Maryland Roadside Tree Care Expert Study Guide

Version 3.0

Table of Contents

Introduction

This Study Guide is intended for public agency employees who are preparing to take the Maryland Public Agency Roadside Tree Care Expert exam as required by the Maryland Roadside Tree Law.

The guide has ten chapters. The exam consists of 140 multiple choice or true/false questions for a total of 140 possible points. The examinee must answer 70 percent of the questions correctly to pass, which is 98 of the 140 questions.

The Forest Service conducts one preparatory course for Maryland Roadside Tree Care Expert examinees in each region each year. This guide is information used during this course. Most of the material on the exam can be found within this study guide. This guide is intended for individual use and study. Any commercial or other use of the guide is prohibited.

Chapter 1: Tree Laws and Standards

Version 3.0

The Maryland Roadside Tree Care Expert class will discuss four of Maryland's laws that the certified Roadside Tree Care Expert is likely to encounter. They are:

1. Tree Expert Law
2. Roadside Tree Law
3. Reforestation Law
4. Forest Conservation Law

1. Tree Expert Law

Under the Maryland Tree Expert Law, any person performing or advertising commercial (for compensation) tree care in the State of Maryland must obtain a Tree Expert License from the Maryland Department of Natural Resources (DNR) Forest Service. Any person who has not obtained this license may not advertise a tree expert business, trim, or remove trees for monetary compensation, or operate a tree expert business.

To obtain a license, the applicant must possess adequate and related college education plus one year of experience under a LTE; or, have three years experience under a Licensed Tree Expert (LTE); then, have passed an exam and carry adequate amounts of liability and property damage insurance. The Department may permanently revoke or temporarily suspend the license of any LTE who is found guilty of any fraud or deceit in obtaining the license, or negligence or wrongful conduct in the practice of tree culture or care.

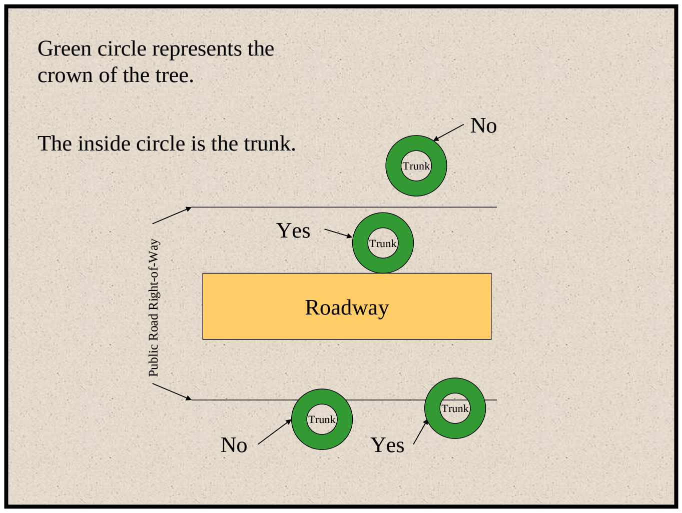
A <u>Maryland Certified Roadside Tree Care Expert</u> is someone who works for a governmental agency and supervises that agency's tree care programs and is certified by the Maryland Department of Natural Resources. A <u>Maryland Licensed Tree Expert</u> is someone who works in the private sector and is licensed by the DNR. A Certified Roadside Tree Care Expert may <u>**not**</u> operate independently of his/her public agency job in the work or business of a tree expert without obtaining a Tree Expert License.

A conviction for an offense under the Maryland Tree Expert law is punishable by a fine or up to one year imprisonment, or both, plus court costs.

2. Roadside Tree Law

The Maryland Roadside Tree Law was passed in 1914 to protect our roadside trees by ensuring their proper care and protection and their compatibility with an efficient and dependable public utility system. A Roadside Tree Care Permit must be obtained from the Maryland DNR Forest Service before a tree located in a public road right-of-way is planted, pruned, has pesticide applied, or has any other tree care applied to it.

Tree care is defined as any treatment that affects the health or growth of a roadside tree, including removal. A *roadside tree* is any plant with a woody stem that grows all, or in part, within a public road right-of-way.



Permits are a good tool to help protect our roadside trees. Permits may be requested by a person whose property abuts the right-of-way at the location of the tree or an agency charged with managing the group of trees that the tree is part of. Issuance of Tree Care Permits is important to ensure:

- Only beneficial and necessary tree trimming, root cutting, fertilization, or other maintenance practices will be done and done correctly to roadside trees.

- Tree hazards are documented and corrective action, including removal and replacement, is done in a timely and safe manner by trained professionals (Licensed Tree Experts or Roadside Tree Care Experts).

- The right tree (correct type) is planted in the right location, thereby avoiding future problems and conflicts with sidewalks, overhead and underground utilities, and sight distances.

The permit procedure requires that the **property owner** who has a roadside tree (within the public road right-of-way) in front of his/her property signs the application. If the roadside tree straddles two properties, both **owners** must sign the same application. Ownership of the tree is determined by the location of the trunk of the tree. The permit itself does not grant permission to do the tree work. Permission must be granted by the tree owner.

Maryland has adopted the so-called Massachusetts Rule that limits a landowner's remedy against encroaching vegetation to "self-help" in nearly all circumstances. A landowner must assume responsibility for the care and preservation of his or her own property. This means that a neighbor can cut back encroaching limbs or roots of an adjoining neighbor's tree to the property line, but they:

- May not destroy the tree by the pruning;
- May not cut down the tree itself;
- Must stop at the boundary line, unless they have the neighbor's permission.

Any person who trespasses and removes trees without the owners permission, unless they work for a public service company or a public roads agency, is liable for any surveys or appraisals needed, court costs that may incur, and triple the amount of the value of the trees or timber cut.

When tree care is performed on a roadside tree without a permit, a fine may be assessed or more severe actions taken by the Department of Natural Resources. A person may cut down or prune a roadside tree without a permit only if the tree:

- Is uprooted or broken and in contact with an electric line (trees in contact with electric lines, or closer than 10 feet to an electric line, must be removed by a Tree Expert certified to work near electric lines);
- Its branches are in immediate danger to persons or property;
- Stands within the right-of-way of a dedicated but unimproved road.

When root pruning or cutting trenches around roadside trees, the maximum diameter root that may be cut without approval of the Forest Service is one inch.

Roadside Tree Blanket permits are issued to **State agencies**, **counties** and **municipalities** for continuing programs of general tree care. This may also include removal of live trees if the agency has a Certified Roadside Tree Care Expert on staff. Roadside Tree Individual (RTI) permits are issued for a specific tree or group of trees for specific tree care operations. Individual projects are not covered by blanket permits.

3. Reforestation Law

When highway construction using state funds causes the cutting or clearing of one acre or more of forested lands, the Maryland Reforestation Law requires that these trees be replaced. Replacement is one acre planted for one acre removed. This law mostly affects new highway construction.

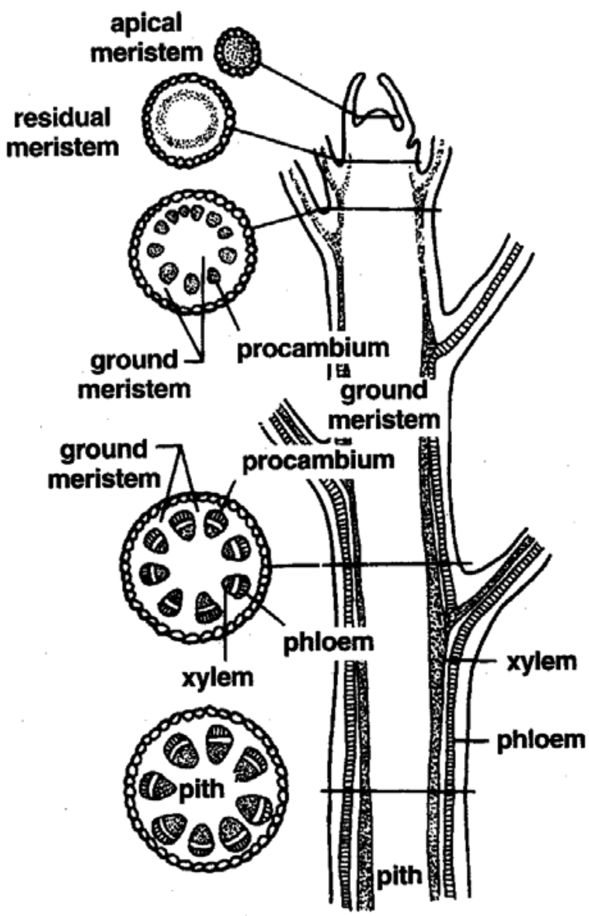
4. Forest Conservation Law

Any activity requiring an application for a subdivision, grading permit or sediment control permit on areas 40,000 square feet or greater is subject to the Forest Conservation Act and will require a Forest Conservation plan.

Chapter 2: Biology

Version 3.0

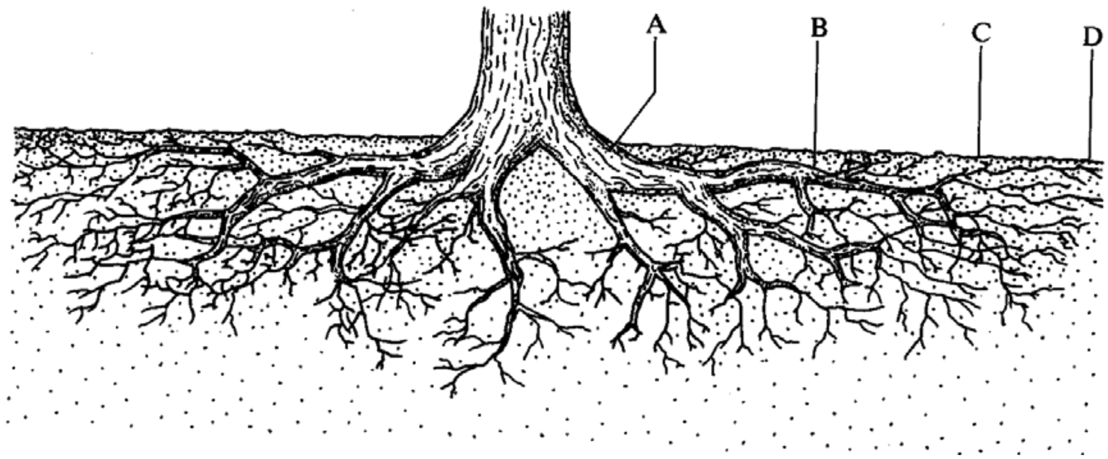
Before one can care for and manage trees there needs to be an understanding of how trees grow. Trees are made of cells, just like other living beings. These cells divide in meristematic zones of the tree and then differentiate to form various tissues such as wood. If the meristematic tissue is where cells elongate, such as the tips of branches and roots, then this is called apical meristem.



The tissues then form the five main components that make up a tree: roots, trunk or stem, leaves, fruits and flowers. Each component has specific roles in the process of tree growth.

Trees need light, water, air, nutrients and space to live and grow.

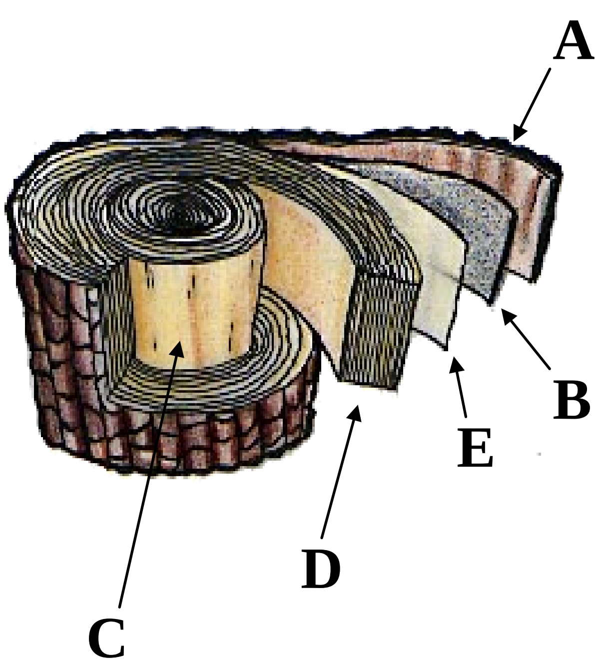
Roots serve multiple functions including anchoring the tree in the ground, storing excess starches (food), absorbing water and nutrients from the soil, producing hormones that regulate growth, and conduction. The roots system of a tree can be 1/3 to 1/2 of its total biomass.



A = The Large woody roots whose main functions are anchorage and conduction;
B = The long ropelike lateral roots whose functions include anchorage, conduction and storage;
C = The fine absorptive roots are small fibrous, primary tissues that have epidermal cells that are modified into root hairs (D);
D = The fine root hairs that aid in the uptake of water and minerals.

Many roots live in a symbiotic relationship with certain fungi. The result is termed **Mycorrhizae (fungus roots)**. The fungi derive nourishment from the roots and the fungi aid the roots in absorption of water and essential mineral elements. More information on Mycorrhizae is available in chapter 3.

The trunk, or stem, of the tree functions to provide support, conduct water and nutrients up from the roots, food produced by photosynthesis in the leaves down to the rest of the tree, and stores the excess food.

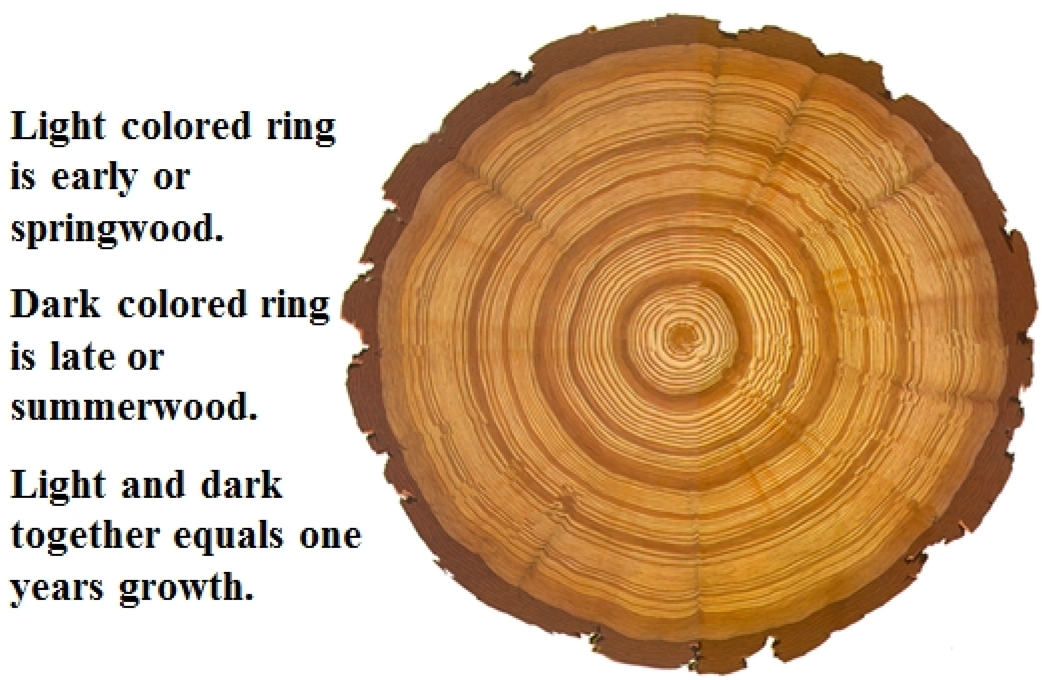


If you look at a cross-section of the trunk of a tree the center is heartwood (C) and consists of nonliving tissue. The heartwood has the function of structural support. It holds the tree upright. Sapwood (xylem) is outside the heartwood and is living tissue. It contains the vascular system of the tree and is a place where excess starches (food) are stored.

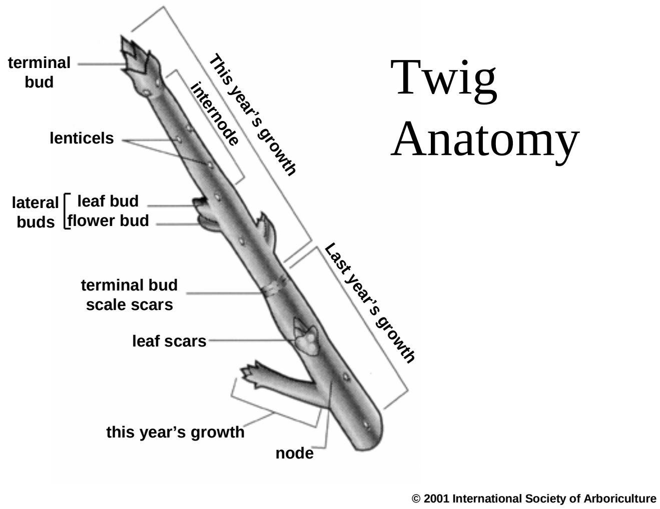
The Cambium (E), a meristematic zone, is the thin layer of dividing cells just under the bark between the xylem and phloem. When the cells in the cambium divide they form new xylem and phloem that become the vascular system of the tree. Phloem (B) is formed on the outside of the cambium, xylem (sapwood) (D) on the inside. The division of the cambium, or "laying on of new wood," is what makes the tree grow radially.

The outermost layer of the cross-section is the bark (A) and protects tissue underneath. It moderates the temperature inside the stem, offers defense against injury, and reduces water loss. Bark is composed of nonfunctional phloem and corky tissues.

Annual rings of xylem growth are evident because earlywood, produced in the spring, usually has larger, lighter colored cells with thinner walls than does latewood, formed later in the growing season. The width of annual rings can be used as a measure of the vigor of growth that year. To determine the age of a tree count the annual growth rings. Each light and dark ring together is one year. The light, usually wider ring is the early or springwood. The dark, usually thinner ring is the late or summerwood.

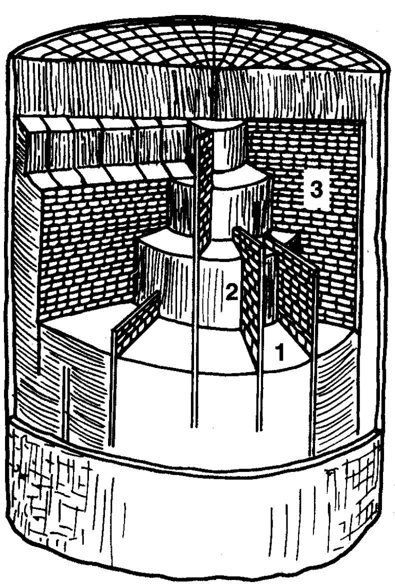


Moving up the tree from the trunk are the branches. Twigs can be arranged on the branches in either an alternate or opposite pattern. The terminal bud is the growth point at the end of the twig. You can tell how much a tree has grown by measuring from the current terminal bud back to the scarring where the previous year's bud occurred. Twigs support the leaves and are yet another place the tree stores excess starches (food).



The leaves are where photosynthesis occurs. Photosynthesis is the process by which the tree transforms carbon dioxide and water into starches and sugars needed as food. Oxygen is another product of photosynthesis. The chemical process is driven by the energy from the sun. The sugars and food are then carried from the leaves to the rest of the tree by the phloem.

When there is insufficient water, such as in a drought, the process of photosynthesis slows, the leaves start to wilt and the stomata cells in the leaves close to reduce transpiration of water from the leaves. Stomata, usually on the underside of the leaf, are important openings for other reasons too. Through them gases are exchanged. Carbon dioxide needed for photosynthesis is absorbed and oxygen, a product of photosynthesis, is released.



Water is transpired through the leaves. This means that water is released into the air through the leaves as water vapor. This evaporation of water creates a "transpirational pull" that draws water up through the tree in the xylem and is one reason why it feels cooler near trees. This is called "Transpiration" and is influenced by temperature, humidity levels and water availability.

Compartmentalization of Decay in Trees (C.O.D.I.T.) is a model used to describe the response made by a tree when injured. There are chemical and physical processes that occur in response to a wound to compartmentalize the injured site and seal it off from the rest of the tree to stop the spread of decay.

Four “walls” of defense are generated by this process. First the tree tries to stop the spread of decay up and down through the vascular system (Wall 1). The second defense wall resists inward spread by the more compact summerwood cells and by depositing chemicals in these cells (Wall 2). This helps stop progression in the annual growth rings. The third wall (Wall 3) tries to keep decay from progressing into the ray cells, and finally, a fourth wall (see pictures below) forms callus wood to prevent the decay from spreading outward to the new wood as it is generated at the injury site.

Wall 4 is forming from a properly-pruned branch collar.
Tod Ericson, MDNR Forest Service

Wall 4 has completely closed to prevent decay spread to new wood as the tree grows out around it.
Tod Ericson, MDNR Forest Service

Trees are living organisms and their growth and health influenced by a range of biological, physiological and environmental factors. It is important to understand these factors and how they interact before providing care and management.

Chapter 3: Soil and Water

Version 3.0

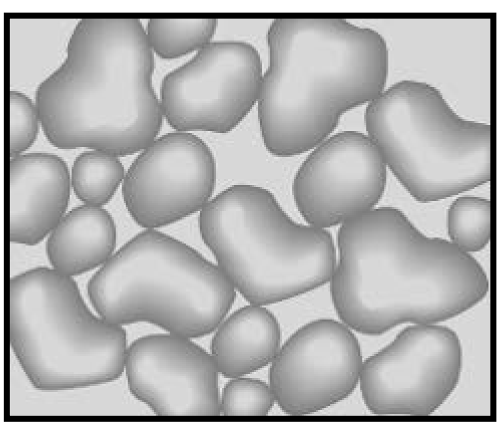
Soil is very important to plant health and success. It provides plants with nutrients, root anchorage, and water. The physical properties of soil influence the amount of nutrients that the soil hold and the availability of nutrients to plants.

Though soil appears solid when you look at it with the casual eye, only about half of a good soil is made up solids (the solid portion is mostly mineral soil with a small percentage of organic matter). The rest is pore space – gaps between the particles of soil. The pore spaces allow for air and water exchange and uptake by plant roots.

The characteristics of a given soil are determined in part by its soil texture. Water percolation and retention, aeration, capacity to hold nutrient elements, and soil strength ate properties affected by soil texture. The term "**soil texture**" refers to the size of the particles in the soil. As soil becomes finer in texture, it will hold more nutrients and water.

There are three main types of particles: sand, silt, and clay. Sand is the largest, clay is the smallest, and silt is intermediate. Because sand particles are the largest, sandy soils drain very well but also do not hold water well. Soils with high clay content do not drain well, hold water, and flood easily because they have fine particles and little pore space. Most soils have some combination of the three soil types. A well-aggregated clay soil can have the good drainage, aeration and root penetration characteristics generally associated with sandy soils, while retaining more water and nutrient elements. A loam soil combines the desirable attributes of each particle size, exhibits intermediate characteristics, and is ideal for growing a wide variety of plants.

The capacity of a soil to adsorb cations is called its "cation exchange capacity." The finer the texture of the soil is, the more surface area per unit volume it has and the greater its cation exchange capacity. Fine-textured soils are usually more fertile than coarse-textured ones. Adsorption is the adhesion of atoms, ions, or molecules from a gas, liquid, or dissolved solid to a surface.

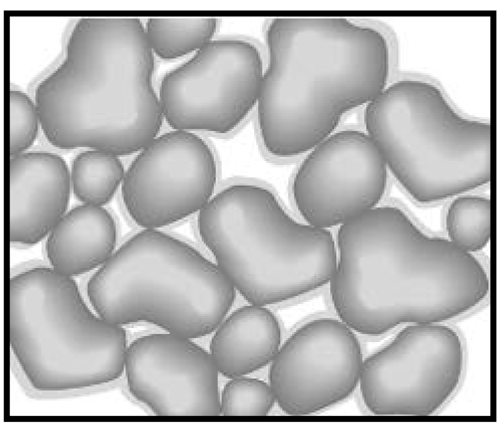


When all pores in the soil are filled with water, the soil is considered to be saturated. **Saturation** is the condition where water fills both the macropores and micropores.

Plant available water is that portion of the water holding capacity that can be absorbed by a plant. The available water is the amount of water in the soil between field capacity and permanent wilting point. The amount of water in the soil that is available to plants differs with soil textures. Clay soils have a greater water-holding capacity than sandy soils. Infiltration is term for water movement into the soil. Percolation describes water movement within the soil.

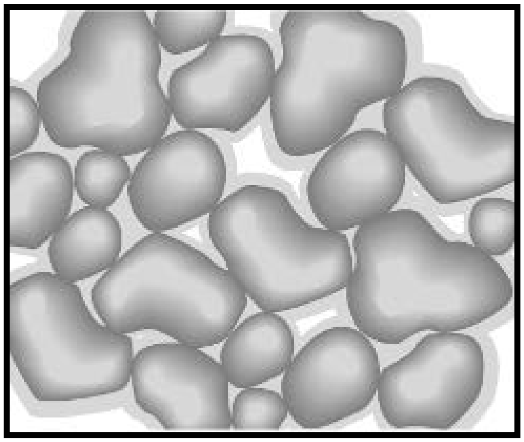
When excess or gravitational water drains away from soil pores, oxygen is available in macropores and water is held by soil particles and is available to plants. When this condition occurs, the soil is considered to be at field capacity. **Field capacity** is where the gravitational water has drained away from soil pores and oxygen is available in macropores. This is the amount of water remaining in the soil a few days after having been wetted and after free drainage has ceased. This remaining water is held by soil particles and is available to plants. Field capacity is not the same as saturation. When the soil is saturated, all the spaces between the soil particles are filled with water. When the soil is at field capacity, the spaces between the soil particles contain both air and water. The structure and texture, of the soil determines how much water can be held in the soil. Sand, for example, does not hold a lot of water because the large grains do not have a lot of surface area.

Above field capacity, water moves downward through the soil in response to gravity as excess water drains from the macropores. Below field capacity, water moves through micropores from areas of higher moisture content to areas of lower moisture content. This movement can be in any direction, including upward from the water table. Compaction and changes in soil texture layers can interfere with normal percolation.



When both the water in the pore spaces and the water held by the soil particles are gone, drought conditions begin. Plants in drought conditions may wilt due to water loss and ultimately reach the permanent wilting point. **Permanent wilting point** is where water is held tightly by soil particles and is unavailable to plants. This occurs when the volumetric water content is too low for the plant to remove water from the soil. This is “the point of no return” for plants – the point at which they will die if adequate water is not added to the soil.

The term ‘pH’ refers to the acidity or alkalinity of a soil. The pH is important because various nutrients required by plants bind to the soil and become unavailable at certain pH ranges. The pH of the soil may limit the availability of a nutrient even if you apply a considerable amount of it. The pH range varies depending on the nutrient in question, and is one reason why certain plants flourish in a particular pH range. The pH of soil can be determined by a soil test.



Copyright International Society of Arboriculture. Used with permission

Compaction, one of the biggest problems in urban soils, can be caused by pedestrian and vehicular traffic or grading and other construction activity. In preparing soils for structures, roads, and pavement, engineering specifications usually require that the load-bearing soil be compacted to 90-97% compaction. While this compaction provides stability to buildings and other improvements, it is bad for trees. When compacted to meet load-bearing engineering specifications, soil is almost impenetrable to roots. The best way to address soil compaction is to prevent it. Compacted soils are difficult to remedy after the fact. Once the soil structure is destroyed by compaction, it is hard to get those pore spaces back.

Mycorrhizae are fungi that live in a symbiotic relationship with roots, and increase the roots' ability to absorb water and essential elements. Mycorrhizal fungi are essential to the health of all plants. They form a symbiotic (mutually beneficial) association with the roots of the tree and act as an extension of the tree's root system by increasing their absorption of water and nutrients. Mycorrhizal fungi produce structures called hyphae that allow the them to forage for some nutrients more effectively than roots alone. The fungi transfer some of these nutrients to the root and receive carbohydrates from the root.

Because the relationship between trees and Mycorrhizae is symbiotic, both the tree and the fungi extract some benefit. Mycorrhizae are more effective than tree roots at accumulating water and nutrients, and can store excess nutrients, releasing them to the tree as needed. Nutrient uptake, particularly that of phosphorus, is enhanced in infertile soils because mycelial strands and their protruding hyphae explore the soil more extensively than nonmycorrhizal roots. The fungi also inhibit invasion by damaging fungi, and extend the life to root tips. Mycorrhizae release acids that break down substances that the tree cannot use without this help, and fix nitrogen from both the soils and atmosphere so that it is more available to the tree. Mycorrhizal fungi produce hormones that encourage the production of new root tips, which aids both the tree and the fungi.

The symbiotic relationship between Mycorrhizae and trees benefits the fungi as well. Fungi cannot manufacture their own food due to lack of chlorophyll, a process that converts sunlight to energy used for producing sugars. Therefore, fungi must get this food from chlorophyll-producing plants. They do so by either penetrating the plant roots or forming a sheath around the root tips. This energy allows the fungi to reproduce and form large networks within the soils.

The characteristics of a site's soil may be significantly altered when site development occurs. Many urban soils are low in organic matter due the fact that nutrient cycling is often interrupted in that plant debris (leaves, etc.) is generally removed from the soil surface. In forests, leaf litter decomposition creates a zone of complex biological activity that is beneficial to trees. In urban areas, these processes are often simulated through the use of organic mulch.

Chapter 4: Nutrition, Fertilization, and Mulching

Version 3.0

Trees need essential (chemical) elements to use in metabolism to be able to grow. If there are insufficient elements that the tree needs then fertilization may be a way to provide those elements.

Fertilization shall not be undertaken without establishing an objective. Why are you fertilizing the plant? To induce growth? To make up for a nutrient deficiency in the soil? Knowing why you are fertilizing will drive other decisions in the process such as fertilizer type and rate. A nutrient is an element or compound required for plant growth, reproduction or development. Nutrients are categorized as macronutrients (needed in relatively large quantities by plants) and micronutrients (needed in relatively small quantities by plants). These nutrients are listed in Table 1.

Nitrogen	**N**	**Macronutrient**
Phosphorus	**P**	**Macronutrient**
Potassium	**K**	**Macronutrient**
Sulfur	**S**	**Macronutrient**
Calcium	**Ca**	**Macronutrient**
Magnesium	**Mg**	**Macronutrient**
Iron	Fe	Micronutrient
Manganese	Mn	Micronutrient
Zinc	Zn	Micronutrient
Copper	Cu	Micronutrient
Boron	B	Micronutrient

Table 1 - Nutrients

A “complete” or “balanced” fertilizer contains nitrogen (N), phosphorous (P), potassium (K) and possibly other nutrients. The nutrient to which plants most commonly respond is nitrogen and it is the most commonly deficient soil nutrient. Even though applications of complete fertilizers are still widely recommended, most soils contain phosphorous and potassium in sufficient amounts for forest and landscape trees and shrubs.

Nitrogen is what most fertilization prescriptions are based on. Soil and/or foliar nutrient analysis should be used to determine the need for fertilizer. Nitrogen often comes in salt form. However salts can dry out and damage plant tissues (this is where the phrase ‘fertilizer burn’ comes from). This is why the ANSI standards say that fertilizers with a salt index of less than 50 should be preferred.

A fertilizer analysis is the composition expressed as a percentage by weight of nutrients in the fertilizer. The three numbers listed on the packaging of a complete fertilizer stand for the percentages of nitrogen, phosphorus and potassium present. For example, a 100 lb. bag of 10-10-10 fertilizer has 10% each of N, P, and K, and so has 10 lbs. of nitrogen, 10 lbs. of phosphorus, and 10 lbs. of potassium. A 140 lb. bag of 10-10-10 fertilizer also has 10% each of N, P, and K, and so has 14 lbs. of nitrogen, 14 lbs. of phosphorus, and 14 lbs. of potassium.

Slow-release fertilizers should be applied at rates between 2 to 4 lbs. of actual nitrogen per 1,000 square feet. However, slow- release fertilizers should be applied at rates that do not exceed 6 pounds of actual nitrogen per 1,000 square feet within 12 months. This is important if you plan to fertilize more than once per year.

Quick-release fertilizers should be applied at rates between 1 and 2 pounds of actual nitrogen per 1000 square feet.

How do I calculate the amount of fertilizer needed? You need to know the following things:

- The size of the area to be fertilized. According to ANSI standards, the fertilization area is determined by the arborist, based on site considerations.
- The amount of nutrient (normally based on the amount of nitrogen or N) you want to apply per 1,000 sq. ft. of area to be fertilized. This will vary depending on whether you are using slow-release nitrogen or quick-release nitrogen as noted above.
- The fertilizer analysis for the fertilizer you intend to use (i.e., 10-10-10, 46-0-0. etc.).

EXAMPLE: If applying ammonium nitrate (16-20-0), how many lbs. of fertilizer should be applied to a 5,000 square foot area in order to apply 2 lbs. N per 1,000 square feet?

SOLUTION:
Size of area to be fertilized = 5,000 sq. ft.
Amount of N = 2 lbs. per 1,000 sq. ft. (again, this number will vary depending on whether slow-release or quick release fertilizer is used and what the soil analysis recommends).
Fertilizer analysis: 16-20-0 (16% N, or 0.16 N)

2 lbs. N per 1,000 sq. ft. = 2 lbs. N x 5 (5,000 sq. ft. area to be fertilized) = 10 lbs. N

If 10 lbs. of N are needed and the fertilizer is 16-20-0, how many lbs, of fertilizer are needed?

100/16 (100 divided by percentage of nitrogen in the fertilizer) = 6.26 (6.26 lbs. of 16-20-0 has 1 lb. N).

6.26 x 10 = 62.6 lbs of 16-20-0 needed for 10 lbs. N

TO CHECK: 62.6 x 0.16 = 10 (62.6 lbs of 16-20-0 fertilizer times 0.16, or 16%, N content equals the 10 lbs of N needed for the 5,000 square foot area).

The preferred method of fertilizer application where turf or ground covers exist is sub-surface liquid application. The advantages of this method are better distribution of fertilizer and the injection of water into the root zone. Often the factor limiting fertilizer uptake is lack of available water. However, other methods may also be used. When applying a sub-surface liquid fertilizer injection, injection sites should be 12” to 36” apart, and 4” to 8” deep.

Mulch provides organic matter to the soil around the tree as it decomposes. It also retains soil moisture, helps reduce turf and weed competition and helps keep string trimmers and mowers away from the trunk. It is important to use organic mulches. Mulch should be placed around the tree at a minimum depth of 2 inches and no deeper than 4 inches. The broader the ring of mulch, the better. Mulch that is too deep can restrict oxygen and water availability to the roots. The mulch should not touch the trunk of the tree. This can create a moist and warm environment for rot to occur. Mulch may need to be replaced every year or two.

Chapter 5: Tree Pruning

Version 3.0

Pruning is defined as the selective removal of plant parts. The objective is to produce strong, healthy, attractive plants. To obtain the defined objective, consider the growth cycle of the species, the structure of the species, and the type of pruning to be performed.

No tree should be pruned without first establishing clearly defined objectives. The location and size range of parts to be removed shall be specified before pruning begins. Some **objectives** include:

- Reduce risk of failure;
- Provide clearance;
- Reduce shade and wind resistance;
- Maintain health;
- Improve a view;
- Improve aesthetics.

Specifications for pruning are based on the objectives and should include:

- Location of parts to be removed;
- Size range of parts to be removed;
- Pruning objectives;
- Pruning types to be used.

No branch should be removed without a reason. Some reasons for pruning include:

- **Safety (Hazard Mitigation)** Remove branches that could fail and cause injury or property damage. Remove branches to increase light penetration if the area is too dark.
- **Health** Remove branches that are diseased, contain insect-infested wood, are crossing or rubbing, and to increase air flow.
- **Aesthetics** Remove branches to enhance the natural form and character of the tree or to stimulate flower production.

Producing strong structure should be the emphasis when pruning young trees. Remove only broken and dead branches when first planted. In one or two years, after the tree has become established, remove no more than 25% of the canopy in one year. Consider removing defects, establishing a single dominant leader, and spacing branches well along the main trunk.

The five steps in training a young tree:

1. Remove broken, dead, dying or damaged branches.
2. Select and establish a **dominant leader**.
3. Select and establish the lowest **permanent branch**.
4. Select and establish **scaffold branches**.
5. Select and subordinate **temporary branches**.

As trees mature, the aim of pruning will shift to maintaining tree structure, form, health and appearance. Consider:

- The site where the tree is located,
- The time of year when the tree will be trimmed,
- Tree species and how well that species responds to pruning,
- The size of the tree and its branches and trunk,
- The growth habit of the species,
- The vitality of the tree and its ability to withstand the stress of pruning,
- The age of the tree.

Proper pruning cuts are made at a node, the point at which one branch or twig attaches to another. Always cut back to a lateral that is at least 1/3 the size of the parent limb so that it may assume apical dominance. In all tree pruning no more than 25% of the crown may be removed in any one year.

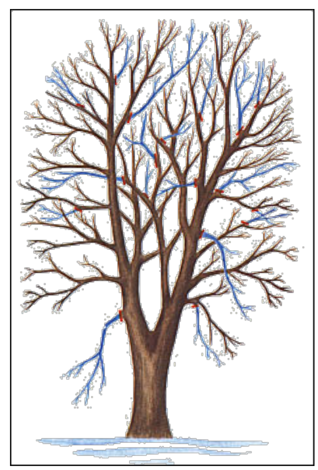
ANSI standards state that all severed branches shall be removed from the crown upon completion of the pruning, at times when the tree would be left unattended, or at the end of the day.

<u>PRUNING TYPES</u>

The six types of pruning cuts are:

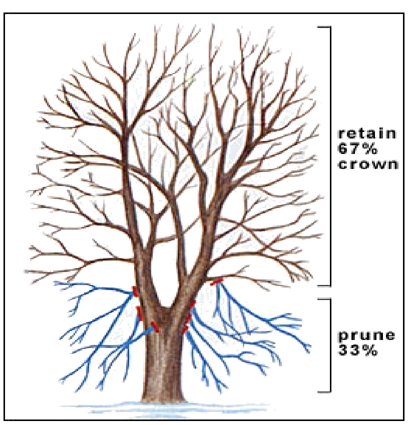
1) Crown thinning
2) Crown raising
3) Crown reduction
4) Crown cleaning
5) Crown restoration
6) Utility pruning

<u>Crown thinning</u> (right picture) is done to increase light, increase air flow, and reduce tree weight. The location and size range of parts to be removed shall be specified before pruning begins.

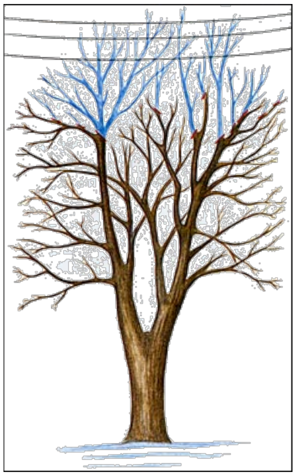


USDA Forest Service:
How To Prune Trees

USDA Forest Service:
How To Prune Trees



<u>Crown raising,</u> or elevating, (left picture) is the selective removal of the lower branches to provide clearance for such things as buildings, signs, vehicles, pedestrians, and lines of site. The clearance should be specified before any cutting is done. After pruning, the ratio of the living crown to total tree height should be at least two-thirds. Crown raising is the pruning type often used by public highway departments to provide clearance for pedestrian and vehicle traffic.



USDA Forest Service:
How To Prune Trees

Crown reduction (left picture) is the selective removal of upper branches to reduce tree height, reduce tree spread, and reduce weight. Again, clearance should be specified before trimming is done. Cut the limb back to its origin or back to a lateral capable of assuming apical dominance. When cutting back to a lateral, bisect the angle between the branch bark ridge and an imaginary line perpendicular to the leader or the branch being removed. This is called a **drop-crotch cut**.

USDA Forest Service:
How To Prune Trees

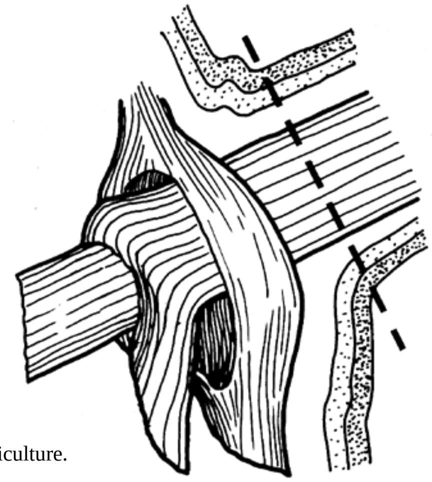
Crown cleaning (to the left) is the selective removal of deadwood, diseased limbs, broken branches, and weakly attached branches. When crown cleaning, the tree care worker shall provide for the selective removal of dead, diseased or broken branches, specify the location of parts to be removed, and specify the size range of parts to be removed.

Crown restoration includes pruning of branches in trees that have been topped or damaged in a storm to help improve crown structure and appearance. This would include the selective removal of water-sprouts, all stubs, and all dead branches.

Utility pruning is done in trees planted too close to utilities in order to prevent loss of service and prevent damage to the utility.

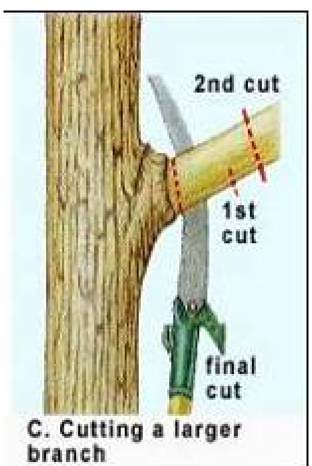
PRUNING CUTS

A pruning cut should be made close to the trunk or parent limb without cutting into the branch bark ridge or collar and without leaving a stub. Natural-target pruning should be used for live branches as this removes only the tissue of the target branch and does not damage the branch collar. Proper pruning allows for a developmental process unique to trees that allows them to compartmentalize decay.



Compartmentalization is the process by which trees limit the spread of discoloration and decay. After a tree is pruned, reactions are triggered to form boundaries around the wounded area. A model of this process is called **CODIT** = **C**ompartmentalization **O**f **D**ecay **I**n **T**rees.

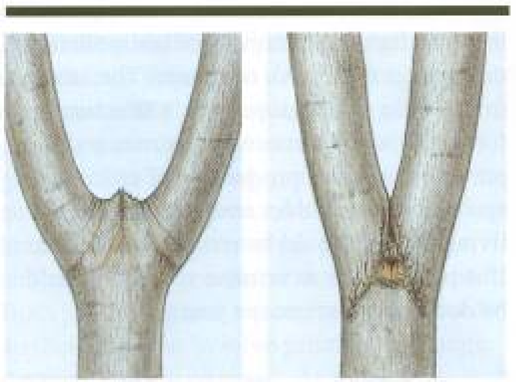
The pruning of small branches should be made with sharp tools just outside the branch bark ridge and angle down away from the stem of the tree. It is generally recommended that you use sharp by-pass clippers instead or the anvil type to make a clean cut and not crush branch tissue.



USDA Forest Service:
How to Prune Trees

Large cuts requiring saws should be supported by one hand when possible. If you can not support the branch with one hand, then use the **three-cut technique.** The first cut eliminates the chance of tearing the bark when the limb is removed. The second cut allows the limb to drop smoothly when is weight is released. The third cut just outside the branch collar removes the remaining stub.

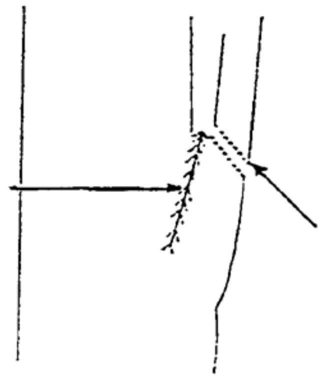
When removing a dead branch or stub, remove only the dead tissue and make the final cut (D-E) just outside the collar of living tissue. Avoid damaging any of the live tissue.

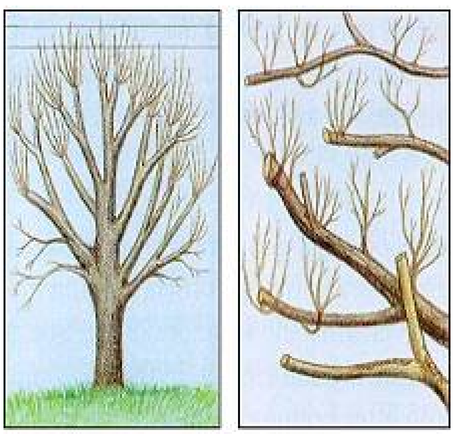


A. U-shaped strong union B. V-shaped weak union

Codominant stems are prone to failure as the tree grows larger. One of the stems should be cut back or removed if possible allowing the other to assume dominance. Codominant stems with V-shaped crotches and branches with sharp-angled branch attachments should be removed. These V-shaped angles often form included bark and create a wedge of in-rolled bark between them producing a weak attachment. Branches with strong U-shaped attachment should be retained.

A final cut that removes a branch with a narrow angle of attachment should be made from the outside of the branch to prevent damage to the parent limb.





A. Topping B. Tipping

Topping and **Tipping** pruning practices are considered harmful to trees. Directional pruning, lateral pruning, or drop-crotch pruning should be used in crown reduction, not topping (sometimes improperly called pollarding). Stubs left from topping usually decay. The shoots that are produced below the cut are weakly attached and often become a hazard as they grow larger and heavier.

Topping is not an alternative term for crown reduction.

Lions-tailing is the removal of the inner branches along a larger branch that makes the limb prone to breakage. It can be an energy drain on the tree.

Conifers may be pruned any time of the year. Pruning during the dormant season may minimize sap and resin flow from the wound. Avoid heading back to older wood with no foliage, this usually causes the branch stub to die. Hardwood trees and shrubs without showy flowers should be pruned in the dormant season to see the tree structure, maximize wound closure in growing season, reduce chance of transmitting disease from tree to tree, and discourage sap flow from wounds. Hardwood trees and shrubs with showy flowers can also be pruned in the dormant season but trees that flower in early spring (redbud, dogwood, etc.) should be pruned immediately after flowering. Trees and shrubs that flower in the summer and fall should always be pruned during the dormant season to discourage sap flow from wounds. Dead branches can be removed any time of the year.

Remember, the objective of pruning is to produce strong, healthy, attractive plants. By understanding how, when, and why to prune, and by following a few simple principles, this objective can be achieved.

Chapter 6: Problem Diagnosis

Version 3.0

Trees often decline or experience problems due to multiple factors. Problem diagnosis is more complex than simply looking for the first insect or disease you can find and then declaring that the problem has been identified. A tree expert would follow a pattern of research, observation and testing to diagnose and recommend treatment for a tree.

The cause of poor plant health usually is combination of nonliving stresses (abiotic) and living contributors (biotic) and a systematic process is the key to properly identifying plant diseases and disorders. A **Systematic Process** requires us to:

1. Accurately identify the tree.
    - What type of tree are we diagnosing? The "family history" of the tree is very important, as certain pests are specific to certain species, genera, or families of plants.
2. Look for a pattern of abnormality.
    - The *Body Language of Trees* tells us that trees grow and develop in a logical way, and if something looks unusual it means something may be wrong. Learning how to read these signs can help us understand what the tree is "telling" us about its condition. Trunk lean, decay fungi, root plate heaving, bulges on trunks, and spots on leaves all indicate potential problems. Trees will tell us what the problem is if we look carefully and thoroughly at the entire tree: roots, stem, and crown.
3. Carefully examine the site.
    - Examine the site around the tree. Trenching, ground disturbance, herbicide application, storm damage, and other factors that could affect tree health may be revealed by examining the site surrounding the tree.
4. Examine any available site maintenance history.
    - The "medical history" of a tree, if available, should provide background on attending tree experts and treatments performed. We may be able to contact prior practitioners to confer on what was done and why, or find a pattern of previous problems based on prior treatments performed.
5. Perform certain diagnostic tests, if appropriate.
    - A soil test can provide information on nutrient deficiencies of pH problems. Invasive but useful tools for evaluating tree growth include the increment borers and various types of decay detection equipment. These tools can allow the tree expert to examine changes in tree ring growth over time.

Non-invasive tools for evaluating the extent of internal decay include tools using radar technologies or sound waves. These tools can detect the quantity and quality of remaining wood without disturbing the wood of the tree. Root collar excavations, whether performed solely by hand or with mechanical assistance, can reveal stem girdling roots, whether a tree was planted too deeply, or whether the burlap and twine or wire basket was removed at planting.

Identify tree type

↓

Examine the tree
Condition, cracks, bulges, decay, insects, disease, etc.

↓

Examine the site
Location, activity, soil, moisture, planting depth, mulch, etc.

↓

Examine the maintenance history
Previous treatments; what and why

↓

Perform diagnostic tests
Soil, nutrient, pH, pest identification, amount of sound wood

↓

Provide appropriate treatment
Should be based on findings in prior steps

Problems are diagnosed by looking for symptoms and signs of potential problems. Symptoms are changes in growth or appearance of the plant in response to a damaging agent. The agent may be living (biotic) or nonliving (abiotic). Signs are evidence of the damaging agent, such as insect bodies, fungal spores or mushrooms, frass from boring insects, insect eggs, or pupal cases.

Some common symptoms include:

Leaf chlorosis – The general yellowing of a leaf that can be caused by a variety of factors and is associated with poor growth. Chlorosis may be caused by disease or insects, excess soil moisture, cold weather, air or soil pollutants, or nutrient deficiencies.

Leaf necrosis – Dead plant tissue scattered between the veins or at the tip and along the margins of leaves. There are many possible causes of necrosis.

Wilting – The collapse of tissues due to loss of turgor pressure
(the pressure exerted on a plant cell wall by water passing into the cell by osmosis) in the cells. It results from the lack of water supply to the leaves.

Defoliation – The loss of leaves. The pattern of defoliation is important to narrowing down the cause.

Dieback – Progressive death of twigs and branches from the tips downward.

Epicormic shoots – Short twigs and small leaves growing on the upper surface of one or more main branches that are symptoms that indicate a severely weakened tree. They occur when dormant buds, whose growth is normally suppressed, begin to elongate and produce shoots to add leaves to make more food. The cause may be excessive pruning, a noninfectious agent, a slow-acting disease, or old age.

Decline – Multiple symptoms on a tree that include dieback, poor vigor, small leaf size, presence of epicormic shoots, and poor leaf color.

Tree health problems can be caused by factors that can be categorized as either biotic (living) or abiotic (nonliving). **Biotic** (living) factors include plant pathogens such as fungi, bacteria, viruses, and nematodes, as well as insects, mites, and other animals. The most likely biotic cause of discolored roots is infectious disease. These are considered to be infectious as they can spread from one tree to another.

Injuries caused by ice, lightning, or pesticides are examples of impacts from **abiotic** (non-living) factors. In urban areas, most tree failure occurs as a result of storms. If a vertical strip of bark is missing from a point in the crown down to the ground, with a rough grove that follows the grain of the wood, a likely cause is a lightning strike. Other abiotic disorders include damage from temperature extremes, pollution damage, and chemical injury (normally from herbicide misapplication). Abiotic factors are considered noninfectious.

Holes in the bark that are in uniform horizontal bands around the trunk are likely caused by sapsuckers. The sapsucker is known for its boring of numerous holes in the bark of live trees to obtain sap, the activity from which it derives its name. Puncture wounds and resulting sap flow on branches and trunks of trees are the most obvious symptoms of injury inflicted by the sapsucker.

Aphids and scale are examples of sucking insects. Aphids (plant lice) are common plant feeding insects (photo left).   Usually they do not occur in damaging numbers. Low aphid numbers usually do not result in plant damage. However, large aphid populations can cause wilting, yellowing, and curling of leaves. This may kill small plants such as flowering annuals, unless the aphids are controlled by beneficial insects or by human intervention. Large shrubs and trees outgrow aphid damage during the growing season because beneficial insects reduce aphid populations below damaging numbers.

Aphids also transmit many virus diseases between ornamentals. Viruses are spread from plant to plant when aphids feed on diseased plants and then move to feed on healthy plants. The viruses are carried from plant to plant inside the aphid in the insect infected plant sap.

Some plant pests travel on their own. Some are carried by vectors (carriers). Elm yellows and Dutch elm disease are both examples of diseases that are often transmitted by insect vectors. Bacterial Leaf Scorch is thought to be transmitted by insect vectors. Some pests transported primarily by people.

Examples of insects with chewing mouthparts are borers, caterpillars and leaf miners. Many different borers attack shade trees. They may be beetles or caterpillars. Beetle borers include bark beetles, long horned beetles (locust borer) or round headed borers (red headed ash borer larva) and metallic wood borers (bronze birch borer or flatheaded appletree borer) or flatheaded borers. **Beetle borers** are generally stress pests and usually only attack stressed trees. Symptoms include branch dieback and exit holes. Healthy trees are usually not attacked. The best control for beetle borers is to keep trees healthy and well watered. No sprays are effective for control.

Clearwing borers are the larvae or caterpillars of clearwing moths. The moths resemble wasps in appearance. Common examples are peach tree, lesser peach tree, dogwood, lilac, and ash tree borer. Larvae of these borers are creamy colored with brown heads. Signs of damage include holes in the bark, reddish frass in bark crevices or around the bottom of the tree and branch dieback. In the case of peach tree and lesser peach tree borer in flowering cherries, gummosis may be present.

In some cases the most obvious pest is not the primary culprit. Sucking insects, though easy to detect, are not normally primary causes of tree death. Some apparent diagnostic clues do not indicate anything. For example, exfoliation (peeling) of the bark on a mature plane tree (*Platanus x acerfolia*) is normal. However, peeling bark on a type of tree that does not have exfoliating bark under normal conditions would be a clue for further assessment.

The emerald ash borer is a serious invasive insect that, prior to Maryland's detection in late August 2003, had only been detected in the U.S. in Michigan (2002) and Ohio (2003). The insect feeds on and kills ash trees, an important neighborhood and landscaping tree, one to three years after infestation. Emerald Ash Borer adults are dark metallic green, one-half-inch in length and one-sixteenth of an inch wide. They are present only from mid-May until early August. Larvae are creamy white in color and are found under the bark.

Affected trees show symptoms of infestation including: die-back on the upper third of the tree, D-shaped exit holes in the bark where adults emerge, vertical splits in the bark, and distinct serpentine-shaped tunnels beneath the bark in the cambium, where larvae effectively stop food and water movement in the tree, starving it to death. It takes 1-3 years for the infested tree to die.

The Asian longhorned beetle (ALB) has been discovered attacking trees in the United States. Tunneling by beetle larvae girdles tree stems and branches. Repeated attacks lead to dieback of the tree crown and, eventually, death of the tree. ALB probably travelled to the United States inside solid wood packing material from China. The beetle has been intercepted at ports and found in warehouses throughout the United States. The Asian Longhorned Beetle has not yet been detected in Maryland.

In the United States the ALB prefers maple species (*Acer* spp.), including *boxelder, Norway*, *red, silver*, and *sugar maples*. Other preferred hosts are *birches, Ohio buckeye, elms, horsechestnut,* and *willows*. Occasional to rare hosts include *ashes, European mountain ash, London planetree, mimosa,* and *poplars*. A complete list of host trees in the United States has not been determined.

Anthracnose is a name for a group of diseases caused by several closely related fungi that attack many shade trees. Each species of anthracnose fungus attacks only a limited number of tree species. Look for leaves with brown spots and blotches or young shoots that are entirely blighted and still hanging on the tree. Severe infections during very wet and cold springs can cause tree defoliation in some seasons. Some methods of sanitation to control disease are: pruning diseased branches, raking and destroying discarded leaves and removal of an infected tree from nearby healthy trees.

Dogwood anthracnose is a disease of flowering dogwood (*Cornus florida*). An anthracnose fungus, *Discula sp*., has been identified as the causal agent. Infection of dogwoods is favored by cool, wet spring and fall weather, but can occur throughout the growing season. Drought and winter injury weaken trees and increase disease severity. Consecutive years of heavy infection have resulted in extensive mortality in both woodland and ornamental dogwoods.

Sudden Oak Death is a recognized disease that is killing oaks and other plant species in the western United States. First noticed in 1995, the disease has been confirmed in the coastal areas north and south of San Francisco, and in a relatively remote location in southwestern Oregon. The pathogen responsible for the disease, a fungus-like organism called *Phytophthora ramorum.* Although the disease has been found only in California and Oregon, it is of great concern to land managers in the Eastern United States as well, because at least two eastern oak species, northern pin oak *(Quercus palustris)* and northern red oak *(Quercus rubra)*, are highly susceptible to the disease when inoculated with the pathogen. Some symptoms of *Phytophthora ramorum* infection which may cause Sudden Oak Death (SOD) are large cankers on the stem or trunk, foliar lesions or browning of the leaves, and leaf defoliation and twig dieback.

Gypsy moth attack many deciduous species. It is a type of insect defoliator, which eat all or parts of the leaves on a tree. Control is a microbial pesticide known as <u>Bacillus thuringiensis</u> or Bt.

Decay which only affects the dead tissue in the center of the tree trunk is normally referred to as heartrot. Most experts agree that 30-35 percent loss of the stem diameter due to heartrot requires that some action be taken to address the risk of failure. Mushrooms or conks on a trunk or branch indicate a need for further assessment to determine whether or not internal decay is present.

Brown rot fungi consume cellulose but leave lignin behind, resulting in wood that is stiff, but brittle and crumbly, and subject to failure without warning. Brown-rotted wood often breaks up into cubical fragments, and has a red-brown color.

White rot fungi consume both cellulose and lignin, resulting in soft and flaky or stringy decay that is whitish to reddish in color.

When collecting samples for the purpose of diagnosing plant problems, it is important to collect samples that include the transition from diseased or affected tissue to healthy tissue so that the diagnostician can compare the healthy and infected portions of the plant.

Tree Experts often are requested to perform risk tree assessments. The need for risk tree assessment is normally based on the premise that personal injury or property damage could result if a certain tree failed. Because liability is possible, such assessments should be documented in writing. People, structures, improvements, and vehicles are potential targets for hazardous trees. A hazard tree is defined as a tree with a defect and a target. An unsound tree in an area with no target is not a hazard. If a previously unimproved area becomes developed, there may be a corresponding change in the need for tree assessment.

Sometimes the risk of failure may be due to the type of tree. Fast-growing trees are usually weak-wooded and failure prone. The tree expert will normally read the tree's "body language" for things out of the ordinary, including:

- Longitudinal cracks or splits in the trunk or branches;
- Branches or stems that lack taper;
- Codominant stems or branches;
- An external swelling or bulge (a likely indicator of internal decay or a cavity);
- An external rib on a tree (a likely indicator of an internal crack);
- Cracks of lifting of the soil on the opposite side of the lean on a leaning tree likely indicate movement of the root system, soil failure, and/or pending tree failure.

Sign or Symptom	Possible Cause
Sooty mold	Infestation by aphids or scale
White to gray-white fungus on leaf and shoot surfaces	Powdery mildew
Canker (localized dead tissue) on stem or branch	Wounding or disease
Dark, discolored streaks in the young xylem	Verticillium wilt
Root galls	Insects, nematodes, or nitrogen-fixing bacteria
Mushrooms or conks	Decay fungi
Lack of trunk flare on a portion of the trunk at the soil line	Stem girdling root
Small emergence holes in the trunk or branches with frass (looks like sawdust)	Wood-boring insect

Holes in leaves	Insects or diseases
General yellowing of leaves (Chlorosis)	Sucking insects, pH problems, nutrient deficiency
Marginal leaf necrosis	root damage, high soil salinity, fungus or bacteria that restrict water movement to the leaves, or chemical injury.
Wilting of leaves	Lack of water, vascular system disease

Chapter 7: Tree Selection, Installation and Establishment

Version 3.0

The most important part of tree selection is matching the tree with the site. We want to plant the right tree in the right place for the right reason. For example, if site is underneath overhead utility lines, plant a small scale tree with decurrent branching pattern.

Some site conditions to consider include:
- **Climate –** hardiness zone (the ability of a plant to tolerate the coldest temperatures experienced in a particular area), moisture availability, light, winds;
- **Soil** - soil test, texture, pH, nutrients, compaction
- **Space** - growing space – above and below, nearby signs, buildings, and utilities overhead and underground;
- **Other plantings –** turf, other shrubs and trees nearby;
- **After planting maintenance needs –** irrigation, watering

Tree considerations to think about include:
- **Size** - size, height and width at maturity;
- **Growth rate** - fast or slow growing;
- **Fruit, litter -** fruit problems, fall color, flowers, bark, wildlife food, litter, thorns;
- **Water needs –** enough water available for that species;
- **Light needs –** is tree shade tolerant or intolerant;
- **Pest problems -** insect and disease problems in the area;
- **Hardiness -** able to survive low or coldest temps in the area.

Also consider what the purpose of the planting is. For instance:
- **aesthetics**
- **engineering**
- **architectural**
- **screening**
- **shade**
- **beauty**

Try to select a tree that meets all three factors of site conditions, tree requirements, and purpose of planting. Other considerations to consider include the functional uses of the tree, the tree's ability to adapt to the new site, and the amount of care the tree will need after planting.

All plant material should conform to American Standards for Nursery Stock ANSI Z60.1. These standards provide the general specifications that all nursery grown planting material should meet. They also provide buyers and sellers of nursery stock with common terminology to facilitate transactions involving nursery stock. They establish common techniques for measuring plants, specifying and stating the size of plants, determining the proper relationship between height and caliper, or height and width, and determining whether a root ball or container is large enough for a particular plant.

Trees are generally available from nurseries in one of three forms: bare root, balled and burlaped, and containerized.

When planting a BARE ROOT tree, dig the hole two to five times larger than the diameter of the stem at the root collar. The side should be slanted and the depth the same or a little less than the root ball. The hole should then be domed in the middle and the tree set on the dome with the roots spread out around the dome. This will allow the roots to grow into the surrounding loose soil. Do not expose bare roots to air as they will dry out.

Planting a tree with a TAP ROOT requires digging a hole deep enough to extend the root down straight beneath the stem. Do not bend the tap root. The hole should not be deeper than the extended tap root because the root collar will be covered by soil.

If planting a tree in a paved area, the planting site should have a minimum of 100 cubic feet of space.

Before accepting planting stock, the soil level at the top of the root ball or container should be examined in order to determine if the root collar is at the proper level.

To plant balled and burlaped (B&B) stock, remove the sod from the planting site and loosen the soil. Dig a hole at least 1.5 times as wide and as deep, or slightly less than as deep, as the rootball. Slope the sides of the hole and make sure there are no glazed sides. Handle the trees carefully, lifting them by the root ball and not by the stem. If drainage is problem, the root ball can be planted 1/3 the height of root ball above the grade. To eliminate settling, the bottom of hole should remain undisturbed to give solid support to root ball.

Cut the burlap and twine. Remove burlap from top and sides of root ball. You may leave burlap on the bottom of ball. This will allow the roots to grow out the top of the root ball.

Fold burlap down below the ground level to avoid wicking. Remove the twine around the root ball. The same is true of wire baskets. Wire baskets are used for larger B&B trees. Cut away as much of wire as possible, unless the root ball is too loose to move it into the hole without breaking.

For containerized material, remove the container before planting, unless it is biodegradable. A containerized tree may be root bound. Therefore, separate and cut the roots, especially any girdling/circling roots. This will encourage roots to grow out into soil. Girdling roots are common in trees which were started in containers. Girdling, kinked and circling roots could reduce the growth of a tree or even kill it.

Backfill the hole with the same soil, unless it is very poor soil. In most cases, amending the soil with organic material will not be of any particular benefit. Make sure there are no air pockets and the trunk is vertical. Firm up the soil, then water. Trees should not be fertilized for the first year after planting. Watering weekly helps establish new root growth. Know that trees can succumb to overwatering.

Under normal conditions, root growth is best encouraged by planting even with the surrounding terrain. In wet conditions where drainage is a problem, raising about 1/3 of the root ball above ground will aid the spread of lateral roots. In arid conditions, a basin can be used to collect water. Make a berm to collect water, turn grass upside down. Avoid concentrating water at root ball to encourage root growth. Remove all tags, labels, and tree guards.

Mulching around a tree will aid in moisture retention, moderate soil temperature, reduce competition from weeds and grass, and help keep string trimmers away from the trunk. The mulch layer should not exceed 2 to 4 inches in depth. It is recommended that it be 3 feet to 6 feet diameter around the tree, although it can be as large as you wish. Mulch should not be placed against the trunk as the moisture and heat may cause the root collar to rot.

Prune only dead or broken branches after planting. Prune according to ANSI standards. Do <u>NOT</u> prune the crown to balance it with remaining root stock. If an evergreen, do not prune because the tree has no latent buds.

Staking is not always necessary unless the tree has a limited root system. Staked trees often have a smaller caliper, less trunk taper, and are more subject to tipping after the stakes are removed. Also stake if the site is windy, has sandy soil, if it is a tall tree or has a large canopy, or there is a lot of pedestrian or equipment traffic around it. If a single stake is used, place it on the upwind side. Trees greater than 4 inches in diameter often require guying. Trees are guyed with three or four wires anchored to the ground.

When using metal stakes, wooden stakes or eye screws with turn buckles as devices for staking and guying, check several times a year for maintenance to make sure that the tree is not being girdled and that the system is still intact.

Remove wires and tags to prevent girdling. Tree staking and wraps should not be left on for more than one year. If trunk wrap and staking materials are left on indefinitely, trunk girdling and constriction may occur.

When digging a tree for transport, a rule of thumb for the width of the rootball is a minimum of 10 inches rootball diameter for every inch trunk diameter. Make clean cuts, wrap with burlap if greater than 18” unless loose soil, drum lace large root ball. Balled and burlaped trees with large soil balls should be drumlaced with rope for additional support. Trees with large tap root systems are harder to transplant than fibrous root systems.

Root pruning helps before transplanting. Pruning should be done with sharp tools to make clean cuts. When a tree is harvested for transplanting, as little as 5% of the root system is likely to remain.

Times of year to transplant can be species specific. Check first. In general though, the best time for deciduous trees is after leaf drop or abscission in the fall and before leaf out in the spring. If deciduous trees must be moved in leaf, the use of antitranspirants may be warranted to reduce the possibility that plants will reach the permanent wilting point before, during, or after transplanting. Evergreens can be transplanted earlier in the fall and later in the spring than deciduous plants.

Anticipate the height and spread of tree at maturity when choosing the site to transplant. Check the proximity of the tree's location to hardscape features and utilities. Consider the "shade tolerance" of the tree compared to the length of sunlight (photoperiod) on site.

Large trees can be transplanted by a mechanical device known as a **tree spade**. When using a tree spade, no attempt should be made to move trees that exceed the size limitations of the machine being used. If installing trees over 8 inches in diameter, support the tree from four guy wires of ¼", 7-strand cable, 3/8" lag hooks, turnbuckles and deadmen.

The rate of recovery and re-establishment after planting and transplanting varies with species. The general rule of thumb for re-establishment in temperate climates is one year for each inch of caliper.

Chapter 8: Safety Standards

Version 3.0

The *ANSI Z133 Standards* contain arboriculture safety requirements for pruning, repairing, maintaining, removing trees, cutting brush, and for using equipment in such operations. All Licensed Tree Experts and Certified Roadside Tree Care Experts shall comply with safety standards while working in the State of Maryland.

Each person, employee or other, shall be responsible for his/her own safety and comply with the appropriate federal and state occupational safety and health standards and all rules, regulations, and orders which are applicable to his/her own actions and conduct. **Employers** shall instruct their employees in the proper use, inspection and maintenance of tools and equipment, including ropes and lines; and require that appropriate working practices be followed. A job briefing shall be performed by the qualified tree expert in charge before the start of each job. The briefing shall be communicated to all affected workers.

Proper personal protective equipment (PPE) shall be worn when performing tree care operations. Clothing and footwear appropriate to the known job hazards shall be approved by the employer and worn by the employees. Workers shall wear head protection that conforms to ANSI Z89.1. Class E helmets shall be worn when working in proximity to electrical conductors, in accordance with ANSI Z89.1. Face and eye protection shall comply with ANSI Z87.1. When noise levels exceed acceptable standards, as established by federal regulations, approved hearing protection shall be provided by the employer and worn. Chain saw resistant leg protection shall be worn while operating a chain saw during ground operations.

A first-aid kit, adequately stocked and maintained, shall be provided by the employer. Tree Experts and other workers shall be instructed in its use and specific location. Instruction shall be provided in the identification, preventive measures and first-aid treatment of common poisonous plants (poison ivy, poison oak and poison sumac), stinging/biting insects and other pests indigenous to the area in which work is to be performed.

Effective means for controlling pedestrian and vehicular traffic shall be instituted on every job site where necessary in accordance with U.S. DOT *Manual on Uniform Traffic Control Devices* (MUTCD), or applicable state and local laws and regulations.

A roadside tree care expert should take immediate action if a tree is leaning with recent root exposure, soil movement, or soil mounding neat the base of the tree. Immediate action is also needed if more than half of the roots under the tree’s crown have been cut or crushed or of there is advanced decay present in the root flares or “buttress” roots. Dead branches of sufficient size to cause injury should be removed immediately. All of these conditions create a hazardous situation. A tree is considered hazardous if it has the potential to fail and there is a target it may strike.

Before working in a tree, always look for dead or broken branches, signs of decay, cables, bracing, or guying wires, and electrical conductors and utility lines. All overhead and underground electrical conductors and all communication wires and cables shall be considered to be energized with potentially fatal voltages.

Electrical shock may occur during a ground fault simply by standing near the grounding object. Only qualified line-clearance tree experts or qualified line-clearance tree expert trainees shall be assigned to work where an electrical hazard exists. Qualified line-clearance tree expert trainees shall be under the direct supervision of qualified line-clearance tree expert. An electrical hazard exists when a worker, tool, tree, or any other conductive object is closer than <u>ten feet</u> from an energized electrical conductor rated 50 kV, phase-to-phase, or less.

<u>Direct contact</u> is made when any part of the body contacts an energized line. <u>Indirect contact</u> occurs when any part of the body touches a conductive object that is in contact with an energized line. Conductive objects include a saw, tree branch or another person. Even in an insulated bucket truck indirect contact can be made. When climbing a tree, the tie-in position should be above the work area and located in such a way that a slip would swing the tree expert away from any energized electrical conductor or other identified hazard.

Footwear, including lineman's overshoes, having electrical-resistant soles, shall <u>not</u> be considered as providing any measure of safety from electrical hazards. Rubber gloves, with or without leather or other protective covering, shall <u>not</u> be considered as providing any measure of safety from electrical hazards. Qualified line-clearance tree experts and qualified line-clearance tree expert trainees performing line clearance in the aftermath of a storm or under similar conditions shall be trained in the special hazards associated with this type of work.

Aerial devices shall be provided with a point of attachment to secure a full body harness with a shock-absorbing lanyard or body-belt and lanyard. Fall protection shall be worn when working aloft. Aerial devices shall not be used as cranes or hoists to lift or lower materials, unless specifically designed by the manufacturer to perform such operations. Wheel chocks shall be set before using an aerial device, unless the device has no wheels on the ground or is designed for use without chocks. No part of the boom or bucket shall make contact with energized electrical conductors, poles, trees or similar objects.

Brush chippers equipped with a mechanical infeed system shall have a quick stop and reversing device on the in-feed system, which shall be:

- close to the feed end of the in-feed hopper;
- located across the top and along each side of the in-feed hopper;
- within easy reach of the worker.

Trailer chippers, when detached from the vehicles, shall be chocked or otherwise secured in place.

Vision, hearing and/or other appropriate personal protective equipment shall be worn when in the immediate area of a brush chipper in accordance with ANSI Z133.1 standards.

Towable stump cutters or stump cutter trailers, when detached from the vehicle, shall be chocked or otherwise secured in place.

ANSI Z133 standards require that when a chain saw is being started, it shall be held firmly in place on the ground with the chain brake engaged. The kickback zone of a chainsaw is the front upper quadrant. Kickback happens while, in making a cut, the top of the bar nose contacts a solid object or is pinched. This causes the guide bar to fly back towards you. Kickback occurs at a rate twice as fast as a human can react.

The direction of safe retreat from a falling tree is 45 degrees from the sides and back on either side opposite the felling direction. NEVER move away directly behind the tree- you can be seriously hurt if the tree butt kicks back during the fall.

Using a bore cut and a release cut will make it easier to retreat in plenty of time. Don't turn your back on the falling tree. Walk quickly away to a distance of 20 feet from the falling tree and position yourself behind a standing tree if possible.

When felling a tree, the notch depth should not exceed 1/3rd the diameter of the tree. Notches shall be used for felling all trees over 5 inches diameter at breast height (4.5 feet above the ground). A conventional notch is a directional felling cut into the side of a tree, facing the intended direction of fall and consisting of a horizontal face cut and an angle cut above it, creating a notch of approximately 45 degrees. A Humboldt notch is a directional felling cut facing the direction of fall and consisting of a horizontal face cut and an angled cut below it. A Humboldt cut is usually reserved for larger trees on steep slopes. An open-faced notch is a directional felling cut facing the intended direction of fall and consisting of two cuts creating a notch greater than 70 degrees. Be sure that the back cut does not penetrate into the predetermined hinge area.

When limbing and bucking a tree, the tree expert must stand on the uphill side of the work. Whenever possible, cut limbs on the opposite side of the tree trunk from which you are working. Doing so keeps the tree trunk between you and the saw. Wedges should be used as necessary to prevent binding of the guide bar or chain when bucking up trunks of trees.

Chapter 9: Construction and Trees

Version 3.0

Construction damage is one of the most common causes of tree death and decline in urban areas. Tree damage on construction sites can occur from soil compaction, root removal caused by changes in soil grade, branches that may be broken, tree trunks that may be damaged, and by incorrect pruning by untrained personnel. The two most important factors to protect trees from during construction activity are **soil compaction** and **root removal** from grade changes.

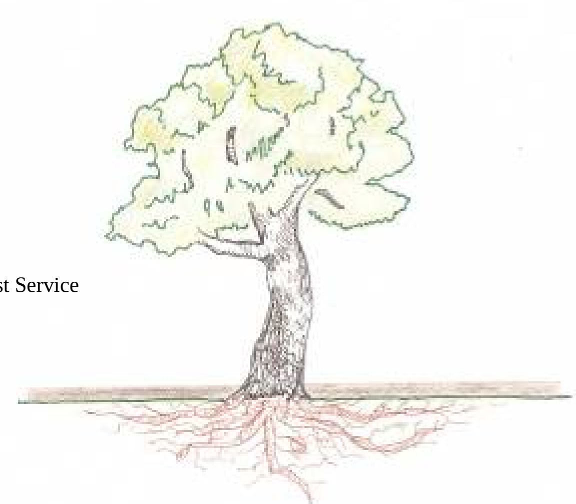
Roots extend much farther than the dripline of a tree and will be found mostly in the upper few inches (12 to 18) of the soil. Most of a tree's absorbing roots are in the upper 12 inches of soil to be able to use oxygen and water.

When soil is compacted by construction activities, the pore space between soil particles is greatly reduced. This reduces the ability of roots to absorb oxygen, water and minerals. The ability of roots to grow and expand is reduced as they cannot penetrate the soil.

Changes in grade can reduce root volume and affect the roots ability to get oxygen and water. If roots are removed or damaged, decline may occur within a few months or few years. It is commonly thought that a healthy tree can tolerate removal of approximately 1/3 of its roots. If few to no roots over 1 inch in diameter will be impacted by construction activity, the tree will probably tolerate the impact.

If the grade is raised, roots may be suffocated. As little as four inches of soil can kill some species. Aeration can help soils that have been compacted or where grade has been raised six inches or less. The aeration holes can be filled with peat moss, sand, vermiculite, or pea gravel.

Even as little as 4 inches of soil placed over tree roots can kill some species. →



Katherine Kronner, MDNR Forest Service

If the grade is raised, use tree wells. If grade is raised more than 6 inches, then a tree well with aeration and drainage tiles should be considered.

If the grade is lowered, then a retaining wall should be considered. Maintain as much of the roots and original grade as possible. Prune the roots cleanly with a sharp tool. A tree island can be used where the grade has been lowered completely around the tree.

Horizontal trenching can be used when compaction has occurred. Narrow trenches are dug in a spoke pattern around the tree, then backfilled with topsoil or compost. Root growth in the trenches will exceed root growth in the surrounding soil. A two to four inch layer of wood chips may also be added over the top of the backfilled trenches.

Prevention is the best way to minimize damage to trees during construction. Assess the site before construction, decide which trees to save before construction begins and write construction specifications to protect them. Place construction fences around trees to be saved. Minimum distance to place the protective devices would be the dripline of the crown. Ideal distance would be the “Critical Root Zone” which means 1.5 feet radius for each inch diameter of the tree measured at 4.5 feet above ground level.

For temporary traffic over the critical root zone, you can use vertical mulching and then place 6-12 inches of mulch to disperse the weight of equipment. When construction is finished, half of the depth can be removed and spread out over the area under the dripline as mulch.

Trenching can severely injure a tree. Tunneling can help to prevent root damage. Minimum depth below the surface should be 24 inches and should be slightly off center. This will allow the tunnel to travel under the roots in the upper 12 to 18 inches and to miss any tap roots that may be present.

If roots must be severed, clean cuts should be used. Backfill soil to minimize any drying of the roots. Treatment of damaged trees should begin when the damage occurs. If a significant portion of the root system is destroyed, then the remaining root system should be pampered. Mulch it to hold soil moisture, moderate temperature extremes and remove competition from turfgrasses and weeds.

If root damage occurs, the remaining roots must be pampered. Mulch around the roots to hold soil moisture, moderate the temperature, and remove competition from turf and weeds. Regular irrigation is effective as trees that do not become moisture stressed have a better survival rate. Maintain the tree’s vitality to avoid stress and infestation of insects and diseases. If fertilizer with nitrogen is needed, use a slow-release form after a period of recovery.

Another important element to protect trees from construction damage is operator care when maneuvering booms and trucks near trees to avoid mechanical damage. The single most important element to protect trees from construction damage is highly visible tree protective fencing that can help remind workers to stay away from tree protection zones.

A tree's ability to tolerate impacts from construction depends on its age, health, and vigor. Some defensive dieback will occur when root loss is significant. Expect this to begin one to two years after construction. Treatment of construction-damaged trees is an on-going process and should be continued over the life of the tree.

Chapter 10: Tree Identification

Version 3.0

Proper identification of trees is the first step to being able to manage them properly. In order to correctly identify trees in nature it is important to know certain characteristics used in tree identification. Using multiple characteristics and characteristics other than leaves of a tree will help to identify it. This helps when there are no leaves on a tree or they are too high to see properly. Being able to accurately identify trees takes knowledge, experience and practice.

Trees are classified based on biological characteristics. Trees with similar characteristics that are closely related are in the same *genus*. The *species* is the level of classification that identifies a particular tree. A tree's scientific name includes both the genus and the species. This name is the same throughout the world. It is important to know the scientific name because common names vary depending on the local culture. Scientific names are written either underlined or in italics. An example is: *Quercus alba* or white oak.

Tree can be identified from their gross form or shape down to the tiniest leaf scars and vascular tissue arrangement. Some of these characteristics that should be looked at when identifying a tree are:

- Range
- Site condition where the tree is growing
- Bark
- Tree form/branching pattern
- Leaf shape
- Twigs
- Buds
- Bud scars
- Fruit
- Flowers

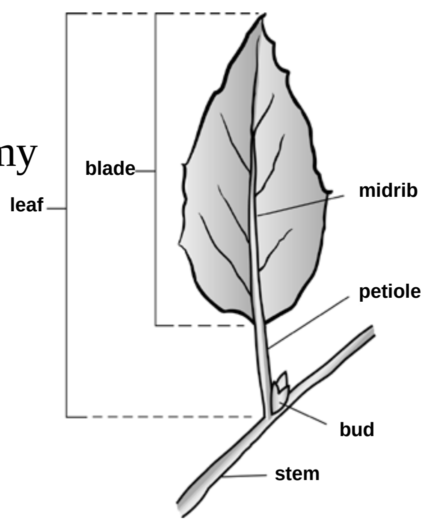
Leaves are the best and often the easiest way to identify a tree. Needles and scales of conifers are also considered leaves. Leaves are arranged on the twig either opposite, alternate or whorled. Some characteristics of the leaf to consider are: the outer edge or margin of the leaf; the pattern of the veins in the leaf; the size; length and color of the petiole or stem.

Alternate

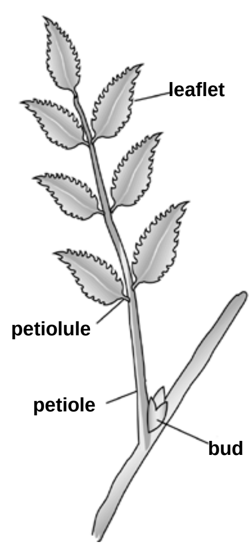
Whorled

Opposite

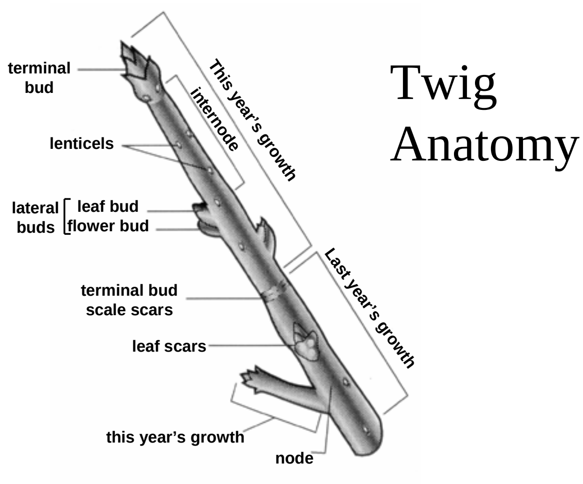
Anatomy of a Leaf



Compound Leaf Parts



An easy way to remember trees with opposite branching in deciduous trees is the acronym: MAD Horse.
M = maple
A = ash
D = dogwood
Horse = horsechestnut, buckeyes



Fruits are the seed containing part of trees. Below are some of the types of fruits:
- Acorns: oaks
- Nuts: hazelnuts; beech nuts
- Cones: pines
- Samaras: maples
- Pomes: apples, pears
- Drupes: cherry
- Legumes: locusts, catalpa

Conifers are identified differently than deciduous trees. In conifers, needles or scales do not fall off in the winter except in a few species like the tamarack or larch. Conifers have either needles like a white pine or scales like a cedar or juniper. Needles occur in three ways on conifers: 1)in clusters of two or more (ex. true pines); 2) in clusters of 10 or more in short lateral shoots (ex. Tamarack or Larch) or 3) solitary along the branch (ex. Spruce, Fir, Hemlock) Cone shape, size, and color can also be used in conifer identification.

In addition to using visual cues to identify trees, other senses are also helpful. From the wintergreen smell of birches, to the whispering sound of pines to the rough feel of slippery elm leaves to the spicy taste of sassafras it is important to use multiple characteristics from multiple parts of the tree to confirm proper identification.

The use of an identification key is helpful in correctly identifying a tree. Keys organize the morphology of tree characteristics usually into a series of choices. Leaf keys are common but there are keys based on flowers, tree shape, buds, etc. Keys are only a guide as each tree is individual and its morphology subject to a variety of genetic, climatic, environmental, biological and cultural influences.

Twenty trees chosen from this list will be on the Roadside Tree Care Expert examination.

	Family	**Genus**	**Species**	**Common Name**
1	Aceraceae	Acer	negundo	Boxelder
2	Aceraceae	Acer	rubrum	Red Maple
3	Aceraceae	Acer	saccharum	Sugar Maple
4	Aquifoliaceae	Ilex	opaca	American Holly
5	Anacardiaceae	Rhus	typhira	Staghorn sumac
6	Betulaceae	Betula	nigra	River Birch
7	Betulaceae	Carpinus	caroliniana	American hornbeam
8	Betulaceae	Ostrya	virginiana	Eastern hophornbeam
9	Cornaceae	Cornus	florida	Dogwood
10	Cuppressaceae	Thuja	occidentalis	Northern White Cedar
11	Cupressaceae	Juniperus	virginiana	Eastern Redcedar
12	Ebenaceae	Diospyros	virginiana	Persimmon
13	Fagaceae	Fagus	grandifolia	American Beech
14	Fagaceae	Quercus	alba	White Oak
15	Fagaceae	Quercus	bicolor	Swamp White Oak
16	Fagaceae	Quercus	falcata	Southern Red Oak
17	Fagaceae	Quercus	phellos	Willow Oak
18	Fagaceae	Quercus	prinus	Chestnut Oak
19	Fagaceae	Quercus	rubra	Northern Red Oak
20	Hamamelidaceae	Liquidambar	styraciflua	Sweetgum
21	Juglandaceae	Carya	glabra	Mockernut hickory
22	Juglandaceae	Carya	ovata	Shagbark Hickory
23	Juglandaceae	Juglans	nigra	Black Walnut
24	Lauraceae	Sassafras	albidum	Sassafras
25	Leguminosae	Cercis	canadensis	Redbud
26	Leguminosae	Robinia	pseudoacacia	Black Locust
27	Magnoliaceae	Liriodendron	tulipifera	Yellow Poplar
28	Magnoliaceae	Magnolia	virginiana	Sweetbay
29	Moraceae	Maclura	pomifera	Osage Orange
30	Nyssaceae	Nyssa	sylvatica	Blackgum
31	Oleaceae	Fraxinus	americana	White Ash
32	Oleaceae	Fraxinus	pennsylvanica	Green Ash
33	Pinaceae	Pinus	rigida	Pitch Pine
34	Pinaceae	Pinus	strobus	Eastern White Pine
35	Pinaceae	Pinus	taeda	Loblolly Pine
36	Pinaceae	Pinus	virginiana	Virginia Pine
37	Pinaceae	Picea	rubens	Red Spruce
38	Pinaceae	Taxodium	distichum	Baldcypress
39	Pinaceae	Tsuga	canadensis	Eastern Hemlock
40	Platanaceae	Platanus	occidentalis	American Sycamore
41	Rosaceae	Amelanchier	canadensis	Canadian Serviceberry
42	Rosaceae	Malus	sp	Crabapple
43	Rosaceae	Prunus	serotina	Black Cherry

44	Rosaceae	Pyrus	calleryana	Bradford pear
45	Salicaceae	Populus	deltoides	Cottonwood
46	Salicaceae	Populus	grandidentata	Aspen
47	Salicaeae	Salix	nigra	Black Willow
48	Simaroubaceae	Ailanthus	altissima	Ailanthus
49	Tiliaceae	Tilia	cordata	Little Leaf Linden
50	Ulmaceae	Ulmus	americana	American Elm

References

Version 3.0

American National Standard for Tree Care Operations – Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices (Pruning) ANSI A300 (Part 1)-2008 Pruning

American National Standard for Tree Care Operations – Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices (Fertilization) ANSI A300 (Part 2)-2011 Fertilization

American National Standard for Tree Care Operations – Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices (Support Systems - Cabling, Bracing, and Guying Established Trees) ANSI A300 (Part 3)-2013 Support Systems

American National Standard for Tree Care Operations – Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices (Lightning Standard) ANSI A300 (Part 4)-2008 Lightning

American National Standard for Tree Care Operations – Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices (Management of Trees and Shrubs During Site Planning, Site Development, and Construction) ANSI A300 (Part 5)-2012 Management

American National Standard for Tree Care Operations – Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices (Transplanting) ANSI A300 (Part 6)-2012 Transplanting

American National Standard for Tree Care Operations – Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices (Integrated Vegetation Management IVM) ANSI A300 (Part 7)-2012 Integrated Vegetation Management

American National Standard for Tree Care Operations – Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices (Root Management) ANSI A300 (Part 8)-2013 Root Management

American National Standard for Tree Care Operations – Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices (Tree Risk Assessment a. Tree Structure Assessment) ANSI A300 (Part 9)-2011 Tree Risk Assessment a. Tree Structure Assessment

American National Standard for Arboricultural Operations – Pruning, Repairing, Maintaining, and Removing Trees, and Cutting Brush – Safety Requirements ANSI Z133-2012

American Standard For Nursery Stock, ANSI Z60.1-2012

Arboriculture: Integrated Management of Landscape Trees, Shrubs, and Vines. Fourth Edition, 2004, Harris, Clark and Matheny

Arborist's Certification Study Guide, Third Edition, 2010, International Society of Arboriculture

Best Management Practices, Tree Pruning. Special companion publication to the ANSI A300 Part 1: Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices (Tree Pruning) 2008, International Society of Arboriculture, Gilman and Lilly

Best Management Practices, Utility Pruning of Trees. Special companion publication to the ANSI A300 Part 1: Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices (Utility Pruning of Trees) 2004, International Society of Arboriculture, Kempter

Best Management Practices, Tree and Shrub Fertilization. Special companion publication to the ANSI A300 standard for Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices (Plant Fertilization) 2007, International Society of Arboriculture, Smiley, Lilly, and Kelsey

Best Management Practices, *Managing Trees During Construction*. Special companion publication to the ANSI A300 Part 5: Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices (Management of Trees and Shrubs During Site Planning, Site Development, and Construction) 2008, International Society of Arboriculture, Fite and Smiley

Best Management Practices, Tree Planting. Special companion publication to the ANSI A300 Part 6: Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices (Tree Planting) 2012, International Society of Arboriculture, Watson and Himelick

Best Management Practices, *Integrated Pest Management*. 2007, International Society of Arboriculture, Wiseman

How to Prune Trees, USDA Forest Service, NA-FR-01-95

Tree Maintenance, Seventh Edition, John R. Hartman, Thomas P. Pirone and Mary Ann Sall