Forestry Challenge Instruction Manual

For Students and Teachers

August 2019

FORESTRY CHALLENGE℠

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INTRODUCTION

ABOUT FORESTRY CHALLENGE Welcome to Forestry Challenge! The Forestry Challenge is an academic event for high school students in technical forestry and current forestry topics. Since its inception in 2003, the program has grown from one event to five, a complete buildout of the program in California. Participants spend four days in the forest learning about the ecology and management of the forested landscapes that provide communities with water, recreational opportunities, wood products, and wildlife habitat. Youth benefit by better understanding the relationship of the forested environment to their community, by exposure to natural resource management as a potential career option, and by undertaking a rigorous critical thinking exercise which is timely and addresses current forestry topics such as wildfire, insects, and forest health.

OBJECTIVES Students gain scientific knowledge and learn practical skills involved in environmental stewardship, as well as understand the complexities of balancing social, environmental and economic values. Those who may have never set foot in a forest environment have an increased appreciation for the woods and a desire to incorporate outdoor activities into their lives. Students are more likely to choose a career path in natural resources and attend college. Students participate as a team representing their school and learn important lessons of cooperation, teamwork and public speaking.

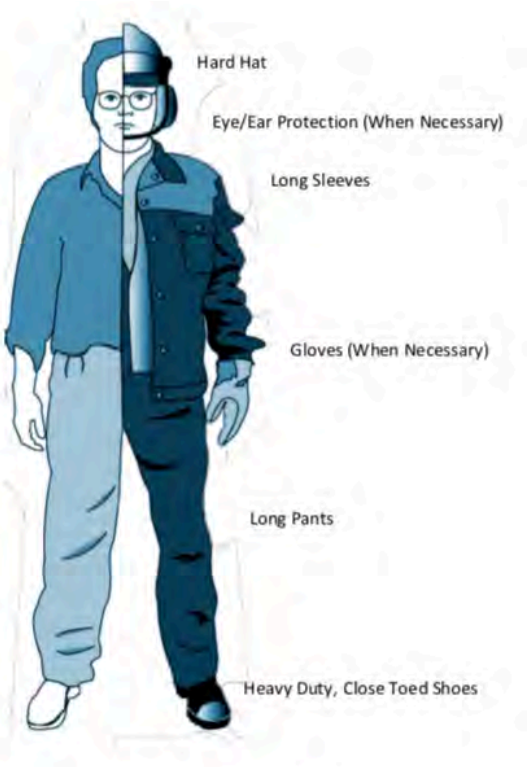
PURPOSE OF THIS MANUAL This manual is to provide instruction in practical forestry skills that will be used at the Forestry Challenge. Instruction will be provided during training at each event, but it would be advantageous to refer to this manual first and at your own pace, as event training is on a tight schedule. Supplemental instruction is highly recommended. If applicable, reach out to foresters assigned to your school and practice hands-on skills as much as possible.

PREPARING FOR FORESTRY FIELD WORK

Before entering the field, it is important to know the hazards that are present and to properly prepare yourself so that you can safely conduct your work.

PPE

Personal Protective Equipment (or PPE) is the first step in readying yourself to enter your work environment. PPE includes items like hard hats, gloves, safety glasses, earplugs/earmuffs, and more.




Uneven Terrain


Stinging Insects


Snags/Falling Branches


Barbed Wire


Rattlesnakes


Poison Oak

HAZARDS

PPE is important in most fields of work where you may find yourself in the outdoors or industrial area. Each environment is unique, though, in the types of hazards that are present. Before heading out, be sure to take into account what you might encounter. Things like snakes, poisonous plants, and stinging insects can vary. Be aware of your surroundings.

LOG SCALING & TIMBER CRUISING

Log scaling is the determination of the gross and net volume of logs. The primary purpose of scaling is to determine the volume by product or species that will be charged at a predetermined rate, also known as "*scaling for payment"*. *(USFS)*

Log volume is expressed in **board feet.** A board foot is equal to a 12-inch by 12-inch board that is 1-inch thick.

In order to determine the volume of a log, **length** and **diameter** are needed. Length is measured in feet and diameter is measured in inches.

When scaling a log, things like species, defect, shape, taper, bark thickness, and trim allowance are all taken into the final, net volume.

While these more precise measurements are taken *after* a tree has been felled and delivered to the mill, gross board foot volume can still be measured in a standing tree. This is called **timber cruising**, and it is what we will be doing at Forestry Challenge.

Length and diameter are still needed to determine the volume of a standing tree. Diameter is measured at **4 1/2 feet above the ground**. This is referred to as **diameter at breast height** or **dbh**. The height of a tree is generally measured from the ground to the top of the tree - or sometimes to an 8-inch or 6-inch “useful” top. For purposes of Forestry Challenge, we will be measuring to the very top of the tree. Once both measurements are taken, a **volume table** is used to find the total board foot volume in the tree.

To find diameter at breast height (dbh), there are a couple commonly used tools.

Also known as a **d-tape**, a **diameter tape** is a measuring tape with specifically calibrated measurements for finding the diameter of a tree (this is not your typical 12-inches/foot measuring tape). Measurements are expressed in what is known as “Pi Inches”. This allows the user to

measure the diameter of a tree using the circumference without any further calculation. You may also use a **logger's tape**. Generally, in addition to the diameter inches on one side, a logger's tape can also measure in feet and tenths of inches on the reverse side of the tape. On either of these tapes, you should find a hook at the end of the tape which can hold its place in the bark of the tree to aid in measure the tree without additional help.

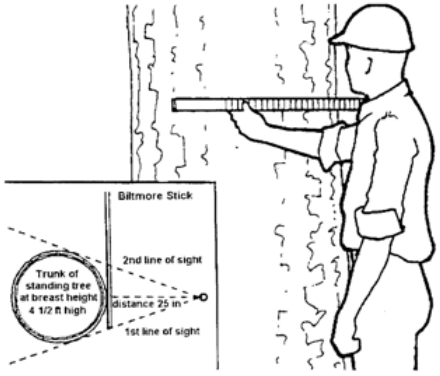
To find diameter, first find breast height by measuring 4 1/2 feet up the trunk from the ground (from the uphill side of the tree, if applicable). Next, place the tape's hook into the bark at that height and wrap the tape around the trunk of the tree, keeping it level as you go. Your measurement is the number where the tape comes back around and crosses the "0" mark.

The next tool you can use is called a **Biltmore stick**. While considerably less accurate than a logger's or diameter tape, it can still serve as a good estimate, especially if it is the only tool you have on hand. A Biltmore stick has four sides. It can be used to determine the number of logs in a tree, diameter, board feet (Scribner decimal C scale), and also serves as a 25-inch reach.

To estimate diameter with a Biltmore stick, first, use the 25-inch scale to position your eye 25 inches from where you have measured breast height. Holding your head still, line up the left end of the rule with the left side of the tree. With the same eye and still holding your head steady, look to where the right side of the tree crosses the rule. This is your diameter.

Biltmore Stick

Measuring Diameter



To Measure Diameter

1. Diameter is measured at what is called Diameter Breast Height (DBH). This is 4.5 ft. (1.37 m) up the trunk from the ground. If the tree you are measuring is on a slope, diameter should be taken at 4.5 ft. (1.37 m) on the uphill side of the tree.
2. Hold the Biltmore stick against the tree at DBH, 25 in. (62.5 cm) from your eye. Make sure the edge of the stick that reads diameter is facing you.
3. Sight past the zero end of the stick and the edge of the tree.
4. Without moving your head, shift your eyes to other side of the tree and read the black diameter mark nearest to your line of sight.
5. Tree trunks usually are not round. If a trunk is very much out of round, you should measure both wide and narrow diameters and take the average of the two.

Next, you will need to find the total height of the tree. The best tool for this is a **clinometer**. A clinometer with Percent and Secant scales can be used to measure heights of things like trees and buildings, as well as measuring angles and slopes.

To use a clinometer, keep both eyes open and hold the tool up to your sighting eye (typically recommended is the right eye unless the left is more comfortable for you) with the lanyard positioned below the lens opening. Without obstructing your view with your supporting hand, look directly at your target alongside the clinometer with your left eye and through the lens of the clinometer with your right eye. An optical illusion is created and the horizontal sighting line will appear to project outside of the clinometer housing. Place this sighting line on your target and read the scale.

Height Measurements On Level Ground And Above a Tree

Using the percent scale and horizontal baseline distance convenient for you to see both the top and bottom of the tree, follow these simple procedures. Back away from the tree the baseline distance. In this example, 80'. Sight the top of the tree and read the % scale (63%). Sight the bottom of the tree and read the % scale (-7%). Subtract the bottom reading from the top reading: 63% -(-7%) = 70%. To obtain tree height, simply multiply this percentage times your horizontal baseline distance. 70% x 80' = 56' tree height. (See Figure 1.)

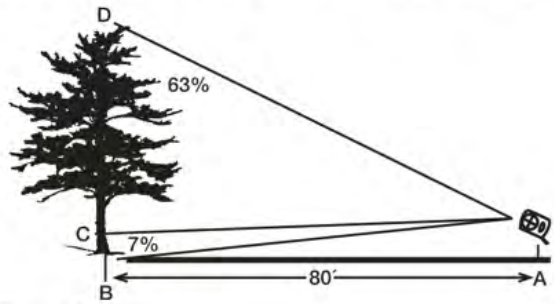
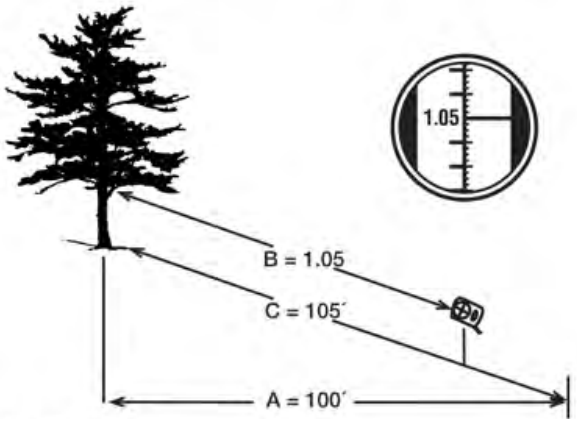


Figure 1

Using a Secant Scale Clinometer To Determine Horizontal Distance On Sloping Ground

To find an unknown horizontal distance (C), divide the measured slope distance (A) by the secant value of the slope (B). For example:

100 ft. ÷ 1.05 = 95.24 ft. (horiz. distance).
(See Figure 3.)



Again, while less accurate than a clinometer, a Biltmore stick can be used to measure height as well. A Biltmore stick is able to measure a tree in log lengths (or 16’ lengths). By determining the number of logs in a tree, you can estimate the height.

Biltmore Stick
Measuring Height

To Measure Height

1. Stand 66 ft. (20.12 m) from the tree so that --
   - you are about on a level with the base of the tree. Wa!k out across the slope instead of up or down slope from the tree.
   - the tree is not leaning away from you.
   - you can see the top up to its merchantable height. If you are measuring for sawlogs, the merchantable height is the point where the top is 6 in. (15 cm) in diameter. For pulpwood, merchantable height is to a 3.6 in. (9 cm) diameter top; and for firewood, it is an 3.2 in. (8 cm) diameter top. Practice estimating these top diameters by standing back from a tree with a known diameter of 6, 3.6, or 3.2 inches (15, 9, or 8 cm) and comparing this to the tops of other trees.

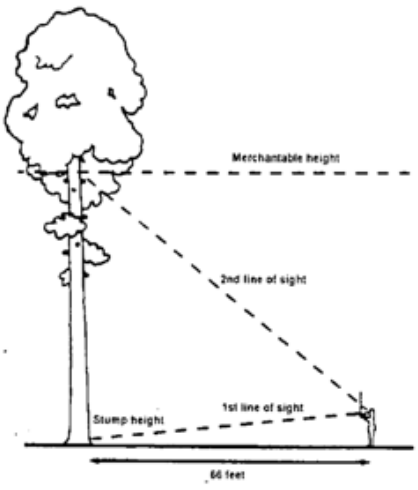
2. Hold the stick vertically 25 in. (62.5 cm) from your eye with the lower end approximately at eye level and with the scale for measuring heights facing you.

3. Line up the zero end of the stick with the stump height - the height of the stump if the tree were cut. This is usually not more than 1 ft. (.3 m) from the ground.

4. Without moving your head or the stick, raise your eyes and sight to the merchantable top.

5. The nearest log mark or meter is the merchantable height of the tree.

Practice measuring heights and diameters to develop your skill before recording actual measurements from your plots.

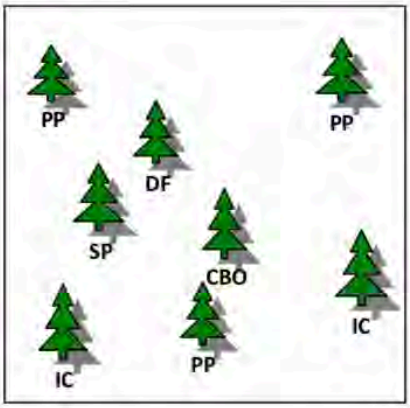


SPECIES COMPOSITION

One of the basic skills needed in forestry is determining species composition. Species composition is a determination of the tree species present in one place in the forest and their proportion to each other.

First, it is necessary to be able to identify the species that you would expect to find in a particular forest. For whichever event you are attending, you will need to be able to identify the list of species given on the Learning Resources page.

A 1/10 acre square plot will be used. You will see four stakes in the ground, forming a square with 66 foot sides. You will walk through the plot and identify each tree with a DBH (Diameter at Breast Height) of 10 inches or more. The test will have a space for you to write each species and tally the number of trees of each species that are present in the plot. Here is an example:



The test will have the following text:
"*The area marked on its corners with stakes and flagging tape is one square chain, or 1/10 acre. Conduct a Species Composition Survey on this plot by identifying and counting by species all trees with a DBH of 10 inches or more.*"

The answer for this plot would be as follows:

Species:	Ponderosa Pine	# trees:	3
Species:	Incense Cedar	# trees:	2
Species:	Sugar Pine	# trees:	1
Species:	Douglas Fir	# trees:	1
Species:	California Black Oak	# trees:	1

This site is **PINE** dominant.

BASAL AREA

Basal area is commonly used by foresters as a simple measured estimate of the density of a stand of trees. It is a measure of the cross-sectional area of a stand of trees at breast height and is expressed in square feet per acre. In other words, think of Basal Area as slicing all trees on a given plot at breast height, then adding the cumulative area of diameters at the point where all trees were cut.

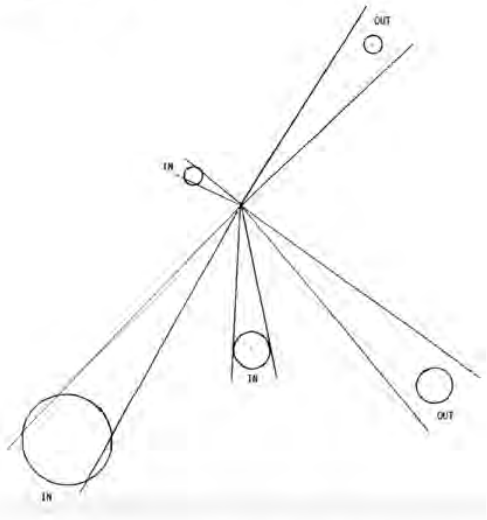
To calculate the basal area of an individual tree:
Basal area (BA) = 0.005454 x DBH(sq)
(DBH = diameter at breast height, or 4.5 feet above the ground)

To determine basal area on a per-acre basis, you can use an angle gauge of a known basal area factor (BAF). Using a known BAF, each tree measuring “in” on the angle gauge counts as one multiple of a predetermined BA. For example, using a BAF 40 angle gauge results in each “in” tree representing one multiple of 40 ft2/ac of BA.

To estimate basal area per acre:
Basal area/acre (BAacre) = (number of “in” trees) x (BAF)

During Forestry Challenge, you will be using an **angle gauge** to determine basal area in variable radius plots. It is used to determine which trees to measure (or which trees are “in”). To use an angle gauge, hold the end of the chain to the outside of your eye with one hand. With your other hand, hold the plexiglass at the other end of the chain fully extended in front of your eye. Keep the chain extended during the entirety of use. Stand at the center of your measurement plot keeping your eye centered in space above this point. As you pivot in a circle around this point, note which trees are “in” (see graphic). Once you have completed the measurement (be sure not to overlap as your finish your circle), use your total number of “in” trees in the formulas above to find your plot’s basal area and calculate basal area per acre.

Angle Gauge



INCREMENT BORER

An **increment borer** is a tool used to estimate the age of a tree. By "boring" into the tree and taking a sample, you can count the number of annual growth rings in the cross section and determine the age.

Increment Borer

Align the borer bit and the handle so that the bit will penetrate through or towards the center of the tree and at right angles to the tree. In any other alignment, the annual growth rings seen in the extracted core will be distorted and could result in erroneous growth rate analysis.


Right


Wrong

Place the borer bit threads against the tree (Fig.1, right), preferably in a bark fissure where the bark is thinnest. Hold the threads in place with one hand. With your other hand push forward on the handle and simultaneously turn it clockwise until the bit threads penetrate the wood enough to hold the bit firmly in place.


Fig. 1

Then place both hands, palms open, on the ends of the handle and turn the handle clockwise until the bit reaches the desired depth (Fig. 2).

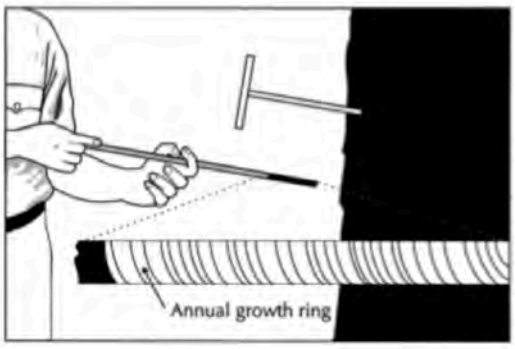

Fig. 2

With the bit at the desired depth, insert the full length of the extractor, concave side down like this ⌒ (Fig. 3). Then turn the handle one-half turn counterclockwise to break the core from the tree and also to turn the extractor concave side up like this ⌣.


Fig. 3

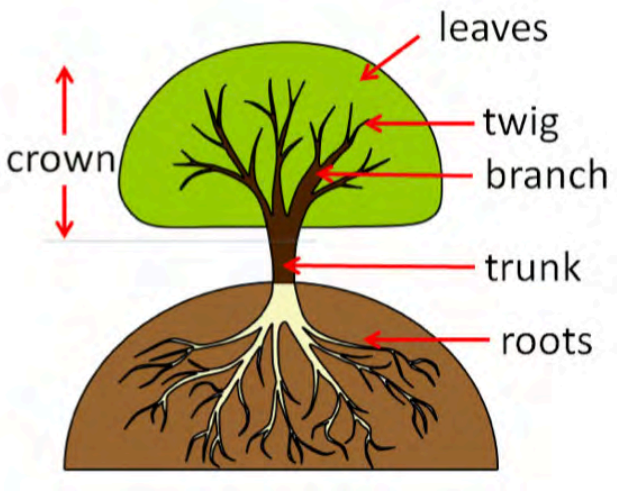
Pull the extractor from the borer bit (Fig. 4). The core will be resting in the channel and held in place by the small "teeth" at the tip of the extractor. Before examining the core sample, promptly remove the borer bit from the tree. Clean it and place it and the extractor back in the handle.


Fig. 4



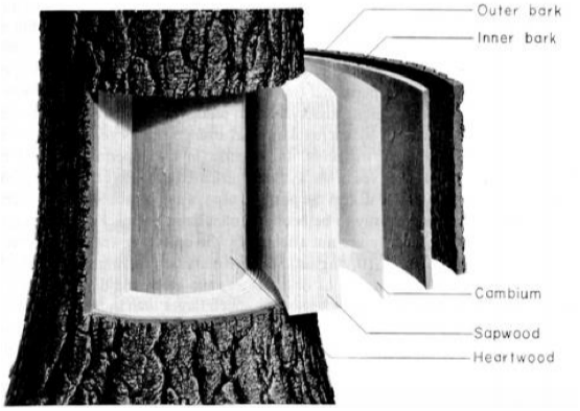
BOTANY AND PLANT IDENTIFICATION

PARTS OF A TREE



ROOTS - A tree's root system pulls nutrients and water from the soil and carries it to the trunk for distribution through the tree. A tree that grows tall and thick like a redwood needs a root system that grows thick and deep to anchor it. Trees that grow in desert climates tend to have long, tendril-like roots that stay near the surface of the soil to catch rain more easily. Roots tend to grow to the size and depth needed to adapt to water levels in the soil. When a seedling forms, a taproot grows straight down and sub-roots grow off it. As the tree develops, a number of central taproots grow and the root system becomes a fibrous root system with many branches supporting and feeding the tree.

TRUNK - Once the water and minerals pass through the roots and reach the trunk, they're carried up through the outer layers of the tree just below the bark. The trunk doesn't just transport water and minerals up from the ground, it also carries sugars from the leaves down to the roots to support and feed the root system. The trunk is the central support system for everything that happens in the tree. It's also the part of the tree that's harvested for lumber and to make paper.

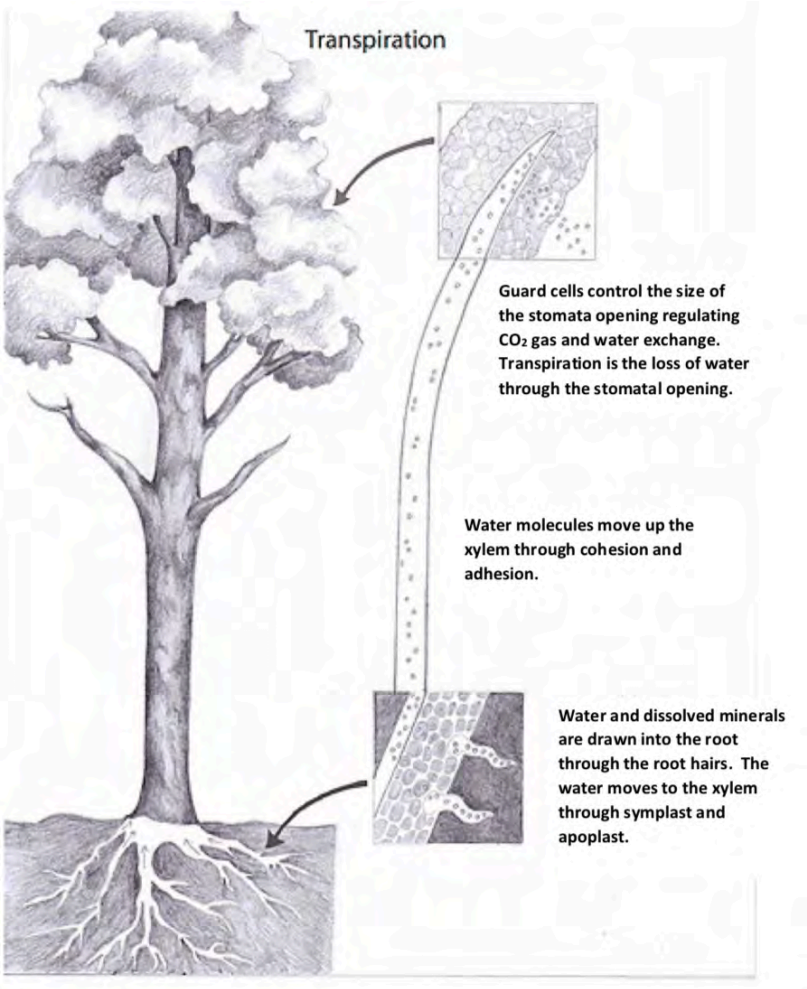


THE FOUR LAYERS - Within the trunk there are four layers. Starting from the center there's heartwood, xylem (sapwood), cambium and phloem (inner bark). The heartwood is a hard core of old xylem layers that have died and become compressed by the newer outer layers. The xylem is also called sapwood and carries water and minerals up the trunk. The

cambium is a thin layer where new cells develop to either become xylem, phloem or more cambium. A cambium layer is turned into xylem once per year and this creates an annual ring around the trunk. Just outside the cambium, the phloem (inner bark) transports sugars from the leaves down to the roots and as it dies, it forms the bark.

CROWN - Above the trunk is the crown. The crown is all the branches and leaves on the tree. The crown is the powerhouse of the tree. The leaves take in sunlight which reacts with the green chlorophyll to transform light into sugars. The process is called photosynthesis and the byproduct is oxygen released into the air. Photosynthesis occurs whether the leaves are broad and flat like a simple leaf or thin and pointed like needles. Leaves vary widely, but they all perform photosynthesis to feed the tree. Not only does the crown produce the sugars the tree needs to survive, it also filters dust from the air and protects the soil below from excessive erosion from rainfall.

TRANSPIRATION



PLANT IDENTIFICATION

The ability to identify trees and plants as a forester is crucial. While hands-on learning is the best way to become familiar with flora identification, it's always a good idea to start with the basics like terminology and morphology.

Morphology is the study of the physical form and external structure of plants. When you look at a plant, it has distinguishing characteristics like size, leaf shape, flower color, etc.. Being able to analyze and differentiate these characteristics is the basis of plant identification. In woody plants like trees and shrubs, leaves are often the best way to identify the plant since they are so easily observed.

Leaves typically consist of two parts, the **blade** and the **petiole**. The blade is the more obvious part of the leaf. The petiole attaches the blade to the stem of the plant. At the point where the petiole attaches to the stem, you will find an **axillary bud**. It is not always easy to find the bud at the base of a petiole, it may not be visible early in the growing season and sometimes a mature bud is "hidden", such as being enclosed by the petiole base.

LEAF TYPES

Leaves can be divided into two basic categories: **broad** and **needle-like**. This is the most basic way to begin identifying a plant.

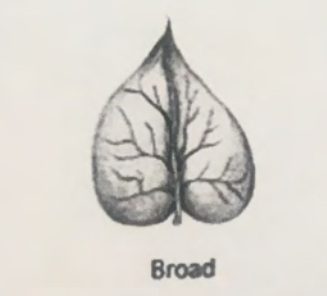
Coniferous trees have **Needle-like** leaves. Needle-like leaves are not limited to single or bundled needles like those that are found on pine or fir trees. Needle-like also includes **scale-like** and **awl** shaped leaves.

Scale-like leaves are usually small, short and overlap; Often scale-like leaves are displayed as two, three or four per node. A hand lens or low power microscope is often necessary to make this determination.

Needles are attached to twigs in several ways:

Single - attached directly to the twig. Commonly found in fir trees.

Bundles - needles are grouped in bundles that are attached to the twig via a **fascicle**; often there are 2, 3, or 5 leaves per fascicle. A single tree usually has the same number of needles per bundle. Commonly found in pine trees.



Broad leaves are generally what comes to mind when you think of a “leaf”. These types of leaves come in many shapes, variations, and arrangements. Veins are commonly visible.

TYPES OF BROAD LEAVES: **simple** and **compound**.

A **simple** leaf (pictured at right) consists of one single blade, with or without a petiole, coming from the stem where the axillary bud is located.

A **compound** leaf consists of three or more **leaflets** and a single petiole coming from the stem where the axillary bud is located. Each individual leaflet does NOT have a bud, only the leaf as a whole does.

There are several types of compound leaves. The common ones are **palmately** and **pinnately**. Palmately compound leaves have three or more leaflets attached at the end of the stalk (petiole) (like fingers on our hands, pictured above left). Pinnately compound leaves have a number of leaflets attached along a central stalk (like you see pictured at right).

LEAF ARRANGEMENTS: **opposite**, **alternate**, and **whorled**.

Leaves that are arranged in an opposite pattern are attached at the same location on a stem, opposite to one another on either side of the stem.

Alternate leaves have a single leaf attached at one location on the stem. They often alternate as you move along the stem from one side to the other.

The third type of leaf arrangement is whorled. While less common, the leaves will radiate from a single point on the stem on multiple sides, similar to a circular pattern.

LEAF MARGINS

Another important leaf characteristic is the edge or **margin** of a leaf or leaflet. Leaves have either smooth edges (entire) or small notches or “teeth” along the margin. Teeth may occur at the base of a leaf, at the tip, or along the whole margin. The teeth may vary in number and size.

Other terms to describe margins include **single serrate** and **doubly serrate**.

Leaves may or may not be lobed. A **lobe** may be defined as a curved or rounded projection. With leaves there is no clear distinction between shallow lobes and deep teeth. A main vein is often visible in a lobe, this may not occur in teeth.

Other leaf characteristics to consider, especially if using a botanical key:

over all shape (e.g., elliptic, lanceolate, linear, obovate, oblong, etc.)
shape of base (cuneate [wedge shaped], cordate, rounded, etc.)
shape of apex (abrupt, acuminate, acute, emarginate, mucronate, etc.)
pattern of venation (e.g., parallel, net-veined, etc.)
surface properties (e.g., pubescent, glabrous [smooth])
odor when crushed (strong, foul, absent, etc.)

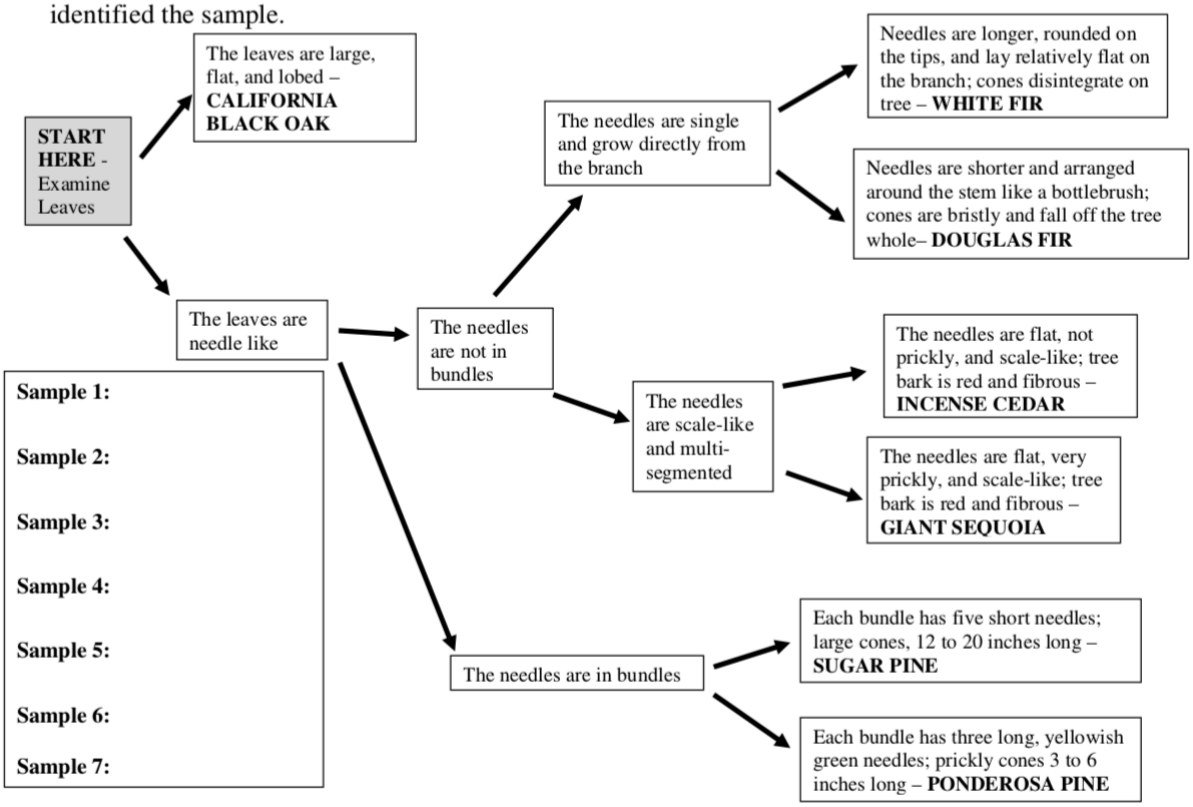
Non-leaf characteristics are also useful in attempting to identify woody plants, these include:

Flower type, color, and showiness.
Fruit type, shape, and color when ripe.

To identify an unknown plant using the characteristics described above, in addition to others, one could use a traditional dichotomous key.

Forestry Challenge Tree ID Using a Key

Directions: Using a foliage sample (and cone, if available) of the tree you want to identify, start at the gray box and answer each question, which will move you to another box until you have identified the sample.



STAND DESCRIPTION

I. TERMINOLOGY OF FORESTS AND STANDS

An important concept often misunderstood in forestry is the difference and utility of the terms forest and stand. Remember that the stand is the unit which is of interest in silviculture. The forester practices silviculture on stands, not on forests. The following terms and definitions will serve to clarify the concept of stands as used by silviculturists.

1. Forest – A plant association predominantly of trees or other woody vegetation, a collection of stands.
2. Stand – An aggregation of trees or other growth occupying a specific area and sufficiently uniform in species composition, size, age, arrangement, and condition as to be distinguished from the forest or other growth on adjoining areas.
3. Stand Species Composition – The composition of stands is conceived of as being either pure or mixed. These are defined as:
   (a) Pure Stand – A stand in which at least 80% of the trees in the main canopy are of single species.
   (b) Mixed Stand – A stand in which less than 80% of the trees in the canopy are of a single species.
4. Stand Density – The density of stocking expressed in number of trees, basal area, volume, or other criteria, on a per-acre basis. In addition, stocking is further modified and defined as:
   (a) Fully stocked stands – Stands in which all the growing space is effectively occupied but which still have ample room for development of the crop trees.
   (b) Overstocked stands – Stands in which the growing space is so completely utilized that growth has slowed down and many trees, including dominants, are being suppressed.
   (c) Understocked stands – Stands in which the growing space is not effectively occupied by crop trees.
5. Stand Form – Stands are usefully described and considered from the standpoint of the age classes of which they are composed. Generally, two stand forms are recognized. These are:
   (a) Even-aged stands – Stands in which there exists relatively small age differences between individual trees.
   (b) Uneven-aged stands – Stands in which there exists relatively large age differences between individual trees. At least 3 age classes are present. A similar term is all-aged stand.
6. Stand Origin – Stands may be classified by origin; whether from seed or sprouts and suckers, or a combination of the two. Also descriptive of origin are natural or planted, and virgin or second growth.

II. TERMINOLOGY FOR INDIVIDUAL TREES

The previous concepts and terms apply in a general sense to stands and are useful in the description thereof. However, to adequately describe stands, it is necessary to employ terms which are descriptive of some characteristic of the individual trees within the stand. Some of the more common ones are given in the following:

1. Tree Size Classification – The timber species are conveniently designated by certain size classes through their life development. They are:
   (a) Seedling – from germination to 2 inches d.b.h.
   (b) Sapling – from 2 to 4 inches d.b.h.
   (c) Pole - from 4 to 12 inches d.b.h.
   (d) Standard – from 12 to 24 inches d.b.h.
   (e) Veteran – over 24 inches d.b.h.
2. Crown Classification - Trees in even-aged stands are classed on the basis of crown position in the canopy by a simple method which has long been standard procedure. These four classes are:
   (a) Dominant – Trees with crowns extending above the general level of the crown cover and receiving full light from above and partly from the side; larger than the average trees in the stand, and with crowns well developed but possibly somewhat crowded on the sides.
   (b) Codominant – Trees with crowns forming the general level of the crown cover and receiving full light from above but comparatively little from the sides; usually with medium sized crowns more or less crowded on the sides.
   (c) Intermediate – Trees shorter than those in the two preceding classes, but with crowns either below or extending into the crown cover framed by the codominant and dominant trees, receiving a little direct light from above, but none from the sides, usually with small crowns considerably crowded on the sides.
   (d) Suppressed – Trees with crowns entirely below the general level of the crown cover receiving no direct light either from above or from the sides.
3. Tolerance – This is an important concept in silviculture which is generally defined as the ability or capacity of a tree to develop and grow in the shade of and in competition with other trees. Species are generally ranked by the broad classification of being either tolerant or intolerant.
4. Site Class or Site Quality – This is an additional concept of classification used freely by silviculturists when considering stands. It is defined as a designation of the relative production capacity or quality of a site (location or place). The volume or the average height of dominant and codominant trees at a given age is usually used as standard for classification.
5. Crown Percent – This is a descriptive tree term and is simply the percentage of crown length compared to total height.

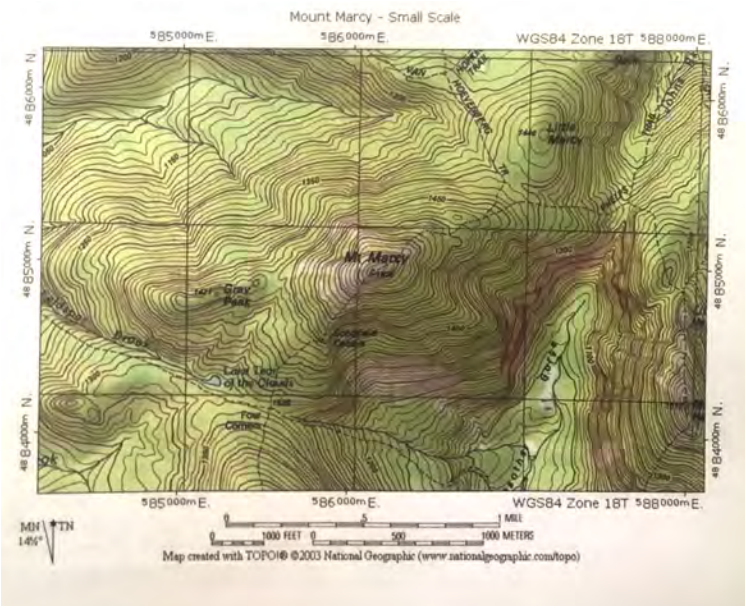
CALIFORNIA FOREST COMMUNITIES

During the Forestry Challenge, you will need to know the distribution of the following forest types: Douglas-fir, Redwood, Ponderosa Pine, and California Mixed Conifer.

MAP, COMPASS, & PACING

TOPOGRAPHIC MAPS

Contour lines: Contour lines indicate a constant elevation as they follow the shape of the landscape. Generally, every fifth contour line is printed on the map in a darker color and marked with the elevation. The contour interval, which is the difference in elevation between one contour line and the one next to it, varies for different maps, so look at the map's key or in its margin to read what it lists as the contour interval for the particular map you're using.



Hilly areas are depicted by closely spaced contour lines, and flat areas have few - or no - contour lines. To determine whether a potential route of travel ascends or descends, look at the elevation numbers. If the route crosses contour lines marked with increasing elevations, the route goes uphill; conversely, if the elevation markers decrease, the route goes downhill.

Scale: Look to the margins of a map or to the map's key for its scale, which gives you information about the ratio between measurements on the map and the landscape's actual measurements. For example, one inch of map space may represent one mile across the land.

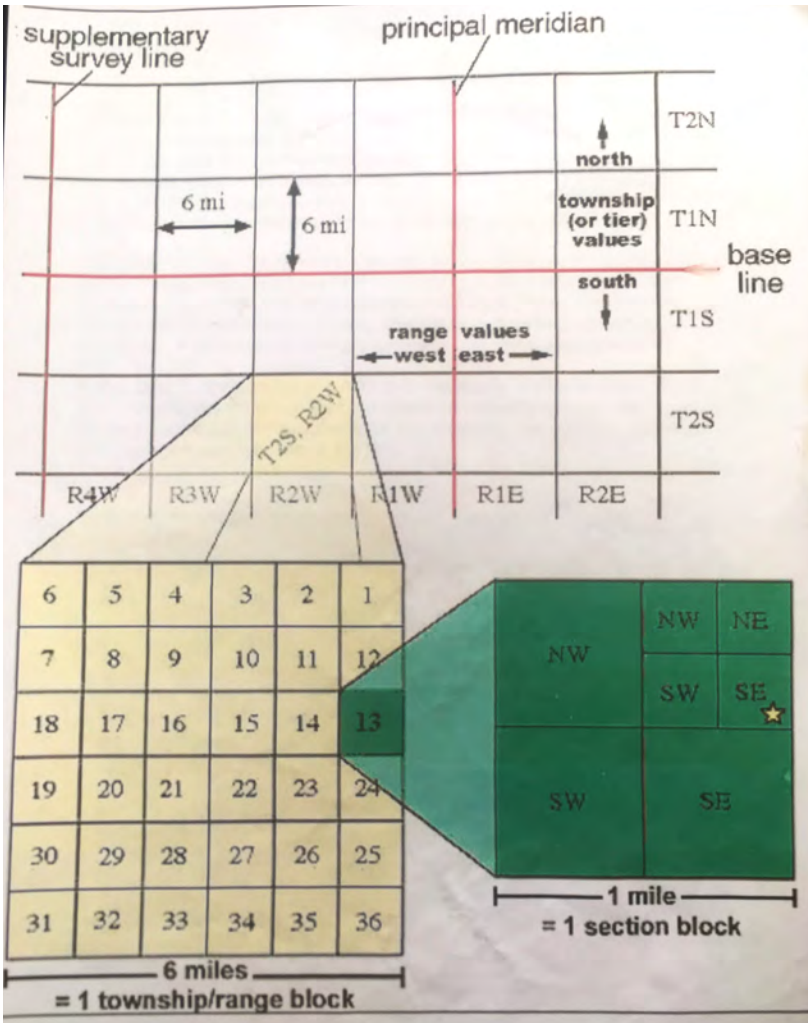
Notes to remember: • All points on any contour line have the same elevation • Summits are indicated by closed contours, with no contour lines inside.• The closer together the contour lines are to each other, the steeper the slope • The further apart the contours are, the flatter the slope • Aspect is the compass direction a slope is facing.

TOWNSHIP AND RANGE

A land survey consists of a series of parallel lines that form a grid over a state. The land survey starts at a point called the “initial point.” An east-west line is established from this point and is called the “Base Line.” The north-south line is established and is called the “Principal Meridian.”

The state is subdivided by lines running at six-mile intervals, both parallel to the Base Line and to the Principal Meridian. The lines running east-west are called Township (T) lines and are numbered consecutively North (N) and South (S) of the Base Line. The first line north of the Base Line is Township 1 North (T. 1 N.) and the first line south of the Base Line is Township 1 South (T. 1 S.).

The lines running north-south at six-mile intervals are called Range (R) lines and are numbered consecutively East (E) and West (W) of the Principal Meridian (PM). Range 1 East is the first column to the right (east) of the PM. Range 1 West is the first column to the left of the PM.



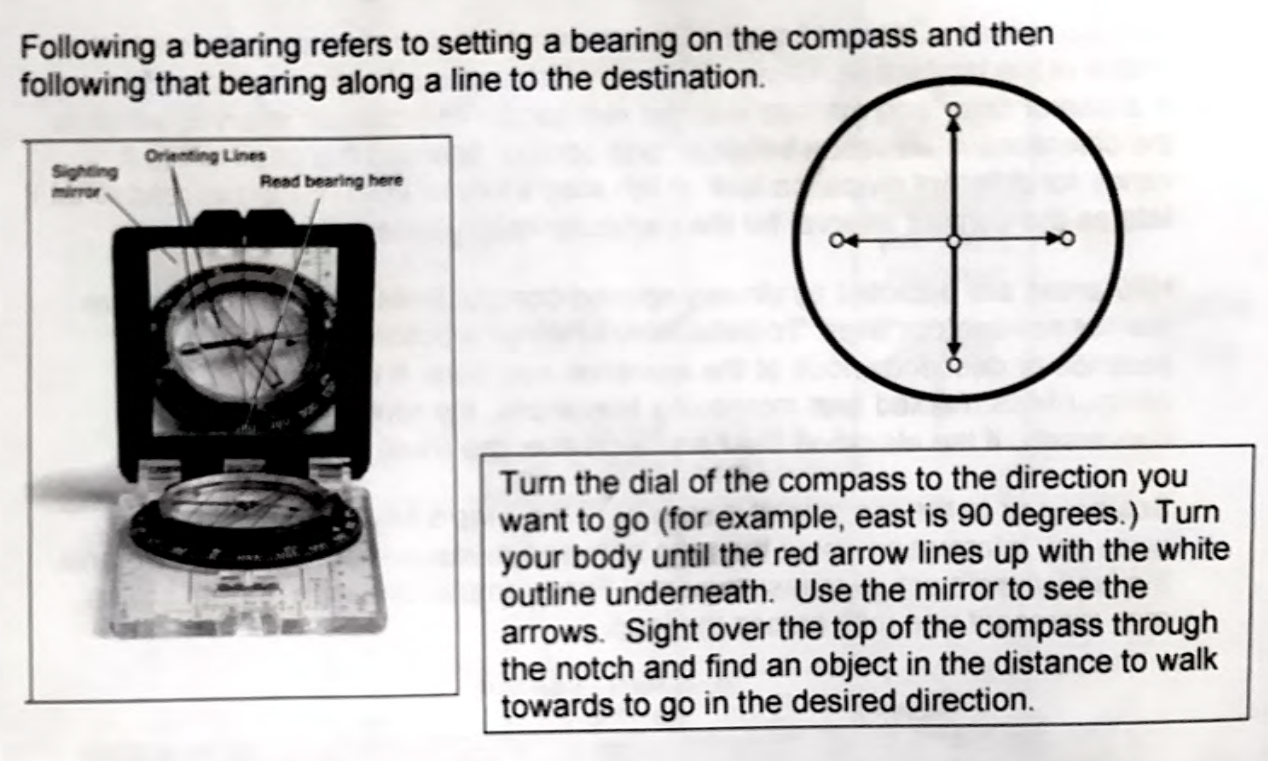
When you combine township lines and range lines on the same map, it makes a grid of squares that are each six miles square. Each square is called a township.

Townships (which have 6 miles per side) are further subdivided into 36 square miles called sections. Each section is one square mile and contains 640 acres.

COMPASS READING TO GET A DIRECTIONAL HEADING

PACING

Pacing is a technique of measuring distances by knowing the length of your pace and counting the number of paces you take. Typically, a **pace** is two steps. You may choose to count your pace as either one or two steps, whichever is easier for you. During Forestry Challenge, there



will be a pacing contest. A 66' (one chain) template will be set up for you to practice. The winner will be determined by the school who can pace out a distance closest to 66'. Knowing your pace - and how many it takes to pace 66' - will come in handy during the entirety of the Forestry Challenge.

FORESTRY CHALLENGE

FOREST PRODUCTS

There are over 5,000 forest products people use daily in their lives. Here are a few examples:

SOLID WOOD PRODUCTS

- Structural Lumber
- Furniture
- Doors
- Musical Instruments
- Baseball Bats

PAPER PRODUCTS

(from cellulose, the predominant component of wood – makes up 40% of the total weight)

- Paper
- Kites
- Newspaper
- Product labels
- Paper towels
- Postage stamps
- Milk cartons

BARK OF TREES

- Cork
- Cinnamon spice
- Shoe polish
- Cosmetics
- Pharmaceuticals

TORULA YEAST

(yeast fermented from spruce wood)

- Baby foods
- Bread
- Commercial baked goods
- Imitation bacon
- Breakfast cereals

CELLULOSE

(fibrous or structural unit of wood made up of polymers, cellulose, hemicellulose, lignin and cellulose acetate)

- Rayon
- Plastic packaging
- Toothpaste
- Nail polish
- Photographic film
- Artificial sponges
- Artificial vanilla flavoring
- Hair spray
- Sausage casings

WOOD DERIVED CHEMICALS

(tree oils, resins, lignin and conipheryl- alcohol)

- Pine oil
- Turpentine
- Rosin-based adhesives
- Asphalt additives
- Epoxy additives
- Emulsifiers

OTHER PRODUCTS FROM THE FOREST

(non-wood/non-paper products)

- Fruits
- Nuts
- Mistletoe
- Carnauba wax
- Electricity (from biomass)

FORESTRY CHALLENGE

GLOSSARY

Acre – A land area of 43,560 square feet (About 209 by 209 feet).

All-aged (or uneven-aged) forest management – Management of a forest by periodically removing some trees from the stand. (See also even-aged forest management.)

Allowable cut – Volume of wood that can be cut during a given period without exceeding the forest's net growth.

Alluvial – Pertaining to material that is transported and deposited by running water.

Anadromous fish – Those species of fish which mature in the sea and migrate into streams to spawn. Salmon, steelhead, and shad are examples.

Aspect – Compass direction towards which a slope faces.

Basal area – A. Cross-sectional area (in square feet) of the trunk of one tree at breast height (4.5 feel above the ground.) For example, the basal area of one tree 14 inches in diameter at breast height is approximately 1 square foot. B. The sum of basal area of the individual trees on an acre of forest. For example, a well stocked mixed redwood stand might contain (a total of) 500 square feet of basal area per acre.

Biological diversity or biodiversity – Refers to the variety of life. It encompasses the number and type of plants and animal species in a given area, as well as the interactions among them. Biodiversity recognizes the importance not only of individual organisms but also the connections and relationships among individuals that permit them to function and thrive as a community or ecosystem.

Board foot – A unit of measure for wood volume equaling 144 cubic inches, commonly used to measure and express the amount of wood in a tree, sawlog, veneer log or individual piece of lumber. For example, a piece of wood 1 foot by 1 foot by 1 inch or one measuring 1 foot by 3 inches by 4 inches both contain 1 board of wood.

Bole – Main tree trunk. Breast height – See DBH.

California Forest Practice Act (Rules) – Also known as the "Z'berg-Nejedly Forest Practice Act of 1973." This legislation initiated the forest practice rules in California that, when followed, will allow maximum sustained production of

timber, while giving consideration to values such as recreation, watershed, wildlife, range and forage, fisheries, and aesthetic enjoyment.

Canopy – Layer of tree crowns in a forest.

Clearcut – A harvesting and regeneration system which removes all the trees (regardless of size) on an area in one operation. Clear cutting is mostly used with species that require full sunlight to reproduce and grow well. Produces an even- aged forest stand.

Commercial cut – A cutting on a forested property that yields a net income (when product sale receipts exceed cutting cost).

Competition – The struggle for environmental resources among trees that require the same resources on the same land area, usually at the same time. Crown: Competition above ground for light, heat, carbon dioxide, space, and perhaps, oxygen. Root: Competition for soil, water, nutrients, oxygen, and space.

Conifer – A tree belonging to the order Coniferales – usually evergreen, cone- bearing, and with needles, awl, or scalelike leaves- for example, pine spruces, firs, cedars, and redwood; often called “softwoods.”

Conservation – Protection, improvement and wise use of natural resources to assure the attainment of their highest economic and social values in perpetuity.

Cord – A stack of round or split wood containing 128 cubic feet. A standard cord measures 4 feet by 4 feet by 8 feet. A face or short cord is 4 feet by 8 feet of any length wood less than 4 feet. A cord contains about 85 to 90 cubic feet of actual wood and is roughly equivalent to 500 board feet of wood.

Crop tree – A tree identified as mature and ready for final harvest cut. Usually selected on the basis of its location to other trees and its quality.

Crown – Branches and foliage of a tree.

Crown class – Any class into which the trees forming a crop or stand may be divided on the basis of both their crown development and crown position relative to the crowns of adjacent trees and the general canopy. For example, dominant, co-dominant, intermediate or suppressed.

Cruise – A survey of forest land to locate timber and estimate its quantity by species, products, size, and quality, or other characteristics; the estimate obtained in such a survey.

Cubic foot - A unit of measure for wood volume containing 1,728 cubic inches – for example, a piece of wood measuring 1 foot on a side. A cubic foot of wood contains approximately 6 usable board feet of lumber rather than 12 board feet because wood is lost as sawdust and shavings during processing.

Cull – A tree or log of merchantable size useless for all but perhaps firewood because of shape, disease, insect infestation, or injury.

Cutting cycle – Planned time interval between major harvesting operations in the same stand, usually in uneven-aged stands. For example, a cutting cycle of 10 years means a commercial cut every 10 years.

DBH – Tree diameter at breast height (4.5 feet above the ground).

Defect – That portion of a tree or log unusable for the intended product and therefore, not measured. Defects are rot, crookedness, cavities, and excessive limbiness.

Diameter – Tree diameter is usually measured 4.5 feet above the average ground level (see DBH).

Ecosystem – An interacting system of living organism (plants and animals), soil, and climatic factors. A forest is an ecosystem.

Environment – Prevailing conditions reflecting the combined influences of climate, soil, topography, and biology (other plants and animals) in an area. Environmental factors determine how well a particular species will grow in a given area.

Even-aged forest – A forest of trees all essentially the same age (within 10-20 years).

Even-aged forest management – Forest management with periodic harvest of all trees on part of the forest at one time or in several cuttings over a short time to produce stands containing trees all the same or nearly the same age. In California, this type of management is commonly applied to conifers using the clearcut, seed tree, or shelterwood silvicultural systems (see definitions). (See also all-aged or uneven-aged forest management.)

Forest – A plant community with trees and other woody plants dominating.

Forest management – Giving the forest proper care so that it remains healthy and vigorous and provides the products and amenities the landowner desires. Technical: Applying technical forestry principles and practices and business techniques (such as accounting and benefit-cost analysis) to forest management.

Forest type – A group of tree species that, because of shared environmental requirements and tolerances, commonly grow together. Three examples of forest types are the mixed conifer, true fir, redwood and Douglas-fir.

Forestry – The science, art, and practice of managing trees and forests and their associated resources for human benefit.

Habitat – Local environment of a plant of animal.

Harvest – As generally used, to remove all or portions of the trees in an area. Technical definition: To remove trees in an area (1) for financial gain; (2) to develop the environment necessary

to regenerate the forest; and, (3) on occasion, to achieve some special objectives, such as the development of special wildlife habitat needs. Contrast with intermediate cut.

Hardwood – A term describing broadleaf (usually deciduous) trees such as oaks, maples, ashes, eucalyptus, and elms. Not necessarily the hardness of the wood.

IHV – (Immediate Harvest Value). Stumpage values determined by the State Board of Equalization from many timber sales in each timber value area and influenced by species, age, logging method, and volume harvest.

Increment borer – A hollow, auger-like instrument used to bore into the tree trunk to remove a cylindrical cross section of the tree's growth rings.

Intermediate cut – Removal of immature trees from the forest sometime between establishment and major harvest to improve quality of the remaining forest stand. Contrast with harvest cut. An intermediate cut may generate income (commercial cutting), or may cost the forest landowner more than income realized (a pre-commercial cutting).

Log – A piece of woody stem (trunk or limb) of a tree. The trunk portion of a tree.

Log rule – A device, usually in tabular form, that expresses log volume content base on log diameter (inside the bark of the small end) and length. The Scribner Rule is the legal rule in California and is most often used.

Log scaling – measuring logs to determine their volume.

Lop – To sever and sometimes scatter branches, tops, or small trees after
felling, leaving the slash closer to the ground.

Mature tree – A tree that has reached the desired size or age for its intended use. Size or age will vary considerably depending on the species, intended use, and markets.

MBF – Thousand board feet.

Multiple use – Land management for more that one purpose.

Plantation – An artificially reforested or afforested area established by planting or direct seeding. Contrast with a forest stand established naturally.

Pole stand – A stand of trees whose diameters range from 4 inches to approximately 12 inches.

Riparian – Referring to the land bordering a stream, lake or tidewater. Reforestation – Re-establishing a forest on an area where forest vegetation has
been removed.

Reproduction – (A) The growth process whereby young trees become the older trees in the future forest. (B) The process of forest replacement or renewal – either artificially by seeding or planting or naturally, by sprouting or natural seeding.

Roots – That portion of the tree, generally underground, which absorbs nutrients, anchors, and stores food and waste products.

Salvage cut – Harvesting trees that are infected by or highly susceptible to insects or diseases to protect the rest of the forest stand.

Sapling - A small tree, usually between 2 and 4 inches DBH.

Sawlog – A log large enough to produce a sawn product -- usually al least 10 to 12 inches in diameter at breast height.

Scribner's Rule – A diagrammatic log rule developed over 100 years ago to estimate the volume of a log assuming a 1⁄4 inch saw kerf and no definite slab allowance. However, the Rule more accurately estimates product output rather than log volume.

Second growth – A loose term for a young stand, or smaller trees, left after cutting. Also, residual trees available for another logging on the same area.

Seed-tree harvest system – Removal of all trees from the harvest area at one time except for a few scattered trees left to provide seed to establish a new forest stand. California Forest Practice rules specify the number and size to be left per acre.

Seedling – (A) A tree, usually less than 2 inches DBH, that has growth from a seed not a sprout. (B) Nursery-grown trees that have not been lifted and replanted in the nursery.

Selection harvest system – Harvest of individual trees or small groups of trees at periodic intervals (usually 8 to 15 years) based on their physical condition or degree of maturity. Produces an uneven-aged stand.

Seral – A biotic community which is a developmental transitory stage in an ecologic succession.

Shelterwood harvest system – Removal of trees on the harvest area in a series of two or more cuttings so that new seedlings can establish and grow in the partial shade and protection of older trees.

Silvicultural system – A process, following accepted silvicultural principles, whereby the crops constituting forests are tended, harvested, and replaced, resulting in the production of crops of distinctive form. Systems are conveniently classified (for example, clearcut) according to the method of carrying out the fellings that remove the mature crop with a view to regeneration and according to the type of crop produced.

Silviculture – The art, science, and practice of establishing, tending, and reproducing forest stands of desired characteristics based on knowledge of the characteristics and environmental requirements of the tree species.

Site index – An expression of forest site quality based on the height of the dominant trees at a specified age, usually 50 or 100 years.

Site preparation – Preparing an area of land for forest establishment, including mechanical clearing, vegetation control, or burning.

Skid – To pull logs from the stump to the skid trail or landing.

Slash – Residue left on the ground after logging, pruning, or other forest operations. Includes tree tops, branches, or bark. Softwood – See conifer.

Soil texture – The feel or composition of soil based on the proportion of sand, silt, and clay in the soil.

Sprout – A tree growing from the base, stump, or root of another tree. Coastal redwoods sprout vigorously.

Stand (timber types) – A community of trees of sufficient uniformity, with respect to composition, age spatial arrangement or condition, to be distinguished from adjacent communities, so forming a management entity. Fully stocked: A forest stand with all growing space effectively occupied but have ample room for crop development. Mixed: A stand having less than 80 percent of the trees in the main crown canopy of a single species. Overstocked: Overcrowding in a stand leading to retarded growth. Pole-timber: A stand with most trees from 4 to 8 or 12 inches in diameter. Pure: A stand with at least 80 percent of the trees in the main crown canopy of a single species. Sawtimber: A stand with most trees large enough in diameter (usually 10 to 12 inches DBH or larger) to be sawn into lumber. Understocked: A stand with the growing space not effectively occupied by potential crop trees.

Stocking level – Number of trees in a forest stand. Often, stocking level is the term used for the desirable number of trees at a given age for best growth and management against which comparisons can be made, such as partially-stocked, well-stocked, or over-stocked.

Stumpage – Value or volume of a tree or group of trees as they stand in the woods uncut (on-the-stump).

Succession – Replacement of one plant community by another until a climax ecosystem in achieved.

Sustained yield – The yield that a forest can produce continuously at a given intensity of management. Sustained yield management implies continuous production so planned as to achieve at the earliest practical time a balance between increment and cutting.

Thinning – Generally, a cutting in an immature forest stand to reduce the tree density and concentrate the growth potential of fewer, higher quality trees resulting in larger trees with faster growth. Commercial: A thinning that pays for itself and then provides a profit for the owner. Natural: A natural process whereby a tree's branches or the tree itself dies as a result of root or crown competition. Pre-commercial: A cutting, which does not yield a net income, usually because the trees cut are too small, poor quality, or not marketable. Row: A plantation thinning

with specified rows removed regardless of size. Selection: A thinning with individual trees selected for removal.

THP (Timber Harvesting Plan) – As a result of Article 7 of the "Z'berg- Nejedly Forest Practice Act" of 1973, a THP is required for timber operation to take place on land other than federal land within the State of California. Timber operations include the cutting or removal of both timber and other solid wood products from timberlands for commercial purposes.
Intent of the legislation is to restore, enhance, and maintain the productivity of California's timber, watershed, range and forage, fisheries, and aesthetic enjoyment.

Tolerance – A tree's capacity to develop and grow in the shade of other trees.

TPZ (Timberland Production Zone) – Created by the "California Taxation Reform Act" of 1976, TPZs were established so that forest landowners would not pay property tax on the basis of the land's "highest and best use." TPZ land is restricted to the growing and harvesting of timber and compatible uses. Lands qualify on the basis of size (minimum sizes are determined by the county in which the land is located) and productivity, as determined annually by the State Board of Equalization for different forest types and sites.

Tree – A woody plant having a well-defined stem, more or less definitely formed crown and usually at least 20 feet tall.

Tree farm – A privately-owned forest in which producing timber crops is a major management goal. Additionally, it may be recognized as a "Tree Farm" by the American Tree Farm System, an organization sponsored by the American Forest Foundation.

Volume table – A table estimating volume of wood in a standing tree based on measurements of the tree, most commonly DBH and merchantable height.

Windfall, windthrow, (blowdown) – An area or group of trees blown over by high wind.

Yield table – A tabulation of volume, basal area, and DBH for forest stands of specified site and age, showing its growth pattern.

Yield tax – Created by the "Forest Taxation Reform Act" of 1976, yield tax is a one-time tax on timber when it is harvested. The tax rate is applied to the value per volume harvested in different timber value areas throughout the state. For example, if the tax rate is 2.9 percent for each 1,000 board feet (MBF) of timber harvested and valued at $500 per thousand board feet on the stump, the yield tax would by $14.50. The tax is based on the IHV.