests are among Earth's great filters for cleansing the atmosphere and replenishing it with oxygen. Animals absorb oxygen and exhale carbon dioxide. Carbon dioxide is also produced when plants and animals decay and when wood, coal, gasoline, and other carbon-based materials burn.

Plants must absorb carbon dioxide in order to survive. In a chemical reaction charged with sunlight, chlorophyll allows plants to combine water with carbon dioxide to produce the simple sugars plants use for food. The process is called *photosynthesis*—making something with the aid of light. A by-product of photosynthesis is the oxygen animals need for survival.

Plants absorbing carbon dioxide can store it—a process called *sequestration*—and slow its return to the atmosphere. Carbon is stored in a tree's trunk, its roots, and in the soil of a forest. Wood eventually will decay and release the carbon back into the atmosphere, but it can be stored in wood products and the forest floor for long periods of time. Many scientists believe sequestration might play a role in reducing the effects of carbon dioxide as a factor in changing the climate of the planet.

Wildlife Habitat

Forests are home to a tremendous range of animals, including large forest animals such as bear, deer, and elk and smaller creatures including birds, squirrels, salamanders, frogs, and fish. These animals *inhabit* the forest; that is, they use it as a home. The four essentials for an animal's *habitat*—the area where a particular species prefers to live—are food, water, space, and shelter. Through careful management, foresters can help the woods provide habitat for a large number of wildlife species in the same forest.

Fisheries Habitat

Forests can be critical to the survival of fish. Trees and shrubs shade streams, keeping water at a temperature inviting to fish. Insects that make their homes in streamside vegetation provide food for fish. Leaves, branches, and other vegetation that drop into the water form pools and other places for aquatic life to rest, feed, hide, and spawn. Forest managers make provisions to protect water quality and fisheries habitat in forests.

Threatened and Endangered Species

Changes that affect forest ecosystems cause animals and plants to adapt to new conditions, migrate to more hospitable locations, or suffer reductions in population. For example, fires moving across woodlands and prairies alter the habitats of many creatures. An early winter storm might catch many animals unprepared for migration or hibernation. Floods can wash away the homes of beavers and alter the spawning grounds of fish. Drought can reduce sources of nutrition for grazing animals and, in turn, for species that depend on those animals for food.

While naturally occurring changes affect many plants and animals, those changes often play important roles in maintaining a healthy balance of species populations. Unfortunately, the same cannot always be said for the disruptions caused by humans. People have not always been aware of the consequences of their decisions that involve the uses of forests. As a result, some animals and plants have become so reduced in number that their very survival is endangered.

Once a species dies out, it is gone forever.

Laws today help protect many of these threatened species. Generations of Americans have also had the wisdom to set aside tracts of unspoiled forest, protecting them in the forms of parks, wilderness areas, and wildlife refuges. Managed forests also play an important role in providing habitat for threatened species. Some threatened and endangered species, including the northern spotted owl, grizzly bear, and California condor are well-known to much of the public. There are hundreds of other endangered species that depend upon forests for survival, and although people seldom see them, their protection is important for maintaining a rich ecosystem diversity.

Why Manage Forests?

A forest left entirely to itself would, over the centuries, remain in balance. There would be changes, certainly, but on the whole it would remain diverse and vibrant. When humans make changes in forests, though, that might not always be the case. Everything is connected to everything else. Forest managers need to make wise choices about how we use and change forests so that we do not damage them.

Long ago, American Indians of the Northeast and Upper Midwest built canoes using the birch bark tree.

A Brief History of Humans' Relationships With North American Forests

American Indians used forests for centuries before European settlers arrived on the continent. Many tribes used forest materials. In the Pacific Northwest, tribes used forest materials to build cedar houses and boats, and to make clothing. Forests also were tremendous sources of food, both from plants and from wildlife.

At times, tribes overused certain forested areas. Sometimes they intentionally burned forests to clear land for cultivation or to make it easier to pursue game. If a forest became overused or too heavily damaged to support a tribe, the group would move on and the forest, left alone, would recover.

European settlers that came to North America realized from the beginning the value of forests as sources of raw materials. Ships that brought settlers to the Americas often returned to Europe with a cargo of North American lumber. For example, when the *Mayflower* returned to Europe, it carried back clapboards and other forest products. Many settlers saw the forests as a force to be pushed back. Forested land in the Midwest and West could be obtained from the government to homestead. Railroad companies were given millions of acres of forested land as incentives to construct the rail lines that would span the continent.

Forested land seemed so plentiful that it was too often harvested without concern for its future. During the late 1800s and early 1900s, poor harvesting practices in many areas of the country led the government to establish agencies to manage the public lands. These agencies brought more balance to the use and protection of forests.

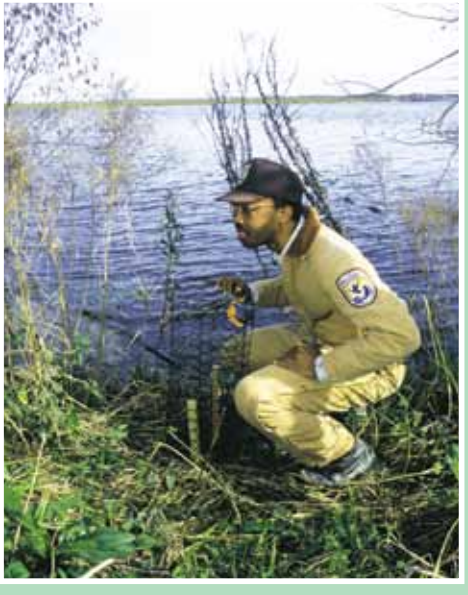
Government management of special areas can be traced back to the creation of the first national park—Yellowstone—set aside in 1872. In 1916, Congress established the National Park Service. Its mission is to preserve natural and cultural resources for the enjoyment, education, and inspiration of current and future generations.

Congress passed the Creative Act in 1891, designating much of the nation's publicly owned forests as protected forest reserves. The Forest Reserves Act followed in 1897, changing the forest reserves to national forests and charging their managers with improving and protecting the nation's long-term supply of wood and water. The Bureau of Forestry became the Forest Service in 1905 when control of the forest reserves was transferred to the Department of Agriculture.

Nonindustrial private landowners in the United States own 58 percent of the forests; governments own 29 percent of the forests; and the forest industry owns the remaining 13 percent.

In the decades that followed, forward-thinking agency personnel and a conservation movement made up of dedicated citizens established the idea of balancing the needs of Americans eager to use public lands for recreation, and as a source of lumber, a repository of biological resources, and protected reminders of the forests as they were before humans intervened. The Multiple-Use Sustained-Yield Act of 1960 officially established multiple-use management of the forests.

The Bureau of Land Management, the U.S. Army Corps of Engineers, the Fish and Wildlife Service, the Natural Resources Conservation Service, and other public agencies also strive to manage forested public lands that fall within their administrative boundaries. State and local agencies oversee smaller acreages of public lands. Private landowners with forested properties—from large forest-product companies to families with a few acres of trees around their homes—have a stake in the proper management of forest resources, too. Their involvement in wise, sustainable management is extremely important, since privately owned forests account for many more acres in the United States than do publicly held forests.



The goals of private forest owners vary widely. Small tracts may be owned for many reasons, including timber production, family recreation, and the protection of wildlife habitat. While public forests are usually managed for a variety of reasons and uses, many large private tracts are owned primarily for timber production. However, forests can be managed for timber production while at the same time protecting other important forest features.

How Forests Change

A fact of life (and death) in every ecosystem is that change happens. Nothing ever stays the same. Plants and animals must adapt to meet changes in the environment or they will not survive. Take, for example, a forest that has recently burned in a wildfire. Over several growing seasons, grasses, shrubs, vines, and small trees will take root in the soil made fertile by the ash of the burned forest. These sun-loving pioneer plants will thrive for a few years, while slower-growing trees establish themselves in the shade of faster growing trees. Gradually, slower-growing trees rise above the first generation of vegetation. Shaded out, the pioneer trees will die and again renew the soil. The larger trees and the other strata will continue to grow and change until there is a stable, diverse stand of many species called a *climax forest*.

The climax forest might stand for many years, but change will continue to happen. Fire might again sweep through the trees, an insect epidemic could dramatically alter the forest's composition and appearance, or a number of the trees might be harvested. Whatever happens, a new phase of the cycle of change will begin.

Change and Diversity

From microscopic bacteria to eagles, wolves, and other predators at the top of a food web, an ecosystem is healthiest when rich in the variety and numbers of species thriving within it. This environment provides flexibility for the ecosystem as a whole. Plants and animals will be more adaptive to change. This diversity of species (that is, many plants and animals that are unlike one another) offers a storehouse of environmental possibilities, the raw material for adaptation and survival.

For instance, when bees harvest nectar from tree blossoms to make honey, pollen sticks to their legs and they carry it from one tree to another. This relationship benefits both species; the trees provide nourishment for the bees, and the bees play a vital role in the pollination of the trees. If bee populations do not survive a harsh winter, though, or die from pesticides sprayed too near their nests, the trees will have lost a reliable means of spreading pollen and might not be able to reproduce.

On the other hand, a diverse ecosystem might include hummingbirds and insects that pollinate plants. A diversity of vegetation can ensure that plant species that do not rely on bees for pollination will move into the ecosystem niche that had been occupied by the bee-dependent trees.

Human-Caused Change

Healthy, diverse ecosystems tend to be stable and to change slowly. Normally, the forces of nature take decades or centuries to create perceivable change in forests and other ecosystems. However, natural events such as hurricanes, wildfires, or volcanoes can affect tens of thousands of acres in a matter of days or even minutes.

Humans also can cause rapid ecosystem change. People pave open land for highways, parking lots, and developments and clear timbered areas to make way for agricultural crops and cities. Cars and trucks, factories, and power plants can pump exhaust into the atmosphere that can have a direct impact on forests near and far.

Our ability to cause dramatic change in forests carries with it the responsibility to make wise decisions on issues that can affect forest health. While humans are capable of activities that are destructive to ecosystems, we also can do much to protect and heal the environment.

Proper forestry techniques can be applied when forests are harvested for lumber and other products. Doing so will result in a new forest being established more quickly than in the aftermath of natural events.

Small actions matter, and personal choices are important. As a group, everyone can work toward creating communities that exist in harmony with the environment. As concerned citizens, each person can learn about environmental issues and the roles that forests play in environmental, economic, and social well-being.

Sustainable Forest Management

Our forests face tremendous challenges. The loss of open space, the potential for wildfire from the buildup of fuels, the devastating effects of invasive species, and the impacts of unregulated recreational choices such as using off-road vehicles in fragile areas are significant threats to our forests. In addition, demands for forest products grow every year.

Multiple-use management addresses the desires of a broad range of forest users. Harvesting, recreation, wildlife, and other interests are all considered in multiple-use forest plans.

Sustainable forest management takes forest planning a step further by emphasizing the importance of considering the needs of today's forest users while also ensuring that future generations will be able to enjoy healthy forests. Accomplishing that goal requires a management approach that looks at forests as ecosystems, not just as stands of trees. While sustainable management views forests as sources of raw materials and recreation, it also involves stewardship that gives full attention to caring for wildlife habitat, increasing the diversity of species, and protecting the quality of the air, water, and soil.

Studies by the Department of Agriculture's U.S. Forest Service indicate that at the time of European settlement, forests covered a billion acres of what was to become the United States. Today, there are 749 million forested acres. Most of the loss came in the northeastern and southeastern regions of the country during the years between 1850 and 1900. The total forest area of the nation has been relatively stable for more than a hundred years even as the population of the United States has more than doubled.

Silvicultural Systems

Among the many tools of forest management are *silvicultural systems.* (*Silva* means "forest" in Latin.) Silviculture is the science of planting, growing, and harvesting stands of trees to meet the objectives of the land manager or forest owner. Foresters can use silvicultural systems to improve the health of forests and to accelerate the production of timber for harvest. The choice of a management system further depends on the characteristics of the tree species that make up the forest type and the features of the terrain where the trees are growing.

Trained foresters can determine how best to develop a silvicultural system that provides for the best mix of benefits to humans and protection of the ecosystem.

The value of a stand of trees as wildlife habitat is influenced not only by the tree species but also by their age, size, form, and health. Old trees have stout limbs on which heavy birds can nest. Bare branches provide roosts. Rotten spots can be hollowed into nests. Large dead trees are particularly important. These *snags* should be left standing whenever possible to provide habitat for hole-nesting wildlife and insect-eating wildlife.

The main treatments making up silvicultural systems involve the felling of trees and the regeneration of a new forest for the future. Systems that result in trees of approximately the same age are called *even-aged* systems. The trees may or may not be equal in size. Systems that result in trees of many ages are termed *uneven-aged* systems. Each system includes steps to establish seedlings and actions to encourage the health and productivity of a developing stand. Some tree species grow best in an even-aged forest, while others grow best in uneven-aged stands. Cuttings in forests are further classed as *regeneration harvest cuttings* that help reproduce or create new forest stands and *intermediate cuttings* intended to improve the health and quality of an existing stand.

Regeneration Cutting Systems

Depending on the larger management plans of foresters, stands of trees may be cut using systems that lead to appropriate harvesting of timber and to the reproduction of tree stands.

Clear-cutting system

Clear-Cut Systems. *Clear-cutting* is the harvesting of all trees in an area except those that are necessary to maintain water quality, fish habitat, and other healthy ecosystem considerations. The clear-cut can then be regenerated by broadcasting seeds, from sprouts, or by planting seedlings. The new stand may also be allowed to develop naturally from seeds dropped by trees bordering the clear-cut, from seeds already on the forest floor, or from stump sprouts and root sprouts of cut trees. The new trees will have equal access to sunlight. The strongest will grow relatively quickly and will be straight and tall.

Clear-cutting can be controversial, in large part because of the changes in appearance it creates on the land but also because clear-cutting can have a large impact on many species. Animals such as rabbits, moles, and gophers that depend on shade and dense vegetation will be forced to migrate to other areas in order to survive. On the other hand, forest openings created by clear-cutting can increase the habitat for deer, bears, certain birds, and other species that get part or all of their food and shelter from low vegetation and brush with little or no overhead shade. Additionally, certain species of trees require full sunlight to thrive and will not grow well under the shade of other trees.

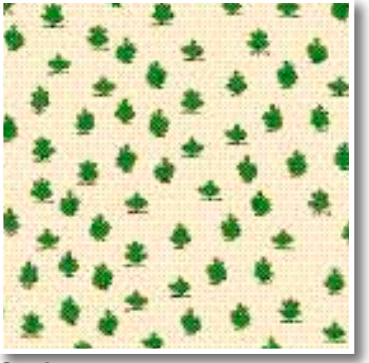
In certain situations, clear-cutting is the best silvicultural tool available to a forest manager. Clear-cutting is often used in forests that have been damaged by fire or that have been poorly harvested over the decades. Clear-cutting also can be used effectively to maximize the production of trees grown for pulpwood and of other sun-loving species that will not grow well in the shade of other trees.

Clear-cutting should be done only when carefully planned by professional foresters and carried out using proper harvesting techniques. Foresters must consider the effects clear-cutting will have on wildlife, the land, and the surrounding forest. For example, streams can be polluted by silt or dirt if forest roads and logging trails are not properly designed. Buffer zones composed of trees that are left uncut must be established along streams to provide continued shade and nourishment for fish.

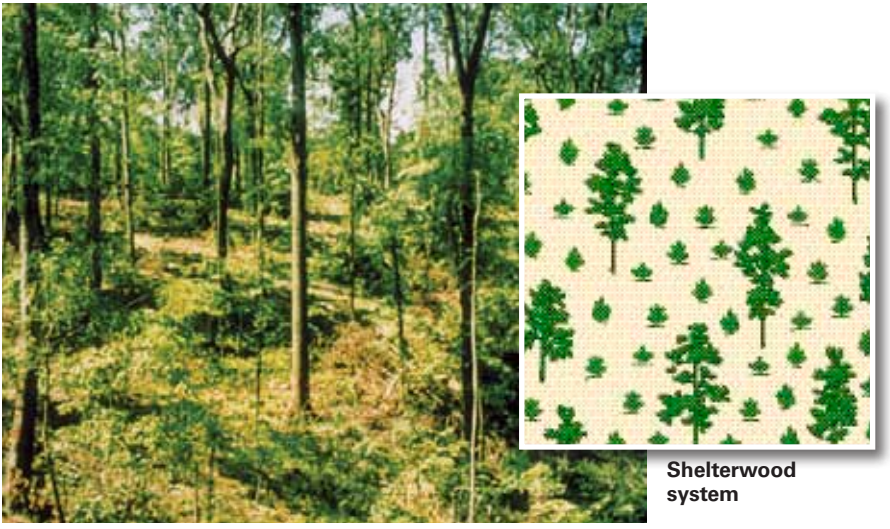
Even-aged management: Clear-cutting, seed-tree, shelterwood

Uneven-aged management: Single-tree selection, group selection

Seed-Tree System. Foresters using the *seed-tree system* to harvest a mature stand of trees leave a few healthy seed-producing trees on each acre. These trees provide the seeds needed to regenerate a new even-aged stand. After the fresh crop of young trees has become established, the seed trees themselves may be harvested. This system is more effective when used with evergreens than with hardwoods.



Seed-tree system

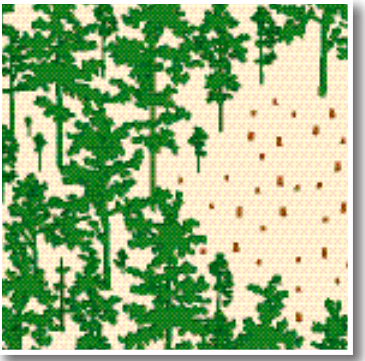


Shelterwood system

Shelterwood System. The *shelterwood system* involves a series of partial cuttings in the mature stand over a period of years. Early cuttings improve the vigor and seed production of the remaining trees and help prepare the site for new seedlings to take root. The trees that are retained produce shade—the *shelterwood*—for seedlings and young trees. As the new trees gain viability, the shelterwood trees can be harvested and the new crop of trees allowed to develop as an even-aged stand.

Single-Tree Selection System. The *single-tree selection system* differs from other systems in that it creates and maintains an uneven-aged stand. Foresters examine a stand and judge each tree on its individual merits, harvesting a tree as it matures. Seedlings or sprouts can then grow in the spaces created by tree removals. Periodic thinning, harvesting, and regeneration result in a stand made up of trees of many ages and sizes. Because relatively few trees are harvested at one time and because the forest floor is generally shaded, this system favors species that thrive in low light.

Single-tree selection system



Group selection system

Group Selection System. The *group selection system* requires the harvesting of small groups of trees. The openings created by this method resemble miniature clear-cuts, although the resulting regeneration occupies too small an area to be considered an even-aged stand. As in the single-tree system, thinning and harvest cuttings are done at the same time. The new trees that grow in these small openings are regarded as part of a larger stand that contains trees of many ages. In either selection system, frequent harvests will maintain a balance of tree ages and sizes.

All silvicultural systems require loggers to go into forests. Whether it is a large operation involving trucks and heavy machinery or a selective cut made using draft horses or helicopters, there will be some impact on small trees and other vegetation and on the soil. In choosing a forest-management system, silviculturalists must consider the full impact on the land, not just a system's effect on trees.

Intermediate Cuttings

Intermediate cuttings, such as improvement cuttings, salvage cuttings, and sanitation cuttings, can be distinguished from regeneration cuttings by their purpose. Regeneration cuttings create a new stand of trees; intermediate cuttings improve an existing stand or maintain the vigor, the desired composition, and the structure of the stands in terms of tree species, ages, and size classes.

A tree needs a place in the sun, soil of its own, and room to expand if it is to thrive. When a stand of trees is too dense, a professional forester may prescribe *thinning* to ease the competition and to accelerate growth of the trees that remain. The trees that are removed might be sold as posts, poles, or pulpwood (for use in making paper). If they are too small to have market value, the thinning is called *precommercial.* These trees are cut and left to decay, returning nutrients to the soil.

Intermediate cutting

Improvement Cuttings. In a stand containing a mixture of desirable and undesirable trees, an *improvement cutting* may be made to favor the desirable ones. Undesirable trees can include undersized trees or ones that are crowding larger trees. Determining which trees to remove depends on a larger sustainable forest management plan to balance the desire for timber with the need for wildlife habitat, aesthetic appeal, or recreation.

Salvage Cuttings. Natural catastrophes, such as windstorms, ice storms, and fires, sometimes cause great destruction in forest stands. *Salvage cuttings* are prescribed to manage economic loss by harvesting damaged trees, to reduce the risk of fire by removing dead material before it falls to the forest floor and becomes potential fuel, and to clear the way for new growth that will keep a forest healthy.

Sanitation Cuttings. If some trees in a stand are harmed by insects or disease, the forester may recommend a *sanitation cutting* to remove infested or infected trees that pose a threat to neighboring healthy trees.

Replanting a Forest

After a wildfire or the harvest of a stand of trees, reseeding will occur naturally, but it can take several years. Foresters may decide to control and hasten the process by planting seedlings or by sowing seeds.

Timber-Stand Improvement

Improvement, salvage, and sanitation cuttings are methods used for *timber-stand improvement.* As with all approaches to managing forests, the goal of timber-stand improvement is to encourage stands of trees to thrive, to resist disease, and to fulfill the goals of an overall forest plan that protects ecosystem viability.

Seeding has several advantages over planting. It is faster and less expensive, and it can be done in places where planting is difficult or impossible. Aircraft can sometimes be used to sow seed. Seeding has some disadvantages because spacing is uncontrolled, and birds or rodents may eat the seed before it germinates. In general, it is less certain that a good stand will be established.

Right and wrong methods for side-hole planting

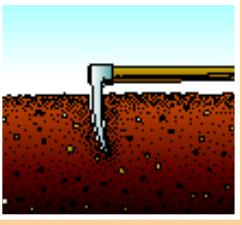
Because certain species of trees are adapted to certain soils, foresters select and plant those that will grow best on a particular site. They consider which species will make the best timber or pulpwood, protect watersheds, favor recreation, improve wildlife habitat, or meet the land manager's long-term sustainable forest objectives.

An area to be planted may be prepared in advance by prescribed burning or by other means of baring the soil such as using a bulldozer or a cultivating machine. Planting machines can be used where large areas are to be reforested and the site is level and free of large stones. In more rugged terrain, planting must be done by hand.

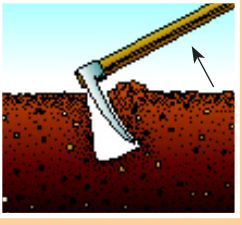
Planting Seedlings

By planting seedlings, foresters can space the plants for good growth and vigor. Seedlings must be carefully handled and the roots kept moist at all times. Planters use a mattock or a special planting hoe called a *hoedad* to create a hole of proper depth. They then set a seedling at about the depth it was growing in the nursery. A slight "collar" on its stem usually marks this depth. The planter spreads the roots to as natural a position as possible and then tamps the soil firmly around the roots and the stem to get rid of air pockets that might allow the plant to dry out and die.

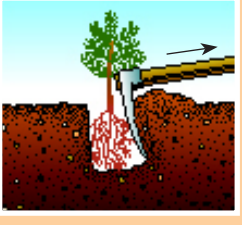
Center-Hole Method



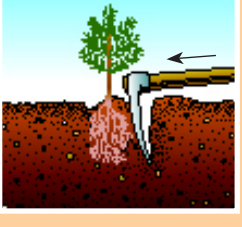
Step 1—Drive the mattock blade straight down.



Step 2—Open a slit by raising the handle.



Step 3—Open the top of the slit by pulling back on the mattock. Insert the tree.



Step 4—Close the slit using the mattock blade.

Step 5—Tamp the soil with your heel.

The full-page illustration shown here reviews some of the factors that must be considered in forest management and some of the practices used in managing a forest in Montana.

1. The slope and *aspect* (the direction the slope faces) help determine what to grow. On a north-facing slope, Douglas fir or larch will grow well. On a south slope, ponderosa pine is a good choice.
2. Elevation is just as important as slope and aspect. Seeds from trees that grow at 5,000 feet often will not grow well at 1,000 feet, and vice versa.
3. Seeds sown from a helicopter must have their "wings" removed first. Otherwise the seeds float to the wrong area.
4. Seeds should be dyed an unappetizing color, such as blue-green or silver, to keep birds from eating them.
5. Nature itself often will seed the forest if the very best trees are left standing about 50 feet apart.
6. Hand-planted seedlings need shade to help them survive better. Rocks situated on the south side of the seedlings will provide shade.
7. Rodent populations should be assessed before seeding. Rodents might eat the seeds.
8. Seeds should be coated with a fungicide to prevent fungi from attacking the seedlings.
9. Seeds scattered on snow will be carried into the soil and kept moist as the snow melts.
10. The ground cover should be burned or scarified to create bare soil where seeds can germinate.
11. Seeds from trees that have straight trunks, dense crowns, and few low branches will produce the best seedlings. Seed from superior trees can grow into superior forests.
12. Thin the trees when they are about 10 years old to give those that remain plenty of room to grow.
13. To get seeds from cones, wait until the cones ripen and brown on the trees, but not so ripe that they open themselves. Gather the cones and place them in a room heated to 90 degrees for four or five days. The cones will open and the seeds will drop out.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Sowing Seeds

Foresters may sow seed rather than plant seedlings. This method is mainly used for pine. Pine seeds can *germinate,* or sprout, on bare soil surfaces with little moisture. Pine trees grow in most regions of the United States. Pinecones, which contain the seed, ripen in the fall. The cones are gathered when they have turned brown but are not so ripe that they have opened. When kept four to five days in a storage area heated to 90 degrees Fahrenheit, the cones will open and the seeds will drop out.

Seeds must go through a period of *dormancy* (rest) before they can germinate. Winter does this naturally for them. Seeds gathered for seeding usually are kept cold over winter and sown in the spring. Foresters run tests on the seeds to learn their *germination rate,* the percentage of the seeds expected to grow. The germination rate for seeds that have been properly handled often exceeds 90 percent.

Young stands of true fir trees in the Pacific Northwest are sometimes fertilized to encourage development of boughs that can be harvested to make holiday wreaths.

Improving Trees

The growth rate, appearance, and other qualities of trees depend greatly on *genes,* the codes that tell cells how to grow. Foresters use *genetic improvement* to get better trees. One of the ways to do this is to gather seeds from superior trees—trees that grow straight at a rapid rate, stand firm against winds, produce large amounts of seeds and quality wood, and resist insects and diseases. Seeds from such superior trees are used to replant stands. To increase the supply of improved seeds, foresters may artificially *pollinate* trees to develop seed orchards of superior trees.

Fertilizers

Foresters use fertilizer in some stands to improve the growth of trees and other plants. Added to the forest soil, fertilizers may be especially helpful to trees growing on poor ground and may increase the number of seedlings that survive on the forest floor. Although expensive, fertilized trees and other plants may grow healthier and faster and be ready for harvesting sooner.

Fire

Fire can be useful in forest management when it is *prescribed* (planned ahead of time to attain a certain goal), but fire that is not prescribed—a *wildfire*—can damage whole forests.

Wildfire

Nearly 9 out of 10 forest fires are caused by people who have been careless. Only one wildfire out of 10 is caused by lightning. Regardless of what causes them, wildfires can leave great scars on the countryside by destroying trees, brush, grass, and even the fertile top layers of the soil.

Once a fire starts, the rate at which it spreads depends on the type of fuel, the weather, and the topography of the land. Flash fuels such as dry grass, leaves, and twigs burn easily and quickly. Green and wet fuels burn more slowly. The more dry fuel there is in the forest, the faster a fire will spread.

Weather conditions also affect how fast and how far a fire spreads. Sunshine dries fuels. On the other hand, rain dampens fuels and makes them burn more slowly if they burn at all. Perhaps the most critical weather factor, though, is wind. Wind can dry out fuels, fan a fire so that it burns faster, blow flames toward more fuel, and carry sparks that set new fires. Air temperature and humidity also are important. If the air is hot and the amount of moisture in the air is low, fuels can dry out and burn more quickly.

The shape of the land also affects the movement of a fire. The steeper a hill, for instance, the faster a fire will move up it. Fires burn more slowly downhill, though burning pinecones or logs can roll downward and ignite new fires at the bottom of the slope. Fuels on south-facing slopes might burn faster than those on north-facing slopes, because they have been exposed to more sunlight, which has dried them. Firebreaks such as roads, streams, rock cliffs, and bare earth can slow or stop the spread of fire.

The worst wildfires usually occur when flames climb into the forest canopy. These *crown fires* can spread quickly and, if not contained, might damage thousands of acres of forest. Wildfires can destroy the ground litter, which acts as a protective soil covering.

Intense fires can change the composition of soil, causing it to repel water. Water rapidly runs off this soil into streams and reservoirs and may cause floods. It also washes sediment, ashes, and debris from the burned areas into watersheds. Most fish cannot live in waters that become polluted with ash. Woodland fire temporarily destroys food supplies that animals and birds depend on, and it often makes an area unsuitable for outdoor recreation.

Less harmful are *surface fires* that stay in the lower strata of a forest. Moving more slowly and at lower overall temperatures than crown fires, surface fires can clear out brush, small trees, and deadwood without killing large trees or sterilizing the soil. A surface fire might allow the forest to recover and become even more vigorous the following spring or summer.

Fire sometimes can creep into the roots of a tree, where it can smolder underground for long periods of time before resurfacing and blazing again. This is more common in species of trees with high levels of pitch (a flammable secretion) such as Douglas fir and ponderosa pine.

This prescribed forest fire helped clear the forest's understory to provide room for new growth.

Surface fires caused by lightning have a natural role to play in many forests by consuming much of the brush and deadwood choking a forest's understory, releasing nutrients into the soil, and providing a fertile bed for new growth. Mature trees can often withstand the heat of occasional fires, because their bark is dense enough to prevent them from being seriously damaged.

Fire does have some beneficial aspects for forests. The cones of some pines open only after they have been exposed to the heat of a fire. The cones germinate in the ashes and send up saplings as a new forest begins. In addition, animals can move more freely through land opened by fire and can graze on the newly sprouted vegetation. Even when large trees are completely burned, the land is left ready for the process of forest succession to begin once more.

Much modern concern about fires results from past management practices that sought to eliminate all fires. That approach often allowed deadwood to build up on forest floors. When a fire does break out and burns into that deadwood, it may be hotter and more destructive than if the natural cycles of fire and regeneration had been allowed to play themselves out.

Prescribed Fire

To lessen the danger of devastating fires, foresters might intentionally set fire to an area. This *prescribed burning* is carefully planned, and the fire is set according to a prescription written for the conditions that exist and the objectives to be achieved. The fire exposes the soil, releases nutrients into the soil, eliminates some insects and diseases, and removes undesirable trees or brush. The heat also can open up fallen cones.

Prescribed burns made on a regular basis—every three to five years, for example—can reduce dried leaves and brush that, if allowed to accumulate, could eventually feed a very damaging wildfire. Wildfires are uncontrolled fires, and they can be avoided or made less severe by prescribed burning.

Preventing Wildfires

The easiest fire to fight is the one that does not start. You can help educate the public about wildfire prevention by taking part in fire-prevention campaigns conducted by wood-products companies, professional foresters, fire wardens, and others. The Leave No Trace principles for minimizing the impact of campfires also are important guidelines for preventing fires that would pose a threat to a forest.

Leave No Trace: Minimize Campfire Impacts

- Use a lightweight camp stove for cooking, and enjoy a candle lantern for light.
- Where fires are permitted, use established fire rings.
- Keep fires small. Only use sticks from the ground that can be broken by hand.
- Burn all wood to ash, and make sure all campfires are cold out.

In addition to following the Leave No Trace principles, use care in burning anything. Know your state laws about burning brush and debris. If your state requires a permit, you can get one from your local fire warden or ranger. Have plenty of help, tools, and water near the fire, and *never* burn anything outside on hot, dry, or windy days.

If you discover a fire, do not put yourself in danger. Notify the fire department, the police, or a ranger district. Firefighters know that to control any fire, it must be stopped from spreading and then put out completely. Since fuel, air, and heat must be present before a fire will burn, trained firefighters will attack a fire in one or all of the following ways.

- Remove the fuel supply. Using rakes, shovels, or heavy equipment, firefighters create a trench of bare earth around the fire. If bushes are nearby, they clear them away so they will not burn or fall across the trench.
- Cut off the air to smother the fire. Firefighters working on the ground can throw dirt on the fire. Aircraft can spread chemical fire retardants or water on the flames.
- Lower the heat. Fires near roads can be fought using water sprayed from fire trucks. A helicopter slinging a 200-gallon bucket from a cable is sometimes brought in to dump water on the flames of more remote fires. The pilot can refill the bucket from the air by lowering it into a lake. Firefighters on the ground can cool burning fuel by scattering shovelfuls of dirt and mixing it well with the embers.

Visiting a Managed Forestry Operation

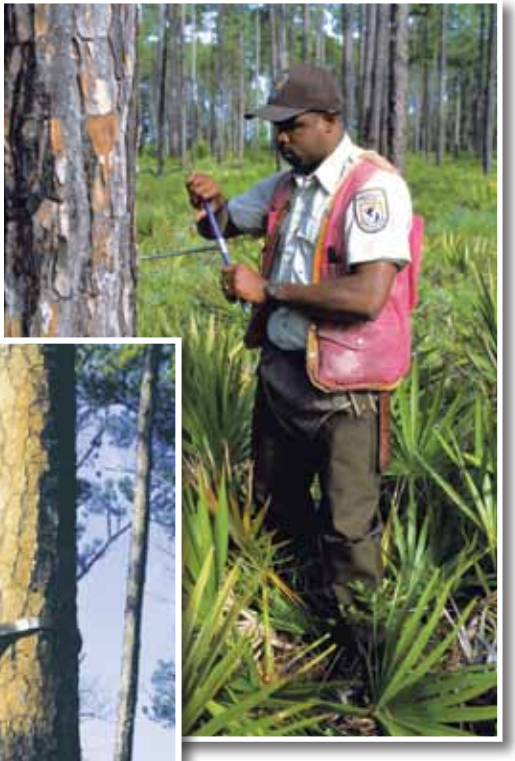
Your merit badge counselor and parents can help you arrange a visit to a managed forest, a logging operation, or a manufacturing plant that uses wood products. You can see for yourself how the work of forestry is carried out. You also will have opportunities to visit with forestry professionals and learn more about their backgrounds, training, and responsibilities. Plan the trip well in advance so that the forestry professionals will have time to prepare for your visit. Get permission in advance if you want to take photographs during your visit.

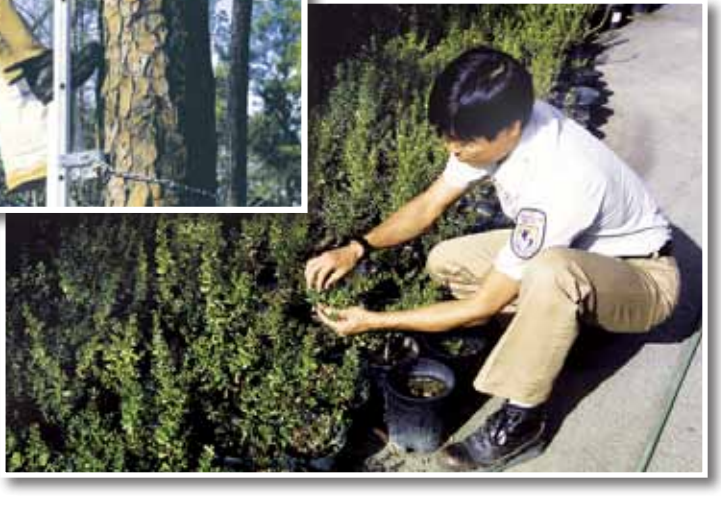
Write down your observations about your visit while they are still fresh in your mind. That way you will have the information you need to write a report about your findings. Be sure to write and send a letter thanking those you visited for taking the time to show you around.

Do some research on the forest, logging operation, or manufacturing plant you plan to visit, and think about some of the questions you want answered. In a managed forest, for example, you can find out about the management objectives and the forestry techniques used to achieve those objectives. You might also research or ask about the species of trees grown, the silvicultural system used, or whether replanting is done with seedlings or seeds.

At a logging operation, you can ask where the trees being harvested are going and how they will be used. Explore the ways a harvest is being conducted and what the future holds for that portion of the forest.

In a manufacturing plant you can discover what products are being made that include raw materials from forests. Where did the raw materials originate? How are the materials transported to the plant? What is the process for turning them into finished products? What is done with the by-products of the manufacturing process?





Careers in Forestry

Forestry is the science, art, and practice of managing and using for human benefit the natural resources that occur in association with forests. Ensuring that our forests are nurtured and used in sustainable ways that will keep them healthy requires knowledge of many disciplines, including economics, biology, chemistry, physics, engineering, and even psychology.

Foresters are trained in recognizing the interrelationships of soil, air, water, trees and other plants, wild and domestic animals, and humans. They direct land surveys, road construction, and the planting and harvesting of trees. They help prevent damage from insects, wildlife, diseases, and fires. They might plan recreational uses of forest lands or supervise timber-harvesting crews, firefighters, and tree planters. Many foresters are employed by private landowners, government agencies, and forest-products companies. Others are researchers and educators.

Those who manage timberlands must be skilled in balancing the needs of humans with those of forest ecosystems. They know how to encourage the growth of trees, and they understand how harvesting, fire, urban development, and other influences can change a forest. They also realize the importance of good communication skills.

Training

Most foresters have at least a bachelor's degree in forestry. Many have master's and doctorate degrees. Forestry students take biology and physical and social science classes. Then comes intensive study of ecology, forest economics, forest protection, silviculture, resources management and use, dendrology (classification of trees), and forest measurement, policy, and administration.

Opportunities

Thousands of professional foresters work in the United States, about half of whom work for public agencies. Another third work for industrial concerns. Most of the others are educators, researchers, and private consultants.

Federal Agencies. The USDA Forest Service employs more foresters than the other federal branches. Natural Resources Conservation Service of the U.S. Department of Agriculture, Bureau of Land Management, National Park Service, Bureau of Indian Affairs, and the Fish and Wildlife Service of the U.S. Department of the Interior all employ foresters. The departments of Defense, State, and Commerce, the Internal Revenue Service, the Environmental Protection Agency, and other government agencies also rely on foresters.

Beginning foresters are often assigned to ranger districts in national forests. They enforce the law, conduct timber inventories and boundary surveys; help control damage by fire, insects, and diseases; conduct reforestation, timber marking, log scaling, and range-forage surveys; and assist with recreational development. They may eventually supervise crews, administer programs, and oversee ranger districts and entire forests. Research foresters can rise to the top of the federal scale through work in regional Forest and Range Experiment Stations.

State, County, and City Governments. Being a forester for state government can include fire protection on public and private forests, management of publicly owned forests, management and marketing assistance to private landowners, conservation education, public relations, and implementation of state forest practice acts. Urban foresters protect and improve the vegetation in and around populated areas.

Private Industry. Industrial foresters work for corporations. They plan and direct tree planting, determine timber-harvesting schedules, supervise operations, and help protect the timber from fire, insects, disease, and theft. They must balance the growing of trees for harvest while protecting other important forest values.

The professional foresters you meet as you earn the Forestry merit badge will be excellent sources of information about forestry careers. They can help you learn about the education that is needed and the experience you must have.

Foresters in industry also fill positions indirectly related to technical forestry. They may be in sales; they may procure wood from landowners and farmers; or they may be involved in the manufacturing of wood products.

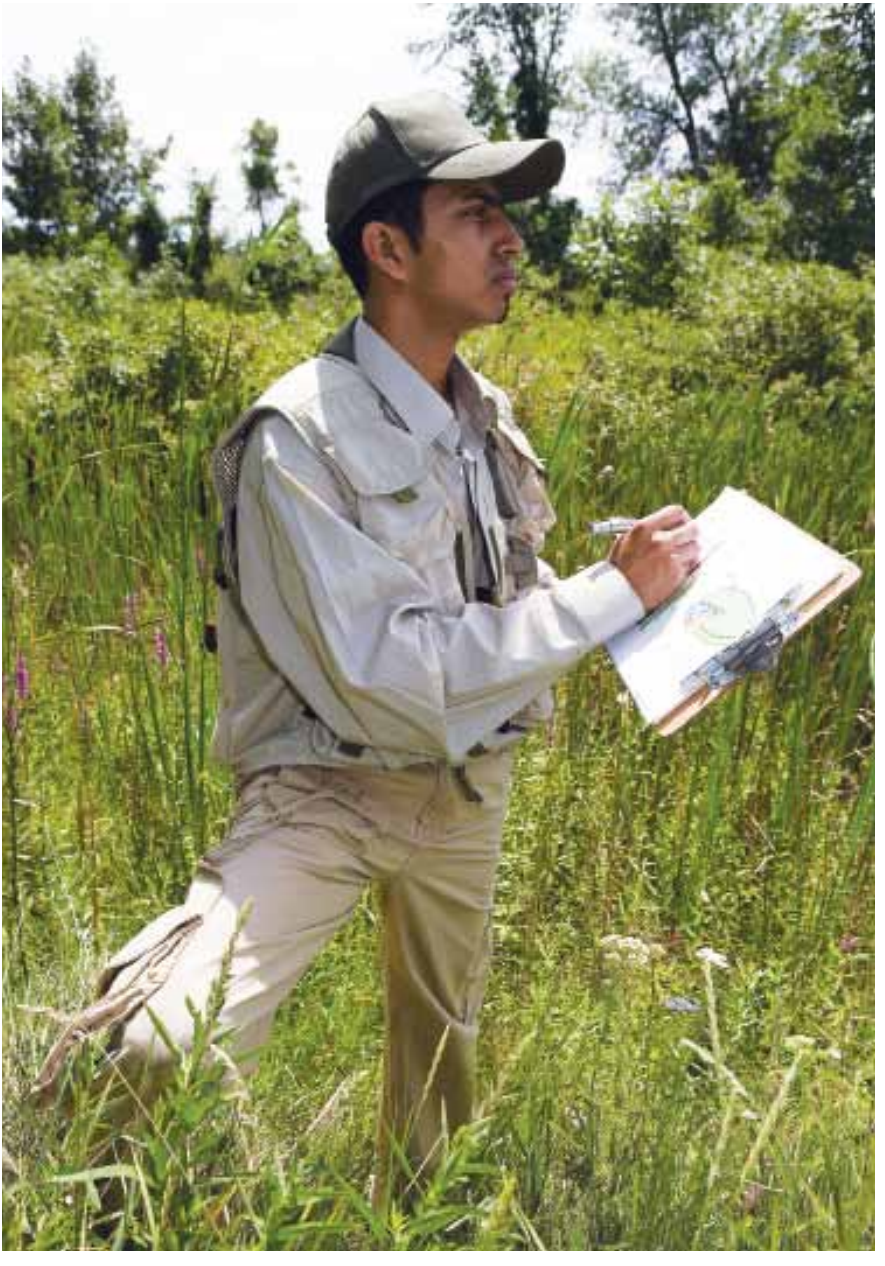
Education. Foresters also work as educators at the nation's colleges and universities. They frequently conduct research in conjunction with teaching. Extension foresters work with U.S. land-grant universities to provide information and guidance to private forest owners and the general public.

Consultants. Consulting foresters advise public and private forest owners about timber-management plans and practices. They appraise and market timber, and advise on forestland investments, among other services.

Other Opportunities. Other opportunities for foresters include work in wildlife, range, and watershed management; in some types of engineering; in park planning, development, and administration; in economics, landscape architecture, public relations, and real estate development; in equipment sales; and in law.

You and the Future of Our Forests

As you complete the requirements for the Forestry merit badge, you will discover that the primary goal of forestry is to ensure the sustainability of forest ecosystems. You can think of forest resources as being on loan to those who are alive today. Citizens have the responsibility of using and caring for these magnificent resources in ways that will sustain their vitality. In the decisions you make today as a hiker and camper and, perhaps, in a future career as a forester, you can have a tremendous influence on protecting and using forests wisely.



Forestry Resources

Scouting Literature

Boy Scout Journal; Trees pocket guide; *Environmental Science, Fire Safety, Fish and Wildlife Management, Gardening, Insect Study, Mammal Study, Nature, Plant Science,* and *Soil and Water Conservation* merit badge pamphlets

Visit the Boy Scouts of America's official retail Web site at *http://www.scoutstuff.org* for a complete listing of all merit badge pamphlets and other helpful Scouting materials and supplies.

Books

Arno, Jon. *Trees.* Discovery Books, 2000.

Baerg, Harry J. *How to Know the Western Trees* (Pictured Key Nature Series). W. C. Brown, 1973.

Bolgiano, Chris. *Living in the Appalachian Forest: True Tales of Sustainable Forestry.* Stackpole Books, 2002.

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Cassie, Brian, and Marjorie Burns. *National Audubon Society First Field Guide: Trees.* Scholastic Inc., 1999.

Day, Trevor. *Taiga.* Raintree Publishers, 2003.

Edlin, Herbert L. *What Wood Is That: A Manual of Wood Identification.* Viking Books, 1998.

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Raphael, Ray. *More Tree Talk: The People, Politics, and Economics of Timber.* Island Press, 1994.

Staub, Frank J. *America's Forests.* Lerner Publishing Group, 1998.

True, Alianor. *Wildfire: A Reader.* Island Press. 2001.

Organizations and Web Sites

American Forest and Paper Association
1111 19th St. NW, Suite 800
Washington, DC 20036
Toll-free telephone: 800-878-8878
Web site: *http://www.afandpa.org*

American Tree Farm System
1111 19th St. NW, Suite 780
Washington, DC 20036
Telephone: 202-463-2462
Web site: *http://www.treefarmsystem.org*

eNature.com
Web site: *http://www.enature.com*

Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Ave. NW
Washington, DC 20460
Telephone: 202-260-2090
Web site: *http://www.epa.gov*

Forest Products Laboratory
Telephone: 608-231-9200
Web site: *http://www.fpl.fs.fed.us*

Identification Keys
Web site:
http://www.backyardnature.net/keys.htm

National Association of State Foresters
Telephone: 202-624-5415
Web site: *http://www.stateforesters.org*

Natural Resources Conservation Service
Attn: Legislative and Public Affairs Division
P.O. Box 2890
Washington, DC 20013
Web site: *http://www.nrcs.usda.gov*

Society of American Foresters
5400 Grosvenor Lane
Bethesda, MD 20814-2198
Telephone: 301-897-8720
Web site: *http://www.safnet.org*

TreeLink
68 East Girard Ave.
Salt Lake City, UT 84103
Telephone: 801-359-1933
Web site: *http://www.treelink.org*

U.S. Department of Agriculture Forest Service
1400 Independence Ave. SW
Washington, DC 20250-0003
Telephone: 202-205-8333
Web site: *http://www.fs.fed.us*

Acknowledgments

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American Business	2002
American Cultures	2005
American Heritage	2005
American Labor	2006
Animal Science	2006
Archaeology	2006
Archery	2004
Architecture	2008
Art	2006
Astronomy	2004
Athletics	2006
Automotive Maintenance	2008
Aviation	2006
Backpacking	2007
Basketry	2003
Bird Study	2005
Bugling (*see* Music)	
Camping	2005
Canoeing	2004
Chemistry	2004
Cinematography	2008
Citizenship in the Community	2005
Citizenship in the Nation	2005
Citizenship in the World	2005
Climbing	2006
Coin Collecting	2008
Collections	2008
Communication	2009
Composite Materials	2006
Computers	2009
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Crime Prevention	2005
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Electronics	2004
Emergency Preparedness	2008
Energy	2005
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Entrepreneurship	2006
Environmental Science	2006
Family Life	2005
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Fingerprinting	2003
Fire Safety	2004
First Aid	2007
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Fly-Fishing	2009
Forestry	2005
Gardening	2002
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Geology	2005
Golf	2002
Graphic Arts	2006
Hiking	2007
Home Repairs	2009
Horsemanship	2003
Indian Lore	2008
Insect Study	2008
Journalism	2006
Landscape Architecture	2008
Law	2003
Leatherwork	2002
Lifesaving	2008
Mammal Study	2003
Medicine	2009
Metalwork	2007
Model Design and Building	2003
Motorboating	2008
Music and Bugling	2003
Nature	2003
Nuclear Science	2004
Oceanography	2009
Orienteering	2003
Painting	2008
Personal Fitness	2006
Personal Management	2003
Pets	2003
Photography	2005
Pioneering	2006
Plant Science	2005
Plumbing	2004
Pottery	2008
Public Health	2005
Public Speaking	2002
Pulp and Paper	2006
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Railroading	2003
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Rifle Shooting	2001
Rowing	2006
Safety	2006
Salesmanship	2003
Scholarship	2004
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Sculpture	2007
Shotgun Shooting	2005
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Snow Sports	2007
Soil and Water Conservation	2004
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Sports	2006
Stamp Collecting	2007
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Traffic Safety	2006
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Whitewater	2005
Wilderness Survival	2007
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Woodwork	2003

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