URBAN FORESTRY

A Manual for the State Forestry Agencies in the Southern Region

Unit: Tree Maintenance

The Urban Forestry Manual is being developed by the USDA Forest Service, Southern Region and Southern Research Station, and the Southern Group of State Foresters as an educational tool for State forestry agency employees and others who work with communities on urban forestry. It can be used for self-guided learning, finding specific information on a topic and developing workshops and presentations. There are 16 units (chapters) in the Manual - at this time several of the units are on the web site (www.urbanforestrysouth.usda.gov).

Table of Contents

Using this Manual

The Urban Forestry Manual provides the scientific, technical, and practical information needed to work with communities on urban forestry. There are 16 units (listed below) that address specific topics in the practice of urban forestry. These units have been developed as a series, each building upon the information in previous ones. The units may also be used individually to gain information about a specific topic.

Benefits and Costs of the Urban Forest is the first unit in the Urban Forestry Manual. This is an introduction to urban forestry and it explains why your work with communities and individuals in urban forestry is important. This unit also includes information about how to maximize the benefits and minimize the costs related to the urban forest.

The Role of the State Forestry Agency in Urban Forestry is an introduction to State forestry agencies' responsibilities and activities in urban forestry. It explains why partnerships are important to State forestry agencies activities in urban forestry. This unit also discusses the importance of working with communities and individuals.

Tree Biology is an introduction to how trees grow and live. It describes how trees are structured, how they function, and how they grow and develop. It also explains how the urban environment influences tree growth and development.

Dendrology is an introduction to identifying and understanding trees in the urban environment. It explains the classification of trees, naming trees and tree identification. This unit also includes information on how characteristics of the urban environment influence tree identification.

Urban Soils is an introduction to the role that soils play in the health of the urban forest. It explains what soil characteristics are important for healthy tree growth. This unit also includes information about common soil problems in urban areas.

Site and Tree Selection provides information on how to select a site and species to maximize the benefits and minimize the costs related to urban forestry. It explains what factors you need to consider when selecting a planting site, tree species, and tree stock. This unit also discusses how to match these factors to ensure healthy tree growth and development.

Tree Planting is a unit that will introduces factors to consider and techniques to implement when planting trees. It includes recommended guidelines for planting and post-planting. It also explains how to work with communities and individuals to successfully plant trees.

Tree Maintenance unit is a general overview of the considerations and techniques for tree care in the urban setting. Preventative maintenance is emphasized as the primary

consideration in tree care. It discusses the specifics of mulching, watering, pruning, fertilizing, disease and pest control, and tree removal.

Tree Diagnosis and Treatment provides an introduction on how to diagnosis and treat tree health problems. This unit explains how your knowledge and application of diagnosis and treatment can improve the health of the urban forest. It also includes information on why it is important to prevent tree health problems.

Trees and Construction is an introduction to the relationship between construction activities and trees. It explains the importance of communication during the construction process. The focus is on the impact of construction activities on trees, the protection of trees during construction, and care for the tree before and after construction.

Hazard Trees is an introduction to the importance of recognizing a hazard tree. It gives a general overview on evaluating a target, site conditions and the tree. This unit also includes information on how to prevent and manage hazard trees.

Urban Wildlife is an introduction to the relationship between wildlife and the urban environment. It first defines urban wildlife and describes the needs of wildlife, such as food, water, cover and living space. Then it discusses wildlife habitat in urban areas and how wildlife adapts to urban habitat. It also includes information on how to encourage and discourage wildlife.

Urban Ecosystems is an introduction to the role that trees play within an urban ecosystem. It first defines an ecosystem and why it is important to understand ecosystems. Then is discusses ecological concepts, such as structure and function, that are important to understanding ecosystems. This unit also includes information on understanding challenges in the urban forest ecosystem.

Urban Forestry Planning and Management is an introduction to the importance of planning and managing the urban forest. It starts with a definition of an urban forest management plan and why they are important. Then it discusses the steps involved in developing a management plan. It also includes information on the different components in a management plan.

Urban Forestry and Public Policy is an introduction to understanding public policy and how it relates to urban forestry. It first describes the role that each level of government has in setting public policy related to urban forestry. Next it provides information on local government in more detail because this is where most urban forestry policy is created and implemented. The role that Tree Boards have with local government is also discussed. The final section reviews public policy tools that can be used to address urban forestry issues in a community.

Working with the Public is an introduction on how to effectively work with the public. It starts with tips on how to work together as a team and how to work with volunteers. Then it discusses the role of communication and education in working with the public. The unit also includes information on the importance of leadership in urban forestry.

Using Each Unit

Each unit in the Urban Forestry Manual is organized as follows:

Table of Contents
Lists major topics that are included in the unit.

Unit Overview
Presents goals and objectives for the unit.

Before You Begin
Consider how your current activities and experiences relate to this topic.

Content
Presents specific material about this subject under several headings.

Next?
Think about how you can use the information in your daily responsibilities and in developing your career in forestry.

For More Information
Lists other sources of information about this subject, as well as the literature cited in the unit.

Appendix
Some units have an appendix that may include checklists or other information.

In addition, each unit has two sections that will help you assess your learning of the information.

Checking Your Understanding
At the end of major sections in the unit, there are short-answer questions about the information you have read. After you have written the answers, you may compare your responses to the answers provided at the end of each unit.

Case Study
These are stories based on the real experiences. The questions at the end of the case study challenge you to use the information you learned to solve a problem similar to what you will be facing when working. You will be asked to analyze an actual urban forestry problem and prepare your solutions. There are no right or wrong answers -- only what you decide is the best course of action after considering all of the information.

Table of Contents

Overview

Proper care is essential for maintaining and improving the health of existing trees and planning for future growth in our urban forests. Unfortunately, when we plant trees we often think the job is finished, when it has really just started. When trees are planted, it is important to consider ongoing maintenance – what needs to be done and who is responsible. This unit provides an introduction to tree maintenance. The unit begins by discussing how the urban setting is unique. Then it discusses different tree maintenance activities, including mulching, watering, pruning, fertilizing, disease and pest control, tree conflicts, and tree removal.

An Ounce of Prevention is Worth A Bunch of Urban Trees

The Money Pit

The urban forester for a medium-sized southern city knew there would be trouble when she first saw the new streetscape plans the City Council had just approved. The city had an out-of-state consultant develop the plans and there was no opportunity for her input. The street plans included small, raised, brick boxes sited along the curbs to hold the new street trees. Even worse, the trees were Bradford Pears, a species popular with the public but susceptible to limb breakage and with a short life span. Unfortunately, it was too late to change the design. Given the circumstances, the urban forester did her best to provide a good growing environment for the trees by using good soil in the small boxes, monitoring soil moisture, and pruning to offset the poor limb structure. This delayed the inevitable for a few years, but eventually the trees overgrew their space, the roots split the boxes, and the tight branch crotches began to break during summer storms. Now the City Council had to find more money to remove the old trees and brick boxes, design another streetscape, and buy new trees. The City Council had learned its lesson. They added a section to the tree ordinance authorizing the urban forester to review and approve all construction plans on public property before construction could begin. And, the urban forester got a raise the next year by never saying, "I told you so."

An ounce of prevention is worth a pound of cure. Henry de Bracton

Before You Begin

Tree maintenance is an essential component of urban forest management. Use these questions to stimulate your thinking about how tree maintenance is being addressed in the communities where you work.

- Have you seen examples of trees that were unhealthy, unattractive, or hazardous due to lack of tree maintenance? What do you think caused these conditions?

- Who has been doing tree maintenance in the communities where you work?

- What types of questions or requests for assistance do you receive related to tree maintenance?

On a separate piece of paper describe your answers to these questions about tree maintenance and think about how this information will assist you in your job.

Tree Care in the Urban Setting

The urban environment is generally harsh for growing trees, and methods traditionally used in rural forestry are not always effective or appropriate in the urban setting. Urban trees, like rural trees, suffer from competition in their surroundings; however, the urban competition looks a bit different: compacted soils, sidewalks, utility lines, vehicles, roads, buildings, and pedestrians. Seldom is there the ideal site or situation for growing trees in the urban setting; moreover the concerns and safety of the community have to be considered.

Many people have roles in tree maintenance and their decisions affect the health of the urban forest. Property owners decide how much money to invest in tree maintenance, who will do the maintenance and what type of maintenance needs to be done. Various other groups may also be involved in tree maintenance activities: landscape, tree care, and utility companies; local government; hospitals; golf courses; and schools. Some of the people who manage and maintain urban trees are tree-maintenance professionals, such as certified arborists, while others have no experience or training. Management approaches to tree maintenance may differ: for example, some tree-maintenance providers act only when there is a problem, such as a hazard tree, while others have a detailed maintenance plan. The unique setting of the urban environment provides challenges and opportunities for tree maintenance.

Maximize Benefits and Minimize Costs

An objective of planning and implementing appropriate tree maintenance is to provide healthy, safe trees at the lowest cost to the owner. As trees increase in age (size) they provide more benefits, such as energy savings, air pollution mitigation, and reduced soil erosion (benefits are related to crown size and leaf area). McPherson's (1994) cost-benefit research in Chicago indicates that planting and establishment account for much of a tree's total cost and that a tree needs to live 9 – 18 years before its benefits outweigh the costs. So by extending the life cycle of a tree (the time a tree is "useful" and "healthy") the early costs of planting and establishment are spread over a longer time. Determining when a tree should be removed – when it is no longer useful and healthy - is an important part of a maintenance program. Examples of activities that can extend the life cycle of a tree include:

- Evaluating the site
- Selecting healthy tree stock and appropriate species
- Using proper planting techniques
- Providing regular maintenance
- Monitoring site conditions

Providing regular tree maintenance can help maximize the benefits and minimize costs of the urban forest.

Tree Maintenance Plan

Developing and implementing a tree maintenance plan is an important management tool, especially for large property owners such as local governments, residential and commercial developments, golf courses, and universities. This written plan, which establishes policy and standards for tree maintenance, needs to be based on local conditions, general age and health of the trees, and the owner's objectives. Guided by tree inventory information, the maintenance plan recommends mulching, watering, pruning, fertilizing, and other tree maintenance activities. The tree maintenance plan may be part of an urban forestry management plan or a stand-alone document. A maintenance plan may include:

- Tree inventory – collect information on trees: such as location, species distribution, size (age), condition, hazards.
- Current condition – assess the current needs for tree maintenance based on inventory information.
- Maintenance cycles – establish maintenance cycles or frequency for planting, pruning, watering, and other maintenance activities that will meet owner's objectives.
- Work plans – prepare immediate, annual, and cycle work plan based on maintenance needs.
- Budget – develop an annual budget to meet projections of maintenance needs.
- Maintenance performed – decide how maintenance work will be performed, for example bidding, contract, or in-house.
- Evaluation - re-inventory, re-assess, and adjust work plans as necessary.

Refer to the "Urban Forestry Planning and Management" unit for more information on the tree maintenance plans and inventories.

Opportunities for Providing Assistance

There are a number of ways State forestry agency employees can help communities maintain healthy, thriving urban forests. Individuals within the agency can collaborative with municipalities, nonprofit groups, professional associations, businesses, and other interested people in the community to provide

technical, educational, and planning information on tree maintenance (table 1). As an employee of the State forestry agency, you can help individuals and communities address the maintenance needs of urban trees.

Table 1. Examples of tree maintenance assistance and potential recipients

Technical/Educational Assistance	Planning Assistance	Potential Recipients
• Stress identification • Mulching • Pruning and removal recommendations • Watering young trees • Fertilization techniques • Biological and chemical pest controls • Tree protection measures	• Tree inventory • Tree maintenance plan • Pruning cycles and policies • Tree life cycle • Water management program • Cost-effective alternatives	• Homeowners • Utility companies • Municipalities • Land trusts • Neighborhood associations • Developers and contractors • Landscape architects • Engineers

Tree Maintenance Activities

Various tree maintenance activities can be used to maintain or improve the health of the tree. When determining what types of tree maintenance activities to provide and when to do them, several factors need to be considered, such as time of year, age and species of tree, site conditions, and costs. The remaining sections in this unit discuss several tree maintenance activities:

- Mulching
- Watering
- Pruning
- Fertilizing
- Disease and pest control
- Removal

Some communities require people who provide tree maintenance to be International Society of Arboriculture certified arborists.

Mulching

Mulching is the least expensive and most beneficial urban forestry maintenance activity available.

- Improves appearance of the area around the tree
- Stimulates root growth
- Helps with weed control
- Improves soil moisture infiltration and retention, soil structure and soil fertility
- Increases soil organic matter and number of soil organisms
- Reduces soil erosion
- Prevents or reduces soil compaction from foot and vehicle traffic
- Helps insulate soil from cold and heat
- Protects tree trunk and surface roots from mower and string-trimmer damage
- Provides environment for mychorrizal fungi

Refer to the "Urban Soils" unit for information on correcting soil related problems.

Types of Mulches

Mulches can be divided into two different categories, organic and inorganic.

Organic mulches

Organic mulches include wood chips, shredded leaves, pine straw, bark, straw, peanut hulls, pecan shells, sludge, and lawn clippings. Some organic mulches, such as pine straw, burn easily, especially in drought conditions. As organic mulches decompose they can replenish some key elements necessary for productive soil and can improve soil structure. Because organic mulches decompose they need to be reapplied periodically. Avoid fine-textured mulches that compact and prevent oxygen and water movement to the root system.

Inorganic mulches

Some inorganic materials used for mulch include crushed rock, gravel, and polyester fabrics. These last a long time and protect better against weeds, seeds, and diseases then organic mulches. However, they do not add any nutrients, enhance the soil or aid in conserving moisture in the root zone. Landscape fabric should be placed under rock and gravel to prevent them from settling into the soil. However, some landscape fabrics can fill with soil particles and become hydrophobic.

General Guidelines

Several general guidelines should be followed when using mulch:

Determine mulch area

The mulch area should cover as much of the root system as practical. Ideally, it should extend well beyond the drip line of the canopy. Gilman (1997) uses the rule-of-thumb, " …mulch at least 2 feet in diameter for each inch of trunk diameter." The mulch area should therefore increase as the tree grows. Whenever possible, trees should be mulched in groups to provide a "shared" mulch and rooting area.

The mulch area does not need to be circular.

Determine mulch depth

Organic mulches should be applied 4 inches – 6 inches deep except for pine straw mulch which should be applied to a depth of 8 inches. Because pine straw decomposes faster than wood chips and bark, it typically needs to be replenished annually. Pine straw may be used in conjunction with wood chips as a top covering for aesthetic purposes.

Use thicker layers of mulch at construction sites as temporary measures to reduce soil compaction from equipment. Excess mulch should be removed at the conclusion of the construction work.

Remove competing vegetation

Remove or kill competing vegetation (e.g. grass, weeds, vines) in the mulch area. However, do not damage the shallow root system or injure the root collar. Hand or chemical weeding should be done

next to the trunk but do not apply chemicals directly on the trunk.

Check source and composition of mulch
The source and composition of the mulch are important, as contaminants in the mulch may leach into the soil, reduce aesthetic characteristics, or require additional maintenance. Examples of contaminants include: non-composted mulch that contains herbicides, acorns and other weed seed, litter, plastic bags, insects, oil cans from chippers and chainsaws, soil, and woody debris (i.e. limbs or large wood pieces). Ideally, composted mulch is best.

Expose root collar
Mulch should not be placed against the trunk of the tree. Leave an un-mulched area 6-12 inches in radius around the trunk. If existing mulch is found against the base of the trunk, carefully remove it and the soil at the base of the tree to expose the root collar, which needs adequate air circulation. Use non-metallic hand tools when working near the root collar to prevent damaging the trunk and roots.

Keep mulch away from the trunk.

Mulch is a protective soil covering and it should not be mixed with the soil in the planting hole.

Watering

Watering, especially the 1st two years after a tree is planted, is essential to a maintenance program. Trees that do not receive enough water during the first few years of establishment have an increased risk for dieback, development of weak, multi-trunks, and possible death (Gilman 1997). Because every planting situation is unique, it is difficult to prescribe a rule of thumb for watering trees; however, keeping the soil in the root ball moist (but not wet) will promote rapid root growth (Gilman 1997). Table 2 lists factors that increase and reduce the need for watering after planting.

Table 2. Factors impacting watering requirements after planting (Gilman 1997, pg 68)

Increases need for watering frequency after planting	Reduces need for watering frequency after planting
• Well-drained soil • Sandy-textured root ball • Planting in warm season • Dry weather • Sunny days • Windy days • Container-grown and freshly dug field-grown nursery stock • Sloping ground • Warm climate • Southern or western exposure	• Poorly drained soil • Clayey-textured root ball • Planting in cool or dormant season • Rainy weather • Cloudy days • Calm days • Hardened-off field-grown nursery stock • Flat ground • Cool climate • Northern or eastern exposure

Young and Established Trees

Young trees need adequate water to become established. For recently planted trees, apply the water directly on the root ball where the absorbing roots are located. When watering 2 or 3 years after establishment, determine by inspection the location and extent of the root system and apply water accordingly.

Over watering is as serious as under watering.

Timing of Irrigation Systems

Irrigation systems that are timed for watering turf or other groundcover plants typically do not adequately water trees. These systems are generally designed to provide 1 inch of water each week in daily applications of 1/7 inch. This watering regime does not penetrate soil deep enough for tree roots.

Refer to the publication, "Trees for Urban and Suburban Landscapes," by Edward. F. Gilman for specific guidelines for watering different sized trees in different hardiness zones.

Pruning

Pruning is the selective removal of plant parts, typically shoots and branches. Knowledge of a tree's development pattern, including the importance of the apical bud in the growth and structure of a branch, is necessary for understanding how pruning affects a tree. Trees may need pruning to –

- Improve and maintain health
- Eliminate and reduce risks, such as limbs falling and interference with utility lines and vehicles
- Enhance appearance
- Improve views

Communities with limited budgets should concentrate their pruning activities on removal of deadwood (hazardous material) and the pruning of young trees.

When and How Often to Prune

The time of year to prune depends on why it is being done. Removing dead wood and hazardous branches or pruning for disease and pest control can be done at any time. Pruning for other purposes should be planned according to the season.

Winter

Winter is often the best time to prune, except for those trees that flower in the spring (e.g. dogwood, magnolia). For most "non-flowering" hardwoods, winter is the best pruning time. Branch removal is easier during dormancy because the structure of the tree is more visible and physiological activity is lowest. Trees that flower in the summer can be pruned during the winter (e.g. crapemyrtle, vitex).

Spring

Spring is the primary growth and flowering period for many trees. To maximize flowering and fruiting, trees that bloom in spring (e.g. dogwood, magnolia) should be pruned soon after flowers have faded.

Summer

Summer pruning can be done to remove (1) limbs that are causing hazards, (2) diseased leaves and/or limbs, and (3) storm or construction damage. Corrective pruning may also be done to prevent future problems. Summer pruning may slow the growth of a tree by reducing leaf area and photosynthesis.

Fall

Do not prune in the fall. The tree needs to conserve energy for the dormant period.

Pruning increases shoot growth and decreases root growth (Gilman 1997).

Pruning Tools

Using proper tools will make pruning easier and give better results.

- A by-pass (or hook and blade) pruning tool should be used for small branches and limbs (usually to ½ to ¾ inch diameter).
- Loppers can be used to reduce the weight of a limb before making the final pruning cut at the branch collar and bark ridge. Use of loppers on small limbs may preclude cuts 1 and 2 in a 3-cut pruning operation (see following section on "How to prune").
- Saws with fine teeth and narrow, curved blades are recommended for most pruning jobs. Saws are available in a variety of blade lengths (6 to 13 inches) and can be easily used in close areas (i.e. acute or narrow branch angles) with minimum damage to the tree trunk or parent limb. Chainsaws should not be used to prune limbs less than 6 inches in diameter and should only be used by someone who is trained and experienced.

Anvils and hedge shears are never appropriate tools for tree pruning.

Training and Pruning Young Trees

Proper training of trees begins with the selection of tree stock in the nursery. Using structural pruning (discussed later in this section) to shape the tree early avoids the necessity for severe pruning later and limiting subsequent hazards. Training has several goals:

- Developing a strong vertical leader and eliminating co-dominant stems
- Establishing well-spaced branches
- Removing branches with included bark
- Removing branches that rub other branches

Pruning young trees requires an understanding of the site and purpose of the tree as well as the growth pattern of the species itself.

Early training and pruning reduces the need for drastic cuts later to manage the crown size or correct structural problems.

First and second growing season

Pruning a young tree during the first growing season should be limited to removing dead or problem branches. Early arboricultural practices assumed that top pruning would compensate for the loss of roots when trees were transplanted, but this is not true. Reducing the leaf area available for

photosynthesis reduces the amount of energy available for growth, reproduction, defense and maintenance. Moreover, pruning apical buds in newly planted trees decreases a growth regulator needed to stimulate root growth.

Third through fifth growing seasons
Beginning in the 3rd year, pruning can promote strong structural growth and prevent future problems. The goal of structural pruning is to develop a strong dominant vertical stem with well-attached alternate branches.

Do not remove more than ¼ of the live growth from the tree in any one year. Also, pruning live branches can cause sprouting.

Types of Pruning

The type of pruning to be used depends upon the purpose of the pruning (Gilman 1997). For example, if the tree is growing into overhead utility lines, reduction pruning will most likely be used.

- Structural pruning encourages the development of one strong leader.
- Cleaning removes dead, diseased, broken, and weakly attached branches. This type of pruning helps maintain tree health and prevents tree limbs from falling or other hazardous conditions.
- Reducing decreases height and/or spread. Reducing is primarily used to provide clearance for utilities and structures and to minimize potential for failure.
- Thinning reduces the density of live branches. Trees may need thinning if branches are too heavy or if there is a foliar disease problem (thinning can increase airflow and light within the canopy). Other benefits of thinning include enhanced appearance of the tree and increased storm resistance.
- Raising provides vertical clearance so people and vehicles can move easily under a tree. Raising is best done by reducing the length of the branch (cutting back to a lateral branch) instead of completely removing the branch.

Refer to the University of Florida Pruning Shade Trees in the Landscape web site http://hort.ifas.ufl.edu/woody/pruning/

Pruning Cuts

Different types of pruning cuts can be used, depending upon the situation.

Visible branch collar
At the base of the branch, where it meets the trunk, there is often an enlarged area called the branch collar (figure 1). The raised bark that develops at the angle of attachment between the branch and the trunk is the branch bark ridge. It is best to cut as close as possible to the branch bark ridge and branch collar at the base of the branch without damaging either one. Cutting just outside the branch collar offers several advantages:

- Prevents damage to the trunk tissue
- Limits possibility of trunk tissue decay
- Retains branch collar as natural protective area
- Creates a small wound

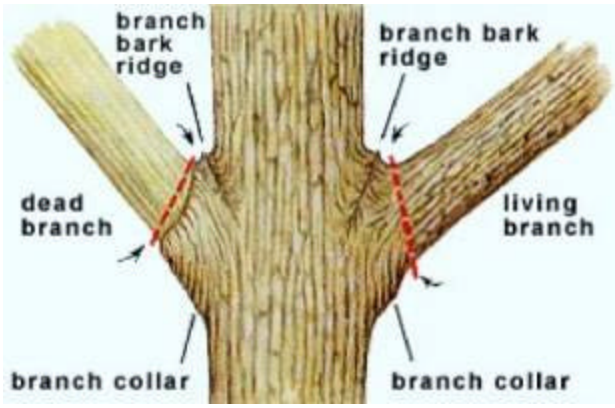

Figure 1. Identifying the branch bark ridge and branch collar is essential to pruning dead and living branches. Courtesy of USDA Forest Service Northeastern Area (Bedker and others 1995).

No visible collar and included bark

Refer to figures 2 and 3 for examples of how to prune trees that have no visible collar and included bark (bark that grows inward into the angle of attachment).

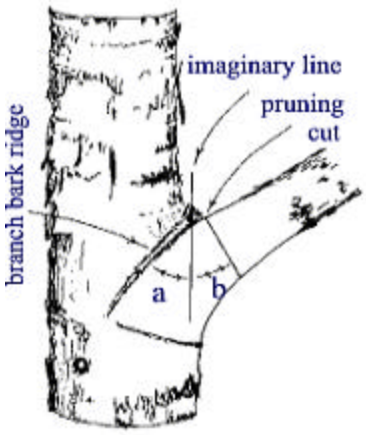

Figure 2. A branch with no visible collar. Courtesy of Edward F. Gilman, Professor, Environmental Horticulture Department, IFAS, University of Florida.

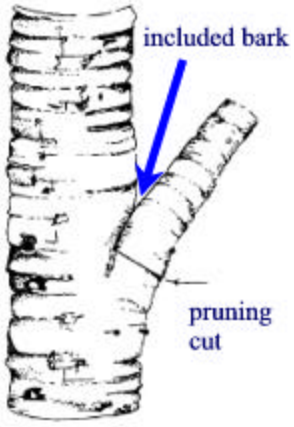

Figure 3. A branch with included bark and no visible collar. Courtesy of Edward F. Gilman, Professor, Environmental Horticulture Department, IFAS, University of Florida.

Reduction or drop-crotch pruning

Reduction or drop-crotch pruning reduces the length of a stem or branch by cutting back to a lateral branch that is large enough (at least one-third the diameter of the cut branch) to assume apical dominance (figure 4).

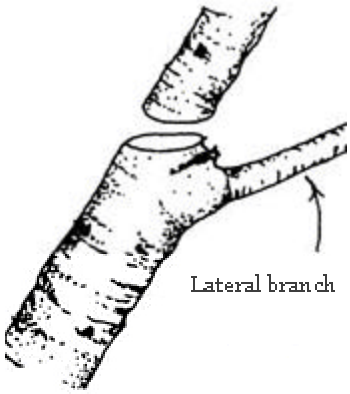

Figure 4. A reduction cut removes a stem back to a lateral branch that will assume apical dominance. Courtesy of Edward F. Gilman, Professor, Environmental Horticulture Department, IFAS, University of Florida.

A heading cut, cutting a branch back to a stub (i.e. between two nodes) or back to a lateral branch not large enough to assume apical dominance, in most cases is not an acceptable pruning practice.

How to Make the Pruning Cut

How the cut is made is as important as where it is made. Removing a limb larger than 1 inch in diameter should be done with three cuts (figure 5):

1. A partial undercut to keep the branch from tearing bark as it is removed.
2. A cut through the entire branch slightly farther out than the undercut to remove the branch. On small limbs (less than 1 ¾ inch) a lopper may be used to do this.
3. A cut just beyond the branch collar and branch bark ridge to remove the stub.

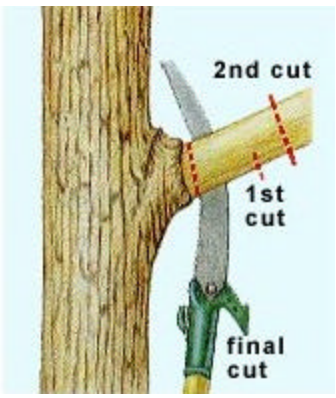

Figure 5. Three cuts to remove a limb more than one inch in diameter. Courtesy of USDA Forest Service Northeastern Area (Bedker and others 1995).

Pruning and Aboveground Utilities

Only properly trained and qualified individuals (i.e. Certified Line Workers meeting 29 CFR 1910.269) should be permitted to prune trees or branches near aboveground electric utilities. The Occupational Safety and Health Administration (OSHA) has set industry standards for pruning trees near utility lines:

- OSHA 29 CFR 1910.269 Electric Power Generation, Transmission, and Distribution.
- OSHA 29 CFR 1910.268 Telecommunications.
- OSHA 29 CFR 1910.331-335 Electrical – General

And, the American National Standards Institute (ANSI) also recommends standards for pruning trees near utility lines:

- ANSI Standard for Tree Care Operations—Pruning, Trimming, Repairing, Maintaining, and Removing Trees, and Cutting Brush-Safety Requirements (ANSI Z133.1-2000)
- ANSI for Tree Care Operations—Tree, Shrub and Other Woody Plant Maintenance—Standard Practices (ANSI A300-2001)

Improper Pruning Techniques

Improper pruning techniques, such as topping, making flush cuts, and using wound dressings, can cause more harm to a tree than not pruning at all.

Topping

Topping is the indiscriminate pruning of tree branches to stubs or lateral branches that are not large enough to assume the terminal role. Other names for topping include "heading," "tipping," "hat-racking," and "rounding over." This technique is inappropriately used to reduce the height of a tree by making heading or internodal cuts. Topping a tree causes several problems: First, it reduces the total leaf surface on the tree, limiting photosynthesis. Second, it creates a stub increasing the possibility of decay in the stem. Third, branches that develop from the regrowth around this type of cut are often weakly attached to the stem and can become hazardous. Alternatives to topping include drop-crotch pruning and thinning by cutting branches back to lower lateral ones. These alternatives will also reduce the size of the crown.

Flush Cuts

This cut removes branches with a final cut that is flush with the trunk or main branch, which removes the branch collar and/or the bark ridge. Flush cuts result in larger wounds and jeopardize the trees ability to compartmentalize (to form a barrier between the damaged tissues and healthy parts of the tree), which can facilitate the spread of decay throughout the tree.

Wound Dressings

Tree paint and other materials applied to pruning cuts do not prevent decay, and if moisture penetrates cracks and collects beneath the covering, they may actually promote decay and tissue damage. Dressings are most commonly used on pruning cuts, primarily for cosmetic value. Proper pruning of branches close to the branch collar allows the tree to use its own natural defenses to compartmentalize the wood and prevent decay.

Fertilizing

Fertilizing is another component of a maintenance program for urban trees. Fertilizers have typically been used to provide certain essential elements to enhance the tree's appearance and health. However, fertilizing for the wrong reason or with the wrong elements can harm the tree. Fertilizing to promote rapid growth in trees can also increase susceptibility to stress, insects, and diseases because the tree's resources are being diverted to growth (Herms and Mattson 1997). Over-fertilizing or improperly applied fertilizer can also directly damage trees.

A major cause of "non-point source" pollution is fertilizer runoff (Herms and Mattson 1997).

Essential Elements
There are 16 elements that are necessary for a tree's growth and survival. A tree gets carbon and oxygen through its leaves (from the carbon dioxide in the air). Hydrogen comes from the water absorbed through the roots. The other 13 elements are usually found in the soil. The six major elements or macronutrients in the soil are nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur. The seven minor elements or micronutrients are also essential: boron, chlorine, copper, iron, manganese, molybdenum, and zinc. Nitrogen, phosphorus, and potassium are most commonly used in fertilizer treatments.

Nitrogen (N)
Nitrogen is the most critical element, responsible for maintaining the green color of leaves (vital to photosynthesis) and normal twig growth. It is rapidly depleted from the soil through leaching and vaporization. Nitrogen is available in water-soluble and water-insoluble forms. It is commonly applied to the soil surface or injected into the soil.

Nitrogen is the nutrient to which trees most readily respond.

Phosphorus (P)
Phosphorus is important in the development of many tissues, including roots, flowers, fruit, and seeds. Most soils have enough phosphorus for these purposes. But when needed it should be applied in holes or injected near the roots of the tree because it is insoluble in water and does not move readily through the soil.

Potassium (K)
Also known as potash, this element is important in photosynthesis. It also enhances the color in flowers. Soils usually contain enough potassium for the health of the trees. Insoluble in water, it should be added directly into the soil.

Complete fertilizers
Nitrogen, phosphorus, and potassium are often combined in one fertilizer with various amounts of each. The percentage by weight for each of the three elements (N-P-K) is always listed on the package or referenced in the same order. For example, a fertilizer listed as 10-10-10 contains 10% each of N-P-K.

Some fertilizers can" burn" roots if too much is applied.

Determining if a Tree Needs Fertilizer

Examining the tree and the site and conducting foliar and soil analyses will help determine fertilization needs. Fertilizing trees that are under stress, such as newly planted, root damaged, or diseased trees, is not recommended because the tree usually does not have the energy reserves necessary for the increased growth that will occur due to the fertilization. Gilman (1997) recommends that during the establishment period, maintenance resources should be restricted to watering, mulching, and weed control.

More information on examining the tree and site, refer to the "Tree Diagnosis and Treatment" unit.

Examine the tree
Examine the tree for any abnormalities in leaf color, leaf size, and twig growth rate, which may be symptoms of nutrient imbalance. For example, a lack of nitrogen will turn foliage yellow; however other things can cause leaves to turn yellow.

Examine the site
Site conditions can also hint at nutrient imbalances. For example, construction of a new concrete sidewalk (which is alkaline) can reduce soil pH impairing availability of some nutrients. If nearby turf and shrubs are being fertilized, there is typically no need to fertilize the trees (Yeager and Gilman 1991). Also, too much of any nutrient in the soil, often the result of over-fertilization in an urban area, may cause stress in a tree.

Establish nutrient level standards
Based on literature or local monitoring, acceptable nutrient and pH levels should be established. For example, a national arboricultural firm has established a 2 percent leaf nitrogen level for most tree species and recommends soil pH in the 5.5 to 6.5 range. Locally, you can select "healthy" trees that represent the predominant species and age-classes and analyze foliage and associated soil samples. The foliage analyses from these "healthy" trees can be used to establish acceptable nutrient levels for nitrogen, phosphorus, and potassium (and other nutrients if desired). The corresponding soil analysis will provide information on pH that may affect nutrient uptake. Reported levels of nitrogen for tree leaves are shown in tables 3 and 4. Dr. Kim D. Coder (2001) recommends 1.5% as an acceptable nitrogen target for urban forest management until further regional research is completed.

Table 3. Quantity of nutrient elements in leaves (Millar and others 1951)

Species	Nitrogen %	Phosphorus %	Potassium %
Red maple (*Acer rubrum)*	0.6	0.4	0.6
Sugar maple *(Acer saccarhum)*	1.4	0.1	2.1
American beech (*Fagus grandifolia)*	1.8	0.2	1.3
White oak (*Quercus alba)*	1.6	0.2	1.5
Scarlet oak *(Quercus coccinea)*	1.6	0.3	1.9
Red oak *(Quercus rubra)*	1.6	0.3	2.0

Table 4. Range and mean levels of nitrogen in leaves (% Nitrogen on dry weight basis) (Perry and Hickman 2001)

Species	Minimum Nitrogen %	Maximum Nitrogen%	Mean Nitrogen %
Silver maple (*Acer saccarhinum)*	2.0	3.4	2.6
Deodar cedar (C*edrus deodara)*	1.0	1.4	1.1
Ginkgo (*Ginkgo biloba)*	1.4	2.4	1.9
Honey locust *(Gleditsia triacanthos)*	2.3	3.1	2.8
Panicled goldenraintree *(Koelreutria paniculata)*	2.2	3.4	2.6
Crapemyrtle *(Lagerstroemia indica)*	1.1	3.5	2.2
Yellow poplar *(Liriodendron tulipifera)*	1.2	2.8	2.0
Southern magnolia *(Magnolia grandifolia)*	1.0	3.5	1.3
Chinese pistache *(Pistachia chinensis)*	1.6	3.0	2.3
Bradford pear *(Pyrus calleryana 'Bradford')*	1.1	1.9	1.6
Zelkova *(Zelkova serrata)*	1.8	2.8	2.2

Send samples to a laboratory for testing
Sending leaf (tissue) and soil samples to a state university or private laboratory can reveal a nutrient imbalance, estimate fertilization needs, and detect how the tree is responding to a fertilization program. Contact the laboratory for instructions on how to collect the leaf and/or soil samples.

- Foliar analysis
  Leaves are analyzed for nutrient content to indicate normal, toxic, and deficient levels. A foliar analysis can detect nitrogen, phosphorous, potassium, magnesium, calcium, sulfur, iron, copper, boron, and other nutrients.
- Soil analysis
  A soil analysis can determine soil pH (concentration of soil nutrients varies with pH), cation exchange capacity (soils capacity to hold nutrients), and the amount of some macroelements (phosphorous, potassium, calcium, and magnesium). Nitrogen and minor element levels are usually not determined by soil analysis.

Soil and foliar tests are the only acceptable method of determining nutrient needs.

Application

Fertilizer should be used according to the manufacturer's instructions, usually provided on the bag or container in which it is packaged. The application method depends on the type of fertilizer, equipment needed, soil composition, site location, environmental concerns, and the tree itself. Refer to current fertilization standards (American National Standards Institute 1998) for accepted methods and rates of application. Fertilizers can be applied in various ways; slow-release nitrogen fertilizers are the preferred over quick-release. Fertilizers may be applied in granular (dry) or in liquid form. Both of these forms are available as quick-release or slow-release formulations. Fertilizers are also rated for salt index; a rating of 50 or less is preferred.

Results from soil and foliar lab testing often include type and amount of nutrients that need to be applied.

Surface application
An easy and effective way to apply fertilizer is to broadcast it over the soil surface, particularly when there are roots close to the surface and competing vegetation (i.e. turf) is not present. This is a good method for applying water-soluble nitrogen.

Incorporating fertilizer into the soil
Dry fertilizer can be applied in holes drilled directly into the soil. This is especially important with nutrients such as phosphorus and potassium, which are not highly mobile in soil and are therefore more effective when placed close to absorbing roots.

Liquid injection
Fertilizer can be dissolved (water soluble) or suspended (water insoluble) in water and applied under pressure 4 to 12 inches deep. Soil amendments often applied by liquid injection include soil humates, mineral supplements, and mychorrizal fungi.

Folige sprays
More difficult and expensive to apply, foliage sprays are particularly effective for applying micronutrients to address a specific, confirmed deficiency.

Trunk implants and injections
These should be used as a last resort, when no other method has proved effective. They can be particularly effective for applying micronutrients to address a specific, confirmed deficiency. However, consult with an International Society of Arboriculture certified arborist to determine whether a tree needs trunk injection fertilizer (Yeager and Gilman 1991).

Disease and Pest Control

A casual inspection of the trees in communities may suggest that there are few serious problems due to diseases or pests. Poor growth or death is nearly always due to other factors, such as soil problems, root damage, improper planting and maintenance, or transplant shock (Herms and Mattson 1997). Despite these observations catastrophic devastation from disease or insects, such as Dutch elm disease, southern pine beetle Asian long-horned beetle, oak wilt, and gypsy moth, can occur. The long-term health of the urban forest depends on protecting trees from harmful diseases and pests. Keeping trees healthy by establishing and following a maintenance plan can prevent many disease and pest problems.

Most pests do minimal damage and can remain untreated (fall webworm, maple bladder galls), and others can be kept in control (suppressed) with attention to the health of the tree (hypoxylon canker on oak, and dogwood borers). A monitoring program, where trees are examined regularly is important to any tree management plan. This is also the first line of defense when dealing with disease and pest problems that can become critical. This section briefly discusses different methods for controlling disease and pests.

For information on diseases and pests refer to the "Tree Diagnosis and Treatment" unit.

Pruning-Sanitation

For some diseases and pests, such as fire blight, infected branches need to be pruned and disposed of properly. Learning more about the disease or pest will help determine the best treatment. For example, removing and burning diseased parts (such as branches and leaves), and sterilizing pruning tools can help prevent the spread of an infectious disease.

Some insect infestations may also be controlled with pruning. For example, selectively pruning trees infested with fall webworm and eastern tent caterpillar will improve aesthetics when the pest does not otherwise warrant control.

Biological Controls

Biological controls include introducing natural enemies or predators, constructing physical barriers (such as fencing for animals), setting traps, and removing pests manually. These can be used alone or in combination.

Chemicals

Insecticides, fungicides, and herbicides are chemicals that may be used to control insect, disease, and weed pests. Read all safety labels before using chemicals and follow manufactures recommendations for application. In some situations, a license may be required to apply certain types of chemicals. Knowing the life cycle of the pest or disease will help determine the appropriate chemical treatment. When considering pest management, determine if chemical treatment is appropriate and, if so, the proper type, dosage, and application frequency.

Trenching

Trenching between trees can help prevent a disease that is transmitted through root grafts (such as Dutch elm disease) from spreading.

Removal

Sometimes removing the tree is the best way to solve a disease or pest problem.

Removal

Tree removal is always an option in managing the urban forest. Trees of all ages and conditions may be candidates for removal. Trees for potential removal should be evaluated according to current arboricultural standards for condition and hazard. Refer to the publications *Guide for Plant Appraisal (2000)* and *A Photographic Guide to the Evaluation of Hazard Trees in Urban Areas (1994)* for more information. Factors to be considered when evaluating a tree for removal (unrelated to condition or hazard) include tree biology (e.g. an evaluation of growing space), other applicable standards (e.g. adopted engineering safety standards), or local policy (e.g. hazard tree standards, recommended tree species, site selection standards, and long-term objectives).

Some local governments develop criteria for evaluating tree removals to provide consistency in decision-making.

Why Trees Need to be Removed

In urban areas, trees may be removed for a number of reasons:

- The tree is in poor condition and is in a stage of decline (with or without a hazard).
- A hazard has been identified and removing the entire tree is the best option.
- The tree is diseased or the host to a pest that may spread to adjacent trees in the urban forest.
- The tree may be interfering (i.e. competing) with other trees considered to be more valuable or more important in meeting long-term objectives.
- The tree is located in the path of infrastructure development (e.g. roadway).
- The tree is obstructing a view or interfering with pedestrian or vehicular traffic.

Removal Guidelines

During tree removal, the possibility for damage to the site (e.g. soil compaction), adjacent trees (above and below ground), or infrastructure always needs to be considered. Only people who are properly trained in safety issues and procedures for reducing or eliminating potential for damage should remove trees. Liability is also an issue and, in some cases, a written contract specifying penalties for damage to landscape and infrastructure would be recommended.

Local policy and the location of the tree (for example a street tree or a tree in a passive recreation area) will dictate whether stump removal or grinding is appropriate. Stump removal can seriously damage adjacent trees and root systems. Stump grinding is much more common and the depth of grinding (e.g. 10 inches below grade), the extent of the grinding (e.g. all structural roots greater than 4 inches within 10 feet of the trunk), and condition of the site following the grinding (e.g. the site will be leveled to grade, seeded with fescue, and covered with straw) should be specified.

Checking Your Understanding about Tree Maintenance

On a separate sheet of paper, briefly answer the following questions.

1. What maintenance practices should be done during the first 2 years after a tree is planted?
2. How would you prune a limb larger than 1 inch in diameter?
3. What role do people play in tree maintenance in an urban area?

Case Study

When Will it Stop? Complaining, Complaining, Complaining,…
Ashtown is a neighborhood of about 400 homes in a midsize southern city. The neighborhood was built in 1931 as a mill village and originally included recreation areas, churches, and schools. Street trees were planted as part of the original design (the village actually had its own tree nursery) and cared for by the mill. In 1965, the homes were sold to the residents of the neighborhood, and the streets, schools, and recreation areas became part of the city. Since that time tree maintenance has been minimal and most activity has been tree removals when residents called City Hall with complaints. Residents continually complain about tree limbs falling on houses, parked cars, and front lawns; in addition, many complain about the "year-round" leaf problem from the water oaks, seeds or seed pods from the southern magnolia, sweetgum, and other oaks. Some of the residents want the trees in front of their homes removed. However, other neighborhood residents complain that too many trees are being removed and no new trees are being planted.

Last year, the city hired a consultant to conduct an inventory (species composition, tree location, tree condition, hazards, infrastructure conflicts) of street trees in Ashtown. This inventory found that there are nearly 1,200 street trees in the neighborhood. Most of the trees are mature or over-mature and significant portions of the crowns have died or are dying. The inventory further showed that few replacement trees have been planted during the past 25 years. Most young trees have been planted by homeowners and are small, maturing trees such as dogwood and crape myrtle. There are numerous sidewalk/tree-root conflicts and damage to sidewalks is extensive in some areas. The consultant recommended the following: "Despite this bleak picture, the street trees in Ashtown can provide benefits for many years and are a significant asset to the community. Efforts should be made to extend the life of most of those trees not identified as hazards, at least until replacement trees can become established." The consultant added, "During the course of the inventory, I asked residents throughout Ashtown 'what do you think the city should do with these street trees?' One-third suggested to cutting them all down, one-third didn't want any trees removed, and one-third didn't have any opinion!"

The City Council instructed (and budgeted) the Tree Board to develop a tree maintenance plan that would address, eliminate, or at least reduce the number of complaints and problems. Lee, the area forester representing the Forestry Commission and an ex-officio member of the Tree Board, was specifically asked by the Tree Board to provide technical assistance.

You, Mature Trees, Complaining Neighborhood, and the Tree Board
Imagine that you are the forester who has been asked to help the Tree Board. What suggestions would you make? What would you want to know about Ashtown, and what might you suggest that would help reduce the complaints? Write your answers to the questions below, explaining your recommendations, before you read the rest of the story.

- What kind of tree maintenance would you suggest that the Tree Board address this year? Within the 2 - 5 years?
- What other urban forest management issues (covered in other units of the Manual) are

important in addressing problems identified by the residents and the inventory?

- How do you think the Tree Board should address the different opinions of the residents?

The Rest of the Story

The Tree Board developed and implemented a maintenance plan that would address the current, deteriorating condition of the street trees, provide regular care for remaining trees, and establish a regular street tree replacement program. First, they sought to eliminate hazards identified during the inventory. The city developed a contract for removing the hazard trees and pruning large, dead limbs from other trees. As part of the maintenance plan, they identified the trees that needed pruning and developed a pruning cycle.

Annual monitoring the health of the remaining trees was a significant feature of their maintenance plan. The Tree Board also began a regular tree-planting program to replace street trees. Species selection and site evaluation were important parts of this plan. The Tree Board adopted a list of about 25 species that would be acceptable as street trees in various street locations; this list included species with minimum likelihood of sidewalk conflicts and leaf-litter and seed complaints. The Tree Board placed an article in the local newspaper explaining why trees were being removed and the plans for planting new trees. They also asked residents if they were interested in watering the trees during the first 2 years – surprisingly 85 percent of the residents were.

During the 2nd and 3rd years of the plan, the Tree Board and city worked with volunteers, contracted to improve mulching and provide fertilization, and trained the local Master Gardeners how to prune young trees. The Master Gardeners accepted primary responsibility for annual pruning of many of the replacement trees.

At the conclusion of the first 5 years of management in Ashtown, the Tree Board is preparing to re-inventory the entire neighborhood and revise their management plan and approach accordingly.

Next?

This unit has provided basic information about tree maintenance. Use these questions to help you think about how you can use this information about tree maintenance in your job. The notes you made at the beginning of the unit may be useful in deciding some of the important points.

- How will you be able to use this information about tree maintenance in your job?

- What communities, organizations, companies and agencies can benefit from receiving tree maintenance information or assistance?

- What specific topics in tree maintenance would you like to learn more about? Where can you find additional sources of information on those topics?

For More Information

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University of Georgia, Warnell School of Forest Resources, Community Forestry
http://www.forestry.uga.edu/warnell/service/library/index.php3?docID=2

Checking Your Answers

Checking Your Answers about Tree Maintenance

1. What maintenance practices should be done during the first 2 years after a tree is planted?

Mulching a newly planted tree is one of the least expensive and beneficial maintenance activities that can be used. Factors to consider when mulching include type of mulch, mulch area size and depth, competing vegetation, source and composition of mulch, and exposing the root collar.

Watering and monitoring the soil moisture in the root ball during the first 2 years are essential to having healthy tree growth. Factors that can increase the need for water after planting include well-drained soil, planting in warm season, sunny days, container-grown nursery stock, and southern or western exposure.

Pruning may be necessary if there are dead or problem branches.

2. How would you prune a limb larger than 1 inch in diameter?

To properly prune a limb it is essential to identify the branch bark ride and branch collar. Removing a limb more than 1 inch in diameter requires three cuts:

A partial undercut to keep the branch from tearing bark as it is removed

A cut through the entire branch slightly farther out than the undercut to remove the branch. A lopper may be used on small limbs (less than 1 ¾ inches) to remove the weight of the limb.

A cut just beyond the branch collar and branch bark ridge to remove the stub

3. What role do people play in tree maintenance in an urban area?

People make decisions that affect the health of the urban forest. The property owner decides how much money to spend on tree maintenance, who will do the maintenance, and what type of maintenance needs to be done. Those who actually do the tree maintenance activities may include homeowners, landscape and tree care companies, and public agencies. And public safety is always an important issue related to tree maintenance.