CALIFORNIA FOREST STEWARDSHIP PROGRAM SPRING 2006

FORESTLAND STEWARD

WORKING TOGETHER FOR HEALTHY FORESTS

Forest Management Part II:
How does your forest grow?

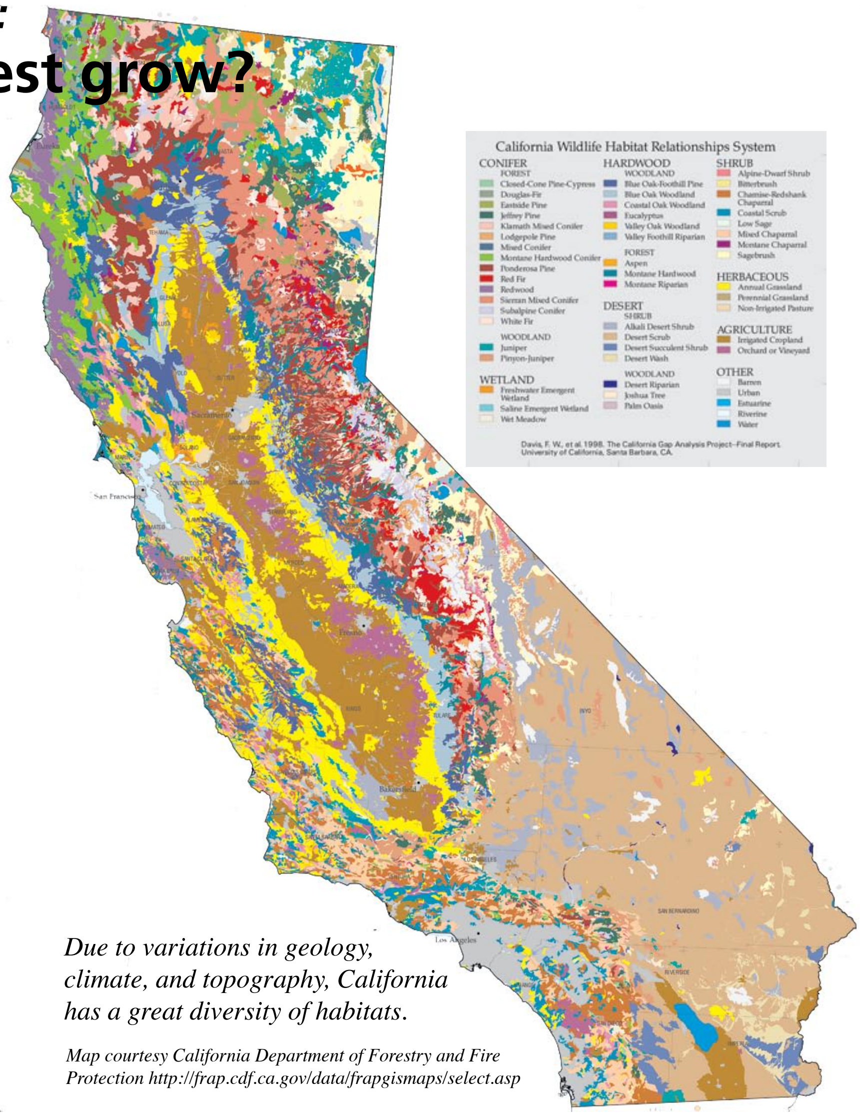
"Caring for and cultivating a forest should be premised on the fundamental principle that not all forests are created equal."
–Greg Giusti, UC Extension Forest Advisor

A pine forest is different from a redwood forest from a fir forest from an oak forest. A self-evident statement, certainly, but one with immense management implications.

California is a large and complex state. It measures 300 miles east to west and 800 miles north to south. Within the state there are great variations in geology (which determines soil type), physiography (mountains and valleys), and climate (coastal, desert, and continental). This diversity of conditions helps to create the many different forest types in the state.

In this issue, we continue our forest management series with some background on how forests grow. This knowledge will form the framework for good management decisions.

Think about the history of your forest–all the many factors that made it what it is. Consider how trees grow, including their physiology, species tolerance, competition, and environmental considerations. Look at the importance of soil productivity and site quality, and strange fungal associations in the soil. Then use all this information to better understand your own unique forest.



Due to variations in geology, climate, and topography, California has a great diversity of habitats.

Map courtesy California Department of Forestry and Fire Protection http://frap.cdf.ca.gov/data/frapgismaps/select.asp

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Inside

FORESTLAND STEWARD

Forestland Steward is a joint project of the CA Dept of Forestry and Fire Protection, UC Cooperative Extension, and USDA Forest Service to provide information on the stewardship of private forestlands in California.

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This newsletter was produced under a grant from the USDA Forest Service.

A point in time

Your forest as it exists today is just one point in a long continuum. It is the result of a long history of physical, biological, and cultural events that have shaped the land and created the plant and animal communities found there. From large-scale geological changes (e.g., glaciers and earthquakes) to smaller local occurrences (e.g., fires and forest harvest practices) all the impacts at various scales have combined to make your forest what it is today.

Hydromining, one technique used to recover gold, was hard on Sierran forests. Many areas still bear scars from the Gold Rush era.
Denver Public Library, Western History Collection, Poley, P-1259

Take a trip

Let's take a very quick trip through time in your forest. On the geological timescale, physical forces (volcanoes, glaciers, rivers, climate) helped shape the land. These forces carved the topography and formed the soil that influence what grows there today.

In more recent history–several thousand to about 150 years ago–Native Californians enjoyed the vast resources found here. They not only utilized the resources, but actively managed the landscape to increase its diversity. Fire was the most common management technique and was used to stimulate plants for food and basket material, create mosaics of habitat to attract desired animals, destroy disease organisms, reduce fuel and prevent major forest fires, and clear the understory. These frequent fires helped maintain meadows, oak woodlands, and native prairie grasslands.

Over the past 150 years, European immigrants brought profound changes to California forestlands. The gold rush, mining, livestock grazing, railroad construction, logging, and other activities have had a lasting impact on our forests. In addition, non-native plants and animals, introduced both accidentally and intentionally, have changed entire ecosystems.

Today's overcrowded forests are partially a result of fire suppression policies initiated in the early 1900s. These policies aimed to protect trees as a valuable resource, but overlooked the major role fire plays in California forests. In fact, plants here are adapted to periodic fires and many require fire to germinate. Loss of the natural fire regime is responsible for many environmental problems.

Laws and regulations, including tax laws, have also had an impact on forest practices. For example, until timber tax law was reformed in the 1970s, property taxes encouraged harvesting in order to avoid repeated taxation at higher assessed valuation.

A historical context will give you a better understanding of your forest. It can help you visualize what it may have looked like in the past and predict what the future might bring. It also serves as a reminder that forests are dynamic; what we see now is simply a snapshot in historical time.

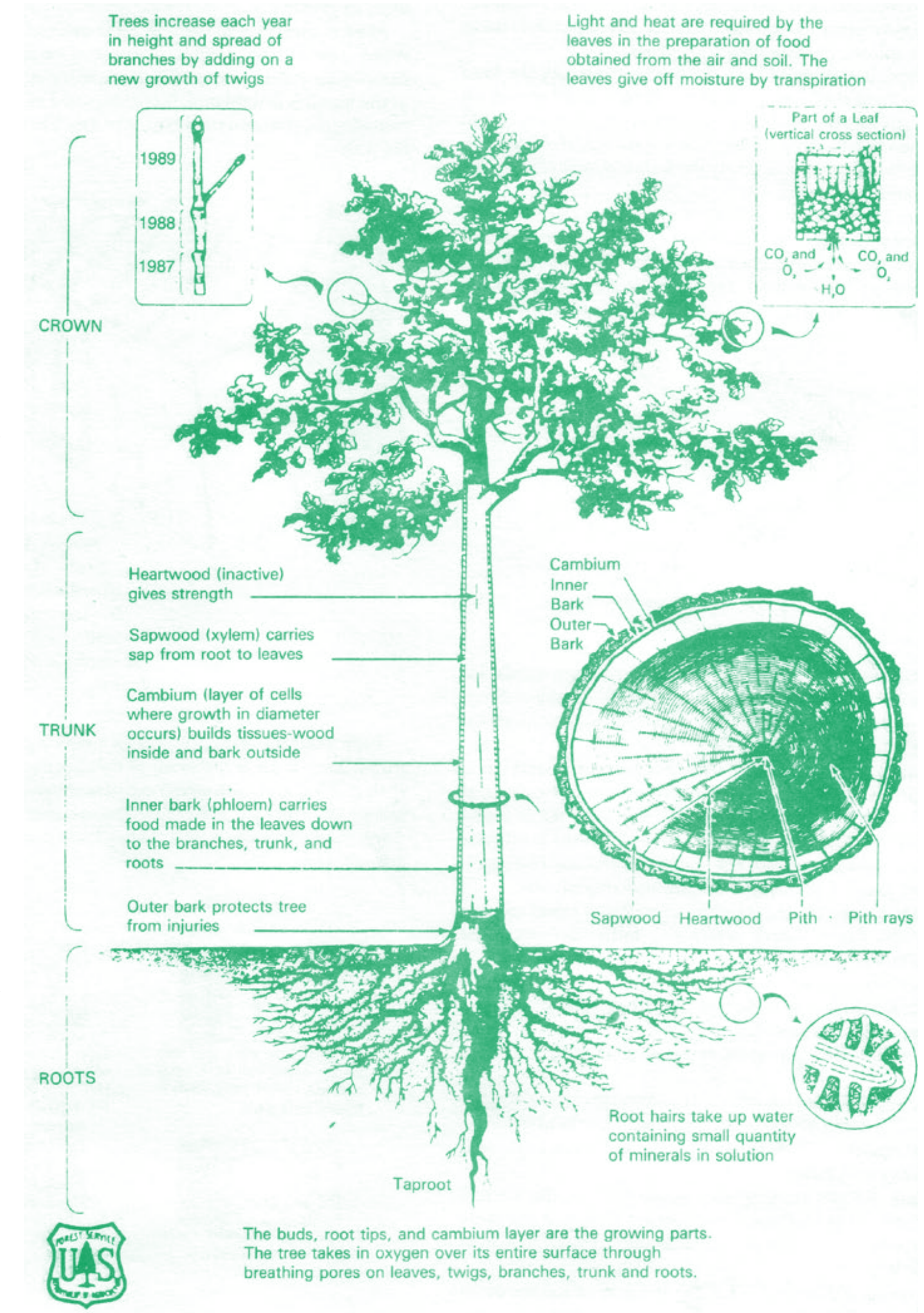
Research the history of your forest

- Talk to neighbors and old-timers to learn what happened on your property. Ask about fires, insect outbreaks, logging history, and any other management activities and changes.
- Seek out old newspapers, maps, and other written material. Old photos may be found in libraries, local historical societies, and government agencies. Aerial photos may be available from the Forest Service and Natural Resources Conservation Service.
- Access archaeological records. The California Office of Historic Preservation maintains a database of known sites and surveys.
- Look for clues on the land itself. Old stumps, fire scars, mine tailings, artifacts, and ruins can all tell a story.

The basics: how does a tree grow?

Understanding how trees grow is the key to understanding the condition of the trees on your property and the potential of your site to grow the kind of forest you want.

Trees are engaged in a constant competitive struggle with each other and with other plants for water, sunlight, and nutrients. The plants winning this struggle are those best adapted to the site's environmental conditions. Note that the most successful plants may not always be trees. Getting to know the species, tolerances, and health of the trees on your site is a critical first step in understanding how best to manage your property.



Tree components

Each part of a tree plays an important role in maintaining health and vigor.

The ***roots*** anchor the tree and absorb water and nutrients for tree growth. The ***trunk*** supports the crown; it conducts moisture up from the roots and energy down from the needles/leaves where photosynthesis occurs.

The ***crown*** is the part with green growing branches. It carries out photosynthesis, grows by adding new twigs each year, and aids in competition by shading out potential competitors.

Water and nutrients are carried up from the roots to the leaves or needles by the ***sapwood***, or ***xylem***. Sapwood is produced by the ***cambium***, a microscopic layer of cells where all the trunk's growth takes place. The cambium produces a new layer of sapwood and of bark each year.

Heartwood forms when inactive sapwood is replaced by newer sapwood. Heartwood gives the trunk its strength and stiffness. The ***inner bark***, or ***phloem***, carries sugars made in the needles/leaves down to branches, trunk, and roots. It becomes outer bark when it dies and is replaced by a new layer of inner bark. The outer bark holds moisture in and protects the tree from disease, heat, cold, and fire.

Tree needs—sun, nutrients, water, air

Trees must obtain adequate amounts of chemical nutrients, water, air, and sunlight in order to survive.

Sunlight. Like all plants, trees turn sunlight into energy through the process of photosynthesis. This energy is then used to grow new parts including wood and needles. In order to continue growing, the tree's rate of photosynthesis must exceed the rate at which it uses energy, a process called ***respiration***.

Trees compete with each other for available sunlight. When trees get overtopped and shaded, their access to sunlight is reduced or eliminated and growth slows or stops. Depending on species, these trees may die.

Shaded branches produce little photosynthetic energy but still cost the plant in energy, nutrients, and water. These branches usually die and drop off through "self-pruning."

Dense forests may be unhealthy because too many trees are competing for too little sunlight and moisture. Increasing the spacing by removing some trees increases the amount of light and moisture received by the remaining trees, and therefore increases their health and growth.

Dense forests may be unhealthy in part because too many trees are competing for the sunlight. Very closely planted trees grow more slowly because no individual tree receives enough light to grow well; some forests may actually stop growing and stagnate. These forests are very vulnerable to disease, fire, and other threats. Increasing the spacing by removing some trees–thinning–increases the amount of light and moisture received by the remaining trees, and increases their health and growth.

Moisture. Trees, like other plants, require water. Water carries minerals and nutrients essential for plant growth, and is also required for chemical reactions in photosynthesis.

During photosynthesis, trees open small pores in their leaves, called ***stomata***, to allow carbon dioxide to enter and oxygen to leave. Water vapor is lost when the stomata are open through a process called ***transpiration***. Transpiration pulls water from the roots to the top of the tree and tips of each branch. When there is not enough soil moisture to replace the lost water vapor, a tree must close down its stomata and stop photosynthesis.

Inadequate soil moisture can cause discolored or withered foliage, decreased growth rate, premature shedding of leaves or needles, or dead branches. Although trees are directly stressed by too little moisture, the most significant effect of moisture stress is to make trees more susceptible to insects and disease. Stressed trees are less able to fight off common insects such as bark beetles, and may die off in large numbers during and after a drought.

Some high-value trees near homes and recreational areas can be deep watered to alleviate moisture stress. However, this is not practical for an entire forest. The best treatment for forest trees is to ensure they have adequate spacing and are not overcrowded. Forest thinning can achieve the desired spacing.

Nutrients. Trees require macronutrients–nitrogen (N), phosphorus (P), potassium (K), calcium, magnesium, and sulfur–in relatively large amounts. Eight other elements are required in such small quantities they are called micronutrients: iron, manganese, copper, zinc, boron, molybdenum, cobalt, and chlorine.

Nutrients play critical roles in physiological processes including photosynthesis, cell growth, nitrogen fixation, protein synthesis, respiration, water absorption, and root growth. Plants grow best when these elements are present in adequate quantities and suffer from deficiencies when they are scarce. The quantity of these elements present in soils is related to their presence in the soil-forming rock on site.

Although forest soils are typically low in nitrogen, nutrient availability is rarely a problem for California forests except where soil has been severely disturbed by removal, erosion, or wildfires, or on serpentine soils (where soils develop from serpentine rock).

A few common visual symptoms of nutrient deficiency are stunted tree growth, discolored foliage, premature death of buds and foliage, death of needle tips, and poorly developed root structure. Deficiencies in micronutrients are most likely in soils that are acidic and sandy, organic, high in pH, intensively fertilized, or disturbed, compacted, filled, or have altered drainage. Diagnosis should include soil testing by a qualified professional. Nutrient deficiencies can be treated with fertilizers after diagnosis but this is rarely done in forest stands.

Air. Trees must take in carbon dioxide through their stomata for photosynthesis. They also take in oxygen and water through their roots. About 90 percent of tree roots are found in the first three feet of soil, including specialized absorbing roots found in the first foot of soil where water and air are most available. Depending on soil conditions, roots may extend out two to three times the width of the crown.

The roots of most tree species are associated with beneficial fungi called mycorrhizae (*see page 9*). These fungi increase the roots' ability to absorb water and minerals.

Compaction can restrict root growth, disrupt fungal associations, and cause root death. This condition impedes the ability of the roots to absorb moisture and exchange gases. Trees growing on compacted soils may have many of the same symptoms as those suffering from moisture stress. Construction, logging and road building equipment, and unmanaged herds of domestic livestock can cause soil disturbance and compaction around tree roots.

Soil compaction and disturbance can be avoided by careful planning for construction or forest operations. In addition, avoid harvesting operations during periods of soil saturation.

Tolerance

Trees are in constant competition for available sunlight, water, and nutrients. Each species has evolved its own strategy for survival in this competitive environment.

Shade tolerance. One of the most important characteristics of any tree species is its ability to grow under partially shaded conditions. Shade-intolerant trees grow quickly in sunny conditions but slow down if they are overtopped and shaded by other trees. Overtopped trees eventually succumb to insects or disease. Ponderosa pine is a good example of a shade-intolerant species. Its growth slows to half its normal rate under 50 percent shade, and it is likely to die in full shade.

Shade-tolerant trees, on the other hand, can grow and survive in the sun as well as in the shade of other trees. However, the price for this adaptation is that they usually cannot grow as quickly in full sun conditions.

White fir is an example of a shade-tolerant species. It cannot grow as quickly in full sun as ponderosa pine, however, it can survive in the shade of other trees for some time. When taller trees die and allow more sunlight in, white firs continue to grow and replace them. The life strategy of shade tolerant trees is to outlast shade intolerant trees rather than outgrow them.

Trees exhibit a range of shade tolerance. Douglas-fir is intermediate in tolerance. While they do best in full sunlight, intermediate trees can survive in the shade and thrive if more sunlight becomes available. Very few species survive only in shade; Pacific yew is one.

Drought tolerance. Drought tolerance is the ability to survive limited soil moisture, based on how well a tree can access soil moisture during dry times and its ability to control moisture loss through its leaves. Water that is lost through transpiration must be constantly replaced.

In general, broadleaf trees are much less drought tolerant than conifers. Broadleaf trees have wide leaves with large surface areas that lose more water than conifers with small narrow needles. However, some broadleaf trees, such as holly and live oaks, have waxy or wooly leaf coverings that can reduce water loss. Other adaptations to water loss include vertically oriented leaves, light-colored leaves, and stomata that are sunken or located on the underside of the leaf.

Fire tolerance. Fire tolerance is the ability of a tree to survive fire. This ability is compromised in heavy fuel situations that exist in many areas today. Generally, trees with thick bark and deep roots are more fire tolerant. Thick bark protects the living tissues of the tree and deep roots are not as vulnerable to the surface heat. Mature trees with fewer bottom limbs may survive because they are less likely to transmit a ground fire up into their crowns.

Cold and snow load tolerance. Cold tolerance is the ability of a tree to withstand frost. Snow load tolerance is also important at higher elevations. Conifers with short flexible branches can generally shed heavy snow. Deciduous trees fight both cold and snow by losing their leaves each fall.

Winners and losers

A tree's genetic makeup determines its tolerance to environmental conditions. A shade intolerant /drought tolerant ponderosa pine is better suited to a sunny dry site than a white fir that is shade tolerant but not drought resistant. If planted at the same time, the ponderosa pine will likely outgrow the white fir and come to dominate the site.

As trees compete within the forest, some begin to "win" as they outcompete to capture the site's light and moisture. The winners will be the largest and healthiest. The losers will start to grow very slowly or not at all, and eventually die.

The management implications of tree growth and competition are profound. Forest harvesting that removes the smaller, suppressed, and intermediate trees will leave behind those with the most potential for future growth. Conversely, harvesting only the biggest, healthiest trees often leaves behind unhealthy suppressed trees with reduced potential for future growth. Removal of tree species that are most tolerant of site conditions can leave behind those least adapted to site conditions, reducing the potential of the site to maintain a healthy forest over time.

—adapted from the Forest Stewardship curriculum

Succession

The change in forest stages over time is called succession. In an idealized forest, succession would proceed from bare ground to herbaceous plants to woody shrubs to fast growing shade-intolerant trees to a climax forest.

However, forests in the real world do not follow this perfect course. Forest development is affected by climate, soil, species present, competition; natural disturbance including fire, windstorm, and disease; and human activities such as harvesting and fire exclusion. Your forest is the product of all these factors.

For example, cooler shady sites at middle elevations in the Sierra Nevada favor the growth of shade tolerant/ drought intolerant white firs. With frequent fire, thin-barked white firs are likely to be killed. Ponderosa pine with its thick bark and rapid self-pruning tolerate light fires quite well. Open areas where firs are killed are more likely to reforest in ponderosa pine. Therefore, frequent fires promote ponderosa pine over time, despite climate conditions that favor white fir. If the owner selectively harvests ponderosa pine, young white fir left behind will respond to the increased sunlight and reclaim the site.

Soil: treat with care

The soil's chemical and physical properties—which include texture, structure, organic matter content, nutrients, soil acidity (pH), and strength—determine its productivity and capacity to grow plants.

Soil is the substrate upon which plants grow and from which they get their nutrients and water. The soil determines what can and cannot grow on a site. Keeping the soil healthy and in place protects your land.

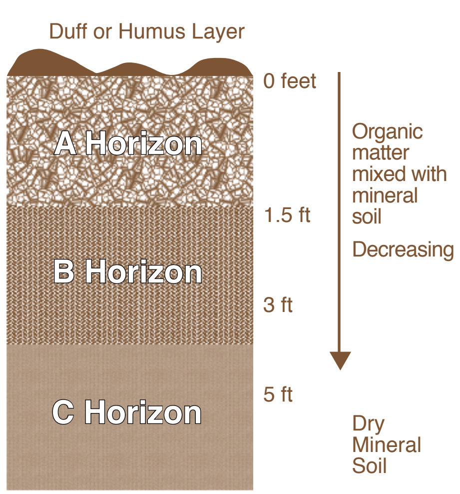
Productive forest soil is a mixture of mineral particles, plant and animal matter, nutrients, air, and water. Much of what we consider soil is actually the pore space between particles containing water and air.

Soil is derived from decomposed parent rock, which may be granite, volcanic, or sedimentary materials, depending on where you are. Soils are further shaped by weathering, movement, and mixing with various amounts of organic matter.

The chemical and physical properties–which include texture, structure, organic matter content, nutrients, soil acidity (pH), and strength–determine a soil's productivity and capacity to grow plants.

Soil texture is determined by the size of particles that make up the soil. It governs how well the soil will hold on to water and nutrients. The three major soil texture categories are sand, silt, and clay. Their relative proportions determine texture class.

Sandy soils are coarse-textured, clay soils fine-textured, and silty soils intermediate in texture. Loam consists of nearly equal amounts of sand, silt, and clay. Textures between these classifications can also be used to describe soil types, e.g., sandy loam or clay loam soils.



Soil horizons

Clays are the smallest particles. They are sticky and plastic when wet, and form tiny pores that hold water for a long time. Clay soils also have large surface areas that encourage the exchange of soil nutrients to roots.

Silt is smooth and slippery to the touch when wet. The individual particles are much smaller than those of sand, though larger than clay. Silt-textured or silty soils contain relatively large amounts of silt-sized particles.

Sand is gritty to the touch. It is the largest of the three size classes of soil with individual grains that can be seen with the naked eye. Sand has large spaces between the grains and gives up water to plants easily but also loses water quickly as it drains between the grains.

The soil holds all the water that a plant will access during the growing season. It holds or gives up nutrients at various rates. The most productive soils have a medium or loam texture, and are two to four or more feet deep.

Soil horizons refer to the horizontal layers, starting with the humus on top to the parent material on the bottom. Organic matter (the decomposed remains of plants and animals) holds soil particles together and provides the phosphorus, sulfur, and nitrogen that are essential for plant growth. Darker-colored soil usually means more organic matter is present.

Soil nutrients include the essential elements for plant growth–six macronutrients and 11 micronutrients. The three macronutrients needed in the largest quantity are nitrogen (N), phosphorus (P), and potassium (K). Forest soils are often low in nitrogen. Deficiencies and imbalances in nutrients can be seen in plants. A few unique soils, such as those developed on serpentine, can be toxic to many plants. Specially adapted plant communities have evolved in these areas.

Soil acidity, measured by pH, influences the availability of certain essential nutrients. Forest soils are generally acidic, a condition to which conifers are well adapted.

Soil productivity can increase over time due to increasing organic matter and continued weathering. However, these changes do not occur within the scale of our human lifetimes.

Productivity can be improved by human activities, such as the addition of organic matter, fertilization, and tilling, but these are generally too expensive to carry out over large areas of forestland.

Although it is difficult to improve forestland productivity, it can definitely be reduced through poor management. Once reduced, productivity is difficult to restore. Threats to the soil's productivity include soil compaction, nutrient depletion, removal of surface horizons, and soil erosion. Good forest management practices can minimize these threats.

—from the Forest Stewardship curriculum

Site quality, site index, and site class: How does your site measure up?

A highly productive site can produce taller trees in a shorter period of time than a less productive site. Intuitive, right? But what is productivity and how do we measure it?

Productivity refers to the potential of a site to grow trees. Productivity measurements are important because they are used for many management decisions as well as for estimating harvest volume and income, tax rate, and for zoning and land use planning.

Site quality

Soil and climate are the most important factors in determining how well trees and plants will grow on a site. Soil productivity is based on the soil's capacity to grow plants. Sites with the most productive soils have the fastest growing trees and vice versa. When we look at a site in terms of how well the trees are growing rather than how productive the soil is, we talk about site quality.

Site index

Site index is the most common measurement of productivity on forestland. Site index is the height in feet of dominant and co-dominant trees when they reach a specified age (usually 50 or 100 years). The taller the trees at that age, the higher the site productivity.

Each species grows at a different rate so site indexes must be species specific (see Table 1). Site index information has been collected for most of the major tree species in the U.S.

Most forested properties will have a good deal of variety in the soil and therefore, different parts of the land will have different site quality and site indexes.

You can estimate site index relatively easily. To do this you will need to know the height of the trees, and their age and species for each site you wish to measure (*see Estimating Site Index on the next page*).

Site class

Since site indexes include a range of heights, for simplicity they are grouped into site classes and numbered in Roman numerals I (best) through V (poorest). In general, the best sites are those in humid climates with good soil characteristics while poorer sites are dry with soils with limited ability to provide trees with nutrients and water (see Table 2). Site class is also used to determine whether an area can be zoned as a Timber Production Zone and which of the Forest Practice Rules may apply. In California, five general site classes (I through V) are established within three general forest types: young-growth redwoods, whitewoods (Douglas-fir), and ponderosa pine/mixed conifers. Site I denotes areas with the highest timber productivity while Site V is the lowest.

Some areas of the state have a higher natural productivity for tree growth than others based on the climate that a species is adapted to.

(continued next page)

Table 1. Site Index and Site Class (100 yr)

	Redwood young growth	Douglas-fir	Mixed conifer, ponderosa, Jeffrey pine, true fir
Site Class	**Site Index**	**Site Index**	**Site Index**
I	180 or more	194 or more	114 or more
II	155–179	164–193	93
III	130–154	134–163	75–92
IV	105–129	103–133	60–74
V	<105	<103	<60

—from Working in the Woods http://www.cnr.berkeley.edu/departments/espm/extension/SITE.HTM

Table 2. Site Relationship Table

		Site Class I———V	
Causes	Climate	humid	dry
	Soils	deep	shallow
		loam	heavy clays, excess sand, excess rocks
		good drainage	poor drainage
Effects	Tree growth	excellent	poor
	Site quality	high	low
	Site index	high	low

—from Estimating Site Productivity on Your Woodland, Oregon State University Extension Service

Table 1 shows the relationship of site index at age 100 to site class for three forest types as used by the State Board of Equalization to administer the Timber Yield Tax Law.

Table 2 gives general characteristics of site classes I through V.

Estimating site index

Using a few simple tools you can determine the site index for sites on your property (*for more details, see references at the end of this section*). To do this, you will need to find out how fast your trees are growing, which requires knowing how tall the trees are, their age, and species.

Sample dominant trees

Choose at least three of the taller trees in each area you wish to sample. Be sure these have been dominant (received full sunlight) throughout their lifetime to ensure an accurate measurement.

Determine the age

Estimate the age of each tree using an increment borer, which takes a small core sample from the tree. Then count the annual rings of the sample to get the age (an increment borer is usually used at breast height–4.5 feet above ground–so you may need to adjust the age to include the time it took the tree to grow those 4.5 feet). Alternatively, you can count the rings from the stump of a dominant tree with a diameter similar to the tree where height measurement is made.

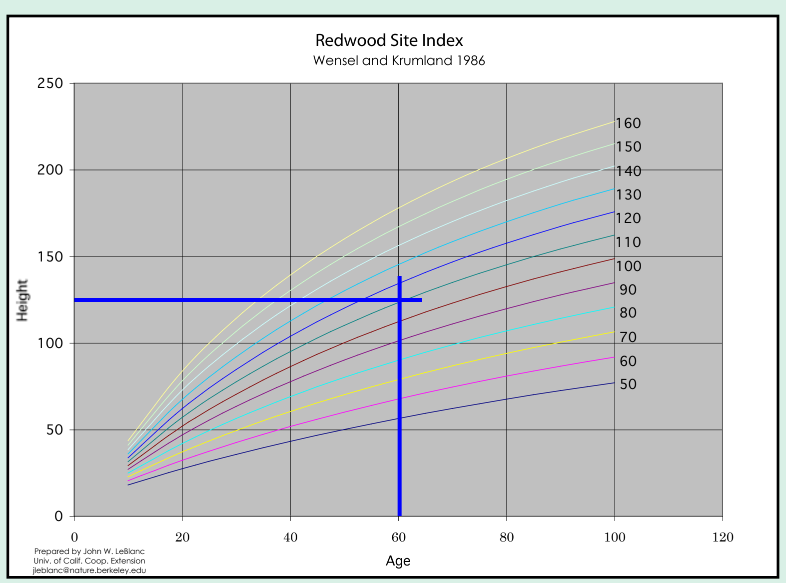
Measure the height

Using a clinometer or tree measuring stick, you can measure the height of the tree. You can also measure wind-thrown trees if they were dominant healthy trees before they fell.

Look it up

After you have the age and height of your trees, you can use a site index curve or table for the correct species to find the site index. In the example below, locate the height of the site tree on the vertical axis and draw a straight line across to the age (this 60-year-old tree is 125 feet tall). Follow the closest curved line where the two points intersect, in this case the site index is 110.

Site Index Curve—Redwood, California



Therefore, site class should only be used for comparison of sites within specific regions and forest types.

Since site class requires local information to be factored in, and taxes and timber harvest regulations are involved, you will need to rely on a Registered Professional Forester (RPF) to determine site class accurately.

Can site index change?

The only way to actually change site quality is to modify the soil or climate factors that influence tree growth. However, it is possible to grow trees more efficiently, leading to apparent rather than actual site quality changes.

Actual changes can be accomplished through activities such as fertilizing, irrigating, draining and tilling a site. Site quality can also be reduced through poor management practices and natural events that damage the soil, e.g., soil compaction, erosion, and burning.

It is also possible to achieve artificially high site index readings in managed stands, through brush control and thinning to reduce the number of trees competing for the available resources, and by using genetically superior stock. These practices can grow taller trees faster without a real change in site quality.

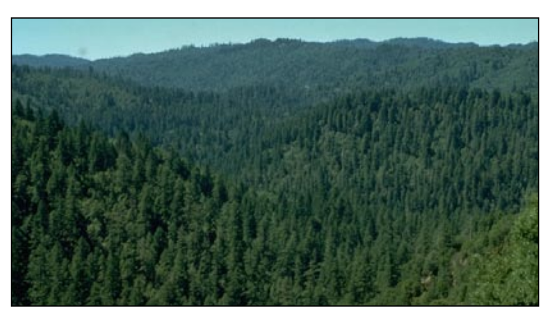
More information and resources:

• Natural Resources Conservation Service (NRCS) has soil survey maps and other information.

• California Department of Forestry and Fire Protection (CDF) for information and advice.

• *Working in the Woods–Why is My Forest the Way It Is: Site Quality* at http://www.cnr.berkeley.edu/departments/espm/extension/SITE.HTM.

• *Estimating Site Productivity on Your Woodland*, a publication prepared by Oregon State University Extension Service at http://extension.oregonstate.edu/catalog/html/ec/ec1128/.



Mona Bourell © California Academy of Sciences

Species Spotlight

Strange goings on under the soil

There is a whole exciting world under the soil that is largely invisible to us. These soil communities are an integral component of your forest with organisms that depend upon one another in strange and complex ways.

For those interested in growing healthy trees and plants, it is important to know about a special relationship that exists between plant roots and certain types of fungi called mycorrhizae (pronounced my-co-RISE-ee; literally fungus "myco" root "rhiza").

This is a symbiotic relationship, meaning that both the plant and the fungus benefit. Nearly all perennial woody plants, approximately 95% of all higher plants, depend on mycorrhizal relationships.

Mycorrhizae attach themselves to the roots of trees or other plants and help their host absorb water and nutrients. In return, the host feeds the fungi with sugars, proteins, amino acids, and other organic substances.

Fungi are made up of filaments, called hyphae. A mass of hyphae is a mycelium, which can grow very rapidly. A fungus colony can produce more than a kilometer of new mycelium in 24 hours!

This growth form has a very high surface area, one of the attributes that makes the symbiotic relationship so successful. Mycorrhizae can spread their net of hyphae far and wide in the soil, penetrating tiny spaces in the soil where plants roots can't go. They obtain water and nutrients that are passed on to the plant. In addition, fungi are also capable of breaking down, or converting, some nutrients to forms usable by plants.

Dave Pilz

Amanita muscaria mushroom (fruiting body) (left). Amanita muscaria and radiata pine mycorrhiza (below).

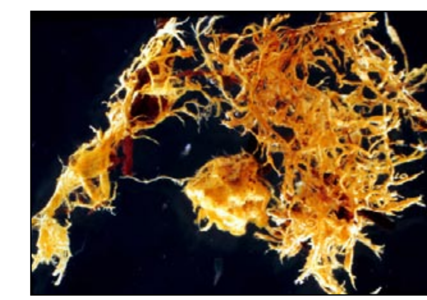
Randy Molina

Mycorrhizae are present in most soils, and are especially beneficial to plants growing in nutrient-poor soil. Without mycorrhizal fungi, plants may grow slowly or fail to thrive altogether.

Mycorrhizae may be somewhat plant specific. For example, Douglas-fir alone has some 2000 species of fungus associated with it.

There is another important and more visible benefit of mycorrhizae…mushrooms. While the main mass of a mycorrhiza fungus is found in the mycelium spread throughout the soil, the fruiting bodies are also prized. Some of our favorite mushrooms, including chanterelles, boletes, and truffles, come from these fungi.

When caring for your soil, remember that mycorrizae can be easily destroyed by many pesticides, especially fungicides, as well as fertilizers. They are also sensitive to soil disturbance. This is one more reason to treat your soil well.



Truncocolumella citrina and ponderosa pine. *Hugues Massicotte*

Douglas-fir ectomycorrhiza. *B. Zak*

Poria terrestria and Douglas-fir. *B. Zak*

Chantarelle mushroom. *Dave Pilz*

Resources

Everything you ever wanted to know about PRC 4291

Defensible space does not mean cutting down all trees and shrubs, or creating a bare ring of earth across the property. Go to ***http://www.fire.ca.gov*** *for more information.*

If you live in an area that requires defensible space clearance, you may be confused about recent changes to Public Resources Code (PRC) 4291 that expand the required clearance from 30 to 100 feet around clearings and structures.

What exactly does this mean? How much vegetation is allowed and are you doing it right?

Not to worry. There is lots of information available on the CDF website (http://www.fire.ca.gov/php/education_100foot.php)–everything from movies to brochures to checklists to a copy of the law itself.

Perhaps the most complete resource is the *General Guidelines for Creating Defensible Space,* a nine-page document with diagrams and photos that will answer most of your basic questions about defensible space.

While the guidelines recognize that fuel reduction standards will vary throughout the state due to California's diverse geography, there are some common practices to guide fuel modification treatments. These include:

- Properties with greater fire hazards require more clearing. This includes lands with steeper terrain; with larger, denser, and more volatile fuels; and in locations subject to frequent fires.
- Defensible space usually means reducing, separating, and trimming fuels. Remove dead vegetation and prune lower limbs.
- Arrange trees, shrubs and other fuel sources in a way that makes it difficult for fire to transfer from one source to another. This does not mean you have to cut down all trees and shrubs, or create a bare ring of earth across the property.
- The homeowner's clearing responsibility is limited to their land. While property owners are not required to clear beyond 100 feet from buildings or structures, groups of owners are encouraged to create community-wide defensible spaces.
- Activities that remove vegetation must comply with all Federal, State, or local environmental protection laws, and obtain permits when necessary. Environmental protection laws include, but are not limited to, threatened and endangered species, water quality, air quality, and cultural/archaeological resources.
- Use care when operating equipment to create your defensible space, keep soil disturbance to a minimum, and help protect wetlands.

If you still have questions, contact your local CDF office and talk to a live person.

Technical Assistance

Many agencies are available to provide technical assistance, referrals, information, education, land management plan assistance, and advice.

California Stewardship Helpline
1-800-738-TREE; ncsaf@mcn.org

California Dept of Forestry & Fire Protection
Forest Landowner Assistance Programs
Jeffrey Calvert
916-653-8286; jeff.calvert@fire.ca.gov

Forestry Assistance Specialists
Jill Butler (Santa Rosa) 707-576-2935
Gary Whitson (Fresno-King) 485-7500 x107
Ed Cranz (Placer) 530-889-0111 x128
Mary Huggins (S. Lake Tahoe) 530-541-1989
Patrick McDaniel (Ama/El Dorad) 530-647-5288
Dale Meese (Butte) 530-283-1792
Alan Peters (Calav/Tuol) 209-754-2709
Rick Carr (Yuba/Nevada) 530-265-2661
Jim Robbins (Fortuna) 707-726-1258
Adam Wyman (Red Bluff) 530-528-5116

California Association of RCDs
916-447-7237
staff@carcd.org

California Dept of Fish & Game
Marty Berbach
916-327-8839; mberbach@dfg.ca.gov

Natural Resources Conservation Service
Jerry Reioux
530-792-5655; jerry.reioux@ca.usda.gov

U.C. Cooperative Extension Advisors/ Specialists
Mike DeLasaux, Plumas-Sierra counties
530-683-6125; mjdelasaux@ucdavis.edu

Greg Giusti, Mendocino-Lake counties
707-463-4495; gagiusti@ucdavis.edu

Richard Harris
510-642-2360; rrharris@nature.berkeley.edu

Gary Nakamura
530-224-4902; nakamura@nature.berkeley.edu

Yana Valachovic, Humboldt-Del Norte counties
707-445-7351; yvala@ucdavis.edu

USDA Forest Service
Sandra Stone
707-562-8918; sstone01@fs.fed.us

Calendar

June 25–28, 2006
Forest Products Society International Convention "Building Smart"
Location: Newport Beach, CA
Sponsor: Forest Products Society
Contact: 608-231-1361 x208; conferences@forestprod.org
Cost: see website
http://www.forestprod.org/confam06.html

July 9–15, 2006
Forestry Institute for Teachers
Location: Humboldt County, CA
Sponsor: N. Cal. Society of Am Foresters & others
Contact: 1-800-738-8733
http://www.forestryinstitute.org

July 11–13
Board of Forestry Meeting
Location: Sacramento
Contact: 916 653-8007
Notes: For an agenda, go to http://www.bof.fire.ca.gov/board/board_current_docs.aspx

July 18–20, 2006
California Forest Pest Council Golf Tournament and Summer Field Tour
Location: Shasta & Modoc Counties
Contact: Beau Miller 916-296-2811 or bjmiller@dow.com; Bob Rynearson 530-336-6986 bobr@wmbeaty.com

July 20, 2006
Calif Fire Safe Council Meeting–Coast Region
Meeting 9 a.m. -12 noon; field tour 1-4 p.m.
Location: East Bay Regional Park District's Trudeau Training Center, 11500 Skyline Blvd, Oakland CA
Contact: Amber Gardner coastfsc@sbcglobal.net; 1/800/372-2350
Notes: Discussions cover funding sources, environmental concerns, CWPP development, examples, and best practices. Field tour of fire prevention projects in the Oakland Hills. Space limited. For lodging, RSVP, and to reserve a space for the field tour, please contact Amber Gardner.

August 1–3
Board of Forestry Meeting
Location: Santa Cruz County
Contact: 916 653-8007
Notes: For an agenda, go to http://www.bof.fire.ca.gov/board/board_current_docs.aspx

August 10–31, 2006
Forest Stewardship Course
Location: Amador
Sponsor: UC Cooperative Extension
Contact: John LeBlanc, jleblanc@nature.berkeley.edu
Cost: TBA
Notes: 4 evening sessions and field trip

September 8–October 13, 2006
Forest Stewardship Course
Location: Plumas/Sierra Counties
Sponsor: Plumas-Sierra Counties UC Cooperative Extension & UC Center for Forestry
Contact: Mike De Lasaux 530-283-6125 mjdelasaux@ucdavis.edu
Cost: TBA
Notes: 6 evening sessions and 2 field trips

September 12–14
Board of Forestry Meeting
Location: Shasta County
Contact: 916 653-8007
Notes: For an agenda, go to http://www.bof.fire.ca.gov/board/board_current_docs.aspx

October 3–5
Board of Forestry Meeting
Location: Sacramento
Contact: 916 653-8007
Notes: For an agenda, go to http://www.bof.fire.ca.gov/board/board_current_docs.aspx

October 9–12, 2006
California Oak Symposium: "California's Oaks: Today's Challenges, Tomorrow's Opportunities"
Location: Rohnert Park, CA
Sponsor: UC Integrated Hardwood Range Mgmt. Program and others
Contact: 510-642-0095; forestry@nature.berkeley.edu
Cost: TBA
Notes: Field tours on October 9
http://danr.ucop.edu/ihrmp/symposium.html

October 25–26, 2006
Forest Stewardship Course
Location: Lassen County
Sponsor: UC Cooperative Extension
Contact: John LeBlanc, jleblanc@nature.berkeley.edu
Cost: TBA
Notes: 2 evening sessions and field trip

Forest Stewardship Courses

Don't miss these workshops!

Coming to a community near you… Forest stewardship workshops have been scheduled in Amador, Plumas, and Lassen counties (*see calendar for dates*). Additional workshops are being planned for San Diego, Los Angeles, Ventura, and Butte–dates TBA.

The forest stewarship workshops have been a great hit with all who have participated. They cover a broad range of topics to help you define your goals and manage your forest to meet those goals. Field trips provide real-world examples of the topics covered in the course.

If you are interested in a workshop near your property, contact your local UC Cooperative Extension office and copy John LeBlanc at jleblanc@nature.berkeley.

For more information on these events call the number provided or the Forest Stewardship Helpline, 1-800-738-TREE. To submit an event, contact Sherry Cooper, 530-224-4902; slcooper@nature.berkeley.edu. Find a more comprehensive calendar at the Forest Stewardship website ***http://ceres.ca.gov/foreststeward****.*

More on fire safe landscaping

See Tree Note Number 17, Fire Safe Landscaping by Jeanette Knutson-Pedersen. ***http://ceres.ca.gov/foreststeward/html/treenotes.html***.

Thanks to California's unique mix of Mediterrean climate, fire-adapted vegetation, and topography, wildfires will continue to be a major concern, especially in areas where people build homes in and adjacent to wildlands.

Since wildland fire is a natural part of our landscape, we have to find ways to live with it. Much of the focus is now on reducing damage from wildfire rather than eliminating it. While you may not be able to completely exclude fire, you have the ability to control certain features of that landscape to help protect you from fire.

Those who live in the wildand-urban interface know about Public Resources Code Section 4291, which requires a "clearance of flammable vegetation for a minimum distance of 100 feet around any structure located in a fire hazardous area." The goal is to establish a greenbelt, or buffer zone, that will slow or stop the advancement of any ground fire.

Quercus agrifolia, coast live oak, is suitable for all zones.
Beatrice F. Howitt © California Academy of Sciences

The zone approach

Landscaping for defensible space uses a zone approach. Zones 1 and 2 correspond to the area within 30 feet of the home–the greenbelt to protect the home. Zones 3 and 4 correspond to the 30- to 100-foot fuel modification area, which act as a fire break to slow down a fire.

Zone 1. This is the area closest to the home. It can be garden-like, innovative, and aesthetically pleasing. Consider low-growing plants with concrete pathways, border plantings, or rock gardens to provide additional protection. Irrigation is important to maintain higher plant moisture–drip irrigation works best. Other essential practices here include pruning out dead branches from shrubs and trees, clearing leaf litter from the ground, and pruning lower branches to increase clearance above the ground. A thin layer of organic mulch will help retain soil moisture, improve soil condition, and reduce invasive weeds.

Zone 2. Still within 30 feet of the home, this area should consist primarily of fire retardant groundcovers and fleshy succulents. Irrigation and maintenance are integral in keeping this an effective protection zone.

Zone 3. This area should have plants with low growth habit to slow a fire's flow. Use drought tolerant plants and irrigate periodically to reduce flammability.

Zone 4. This is the outermost zone of fuel modification, the transition between the home and native vegetation. In this area, native vegetation should be thinned and spaced to help reduce the lateral spread of fire.

Choose the right plants

The species of plants you choose is another way to control fire danger on your property.

Many California plants have adapted to frequent fires by developing characteristics that maximize their flammability and regeneration. These include flammable chemicals (oils, waxes, resins), multiple stems (for a large surface area), rapid accumulation of dead wood and debris, crown sprouting, rapid seed dispersal in burned-over areas, and heat-induced germination. Extremely flammable species (e.g., eucalyptus, acacias, and junipers) are not recommended for areas of high fire danger.

Fire retardant plants are less flammable than other species with the same volume of fuel. Important features that determine how readily a plant will burn include its fuel moisture and the amount of dead fuel present.

Tree Note #17, Fire Safe Landscaping, contains much more detail on this subject, including a list of suggested plants for each of the four zones. For a copy, go to http://ceres.ca.gov/foreststeward/html/treenotes.html

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❑ To save on printing costs and paper, we encourage you to get the internet version of Forestland Steward. Check here for an email copy of each issue instead of a hard copy.

Send to CDF, Forestry Assistance, P.O. Box 944246, Sacramento, CA 94244-2460.
Phone: (916) 653-8286; Fax: (916) 653-8957; email: jeff.calvert@fire.ca.gov