Tree Basics

Our Community Trees

Our community trees are part of our infrastructure and are a valuable asset. Trees perform many essential biological functions that benefit all of us and our environment in substantial, measurable ways. But unlike other assets, trees are living entities and have basic biological requirements for survival and growth. As such, this unique asset must be actively managed and protected to maintain its health, function, safety, beauty, and value. There is a shared community responsibility for tree management that results in considerable costs and risks associated with owning trees. To maximize the benefits we gain from our trees and minimize the costs and risks associated with them, we must have a good understanding of their benefits, costs, structure, and growth requirements, and we must be pro-active in their management.

Tree Structure

A **tree** is defined as a woody plant that grows to 15 or more feet in height, usually with a single trunk, growing to more than 3 inches in diameter at maturity, and possessing an upright arrangement of branches and leaves. Trees are commonly referred to by their size, specifically their *mature* height. In this Guide, tree heights are divided into **small**, **medium**, or **large** height classes and are defined as follows:

- **Small Trees**: Less than 25 feet tall at maturity
- **Medium Trees**: 25 to 40 feet tall at maturity
- **Large Trees**: 40 to 100 feet tall or more at maturity

Trees, like people, are complex living organisms made up of many types of cells arranged into tissues and organs. Unlike people, they are only generating systems, and cannot regenerate new cells in the place of damaged or destroyed cells. Because trees generate new wood each year during the growing season, they can get to be very large and achieve a huge volume (size) and mass (weight).

The three main parts of a tree are its **crown**, **trunk**, and **roots**. The **crown** is the woody and leafy component of the tree. It is composed of large, scaffold limbs that support smaller branches, twigs, leaves, and buds. The leaves absorb carbon dioxide and in the presence of sunlight produce food—carbohydrates—in a process called photosynthesis. As a by-product, the trees leaves produce and release oxygen. Tree growth occurs at the tips of the branches, which can extend a few inches to several feet a year, depending upon the species and growing conditions. Tree crown size is measured as diameter in feet of the width of the branches at their greatest extent.

The horizontal projection of the tree crown onto the ground or the square foot area the crown covers is defined as the tree **canopy**. Tree canopy cover is calculated by multiplying the width of the crown in the north-south direction by the width of the crown in the east-west direction. For example, a tree with a crown width of 40 feet in the N-S direction and a width of 30 feet in the E-W direction
has a canopy cover area of 1200 square feet. Estimates of mature crown canopy size categories for trees growing in urban areas are listed in the ACC Tree Species List as follows:

- **Very Small Canopy**: 150 square feet (approximately 12 x 12 feet)
- **Small Canopy**: 400 square feet (20 x 20 feet)
- **Medium Canopy**: 900 square feet (30 x 30 feet)
- **Large Canopy**: 1600 square feet (40 x 40 feet)

The **trunk** is the main woody stem of the tree and supports the crown. While most trees normally have one stem or trunk, other trees are characteristically multi-stemmed. Carbohydrates and other substances necessary for tree growth are stored in the trunk, roots, and other woody portions of the tree. Water is transported up through the trunk to other parts of the tree. Tree size is often measured as **dbh** or “diameter at breast height” which is the diameter of the trunk at 4.5 feet above ground. For a tree forked at or below 4.5 feet, diameter is measured at the narrowest point below the fork.

You can calculate trunk diameter by measuring trunk circumference at 4.5 feet above the ground with a standard tape measure and dividing by **pi** or 3.14, a constant.

\[
\text{Diameter} = \frac{\text{Circumference}}{3.14}
\]

Knowing the **cross sectional area** of the trunk may also be useful; the cross sectional area of the trunk at 4.5 feet above the ground is also referred to as a tree’s **basal area**. Basal area is often used to describe the stocking of trees (number and size) per acre of land. Cross sectional area is calculated by first dividing the tree diameter in half to get the radius, and then multiplying the radius times itself and then by 3.14.

\[
\text{Area} = \pi \cdot \text{Radius}^2
\]

Beneath the **bark**—the outer protective layer that covers the trunk, limbs, branches, and roots—there is a very thin layer of specialized cells known as the **cambium layer**. The cambium layer is where growth in trunk and root diameter takes place each year when both a layer of wood (xylem) is produced to the inside, and a layer of inner bark (phloem) and bark are produced to the outside. The cambium layer functions as the food transport system for the tree.

The **roots** are the underground structures that anchor the tree and absorb water and nutrients essential for tree survival and growth. The anchoring roots are large, ropelike, and woody and usually number from 4 to 11. **Tree roots grow out from the trunk for a distance of at least 2 to 3 times the radius of the tree’s crown, or at least 2 times the height of the tree.** However, they taper rapidly as they move away from the tree trunk.

While the large roots grow out from the tree trunk, many small, fibrous absorbing roots arise from the woody roots and generally grow up and into the top layers of soil and leaf litter—layers rich in organic material. Attached to the fine root hairs on fibrous roots are beneficial fungi that combine with the root hairs to form **mycorrhizae**, structures of benefit to both the fungus and the tree. These structures increase the surface area that absorbs water and nutrients. **Whether woody or fibrous, 85% of tree roots are located in the top 18 inches of soil.**

**Tree Growth**
Trees require a certain amount of basic substances and a specific combination of environmental conditions to function, survive and grow. Each individual tree species, like all plant species, has a range of soil moisture, soil volume, soil nutrient and acidity levels, air temperature, humidity, and sunlight in which it will grow.

Under optimal conditions, trees will achieve their genetic potential for size, age, and form characteristic of their species. Under less than optimal conditions, trees will grow slower, be smaller at maturity, become easily stressed, have more deadwood, and will be more vulnerable to attacks by insects and disease organisms. The growth requirements of many tree species growing in our region are included in the ACC Tree Species List.

As stated earlier, trees cannot regenerate or replace cells damaged or destroyed with new cells in the same location. Because trees can only “seal” their wounds and cannot “heal” their wounds, any physical damage done to a tree’s roots, trunk, or crown affects it for the rest of its life. This is important to understand before we cut or damage a tree’s roots, wound its trunk, break its limbs, or prune it incorrectly.

The amount of energy that a tree is able to store has an effect on its ability to withstand unfavorable conditions and resist attacks by insects, fungi, bacteria, and other harmful organisms. This energy storage capacity is an important factor to consider when working around trees. Trees most affected by injury or stresses are those that store little energy, are fast growing, have inadequate soil volume and growing space, have been adversely affected by weather conditions, have been repeatedly wounded, or are at a critical point in their seasonal or life stage development.

The Critical Root Zone and Tree Protection Zone

Because trees contribute so much to our quality of life and because they can be a potential liability, they must be actively conserved, wisely selected, well placed, well planted, routinely maintained, and constantly protected. One of the most critical steps in planning for trees and cost effective ways of managing trees is to maintain adequate growing space for each tree’s roots, trunk, and crown throughout the tree’s life. Remember that as a tree gets older it gets larger and the growing space it requires increases accordingly.

For existing trees, there is a minimum amount of area, above (for the trunk and crown) and below ground (for soil health and the root system) that is required to protect trees and preserve tree health. This area has been identified as the critical root zone (CRZ) or tree protection zone (TPZ) by various experts and is generally agreed to be equivalent to the soil area below ground and the space above ground defined by the tree’s dripline, or the greatest extent of the branches. This is depicted in Figure 1.

However, for small trees, newly planted trees, and trees with narrow crowns, the dripline defines an area that is too small for proper protection. So it is best to define both the critical root and tree protection zones as the circular area above and below ground with a radius equivalent to the greater of 6 feet or
1.5 feet for every inch in trunk diameter at 4.5 feet above the ground. For example, a tree with a trunk diameter (dbh) of 20 inches has a CRZ and TPZ of 30 feet (20 inches x 1.5) around the tree. While the radius of the CRZ (and TPZ) is 30 feet, the diameter of the entire CRZ (and TPZ) is 60 feet. Both concepts--critical root zone and tree protection zone--are used throughout the remainder of this Guide. TPZ is more often used when talking about tree protection.

A generalized requirement for the minimum amount of open soil surface area by tree canopy size category is included in the ACC Tree Species List. Athens-Clarke County established these minimums for the purpose of providing tree canopy cover credits under the Development Regulations. Larger areas are recommended wherever possible. The minimum requirements are listed below:

- Very Small Canopy: 25 square feet (5 x 5 feet)
- Small Canopy: 100 square feet (10 x 10 feet)
- Medium Canopy: 225 square feet (15 x 15 feet)
- Large Canopy: 400 square feet (20 x 20 feet)

The minimum depth of soil required for adequate root growth is 2 feet, or 24 inches and the maximum required is 3 feet or 36 inches. The minimum soil volume (in cubic feet) required for each tree canopy size listed above can be calculated by multiplying the minimum open soil surface area by 2.0 feet. For example, the minimum soil volume required for a tree with a large canopy is 400 square feet x 2 feet, or 800 cubic feet.
Figure 1. Location of the Critical Root Zone and Tree Protection Zone

DBH = Diameter of trunk at 4.5 feet above ground

CRITICAL ROOT ZONE AND TREE PROTECTION ZONE

Extends out from the trunk to the dripline, or to a distance of 1.5 feet per inch DBH, whichever is greater.

If this tree's DBH is 20 inches then the critical root and tree protection zone is a 30-foot area (radius) around the tree.

Roots extend out 2 to 3 times the dripline.