Forests Are More Than Trees

No matter where you live, you depend on ***forests***. They provide charcoal, firewood, fruits, lumber, medicines, nuts, paper, turpentine, and other resources that make up more than 5,000 commercial products. Many people use forests for fishing, hiking, hunting, and other recreational activities, as well as for their beauty and solitude.

Every person in the world also depends on forests for a number of beneficial ***ecosystem services***. Though you may not receive a monthly bill or pay for them directly, you use those services every day. They include the following:

- **Clean Water.** Forests are critical to maintaining clean water supplies. Forests absorb rain, facilitate the recharge of underground aquifers, cool and cleanse water, reduce flooding, and sustain watersheds. Forests also help to slow storm runoff, which helps prevent soil erosion and moderates water cycles so that we experience a more consistent water supply.

- **Oxygen.** Like all green plants, trees use energy from the sun to make carbohydrates through photosynthesis. In the process, trees absorb carbon dioxide (CO_2) from the atmosphere and release oxygen, which humans and other organisms need to live.

- **Nutrient Cycling.** Trees absorb ***nutrients*** from the soil through their roots and transport nutrients to cells in their leaves, branches, and trunk. When a tree dies or when parts of a tree fall and decay, nutrients and other ***organic*** and ***inorganic materials*** are returned to the soil and atmosphere.

- **Carbon Storage.** As trees grow, they help to remove CO_2 from the atmosphere by absorbing and storing carbon in their tissues. To grow a pound of wood, an average tree takes in about 1.5 pounds (0.68 kg) of CO_2 and gives off about 1.1 pounds (0.50 kg) of oxygen. The wood continues to store the carbon, even when the wood is made into lumber or other products.

- **Temperature Regulation and Rainfall.** Through their roots and leaves, trees absorb and release thousands of gallons of water each day in a process called ***transpiration***. In forests, this large-scale movement of water can influence regional temperatures and annual rainfall.

- **Wildlife Habitat.** Forests provide a place for thousands of plant and animal species to live. The complex structure of forests creates many niches where animals, plants, and other organisms can find food, shelter, and water.

The Changing Forests of North America

To the human eye, forests may seem permanent and timeless. Trees rise above the forest floor and dominate the landscape. Although there may be dramatic and colorful changes in forests from season to season, the forests may not seem to change much from year to year.

In fact, however, forests are dynamic ecological communities that undergo constant change. Some of the changes are natural processes, such as the growth and death of trees and the cycling of nutrients. Some changes are caused by humans and their activities such as building roads, cutting timber, and expanding cities and communities. Some changes happen quickly over a few hours or days, such as a wildfire or windstorm, while other changes take many years or even decades, such as the gradual transformation of a meadow into a forest stand.

North American forests have changed significantly in the past two centuries. Before the European settlement, native people already had a significant negative impact on the natural forest. They regularly burned areas of forestland to improve wildlife ***habitat*** and hunting, to make it easier to travel, to reduce numbers of insect pests, and to enhance conditions for berries and other foods. In some regions, native people also cleared forests to grow beans, corn, squash, and other crops.

With the European settlement and the dramatic increase in population, the human affects on North American forests also increased. In the 18th and 19th centuries in particular, new immigrants cleared forests extensively for agriculture, fuelwood, timber, and urban expansion. By 1900, nearly two-thirds of the pre-settlement forest in the Eastern United States had been removed, resulting in a reduction in clean water, wildlife habitat, and other ecosystem services provided by forests.

The 20th century brought a range of conservation laws and practices aimed at protecting forests and other ecosystems. As a result, the extent of forested land remains relatively stable in Canada and is even increasing slightly in the United States. Throughout North America, however, forests are still facing significant challenges that threaten their existence and their ability to provide resources and important ecosystem services.

Changes Facing Our Forests Today

When we consider the importance of forests and the demands that humans place on forest resources, it's not surprising that forests face many challenges. The nature of those challenges shifts as research, new technologies, population growth, development patterns, economic conditions, legislation, and political leadership come into play. Pressing issues that face North American forests today include fire, climate change, invasive species, and changes in ownership and land use.

Invasive Species[1]

Invasive plants, animals, and diseases have infested millions of acres of forestland across North America, thereby causing local and regional disruptions in forest ecosystems. A species is considered invasive if it is capable of spreading rapidly and causing economic or environmental harm. Many, but not all, invasive species are ***nonnative*** to the local ecosystem. Invasive organisms affect the health of forest trees, as well as the health of wildlife and human populations.

Human activities related to increased international trade, travel, and transport have caused a surge in the number of species that are introduced to new areas, particularly in the past 50 years.[2] Some new species are harmless, but others may displace native species and trigger a range of disturbances.

In some regions, invasive species may be especially aggressive. New habitats may lack predators and parasites that helped control their populations in their native lands. Examples of invasive species include pests such as Dutch elm disease fungus, plants such as the kudzu vine, and insects such as the gypsy moth and emerald ash borer.

American elm killed by Dutch elm disease. Photo by Joseph O'Brien, USDA Forest Service.

Old kudzu infestation draped on killed trees. Photo by James H. Miller, USDA Forest Service.

Fire[3]

Fire is a natural process that shapes many forest ecosystems. Fire can influence the types of trees and vegetation in a forest stand by favoring species adapted to fire. The thick bark of ponderosa pine and giant sequoia trees, for example, provides insulation from a fire's heat. Fire may help some species reproduce, including trees such as the jack pine, whose cones open only with excessive heat. In addition, fire is a major ecological factor influencing ***decomposition*** and ***nutrient cycling***.

Fire also brings a number of environmental and social costs. Forest managers have traditionally attempted to stop or suppress all forest fires. Although this policy seems like a logical way to reduce fire damage, over several decades suppression has had the opposite result in many places. Without fire to clear downed branches and other flammable material in the forest, the suppression policy can create conditions for even more severe fires.

The greater possibility of severe fires, combined with rising human development in and near forests, puts many people and local communities at risk. Those factors have significantly increased both the difficulty and cost of managing fires when they do occur. For example, the amount that the U.S. Forest Service spent on fire management rose from $300 million, or 13 percent of its budget in 1991, to nearly $2 billion, or 48 percent of its budget in 2009.

A technique known as prescribed burning is now being used to reintroduce the natural process of fire back into many forest ecosystems. This process allows a carefully controlled natural or human-made fire to burn in a specific area under selected weather conditions so the fire can accomplish specific ***forest management*** objectives. ***Prescribed burning*** can reduce the fuel that can feed dangerous fires.

Climate Change[4]

Forests and climate change are closely related. From 1850 to 2010, the amount of CO_2 in the atmosphere rose by 35 percent, mostly as a result of human activities such as deforestation and burning fossil fuels.[5] Climate models predict that increases in CO_2 and other ***greenhouse gases*** will warm the Earth's atmosphere, causing changes in precipitation, sea level, and weather patterns. Shifts in the location, extent, and structure of the world's ecosystems, including forests, are also expected. Such changes may, in turn, alter the way that people manage forests.

Carbon naturally cycles between the animals, atmosphere, oceans, plants, and soils. During the process of photosynthesis, trees absorb CO_2 from the atmosphere and sequester or store it in their woody tissues, especially in their branches and trunks. ***Carbon sequestration*** is the process through which CO_2 from the atmosphere is absorbed by trees, plants and crops through photosynthesis, and stored as carbon in biomass (tree trunks, branches, foliage and roots) and soils.

Forests sequester more carbon than any other land-based ecosystem. One mature coast redwood tree, for example, may hold more than 200 tons (181,437 kilograms) of carbon in its trunk alone—the equivalent of about 800 tons (725,748 kilograms) of CO_2. The potential of forests to store carbon makes them a critical part of controlling and managing atmospheric CO_2.[6]

Prescribed fire in 3-year old rough during a dormant season (December) burn. Photo by David J. Moorhead, University of Georgia.

Changes in Ownership and Land Use[7]

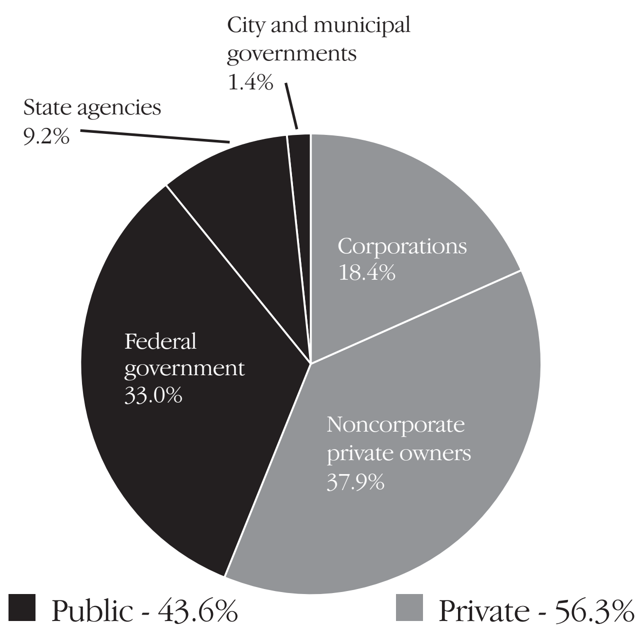
In 2009, about 56 percent of the 751 million acres (304 million hectares) of forestland in the United States was privately owned, while 44 percent was publicly owned.[8] Private owners of forestland include clubs, conservation organizations, corporations, individual families, and Native American tribes. Public landowners include the federal government; local governments; and state forestry, park, and wildlife agencies.

Since the year 2000, significant changes in forest ownership have occurred in the United States. Because of recent changes in tax laws, forest products companies have sold millions of acres of forestland to individual and group investors. Where companies used to own forestland and to manufacture and sell wood products from it, forest landowners are now often separated from manufacturing operations.

In addition to the change in commercial forestland ownership, some 60 million acres (24,281,138 hectares) of private forestland are currently owned by people who are 75 years of age or older, or who plan to sell or transfer their land in the near future. Such sales and transfers will mean further changes in forest ownership.

When forestland changes ownership, changes in management practices and land use may follow. Often, owners get the most economic gain when the forestland is divided into smaller, more developed parcels or recreation properties. Because of this approach, much of the forestland sold by families and individuals will be used for new housing and other development. Over the coming decades, this trend is expected to result in a significant loss of productive forestland.

Forestland Ownership in the United States



The Forest Ecosystem

Many people think of forests as a whole lot of trees. But forests are much more than trees. Forests are complex systems made up of many different ***biotic*** (living) elements, such as animals, bacteria, and plants, as well as ***abiotic*** (nonliving) elements such as air, soil, and water.

The term ***ecosystem*** describes a community of organisms interacting with each other and their physical environment. A ***forest ecosystem*** consists of the living and dead organisms—from the smallest bacteria and algae to the largest birds and mammals—plus the air, the inorganic material contained in the soil, and the water, as well as the interactions among these parts.

The health of a forest ecosystem can affect the local landscape and the local, regional, and even continental weather. The roots of trees and other plants transport water and nutrients; they also hold soil in place. Where forests grow and mature, they help to drain and store water, to reduce erosion, and to moderate surface wind. In addition, the moisture generated by healthy trees contributes to rainfall occurring many miles away.

Forest ecology is the study of the complex interactions among the elements of a forest ecosystem. Some of the components of the forest ecosystem explored through forest ecology are described in the following paragraphs.

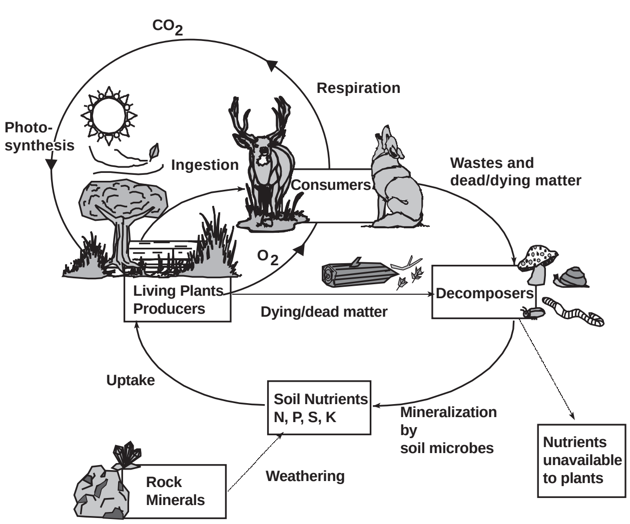
Producers, Consumers, and Decomposers

The living components of the forest ecosystem may be classified according to how they get their food. ***Producers*** are the trees and other green plants that manufacture their own food from simple compounds and from energy obtained from sunlight. ***Consumers*** are organisms that eat plants or animals. ***Decomposers*** are bacteria, fungi, insects, or other organisms that break down the forest's organic material into basic compounds.

The transfer of food energy from organisms on one nutritional level to organisms on another level is referred to as a ***food chain***. For example, a green plant may be consumed by a leaf-eating insect; that insect, in turn, may be consumed by an insect-eating bird. As in other ecosystems, a forest's ***food web*** is a complex and interlocking series of food chains.

Nutrient Cycles

Forest organisms need nutrients such as carbon, nitrogen, phosphorus, potassium, and sulfur for life, growth, and reproduction. Nutrient cycles provide self-regenerating supplies of those life-supporting materials. Trees absorb nutrients from the soil by taking in nutrient-laden water through their roots and by transporting the nutrients to cells in their trunk, branches, and leaves. When leaves or needles fall and decay, they return nutrients to the soil. As organic materials accumulate on the forest floor, their mass decomposes into the soil and air, and the nutrient cycle begins again.



Photosynthesis

In ***photosynthesis***, plants use the sun's energy to convert CO_2 and water (H2O) into oxygen (O2) and carbohydrates (predominantly glucose and starch). In its simplest form, the equation for photosynthesis is

$$\underset{\text{carbon dioxide}}{6CO_2} + \underset{\text{water}}{12H_2O} = \underset{\text{glucose}}{C_6H_{12}O_6} + \underset{\text{oxygen}}{6O_2} + \underset{\text{water}}{6H_2O}$$

Many parts of a forest ecosystem are involved in photosynthesis. Minerals absorbed by the plant and tree roots are carried by water to the leaves where the minerals form ***chlorophyll*** (the green pigment in leaves). Photons, the elementary particles of light, pass into the leaves and are absorbed by chlorophyll. With photosynthesis, oxygen is released into the atmosphere through the leaves. The plants and trees use the resulting carbohydrates as food (chemical energy) for growth and sustenance.

Associations

Within a forest ecosystem, there are many different types of relationships—in addition to the feeding relationships described earlier—that influence the interactions among forest plants and animals. ***Symbiotic relationships*** are close ecological associations between the individuals of two or more different species. A symbiotic relationship may benefit one species, both species, or neither species.

Ecologists use a different term for each type of symbiotic relationship. ***Mutualism*** is when both species benefit. For example, oak trees provide food (acorns) for squirrels, who store the acorns by burying them, enabling the acorns to germinate and grow into oak trees. ***Commensalism*** is when one species benefits, but the other is unaffected. For example, moss growing on tree trunks allows the moss to get light and collect moisture that runs down the trunk, but moss doesn't harm the tree. ***Parasitism*** is when one species benefits, but the other is harmed. For example, gall wasps lay their eggs in living tissues of trees and shrubs, causing a growth to form that protects and feeds the young wasps, but that activity can cause the plant's leaves to fall or branches to die back.

Forests Are More Than Trees (cont.)

Connections

Trees play different roles in the forest community depending on their age, size, and species. Their bark, fruit, leaves, nuts, roots, and seeds provide food for many kinds of animals and microbes. Trees offer homes and resting or hunting locations for different animal species. Trees also create shade and shelter for other plants and animals. Trees can become hosts for many organisms, which may or may not harm the tree.

In some instances, one species of tree can be beneficial to other tree and plant species. For example, the root system of the red alder can "fix," or transfer, nitrogen from the atmosphere and can deposit nitrogen into the soil, thus adding to the soil in much the same way that direct applications of nitrogen-rich fertilizers green up a lawn.

Biological Diversity

Biological diversity of a forest refers to the full range of living organisms that inhabit a particular forest ecosystem. Biological diversity includes the microorganisms in the soil; the grasses and plants that make up the ground cover; the amphibians, birds, invertebrates, mammals, and reptiles that make the forest their home; and the trees themselves. Another measure of the diversity is the number and frequency of each species. A native forest in a natural condition is often more diverse than a forest plantation with only one or two tree species.

Seasonal Changes

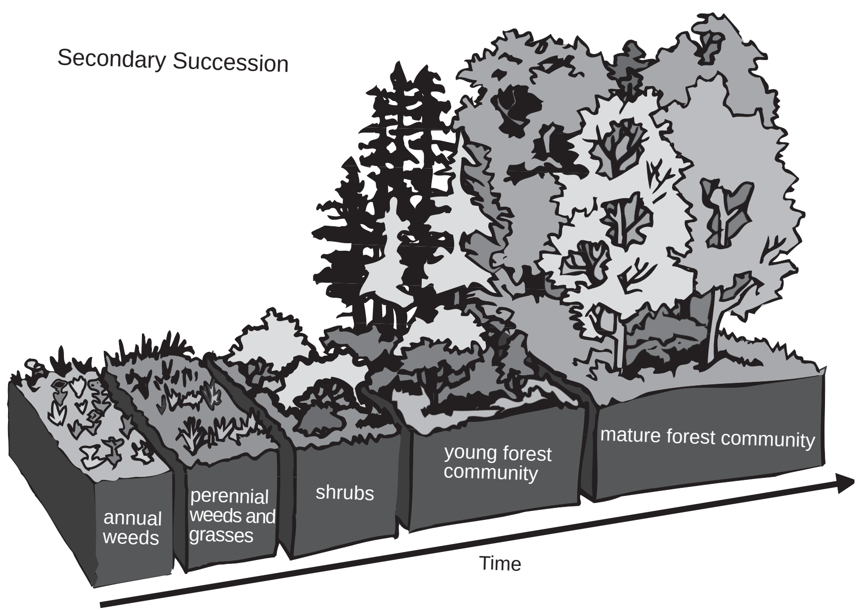
Seasonal changes result from the angle of the Earth's axis and the Earth's movement around the sun. When the Northern Hemisphere starts to angle away from the sun, thus receiving less direct sunlight, the autumn season begins and is marked by shorter and cooler days. (In the Southern Hemisphere, just the opposite is occurring; the spring season begins and is marked by longer and warmer days.)

The changing angle of sunlight triggers a variety of biological changes in North American forest ecosystems. The changes include animal hibernation, a slowing of photosynthesis, and ***dormancy*** in trees and other plants.
Some trees lose their leaves as the colder temperatures and shorter days of autumn cause cells to die at the base of their leaves. In those ***deciduous*** trees, a layer of cork begins to form, which keeps water and nutrients from traveling to the leaf, thus causing the leaf's attachment to the twig to weaken. Chlorophyll starts to break down, which then exposes yellow and orange leaf pigments. At the same time, scarlet and purple pigments are also formed. The blending of such leaf pigments produces the many colors of autumn leaves. Eventually, the leaf detaches from the tree and falls to the ground.

Without its leaves, the deciduous tree is less likely to suffer damage from freezing temperatures and strong winds. But without leaves, photosynthesis is impossible. Deciduous trees will remain dormant in the winter, until the longer days and warmer weather of the spring triggers new growth.

Forest Stand Development[9]

Scientists have long described the process of how a forest grows and develops over time as ***succession***. With succession, plant and animal communities move through different stages, with each being characterized by the dominance of certain species.



The process of succession begins with a barren site. The first plants to grow are called pioneer species and may include mosses, ferns, and grass seeds. Eventually, if conditions are right, a healthy plant community of shrubs and small woody plants will be established. Over time, a young forest community may form and develop into a mature forest community with a semipermanent mix of species.

Although succession may be pictured as a simple, linear, and predictable process, it is actually not any of those things. It is a dynamic process with many variables and possible outcomes.

The term ***forest stand development*** is used to describe the complex interrelationships between trees growing in a forest over time. A ***stand*** is defined as a uniform group of trees that are all about the same age or species. Depending on their location, forest stands may be different sizes and shapes.

Forest stand development occurs as individual trees and groups of trees (called ***cohorts***) grow and compete for light and space. When a tree declines, dies, or is removed from the stand, growing space becomes available to other trees and plants, which may, in turn, change the appearance of the stand.

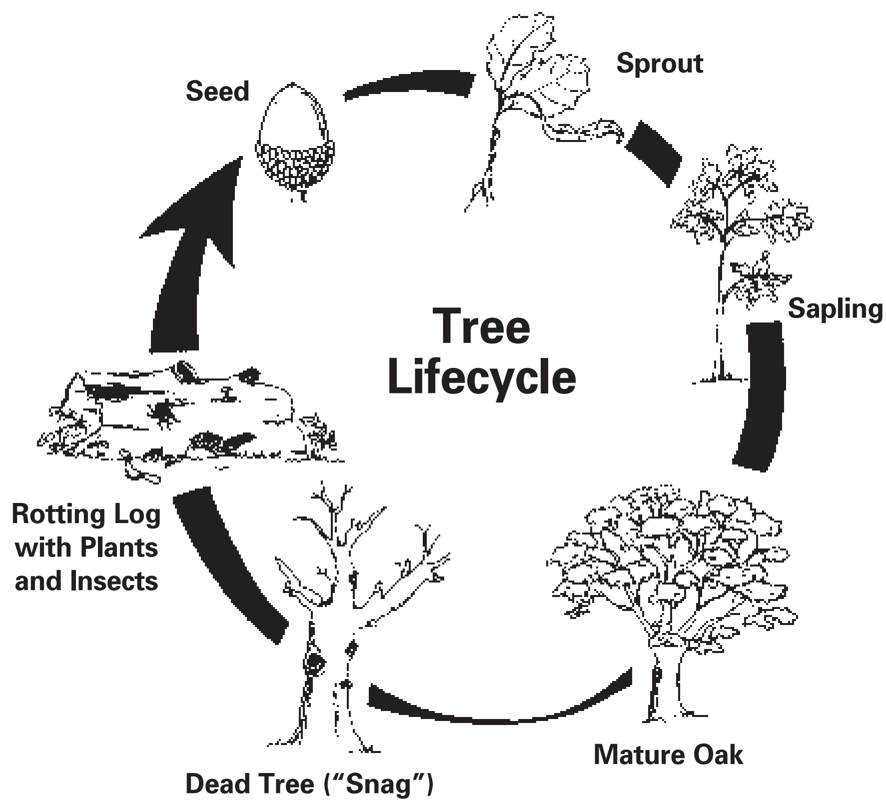
This natural process may be accelerated when an event such as a wildfire, storm, or human-caused disturbance causes trees in the stand to be removed or die. Tree species adapted to the new environmental conditions on the site may have a competitive advantage to grow in the space. After a major disturbance where the majority of trees are removed or killed, the open space may begin to re-fill with new grasses, herbs, and tree seedlings.

At first, most of the new trees will be about the same size. Eventually, though, some of the trees will become larger and thereby increase the competition for nutrients, sunlight, and water. Some trees may end up growing more slowly or die. Over time, the appearance and composition of the stand will change as different trees grow to dominate the stand.

A Tree's Life Cycle

Trees have ***life cycles*** that include seeds, seedlings, young trees, mature trees, and death. As trees go through their life cycles, both their physical form and their role in the forest ecosystem will change.

By looking at the growth rings of a tree, one can learn (a) about past influences on tree growth; (b) about disturbances such as fire, drought, or disease; and (c) about changes in environmental conditions. By taking a core sample, one can observe growth rings in a living tree with a minimum of damage to the tree.



Starting as Seeds

Most trees begin as seeds, and trees are classified by how their seeds are produced. Some trees, such as aspen, beech, eucalyptus, redwoods, and willows, may reproduce without seeds by sprouting from the roots of a parent tree or from the stump or injured portion of a predecessor. By far, however, the largest number of tree species are ***angiosperms***. Angiosperms have flowers and produce their seeds inside fruit or as a woody nut form. The seeds are usually pollinated by insects or other animals. Maples, oaks, and dogwoods are angiosperms.

In contrast, ***gymnosperms*** have "naked" seeds, meaning that the seeds are not enclosed in fruit. Gymnosperms produce their seeds inside fleshy or woody cones or ariels, and they are pollinated by the wind. Gymnosperms have no flowers. Gymnosperms are also called conifers or cone-bearing trees, and they include species such as pines, firs, spruces, and yews.

If a seed lands in a site with favorable light, soil, temperature, moisture, and nutrient conditions, the seed may germinate and grow into a seedling. The seedling must then compete with other growing plants in the area, and it must also survive browsing by plant-eating animals. The seedling may grow and mature quickly or slowly, depending on environmental conditions.

Growing from Young to Mature Trees

Young trees must compete with other trees and plants for sunlight and other resources, such as nutrients in the soil, space for roots, and water. All trees need light, but certain species may require more or less light than others. In dense forests, small trees may grow slowly unless a larger tree falls and creates an opening in the canopy.

Trees that can persist in the low-sun conditions of the ***understory*** are called ***shade-tolerant.*** Hemlocks are one example of shade-tolerant trees. Trees that are not shade-tolerant, such as the Douglas fir, require full sunlight from the very beginning stages of their lives. Some species are shade-tolerant as seedlings but become less shade-tolerant as they age.

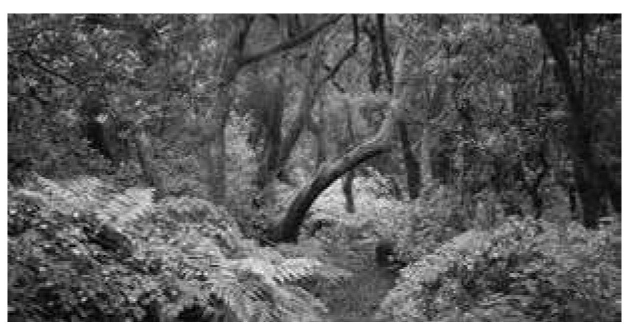
The length of time it takes a tree to reach maturity depends on the species of tree and the environmental opportunities that are present during its life. Trees are considered mature when they can produce seeds. Depending on the species, reaching maturity may require a few seasons or even decades.

Like all living things, trees are subject to disease and injury. Trees that are weakened or damaged by injury and disease will eventually die. Decomposers, such as bacteria, fungi, and insects, will then break down tree tissues, returning their nutrients to the soil to be recycled through the forest ecosystem.

North American Forest Types

North America has more than 1.67 billion acres (677 million hectares) of forestland—about one-third of the total land area of the continent.[10] Forestland includes many different forest types—from the chilly evergreen ***boreal forests*** in northern Canada to the steamy tropical rain forests in southern Mexico.

Tropical forest in Honduras. Photo by Howard F. Schwartz, Colorado State University.



Subtropical forest in El Hierro.

Forests Are More Than Trees (cont.)

Temperate forest in Great Smoky Mountains National Park, Tennessee.

Boreal forest in Canada.

Polar domain, Antarctica Peninsula.

The type of trees or other vegetation that occurs in an area is determined largely by patterns of temperature and precipitation. The Food and Agriculture Organization (FAO) of the United Nations classifies forests based on these two factors, using temperature as the first level, and then using precipitation patterns within a given area as the second level to further distinguish forest types.[11]

For the first level, the FAO uses five basic climate groupings or ***domains***: Tropical, Subtropical, Temperate, Boreal, and Polar. These domains are defined as follows:

Tropical:	Mean monthly temperature of more than 64° F (18° C) all months of the year
Subtropical:	Mean monthly temperature of more than 50° F (10° C) at least 8 months of the year
Temperate:	Mean monthly temperature of more than 50° F (10° C) between 4 and 8 months of the year
Boreal:	Mean monthly temperature of more than 50° F (10° C) between 1 and 4 months of the year
Polar:	Mean monthly temperature of less than 50° F (10° C) all months of the year

Because of the relationship of the Earth to the Sun, the mean monthly temperature of an area is generally lower the farther that area is from the equator, with the lowest mean temperatures occurring at or near the poles. North American forests are primarily subtropical and tropical in Mexico, subtropical in the southernmost United States, temperate in the bulk of the United States, and boreal in Canada and Alaska.

Within each of the five domains, there are forests with different levels of precipitation ranging from desert to rain forest. Trees will not grow where precipitation is too low or where precipitation doesn't come in the right season to support the trees. That is why North America's interior is largely dominated by grasslands.[12]

The Urban Forest[13]

Another increasingly important forest type in North America is the ***urban forest***. An urban forest is the collection of trees in a city, town, or suburb. An urban forest may include street trees, as well as trees and plants in greenways, natural areas, parks, private property, public gardens, and river corridors.

Like other forests, urban forests are dynamic ecosystems that provide ecosystem services such as clean water and air. Urban forests improve water quality by absorbing water and softening the effect of rain, thereby reducing soil erosion and storm water runoff, which can pollute waterways and cause flooding. As their trees grow, urban forests also remove CO_2 and other greenhouse gases from the atmosphere and sequester them in the trees' branches, roots, and trunks.

In addition to providing ecosystem services, strategically placed trees in the urban forest may save energy by shading buildings from the summer sun and by blocking them from cold winter winds. The urban forest may also reduce noise, provide places for recreation, and add beauty and open space to urban communities. Urban forests also provide critical habitat for many wildlife species.

Urban forests have maintenance costs, as do other public services such as street lights or sidewalks.[14] Maintenance costs may include planting, pruning, and replacing the trees; watering trees and removing storm debris and tree litter; and repairing damage to power cables and other property. However, the benefits provided by urban forests usually far outweigh their costs, and communities throughout North America are working to increase the extent of their urban forests.

Forest Resource Management

Forestry is the science, art, and practice of understanding, managing, and wisely using the natural resources derived from forestland. Such resources include fish, plants, recreation, soil, timber, water, and wildlife.

People have been managing forests since prehistoric times. One might think of forests on a continuum of human intervention or management. At one end of the continuum are ***primary forests***. Primary forests are essentially intact forest communities, composed largely of native species and unmodified by human activity. At the other end of the continuum are ***plantations***, on which trees are planted, grown, and harvested as crops.

Along this continuum is a range of forests that are manipulated or managed by people to fill a variety of needs. Some of those forests are managed more intensively than others, and they may be purposely manipulated to serve certain priority functions. Production forests, for example, are managed primarily to produce forest products. Even forests in protected areas, such as national parks and nature reserves, may be managed to minimize fire hazards or the spread of disease.

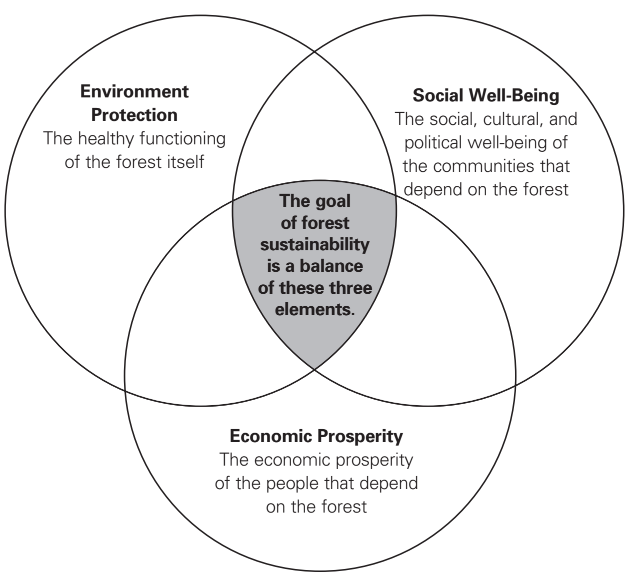
Forest Sustainability

In the past 100 years, humans have learned a great deal about forest ecosystems. Even with this new knowledge, however, we are still faced with the dilemma of how to use our forests in sustainable ways.

Forest sustainability may be defined as managing forests to meet the needs of the present without compromising the ability of future generations to meet their own needs. Sustainability can be described as a balance between (a) society's increasing demands for forest products and benefits and (b) the need for preservation of forest health and diversity. That balance is critical to the survival of both forests and forest-dependent communities.

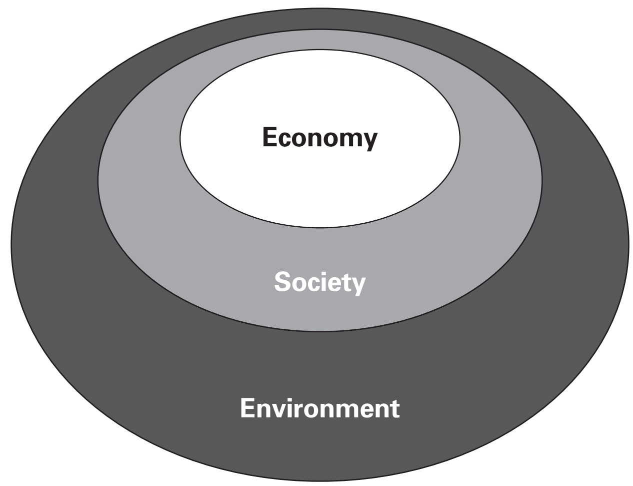
In practice, people often use a "triple bottom line" approach to measure progress toward sustainability by looking at the three elements of economy, environment, and society.[15] One way to think of those three elements is shown in Figure 1 below. Each of the elements— economic prosperity, environmental protection, and social well-being—is interdependent with the other, and each element may be present to a greater or lesser degree in a particular situation. The ultimate goal of forest sustainability involves a balance of all three spheres, as indicated by the shaded area in the middle.

Figure 1: The Elements of Sustainability



Another way to think about the three interrelated elements of sustainability is shown in Figure 2. As that diagram indicates, the human economy depends on society and social interaction.[16] Society, in turn, cannot exist without the environment, which provides basic necessities such as air, energy, food, raw materials, and water. Thus, the economy relies on society, which, in turn, relies on the natural environment.

Figure 2: "Triple Bottom Line" of Sustainability[17]



The essential idea of forest sustainability is that environmental, social, and economic issues and ideals must be integrated into decision making and actions that affect forests, while taking into account both future and present needs.