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 is an introduction to the importance of providing regular maintenance to the urban forest. The basic steps to preventative maintenance are discussed, such as fertilization, mulching, pruning and tree protection.

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.

Benefits and Costs of The Urban Forest

Table of Contents

Overview

Urban forests are all the trees and other vegetation that grow in places where people live, work and play, from small communities in rural areas to large metropolitan cities. This includes trees on public and private land, along streets, in residential areas, parks and commercial developments, and in other locations within a community. They may be planted by design or grow by accident (Miller 1988). This unit will help you understand and communicate the many advantages of and the expenses associated with the growth and management of urban forests. The major benefits are discussed in the first section of the unit, although it is impossible to list all the values received from trees. The costs of urban forestry are included in the next part with suggestions on how these costs can be reduced through education and proper planning.

Longer Than a Lifetime

Who Will Sit in the Shade?

Bill is an urban forester in the piedmont section of the Southeast, where hardwoods are the most common trees. Whenever possible he encourages homeowners to plant hardwoods, and is particularly likely to recommend white oak. Although it grows quite slowly in some parts of the country, this beautiful tree thrives in the warm, humid climate of this area. It can become a prominent feature of the landscape within 10 to 15 years.

Fifteen years is a small part of the life span of a white oak, but many of the people that Bill assists are well past 60 years old. They point out that this length of time may be more than they have left on this planet themselves. Being over 50 years old, Bill does understand this concern, but he always falls back on a favorite saying to counteract the doubt. He is not sure where the quotation came from, but he reminds them that "the person who knows the true value of life is the person who will plant a tree, knowing full well that he will never sit in its shade."

Will urban sprawl spread so far that most people lose all touch with nature? Will the day come when the only bird a typical American child ever sees is a canary in a pet shop window? When the only tree he touches is the cleverly fabricated plastic evergreen that shades his gifts on Christmas morning?

Frank N. Ikard, North American Wildlife and Natural Resources Conference, Houston, 1968

Before You Begin

This manual has been developed to provide you with both technical information about individual trees and management practices for urban forestry. The benefits and costs of the urban forest are a good place to start before exploring the content of the other units in detail. First, take a few minutes to think about and answer these questions about the urban forest in your area:

- How would you describe the urban forest in the communities where you work?

- What do you think are the most important benefits of the urban forest?

- What are some of the expenses of having trees in communities?

- You have been asked to meet with a community's Planning Board and a group of local developers who are building a new industrial and commercial park. With your knowledge of the community, what information would you want to give them about the benefits and costs of protecting the existing trees on the site?

On a separate piece of paper describe your ideas about the benefits and costs of the urban forest, and think about how this information will assist you in your job.

The Important Question

Trees are an important part of our communities, but tree planting, maintenance and protection require an investment of resources, including time and money. Are the benefits that trees afford our communities greater than their costs? The answer is yes. A study of future benefits and costs of a tree planting program in Chicago found that the projected value of trees, when measured by such things as increased property values and decreased energy use, is nearly three times greater than the projected costs (McPherson 1994a). The best way to achieve a net benefit from planting a tree is to select the right tree for the right location and take care of it.

There are many ways to help communities maximize the benefits and minimize the costs of the urban forest. State forestry agencies can work with communities in several ways - providing educational and technical information, offering planning support, and working with specific groups and members of the community - to achieve the goals of urban forestry. This information can be communicated to people in the community through workshops, demonstrations, publications and other educational programs. There are different ways the State forestry agency can provide assistance related to the benefits and costs of the urban forest (table 1).

Table 1. Examples of ways to provide assistance and potential recipients

Technical/Educational Assistance	Planning Assistance	Potential Recipients
· Tree selection · Tree maintenance and care · Urban forest assessment · Urban wildlife habitat protection and enhancement · Storm water control · Soil erosion control · Noise and glare reductions · Tree protection · Construction site evaluations	· Urban and community forestry planning · Recreation site management · Air and water quality management programs · Economic development plans · Storm water management · Urban wildlife management · Urban development plans · Conservation management programs	· Local governments · Policy makers and elected officials · Developers and builders · Community and civic groups · Homeowners and neighborhood associations · Non-profit groups · Local business · Urban forest councils

Benefits of the Urban Forest

Trees benefit communities in a number of important ways. Working with individuals and communities you will be able to increase their awareness of these benefits.

- Increase in property values
- Decrease in energy costs
- Improvement in air quality
- Reduction in storm water runoff
- Decrease in soil erosion
- Improvement in water quality
- Creation of wildlife habitat
- Increase in community pride
- Positive impact on consumer behavior
- Increase in recreational opportunities
- Improvement in health and well-being
- Reduction of noise levels
- Creation of buffer zones

Increase in Property Values

Urban forests contribute to the economic vitality and stability of a community by increasing property values. Most people think that neighborhoods with trees are attractive places to live. The values of houses in these neighborhoods are usually higher than those of comparable houses in neighborhoods without trees (Morales 1980; Morales et al. 1983; Anderson and Cordell 1988). Neighborhood green spaces or greenways typically increase the value of properties located nearby (Kitchen and Hendon 1967; More et al. 1983; Correll et al. 1978). Developers may profit when they receive a higher price for a property with trees. In many instances, careful preservation of existing trees during construction may actually cost less than clearing the land (Seila and Anderson 1982). The cost of preserving trees, such as the extra time needed for planning and using special techniques to protect the trees, should be looked at in relation to the immediate and long-term benefits of increased property values. Mature trees are especially valuable in areas where old housing or buildings have lost value. This is important to keeping downtown neighborhoods vital.

Trees can have a great impact on the appearance and the value of housing developments.

Decrease in Energy Costs

Trees can help reduce heating and cooling costs by shading buildings, acting as windbreaks, and cooling the air through the evaporative process of transpiration. When planting a tree to reduce energy costs, the species of tree, site location, type of building, and year-round climate should be considered. Reducing the need for electricity or gas energy also conserves fossil fuels and reduces carbon emissions. However, planting the wrong tree in the wrong place may increase energy costs.

Contact the U.S. Environmental Protection Agency or U.S. Department of Energy for more information on reducing energy costs.

Shade

Trees properly placed around buildings and air conditioning units can help reduce cooling costs (McPherson 1994b). Trees reflect and absorb solar radiation before it heats the dense building and pavement materials of a home or office. Usually, trees planted to the west of a building reduce air conditioning costs the most by blocking the afternoon summer sun when it is the hottest. There are times when trees located to the east and south of a building also provide this benefit. In tropical climates an evergreen tree offers protection from the sun throughout the year (Harris 1992). In colder climates, trees located south of a building should be avoided because their winter shade increases heating costs more then summer shade reduces cooling costs. The shade from trees can also reduce exposure to ultra-violet radiation which increases the risk of some types of skin cancer.

Windbreak

Properly placed trees can reduce heating costs for a building by blocking the wind (McPherson 1994b). Although both conifers and deciduous trees reduce wind speed, conifers tend to have a greater impact during winter months. The density, or compactness, of the trees and the planting location determine the amount of wind reduction that occurs (Harris 1992). In cool and windy climates, windbreak trees should be planted to the west and north of a building.

Evaporative cooling

Urban areas typically are warmer than rural areas because of the urban "heat island" effect (Figure 1). Buildings, paved areas, and sparse tree canopy in an urban area contribute to the higher temperature. Trees help to reduce the air temperature around them through the evaporation of water from their leaves, acting as nature's air conditioner.

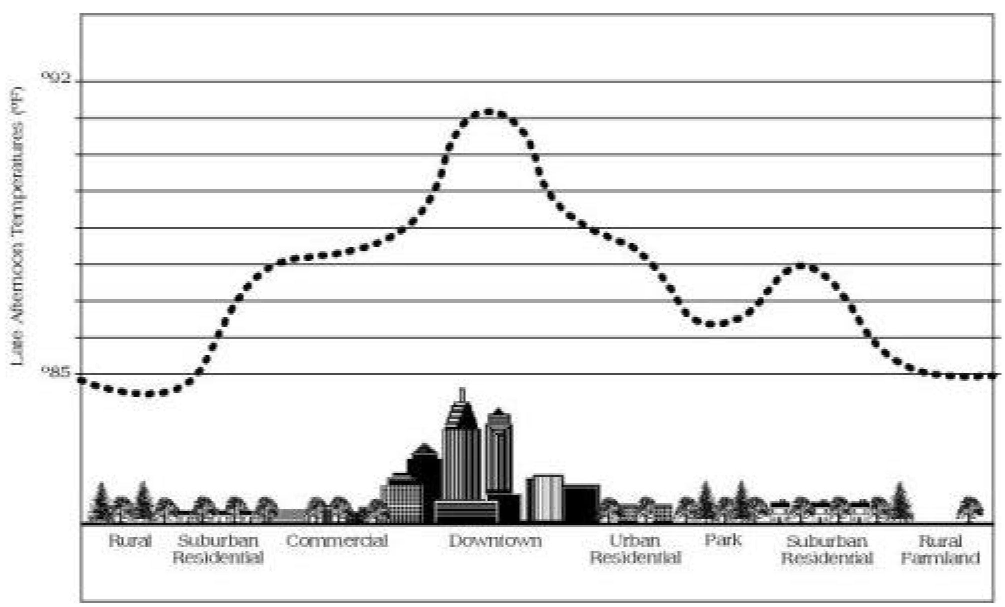

Figure 1. Summer temperatures in a city are higher than those in suburban and rural areas and this is called the urban "heat-island" effect (Akbari and others 1992, p.9, fig. 1-4)

Improvement in Air Quality

Air pollution is not only a major human health risk, but also reduces visibility and damages vegetation and man-made materials. Some species of trees do release chemical compounds (biogenic emissions) that are air pollutants. The amounts of these chemicals produced depend on the species and size of the tree. Because high temperatures increase the production of these chemicals, urban "heat islands" cause this type of pollution to increase. Urban trees, however, contribute less than 10 percent of total pollution emissions in urban areas (Nowak 1992), and the advantages they provide in reducing air pollution are much greater (Figure 2). Trees and vegetation improve air quality in three ways:

Absorption and reduction of airborne pollutants

Trees, especially those with large leaf-surface areas (Nowak 1994), absorb and trap airborne dirt and chemical particles, such as nitrogen oxide, sulfur dioxide, carbon monoxide, and ozone. Trees also help by reducing wind speed so that heavy particles settle out (Harris 1992). Communities benefit not only from cleaner air, but also from the reduced cost of implementing air pollution controls.

Absorption of carbon
Carbon dioxide, a by-product of burning fossil fuels such as gas and coal, is one of the primary chemical compounds that influences global warming (Akbari et al 1992). Urban forests in the United States store millions of tons of the carbon from this compound annually, helping reduce the level of carbon dioxide in the atmosphere (Rowntree and Nowak 1991). However, their effect on the carbon dioxide levels in cities is being studied.

Reduction of carbon emissions
The "cooling effect" of trees, including shade and evaporative cooling, decreases the demand for electricity. This results in the reduction of carbon emissions from power plants supplying the energy. Trees, therefore, provide the double benefit of not only storing carbon, but also helping to reduce carbon emissions.

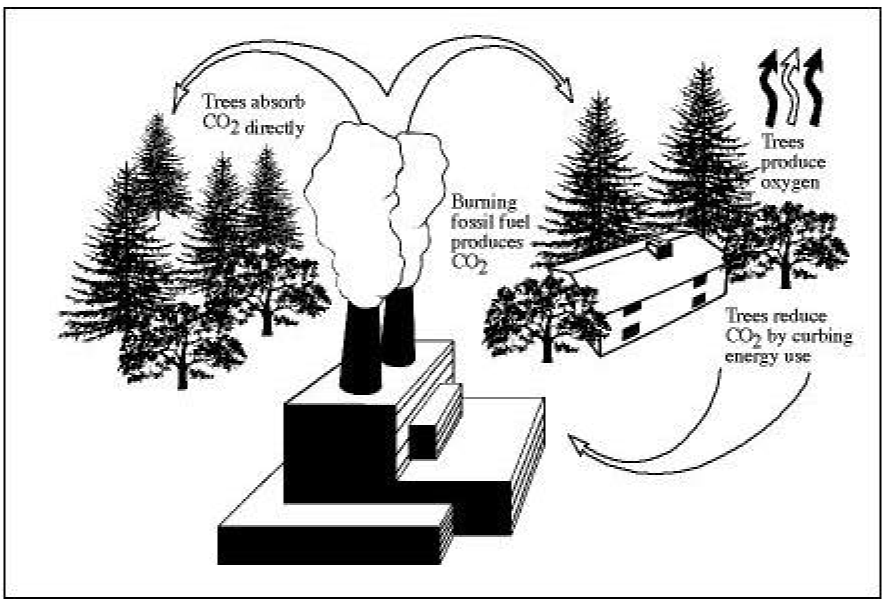

Figure 2. Trees can help improve air quality by absorbing carbon dioxide, which is produced during the photosynthesis process, and by shading buildings which results in reduced amounts of carbon dioxide from the production of energy (Akbari and others 1992, p.35, fig. 2-10).

Improvement in Water Quality
Waterways and lakes in and near urban areas can be polluted by soil erosion and water runoff that contains fertilizers and pesticides from landscaped lawns and trees, oil, and raw sewage. Trees and vegetation can help solve water quality problems in communities by reducing storm-water runoff and soil erosion. Trees also absorb some of the nutrients in the soil that would be washed away. Communities can have cleaner water by managing existing natural vegetation, planting additional trees, and reducing the use of pesticides and fertilizers.

Rate and volume of runoff
In many communities, the rate and volume of storm-water runoff have increased beyond the capacity of existing storm-water drainage systems. This is caused by continued

development of hard, impermeable surfaces such as roads and parking lots that cannot absorb water, thus changing natural drainage patterns. These impervious surfaces also reduce the amount of natural absorption of water by the soil and trees. Many urban forestry activities, such as creating open spaces, saving trees on construction sites, and planting trees after construction, can help reduce the amount of storm-water runoff that enters the drainage system.

Raw sewage spillover

During heavy rainstorms problems occur when storm water floods into the sanitary sewage system. If the sewage treatment facility cannot handle all the storm-water runoff, raw sewage spills over into natural waterways. This can cause a dangerous increase of bacteria in the water. Communities with this problem may be charged large fines, suffer lawsuits from downstream users of the waterways, have to make costly improvements to the sanitary sewer system, or stop further development until water-treatment facilities are improved. Trees, vegetation, and wetlands can help prevent this problem by interrupting and absorbing storm-water runoff.

Find out if the storm water drains into the sanitary sewer system.

Soil Erosion

Trees can limit soil erosion by helping control storm-water flow. Fibrous root systems hold soil in place so that it is not washed away by rain or flowing water (Harris 1992). Erosion can be especially severe at construction sites in urban areas. Research has found that while forested land can lose about 50 tons of soil per square mile per year, developing areas can lose 25,000 to 50,000 tons (Lull and Sopper 1969).

Contact your local Soil and Water Conservation District for more information on improving water quality.

Creation of Wildlife Habitat

Urban forests serve as wildlife habitat, supplying food, water and cover for a variety of animals, such as deer, squirrels, rabbits, reptiles, and birds. These animals enhance the recreational and educational opportunities of the community. Wildlife habitats range from streamside buffers and storm-water detention ponds to backyards and parks. Corridors of trees and other vegetation connecting natural areas in the urban environment add to the wildlife habitat and increase wildlife diversity.

For more information refer to the "Urban Wildlife" unit.

Increase in Community Pride

Trees are a significant part of a community, offering important benefits not easily measured.

Community image
Imagine what a community would be like without any trees. Trees and other landscaping add beauty to an urban area. Retailers often landscape their premises to improve community image and attract customers. A visitor's first impression of a community is greatly influenced by the trees and other landscaping.

Sense of place
Neighborhoods with attractive landscapes foster a sense of community and belonging (Dwyer et al. 1991). People often identify with their own community by its tree-lined streets and historic groves of trees. Trees may also be associated with specific places, such as palm trees at a beach or memories of past events or times, such as a favorite tree climbed as a youth.

Community involvement
Community pride increases when neighborhood residents participate in local tree-planting programs. Such activities enhance a sense of ownership and an ongoing interest in developing and maintaining trees. This participation increases the success rate of the planting program. However, without local involvement in the planning and planting of the trees, the efforts may be viewed negatively by the residents (Miller 1988).

How do people feel about trees?

Historical trees
Many communities have historical trees that have become landmarks. They may also be a focus point in the community's identity, such as the live oaks or magnolias that are part of the culture in many southern cities.

Decrease in violence
Less violence occurs in urban public housing where there are trees. Researchers, Sullivan and Kuo (1996), suggest that trees afford a place for neighbors to meet and get to know each other. Their research showed that friendships developed into a network of support.

Positive Impact on Consumer Behavior

Research from the University of Washington indicates that in business districts "...healthy and well-maintained trees send positive messages about the appeal of a district, the quality of products there and what customer service a shopper can expect" (Wolfe 1998).

Visit the University of Washington Center for Urban Horticulture - Human Dimensions of the Urban Forest web site .

Increase in Recreational Opportunities

Many city residents appreciate the recreational benefits urban forests provide. With the growing emphasis on physical fitness, urban forests, parks, and open spaces have become increasingly popular as places to walk, run, bike, and hike. Urban parks are often sites for large community events, such as art and music festivals. Some festivals are centered around trees such as the Cherry Blossom Festival in Macon, Georgia and the Dogwood Festival in Paducah, Kentucky.

Urban greenspaces provide recreational opportunities such as this bike path through an urban park.

Improvement in Health and Well-being

Life in a bustling urban setting can be both physically and mentally stressful, but there are indications that trees and other plants help improve human health.

Physical and mental health

The soothing influence of trees can help reduce stress levels and increase enjoyment of everyday activities. Trees also contribute to cleaner air and water.

Recuperation rates and therapy

One study of recuperation rates after surgery found that patients whose windows offered a view of a wooded landscape recovered faster and with less medicine than patients who could only look out on brick walls (Ulrich 1984). Therapists are now using trees and other plants to help people with physical and mental problems.

Part of nature

Trees bring urban residents closer to nature. A healthy urban forest is the most effective way to re-establish this sense of being part of the larger natural environment. Some people have a strong emotional attachment to trees. The "People-Plant Council" at Virginia Tech University, Blacksburg, Virginia is one group that studies the ways that trees improve our health and well being.

Reduction of Noise Levels

Trees and vegetation can form a barrier that partially deadens the sound from traffic, lawn mowers, and loud neighbors. To be effective, the landscaping should be dense, tall, and wide, and planted close to the source of the noise. Trees also create "background" noise of rustling leaves and wind through the branches that can help muffle other noises (Harris 1992).

Trees provide a screen from the noise and view of a busy highway.

Creation of Buffer Zones

Trees serve as "screens" by hiding unattractive areas and objects, such as junkyards and dumpsters. With proper design, tree plantings can also re-direct attention away from unsightly areas. Planting designs can be used to "direct" automobile or pedestrian traffic.

Costs of the Urban Forest

A healthy urban forest requires an investment of money. The cost of urban trees varies widely and depend upon such site factors as location, species, and maintenance needs. Each of these factors needs to be considered when deciding to plant, maintain, or remove a tree in an urban area, whether it be an individual tree or a large-scale planting. With careful planning and coordination, these expenses can be minimized. Some of the costs involved in urban forestry are:

- Planting
- Maintenance and removal
- Infrastructure repair
- Litigation and liability
- Storms
- Program administration
- Allergies

Planting

The cost of planting depends on the species, size, site location, site preparation, and labor. Planting costs include purchasing the trees themselves and paying for site preparation, installation, and initial care. McPherson (1994a) found that planting and establishing a tree often represents a large percentage of total cost. Usually, the larger the tree, the higher the planting cost. Many problems and future costs can be avoided by tree selection, site preparation, and planting techniques.

For more information, refer to the "Site and Tree Selection" and "Tree Planting" units.

Maintenance and Removal

Maintenance costs vary tremendously and depend on the species and site location. It is important to know what funds and personnel are available for maintenance work. By providing regular maintenance, future costs can often be prevented while increasing the tree's value. Some of the major maintenance costs are:

Pruning

All trees require periodic pruning, but the frequency depends on the species, age of the tree and location. Young trees need frequent pruning to develop a strong branching structure. The amount of pruning needed is also related to the site location. Trees located near overhead utility lines or sidewalks need more frequent attention. Choosing a species that is compatible with the site will help reduce pruning costs.

Irrigation

In some locations, irrigation systems are needed to supplement rainwater. The cost of installing the irrigation system and supplying water are part of the maintenance cost. Irrigation can keep the tree from being stressed during droughts. However, the soil moisture needs careful monitoring to prevent overwatering, which can also cause stress. Generally, species native to the area do not need irrigating after establishment. Selecting a drought-tolerant species can help reduce irrigation costs.

Insect and disease control

There are times when trees need to be treated for insects and disease. Costs of insect and disease control can be reduced by selecting a species that is resistant to insects and disease, planting a variety of species, matching species to the site and proper planting techniques.

What insects and diseases are common in the communities where you work?

Tree removal

Trees need to be removed in urban areas for many reasons. Hazardous trees, which are trees that have potential to fail and hit a target, can cause injuries or death and damage personal property. A tree may also need to be removed if it is interfering with water and sewage pipes or utility lines. However, it may be cheaper to relocate utility lines than remove the trees. Many trees need to be removed because of storm damage. Usually, the larger the tree, the more it costs to remove. Matching the growth habits of a tree to site conditions will increase its vitality and life span and avoid its untimely removal.

Tree residue from pruning and removal

When trees are pruned or removed the residue must be recycled or disposed of. Sending the residue to the landfill is a costly option for some communities. Many communities, homeowners, and utility companies now recycle tree rsidue into mulch, firewood, compost, and boiler fuel instead of sending it to the landfill. These alternatives may reduce costs and even generate revenue.

Fire protection

As cities and communities continue to grow, homes are often being built in wooded areas adjacent to urban centers. These urban/rural interfaces create the potential for wildfires with the possibility of loss of life and property. Fire management involves fire prevention, fire suppression, and prescribed burning (using fire as a management tool), all of which cost money. Local ordinances can help ensure acceptable protection from naturally caused fires. The hazards of wildfires can be diminished by reducing dense vegetation and trees within 30 feet around homes and businesses and creating a greenspace (Harris 1992).

Check with local fire officials concerning regulations and recommendations.

Infrastructure Repair

Tree growth can damage the infrastructure of a community, such as utilities, sidewalks, curbs, and sewer and water pipes. Sometimes repairs can cost less than removing and replacing the trees. Proper site and tree selection can prevent or minimize future infrastructure conflicts.

Sidewalk damage can often be avoided by selecting an appropriate site and species.

The Center for Urban Forestry Research conducts research on tree roots and infrastructure damage.

Litigation and Liability

There can be legal costs when trees are damaged or when trees cause damage. Property owners may sue when trees are harmed by construction on adjoining property, or when trees die after underground utilities lines are installed. Trees are sometimes stolen, especially unique specimens or rare species. The damage caused by falling trees or limbs, such as during storms or from hazard trees, can also result in legal action. Sidewalks damaged by tree roots can cause trip-and-fall accidents, a common source of liability claims. Careful planning can preclude many of the costs related to the damage of trees during development and construction projects. Selecting an appropriate species for the location and assuring proper maintenance can decrease the injuries to people and damage to property caused by trees.

Storms

Storms, such as hurricanes, tornadoes, ice, snow, and wind, can cause major damage to the trees and property in a community. Costs of planning for storms, cleaning up and repairing the damage after storms, and planting new trees can be minimized by diligent maintenance.

Program Administration

Managing the urban forest requires planning and a trained workforce to carry out those plans. Communities must pay the costs of the people and materials used in these programs.

Allergies

Trees produce pollen that causes allergies for some people. Individuals have the expense of doctor visits and medication. Cities, in an effort to lessen the problems by controlling or regulating the type of trees planted may incur additional management expenses.

Maximize the Benefits and Minimize the Costs

A community receives many benefits from the urban forest however there are also costs associated with having a healthy urban forest. Working towards the common goal of managing the urban forest to maximize the benefits and minimize the costs helps communities grow and develop while maintaining a healthy environment for current and future generations. McPherson's (1994a) cost-benefit research in Chicago indicates that a tree needs to live 9-18 years before the benefits outweigh the costs to the community. This serves as an incentive to use preventive techniques that will extend the life of a tree. There are several things that can be done to help maximize the benefits and minimize the costs of the urban forest, however these are the most important.

- Selecting the proper site and tree
- Using proper planting techniques
- Providing long-term maintenance
- Monitoring and protecting the health of the tree

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Refer to "Site and Tree Selection", "Tree Planting", "Tree Maintenance", "Tree Diagnosis and Treatment", and "Trees and Construction" units for more information.

Checking Your Understanding about Benefits and Costs of the Urban Forest

On a separate sheet of paper, answer these questions about the important points you need to remember:

1. What are the four economic benefits of urban trees?

2. How can urban trees improve air quality?

3. Does the urban forest have a direct effect on the well being of the people who live in the city? If so, how?

4. Maintenance costs can be a factor in the upkeep of urban trees. What are some of the major costs involved? What are five things you can do to minimize these costs?

Answers are at the end of the unit.

Case Study

A Place for the Children

Hopkins Elementary School is bursting at the seams. This had been a quiet, rural area not too many years ago, but the city has been growing rapidly in this direction, and new housing developments now cover much of the land. The school has built additional classrooms, but this meant using land originally intended for outdoor activities. The Parent-Teacher Association (PTA) has finally persuaded the developer of the land next to the school to donate several acres of wooded land between the school and one of his housing developments. The land has not been developed because of the small stream and marshy area on one side of it, but there is more than enough space for some playing fields and playground equipment. The PTA has also agreed to be responsible for developing this area, including the cost for doing it. An architect has volunteered to develop a site plan. The owner of a small construction company has offered to bring in a crew and equipment to clear the entire area and level the site.

The PTA has created a committee representing all the groups in the community interested in developing this land. The PTA has asked four parents, plus the architect, construction company owner and the school principal to serve on the committee. They also asked a representative of the homeowners' association from the neighboring development, a staff member of the local parks and recreation department, and an employee of the local State forestry office to work with the committee to look at all the needs and possible means for developing the area.

Dan, a forester at the local State forestry agency office, told the PTA when they called that he would be glad to provide assistance and would attend the next meeting. At the committee meeting Dan hears two very different opinions about how this land should be developed. One group wants to clear the land completely so they can make full use of the space, with separate areas for each sport and a general activity area. They also think it will probably cost less to do it this way. The other group wants it developed with at least some of the natural vegetation in place, because the students use the stream area for an outdoor classroom. And then there are the homeowners who are not happy at the prospect of suddenly seeing the school's playground in their backyards. After everyone stated what they wanted or did not want, they asked Dan for his suggestions.

You and the Committee and the School Yard

Put yourself in Dan's place, sitting at this committee meeting. Think about what you would say to the other members of this committee. Write your suggestions on a separate piece of paper and then see how your answers compare with the recommendations that Dan actually made.

- What would you suggest as the best way to turn the land into an area for the children and still address the concerns of the community members?

- What benefits and costs of clearing the wooded land have not been mentioned by these committee members? How can some of these considerations make the recreation area a better or worse place to play?
- Are there environmental benefits or costs that need to be considered if the land is cleared of all of the trees?
- What about the costs for the PTA?
- Can an outdoor classroom area be compatible with the other recreational needs of the school?
- What will you suggest to give the homeowners some protection from the noise and possible lights in this area?
- How will you reconcile the differences about clearing the land among the various groups on the committee?

The Rest of the Story

Let it Be

Thinking carefully for a moment, Dan decides he may be able to offer some suggestions that will help solve several of the problems. First off, he feels there are some important issues about clearing the land that have been overlooked. All of the opinions expressed by the committee members were forthright and legitimate, so he wants to be positive in the way he answers the question.

Dan begins by commending parents for volunteering their time and services to create this area for the school. He said that it was obvious some of the land had to be cleared for playing fields, but that it is also important to keep trees on other parts of the land. He will be happy to assist the architect and construction company owner with the plans, helping identify those trees that should remain on the site.

Dan explains several reasons for wanting to leave some of the area's trees. First, the land around the stream is soft and marshy, which was one reason the developer had not built there. With the addition of some paths, it can make a nice outdoor classroom. It can also serve as a natural way for reducing the storm water runoff that had become a problem when the last addition to the school was built. By leaving part of the land in trees and other vegetation there will also be less soil erosion, and the runoff that does occur will probably not affect the quality of water in the stream. The trees can also enhance the enjoyment for those using the area, providing shade and cooler temperatures for spectators on the side of the fields and shaded areas for the some of the playground equipment. Leaving a stand of trees across the back of the area may also reduce the homeowners concern by providing a natural screen between their lots and the playground. Dan thinks the costs of following these suggestions might even be less than removing all the trees and adding new landscape plants. Few additional plants will be needed and maintenance costs for the woodland trees would be minimal. With careful planning, it will take less time to clear the land, a saving for the construction company. While these suggestions do not give each group everything it wants, the committee thinks the plan is fair enough to present at the next PTA meeting for approval.

A Balancing Act

- Did you take the same approach to answering the committee's question that Dan did? Why or why not?
- Are your suggestions about developing the land similar to Dan's? How are they different?
- Did you list other benefits or costs that Dan did not? Does this change the results of the project?
- Are there other educational benefits or expertise from your State forestry office that that you can offer the school?

Next?

Understanding the many benefits an urban forest provides is the first step in developing and implementing a long-term management plan for the trees in a community. It is also important to know what costs are involved and ways to control them. How will the information in this unit help you communicate the importance of the urban forest to the citizens in your area? Answering the following questions can help you focus on how to use this knowledge in your job:

- What types of technical assistance or information can you offer to property owners and local organizations to encourage and help them protect the urban trees? Why do you think this may be important?

- What additional facts should you know about the urban forests in your area?

- What other information about the benefits and costs of the urban forests might be helpful to know? What are the best ways to find out?

- What are some of the ways you would like to be involved with both individuals and organizations in the communities where you work?

For More Information

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Web Sites

Center for Urban Forestry Research

University of Washington Center for Urban Horticulture - Human Dimensions of the Urban Forest

Checking Your Answers

Checking Your Answers about the Benefits and Costs of the Urban Forest

1. What are the four economic benefits of urban trees?

- Urban trees provide the following economic benefits:
- An increase in property values for both residential and business locations
- An increase in the tax base for the community because of increased property values
- A reduction in heating and cooling costs for homes and businesses by providing shade, windbreaks, and evaporative cooling effects
- A reduction in the cost of improving air quality for cities, businesses, and individuals by reducing airborne particles, absorbing carbon dioxide from the atmosphere, and reducing the amount of fossil fuels for heating and cooling
- A reduction of the costs of maintaining or improving water quality by decreasing soil erosion and reducing storm water runoff that may affect the local sewage system

2. How can urban trees improve air quality?

- Trees can improve air quality in three ways:
- The leaves on trees can collect and absorb particles of airborne pollutants, such as sulfur dioxide, and they also store carbon absorbed from the carbon dioxide in the air.
- The physical presence of trees can reduce wind speed, which allows heavy particles of air pollutants to settle to the ground.
- Burning fossil fuels for electricity is a major source of carbon emissions in the air. Properly placed trees can reduce the energy needed for heating and cooling, reducing the need for electrical power.

3. Does the urban forest have a direct effect on the well-being of the people who live in the city? If so, how?

The urban forest affects the well-being of people in several direct and indirect ways. Direct benefits of trees include:

- Stress reduction from being exposed to a more natural setting
- Recreational opportunities in urban parks and open green spaces
- Cleaner air and water
- Reduction in noise
- Faster recuperation when sick
- There are also less obvious ways that people benefit from the urban forest:
- A sense of identity with the community and other favorite places
- Increased involvement with other members of the community

- Reduction of violence in the area

4. Maintenance costs can be a factor in the upkeep of urban trees. What are some of the major costs involved? What can you do to minimize these costs?

The primary maintenance costs for urban trees are:

- Pruning, depending on the species and location. Trees planted in public areas and near utilities require frequent attention.
- Irrigation, if supplemental water is needed.
- Controlling insects and diseases for the health of the trees and for public safety.
- Removing trees to prevent injuries to people and damage to property.
- Recycling tree residue from pruning and removal.

There are many things that can be done to minimize the cost of the urban forest, however these preventative techniques are the most important:

- Select the proper site and tree
- Plant the tree properly.
- Assure long-term maintenance.
- Monitor the tree on a regular basis.

The Role of the State Forestry Agency in Urban Forestry

Table of Contents

Overview

The State forestry agency offers many resources and opportunities for working with communities. Population growth, urbanization, and changes in land use underscore the need for communities to manage their urban forest. As an employee of the State forestry agency, you are in a unique position to provide information and assistance to communities in your State.

This unit first reviews the reasons that your State forestry agency is involved in urban forestry and the types of assistance that can be provided. The following section is about the importance of partnerships to the State urban forestry program. The final section describes the different responsibilities State forestry agency employees have in delivering the urban forestry message to communities.

Is This Work?

A Day in the Park

The once rural area was being urbanized quickly, with several new subdivisions being built on the outskirts of the town. The local parks and recreation board asked for help in planning and developing a new park in the area. This was the reason Dave, the county urban forester, and Jim, a rural forester, found themselves in the area this particular summer morning. Trees had been tagged for removal, and the two foresters wanted to make sure it had been done according to the approved plan. Suddenly they heard a scream and went running. A young boy was standing near the edge of a marshy creek, watching his fishing pole being dragged into the water. Afraid of snakes and not wanting to wade into the mud at the edge of the creek, the youngster did not know what to do. Jim finally could not stand it any longer -- he had to see what kind of fish was on the other end of that line. Taking off his boots and rolling up his pants, he waded in, grabbed the pole, and reeled in a two- pound catfish. Turning to Dave, he said, "If all I have to do is look at trees and go fishing, urban forestry isn't so bad."

I like trees because they seem more resigned to the way they have to live than other things do.
Willa Cather, O Pioneers!

Before You Begin

The State forestry agency has a wide range of people, resources, and programs that can be used to assist various individuals and local groups with their forestry efforts. The following questions are intended to encourage you to think about the urban forestry work you do and the programs that support this work.

- What urban forestry work is currently being done by your local office? Why is it important for you and your office to be involved in these programs and activities in the local community?

- In your own work, what types of urban forestry assistance have you been able to provide to individuals and groups?

- The State forestry agency has a number of different programs and roles related to urban forestry. How do you think an understanding of these will help you in working with people in the community?

On a separate piece of paper describe the urban forestry work you currently know about and how this work is a part of your job.

Why Is the State Forestry Agency Involved?

The State forestry agency mission is usually broadly defined and addresses issues such as forest health, fire protection, forest management, and education. Urban forestry incorporates all the customary roles of the State forestry agency while also addressing the unique needs of urban areas. There are three main reasons why the State forestry agency is involved with urban forestry: leadership, urbanization, and legislation.

Leadership

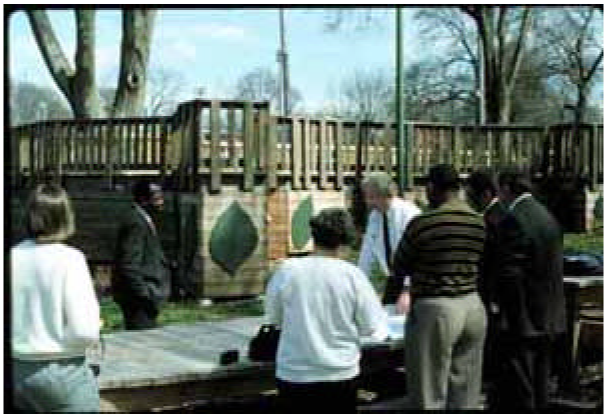
The State forestry agency has the expertise to assist communities in building their own capabilities to manage their urban forests and to increase awareness and promote the benefits of urban forestry. Employees of the State forestry agency have established working relationships with local governments, schools, community non-profit groups, businesses, and others throughout the State. In extending these relationships the agency serves as a facilitator among various groups of researchers, practitioners, and community members, bringing them together to help solve problems and address local urban forestry issues.

Urbanization

The South has become increasingly urbanized with more than 60 percent of the population now living in urban areas. "Among the South's 13 states, those having the highest rates of growth since 1970 were Florida (more than doubling with 118.8 percent growth), Texas (73.9 percent), Georgia (63.1 percent), South Carolina (46.9 percent), North Carolina (46.3 percent) and Virginia (46.0 percent)" (Cordell and others, in press). To meet the demands of the increasing urban population and the impact on the natural resources, the State forestry agency devotes resources, including time and personnel, to urban forestry and related natural resource issues. This involvement in urban forestry benefits the State forestry agency and communities in many ways.

- Providing assistance in urban areas facilitates contact with urban constituents.
- Planning for the management, conservation, and protection of the urban and rural forest increases the forestry agency's impact on future land-use patterns.
- Offering forest management assistance to owners of rural forestland at the urban-rural interface.
- Assisting local governments, citizens, and community groups increases the awareness of the benefits urban and rural forests provide.
- Being involved in the local community allows the total forestry message to be communicated to urban residents.

How much of the land in the area where you work is considered urban? What percentage of the people live in urban areas?



As an employee of your State forestry agency you have the opportunity to assist in urban forestry projects.

Legislation

Although specific legislation varies among States, the State forestry agency has the authority to provide forestry related assistance to communities and individuals. The Cooperative Forestry Assistance Act of 1978, as amended by the Food, Agriculture, Conservation and Trade Act of 1990 (commonly known as the 1990 Farm Bill) authorizes the State forestry agency to deliver urban forestry services through the Urban and Community Forestry Assistance Program. The role of the State forestry agency is to provide statewide program leadership and technical and financial assistance to communities in cooperation with the State Urban Forest Council and other partners.

The Cooperative Forestry Assistant Act of 1978, as amended, also authorizes the U.S. Department of Agriculture Forest Service to provide leadership, research, and technical and financial assistance to the State forestry agencies. The Forest Service's Regional Urban and Community Forestry Program provides regional leadership for the Urban and Community Forestry Assistance Program. The Forest Service also provides program direction and standards for use of federal funds in the State. These standards are developed in cooperation with the State forestry agencies.

Find out about the specific legislation in your State related to urban forestry.

State Forestry Agency Responsibilities in Urban Forestry

Each State forestry agency has three basic responsibilities within the Urban and Community Forestry Assistance Program:

- Provide technical assistance to facilitate the development of local capabilities for managing urban forests.
- Expand educational efforts to increase understanding of urban forestry.
- Offer financial support through the administration of the Urban and Community Forestry Grant Program.

The State's Urban Forestry Strategic Plan

It is also the responsibility of the State forestry agency to ensure that an Urban Forestry Strategic Plan is developed for the State. The Strategic Plan identifies issues, strategies, and actions for the future direction of urban forestry in the State. The Strategic Plan is often developed cooperatively with the State Urban Forest Council. Some typical goals that may be found in a strategic plan are:

- Increase citizen support and awareness of the benefits of the urban forest.
- Maximize the economic, environmental, and social benefits of urban forests.
- Empower and work with communities, groups, and individuals to maintain urban trees and forests.
- Encourage the involvement of many diverse individuals.

Your State's strategic plan for urban forestry is a good source of information.

Technical Assistance

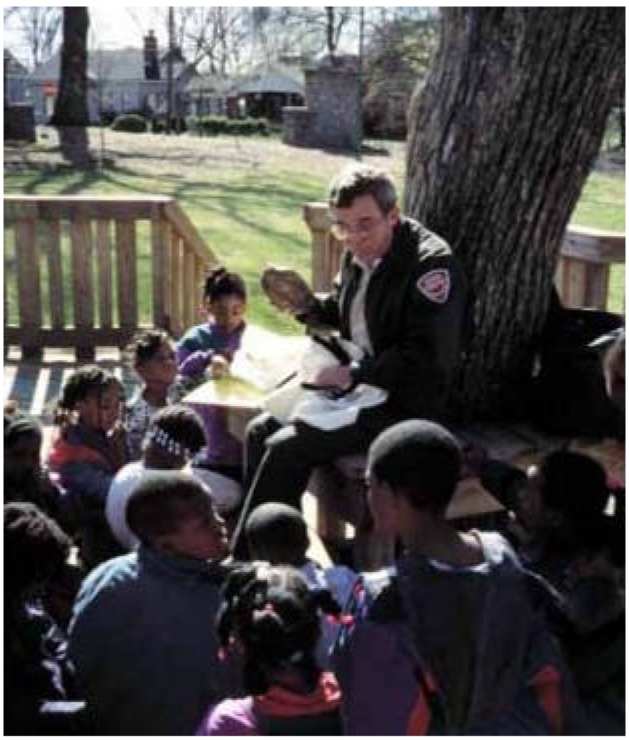
The employees of the State forestry agency offer technical assistance to help local governments, non-profit organizations, homeowners, and others with urban forestry-related concerns or issues. The State forestry agency may provide several different types of technical assistance:

- Site and tree selection
- Tree planting
- Tree diagnosis and treatment
- Urban forest management plans
- Tree inventories
- Tree protection plans
- Regional development plans
- Other urban forestry activities

Educational Assistance

The State forestry agency employees give educational assistance by planning and implementing programs and demonstration projects in urban forestry, including workshops, conferences, and publications. In addition, the Urban and Community Forestry Grant Program often funds educational projects developed by communities. The type of educational assistance provided usually depends upon the educational needs of the particular State. A State forestry agency can:

- Produce videos for developers on protecting trees during construction.
- Sponsor a workshop on trees and the law.
- Sponsor a Project Learning Tree workshop for teachers.
- Assist with the Urban Forest Council's annual conference.
- Write articles for the Urban Forest Council's newsletter.
- Speak to community groups and civic clubs.
- Engage in other educational activities.



State forestry agency employees can provide a variety of educational programs about urban forestry ranging from professional workshops to school presentations.

Financial Assistance

The State forestry agency provides financial assistance through the Urban and Community Forestry Grant Program to local governments, educational institutions, communities, and non-profit groups. The grant program awards competitive, matching grants to communities and organizations for programs that meet the criteria established by the National Urban and Community Forestry Assistance Program and any additional State guidelines. Awards are made on a 50-percent cost-share basis. Some States may also provide State funds for these activities. The grant program enables local communities to develop or expand their urban forestry programs. Several types of projects have been funded by the grant program:

- Tree inventories
- Urban forestry management plans
- Outdoor classrooms
- Urban forestry brochures, publications and videos
- Conferences and workshops
- Other urban forestry related activities

Alabama has a web site for their Urban and Community Forestry Financial Assistance Program **(http://www.aces.edu/ucf)**

Partnerships in Urban Forestry

The State forestry agency has developed partnerships involving individuals, community organizations, local and State government, private industry, and others interested in urban forestry. This network facilitates the exchange of information and cooperation among a wide variety of partners. The State forestry agency's relationship with all of these partners is key to the delivery of urban forestry programs at the local level.

State Urban Forest Council

Many of these partnerships are developed through the State's Urban Forest Council. This is an organization of active citizens, urban forestry practitioners, government representatives, and people with related interests. The Council has an essential role in implementing the urban and community forest program at the State and local level. It facilitates the exchange of ideas and needs among different groups through newsletters and annual conferences, provides education, and establishes grass roots support. It also encourages networking among the communities, organizations, and industries involved in urban forestry. Input from the Urban Forest Council helps the State Forester in program planning, delivery of technical assistance, and leadership development. The State Urban Forest Council is an important partner of the State forestry agency because it can:

- Advise on direction of the urban forestry program.
- Promote the exchange of ideas and information within the State.
- Sponsor educational activities and technical support.
- Assist in reviewing grant proposals.
- Give grass roots support for urban forestry activities.
- Promote the value and benefits of urban forestry.

These State Urban Forest Councils in the Southern Region have web sites: Alabama, Arkansas, Georgia, North Carolina, South Carolina, Tennessee, Texas, and Virginia.

Local, Regional, State and National Partners

Through the urban forestry program, the State forestry agency can develop numerous partnerships with a wide variety of individuals and organizations:

- City foresters, arborists, engineers and landscape architects
- Citizen non-profit tree groups
- Local government agencies, commissions, and departments, such as county commissions, planning commissions, and public works departments
- Utility companies
- Tree care companies
- Nurseries
- Garden Clubs of America local affiliates

- Councils of government
- School districts, community colleges and universities
- Forest industry
- Private landowners
- Land trusts
- Professional associations, such as homebuilders, landscape architects, nurserymen, planners and arborists.
- State League of Municipalities
- State government agencies and commissions, such as the Departments of Transportation, Natural Resources, and Environmental Protection
- National non-profit organizations, such as American Forests and National Arbor Day Foundation.
- National Tree Trust

There are many opportunities to work with partners developing urban forestry programs.

Partnerships and Programs with U.S. Department of Agriculture

The State forestry agency maintains partnerships with various branches of the U.S. Department of Agriculture that conduct research and supply technical assistance to urban communities and organizations.

Forest Service

In addition to the Urban and Community Forestry Assistance Program, the Forest Service has other programs related to urban forestry:

- Rural Community Assistance
- Marketing and Utilization
- Nursery Tree Improvement Assistance
- Forest Management and Tax Assistance
- Research Stations and Research Work Units
- National Forest Supervisor and District Offices

State Cooperative Extension Service
The U.S. Department of Agriculture Cooperative State Research, Education and Extension Service offices at universities and at the county level provide research results and technical assistance on urban natural resource issues, including trees, soil, wildlife, horticulture, and landscaping. Regional or county agents can also assist in the field.

Natural Resource Conservation Service (NRCS)
The NRCS affords technical assistance and services on resource-related issues in urban areas. It advises local governments, community groups, and individuals on soil conservation and erosion control, water quality improvements, streambank stabilization, and improvement of buffer zones. Educational programs are also offered for teachers and students in local schools.

Local numbers for the county extension office and the NRCS are in the phone book.

Positions in the State Forestry Agency

Various State forestry agency employees have responsibilities related to urban forestry activities. However, everybody in the agency may have the opportunity to assist a homeowner, organization, or local community on an urban forestry-related project. Working collaboratively with the people in the communities, you can contribute information and skills that will help the urban forest. There are various ways the State forestry agency can provide urban forestry assistance (table1).

Table 1. Examples of the types of assistance the State forestry agency can provide and potential recipients

Technical/Educational Assistance	Planning Assistance	Potential Recipients
• Tree inventories • Urban forest assessments • Hazard tree identification • Tree diagnosis and treatment • Tree protection techniques • Construction site evaluation • Individual consultations Workshops • Presentations	• Emergency management plans • Urban Forest Council • Grant management • Urban forestry planning & management • Coordination of volunteer efforts • Environmental conservation plans • Recreation site management	• Homeowners • Community and civic groups • School groups • Non-profit groups • Local governments • Local businesses • Professional practitioners • Utility companies • Local media • Tree Boards • Urban forest councils

Job classifications vary from state to state, but the following are general descriptions of urban forestry responsibilities for different positions within the State forestry agency:

Forest Rangers and Technicians

In some State's, the forest rangers and technicians respond to requests for help on an individual tree or urban forestry problem. The technical knowledge and skill of these employees are important in supplying the customer with accurate information. In addition, the rangers may be involved in other aspects of urban forestry, such as assisting local communities in implementing grant programs and working with non-profit organizations.

Service, County, and Urban Foresters

These individuals often give technical assistance to local government representatives, professional practitioners, non-profit groups, schools, and others, involved in urban forestry activities. Because of their familiarity with urban forestry issues in a community, they can often play an important role in communicating educational and technical information to the public.

District, Regional, and Area Urban Foresters and Urban Regional Specialists

These foresters promote regional programs for cities and communities to help them develop or expand urban forestry programs and local volunteer efforts. They also give technical support to the rangers and foresters within their district, region, or area.

Urban Forestry Partnership Coordinator

The Partnership Coordinator assists the Urban Forestry Coordinator in managing the State urban forestry program. Although the Partnership Coordinator responsibilities vary with each State, administration and management of grant funds are often a part of this job.

Urban Forestry Coordinator

The Urban Forestry Coordinator administers the urban forestry program for the State forestry agency. Responsibilities often include:

- Coordinating the State's urban forestry programs, initiatives, accomplishment reports, strategic plan, and special projects
- Administering the urban and community forestry grant program
- Supervising the Partnership Coordinator and other staff, as appropriate
- Coordinating of the State's Tree City USA and Arbor Day programs
- Communicating with all State forestry employees on urban forestry related issues
- Coordinating urban forestry training programs for State forestry agency employees
- Developing urban forestry publications and videos
- Networking with current and potential partners
- Serving as State forestry agency liaison with Urban Forest Council
- Serving as principal point of contact with the Forest Service Regional Urban Forestry Coordinator

State Forester

As administrative head of the agency, the State Forester carries the overall responsibility of incorporating the goals of the urban forestry program into the agency's goal of promoting the economic, social, and environmental benefits and use of the forests for all the State's citizens. This individual gives statewide leadership in urban forestry, facilitates new partnerships with a wide variety of groups and individuals, and ensures strong financial and technical management of the program.

Southern Group of State Foresters

The State Foresters from the southern states have formed an Urban Forestry Working Group, comprised of State Urban Forestry Coordinators from across the region. This group assists the State Foresters in developing long-range planning, assessing needs, and finding funds for programs related to urban forestry. The attention to urban forestry at this level assures that the benefits of the urban forest will continue to enhance the quality of urban life.

The States in the southern region are Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia.

Checking Your Understanding of the Role of the State Forestry Agency

On a separate sheet of paper, answer these questions about the important points you need to remember:

1. What are the three major reasons your State forestry agency is involved in urban forestry? What are the major leadership skills that people in your agency can provide in urban forestry?

2. What are the three main responsibilities of the State forestry agency in urban forestry? Hoes does the agency go about achieving this goal? Name a partnership, program, or activity that is an example of each type of assistance.

3. Describe the responsibilities of the ranger and the forester in urban forestry. How will doing these things help with the management of the urban forest in your community?

The answers are at the end of the unit.

Case Study

Putting the Pieces Together

Linda, the County Forester, knows that her town has a good Tree Board. In the past 7 years it has developed into one of the most active and well-organized boards in the State. At a recent meeting, the city's landscape maintenance employees were the topic of discussion. The Board members realized that additional training in arboriculture would help these employees become more productive and, more importantly, would improve the quality of their work. The Board decided that a 2-day workshop sometime during January would be the best way to provide this training. As an ex-officio member of the Board, Linda was asked to serve as technical advisor to the workshop planning committee.

The workshop planning committee quickly discovered there was no one in the town with the expertise to conduct an arborist workshop. In fact, the group was not sure what information should be included, or where to look for help in planning and presenting the program.

The committee asked Linda three questions:

- What training needs to be included in the program?
- Where can we find speakers to present the topics for the workshop?
- Where can we find money to pay for it?

Linda had a lot to do before her next meeting with the Tree Board.

You and the Tree Board

Put yourself in Linda's place. What steps would you take to help the Tree Board plan a successful workshop? Use the challenge questions below to guide your planning, thinking of the people and resources available to you through your State forestry agency.

- Now that you have been asked to help, describe what you see as your role in the planning process.
- You are not certain how it was decided that a workshop would be helpful. What would you recommend the Tree Board do to find out the specific topics that should be included in the training?
- Once the topics have been determined, is there someone you would consult?
- How can you help identify the best people to teach at the workshop?
- Are there people, programs, or resources available to the State agency that might be helpful in providing information?
- Are there funds available to cover the basic expenses of the workshop?

After you have described the things you would do and the suggestions you would make to the Tree Board, compare them to what Linda actually did.

The Rest of the Story

Solving the puzzle

Linda was excited that the Tree Board was interested in offering additional training to the city's landscape maintenance workers. This was just the type of activity that had made the Board so successful, and she was glad to be able to help. But it was going to take some work! No one even knew the topics to include in the workshop, nor speakers who could present them.

The first thing she decided to do was help the Tree Board better understand the actual training needs of their city tree workers. She encouraged the members to meet with the city officials to get their input and commitment to the training. Some of the Tree Board members even spent one morning with some of the workers on the job to find out what they needed to learn. Once Board members had all this information, they had no problem filling the schedule for two days of training.

Now that they knew the topics to include, who was going to do the training? Linda went to work on the telephone. First she called the State's Urban Forestry Coordinator for advice and recommendations for the speakers. The coordinator suggested that she also contact the Partnership Coordinator and the State's Urban Forest Council, which she did. Both of these phone calls brought great results. The Urban Forest Council agreed to sponsor the workshop and to help with arrangements and speakers. The Partnership Coordinator also suggested some great speakers from among the contacts with various groups throughout the State, including people with the Cooperative Extension Service, the Urban Forester from the largest city in the State, and a representative from the regional chapter of the International Society of Arboriculture. With this list, the members of the Tree Board had more than enough qualified speakers to fill the schedule. The Board was so excited about the program, they decided to open the workshop to all of the communities in the region.

Now the hard part - money! As a local, non-profit group, raising money was not easy. The expenses for this workshop were modest, but there were supplies and printing costs. Another call to the State Urban Forestry Coordinator solved this problem, too. It was suggested that the Tree Board apply for an urban and community forestry grant. Linda gave them guidelines for writing and submitting the grant, and they received the funds needed to pay for the workshop.

Linda was glad that the Tree Board had begun planning early. It took time to arrange sponsorship with the Urban Forest Council, contact and schedule the speakers, and apply for the grant, but the results were worth it. The municipal tree workers from all the communities in the area had a well-planned, successful workshop.

Two Workshops to Compare

Did you plan your workshop differently? As long as they were both successful, it makes no difference! How did Linda's suggestions compare with yours? Has reading this account made you think of other possibilities you did not consider before?

- Did you suggest a different way for determining the topics that needed to be included in the workshop? If so, do you think one way is better than the other?
- Whom did you contact to help identify available people and resources?
- Knowing your community, are there specific individuals, organizations, or programs the State agency works with that you might have suggested for the workshop?
- Did you find the same source of money to pay expenses? Are there other possible sources or ways to pay for this type of program?

Next?

This unit presents an overview of the responsibilities, programs, and types of assistance that are part of your State forestry agency's role and activities in urban and community forestry. Use the questions on this page to look at how the information presented can help you assist the urban forestry efforts in your community.

- How will this broad perspective of the State forestry agency's role in urban forestry help you do your job better?

- How can you use this information to help your local community address the issues and opportunities they have in urban forestry? What group or local program would benefit from some specific assistance now?

- Who are the individuals and groups in your community that you may be able to work with on urban forestry issues? What resources are available from the State forestry agency that you would suggest to them?

- What other information about the State forestry agency's role in urban forestry would be helpful for you to know?

For More Information

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Checking Your Answers About the Role of the State Forestry Agency

1. What are the three major reasons your State forestry agency is involved in urban forestry? What are the major leadership skills that people in your agency can provide in urban forestry?

Your State forestry agency is involved in urban forestry for three reasons:

- Legislation: Legislation by the Federal government and individual States defines the role of the State forestry agency in supporting urban forestry. Federal support is given to the State through the office of the State Forester. State legislation generally provides the authority for the State forestry agency to assist communities and individuals with forestry related issues.
- Urbanization: The continued growth of urban areas has increased the need to address the specific problems that land development and increased population have caused for trees. Your agency has the experience to assist in maintaining the health of urban trees and solving other problems.
- Leadership: Your knowledge and training enable you to work with the public in promoting the benefits of urban trees and supporting efforts to manage them effectively.

2. What are the three main responsibilities of the State forestry agency in urban forestry? How does the agency go about achieving this goal? Name a partnership, program or activity that is an example of each type of assistance.

The basic responsibilities of the State forestry agency in urban forestry include:

- Technical assistance: Assisting with tree inventories, helping local professionals improve their skills, and matching tree species to the site are examples of the types of technical assistance that may be given.
- Educational assistance: This can include sponsoring workshops and demonstrations on the planting and care of trees, increasing awareness of the economic and environmental benefits of trees, and working with local volunteer groups.
- Financial assistance: The primary financial assistance is the urban and community forestry grant program which provides funds to local communities. You may be involved in helping local groups meet the requirements for receiving the grants, serving on grant review boards, and in providing technical or educational assistance to the grant recipient.

There are many more specific ways that your office may assist the community. Many of the things you do may have far-reaching benefits. For example, by giving technical advice on the proper planting of a specific tree, you are also helping teach correct planting methods that can be used later.

3. Describe the responsibilities of the ranger and the forester in urban forestry. How will doing these things help with the management of the urban forest in your community?

In general, rangers and foresters are responsible for working with people in the local community to address specific urban forestry problems or questions and offering technical and educational information to both individuals and groups. The jobs vary in each office, but working with local citizens can increase the visibility of the State forestry agency, promote the benefits of the urban forest, inform the people about programs available to the community, and help them in addressing general issues about forestry.

Dendrology

Table of Contents

Overview

Many different aspects of urban forestry depend on your knowledge of dendrology. Some examples include tree health problems, species selection, hazard-tree identification, tree inventories, and urban wildlife habitat identification. Your knowledge of dendrology and skill in identifying trees can help you communicate this information and make recommendations to the community.

This unit first defines dendrology and reviews types of trees in the south. The second section is about taxonomy of trees, which includes classification, naming trees, and tree identification. This information provides a foundation for the final section, which describes how the urban environment influences tree identification.

Can You Tell the Difference?

The "Sweet" Smell of Spring

It happens every year at the same time. You would think after so many years that Bob would be prepared for this, but he swears that each spring "it" is worse than ever before. The "it" that Bob is referring to is the Gingko tree that is planted by the entrance to the maintenance yard for the public utility. Working in the local office of the State forestry agency, Bob gets a lot of the complaints, which is putting it nicely, about the SMELL! You see, someone, who could not tell the difference between a male and female Gingko tree, planted a female one. While the leaves are just as golden in the fall as the male gingko's leaves, the fruits of the female gingko have a horrible odor. Since the utility company does not want to cut it down, the most that Bob can do is offer his sympathy to the maintenance supervisor who is worried that he needs to post guards so that someone does not solve the problem with a chainsaw.

The tree did make its point though. It is now in the city tree ordinance that only male gingko trees can be planted in the city.

Trees

Trees are funny
Do you know why?
They change their clothes
The same as you or I

They're green in summer
Red in fall
And when it turns cold
They wear no clothes at all

Molly Dwyer, age 7

Before You Begin

This unit looks at many of the individual parts of a tree, such as the leaf, stem, flower, and fruit that give a tree its unique identity. These questions will help you think about how this information can be used in your job:

- What are some instances when identifying a specific tree has been necessary?

- How do you usually go about identifying the species of a tree you are not familiar with?

- How does being able to name and identify trees help you in your job, particularly when you are working with a property owner or local group?

Think about the work you and others in your office do that involves tree identification, and what part this plays in your job.

What is Dendrology?

Dendrology actually means "the study of trees." In common usage it has come to mean the taxonomy of woody plants (Harlow and others 1979), which is the systematic classification, naming, and identification of trees based on natural attributes and relationships. The study of dendrology also includes knowledge about characteristics of trees and their geographical range.

Dendrology in Urban Forestry

Learning how to identify trees takes time and experience, but once familiar with how to do it, it is a valuable skill for urban foresters. Some activities in which knowing about dendrology will be most useful are noted in table 1.

Table 1. Examples of ways to use dendrology when providing assistance and potential recipients

Technical/Educational Assistance	Planning Assistance	Potential Recipients
• Tree identification • Disease and pest diagnosis • Urban wildlife habitat protection and enhancement • Hazard tree identification • Tree selection • Endangered species identification • Valuation	• Tree inventories • Urban forest assessment • Restoration of ecosystems • Urban forest master plan development • Public awareness programs • Urban habitat management • Urban landscape programs • Construction site planning • Hazard tree management plans	• Tree-care companies • Local governments • Individual homeowners • School groups • Builders and developers • Engineers and architects • Utility companies • Non-profit organizations • Community and civic group

What is a Tree?

A tree is a woody plant with several distinguishing characteristics:

- Often reaches 15 feet or more in height at maturity
- Has a single trunk or dominant multiple trunks
- Has no normal branches on the lower trunk
- Has at least a partially defined crown
- Usually larger than other plants and tend to be long-lived

The growth form or shape, rather than size, is the feature that distinguishes a tree from other plants such as shrubs (Harris 1992). A shrub is a woody plant with multiple stems that is capable of growing to a height of 15 feet.

Trees Common to the South

There are two major classes of trees, Gymnosperms and Angiosperms, both of which are found in the South. The Gymnosperms are often called evergreens or softwoods. The Angiosperms include hardwoods, palms and yuccas.

Softwoods

Softwoods belong to a group of plants known as conifers. These trees have needles or scales for foliage and cones for reproduction. This separates them from the hardwood and palm trees. Most softwoods keep their foliage for two or more years. Examples of softwoods include pines, hemlocks, cedars, and cypresses.

Hardwoods

Most tree species found in the South are hardwoods. Usually, they lose their broadleaf foliage in the fall and develop new leaves in the spring. There are exceptions to this, with some hardwoods being classified as evergreens, particularly in tropical and sub-tropical climates. Examples of hardwoods include maple, oak, elm, pecan, and walnut trees.

Palms and yuccas

Palms and yuccas include fewer species than the softwoods and hardwoods. They are most prevalent in semi-tropical and tropical coastal areas, such as the lower peninsular of Florida and the Florida Keys.

Three types of trees that grow in the South are softwoods, hardwoods, and palms.

Taxonomy of Trees

Taxonomy is the categorizing or classifying of trees. There are three components of tree taxonomy:

- Classification, which is the basis for the other two components.
- Naming trees
- Identifying trees

Classification of Trees

Since ancient times, humans have attempted to classify plants. Today, there is no single method of classifying plants because of the complexity of relationships among plants. The U.S. and other countries prefer a system developed by German taxonomists Adolf Engler and Karl Pramtl. This plant classification system provides a systematic way to identify trees based on genetic relationships. It also facilitates the communication between people when they are discussing specific plants. Two principles of this system are important in understanding how plants are categorized:

- The reproductive organs (flowers and fruit) are the basis of the classification system. Other important characteristics are leaves and wood anatomy. Trees can be classified as closely related when they have similar fruits even though they have different leaves and buds..
- The characteristics of a tree in its natural habitat influence its classification.

Classification Definitions

Using the classification system requires knowing the terminology and definitions used in dendrology. The classifications in table 2 divide trees into increasingly smaller groups; each one is given a Latin name. This method of naming natural things is common in science. Knowing the family name helps to understand relationships among trees. The genus and species names are the most important ones to know because a tree's scientific name is made up of these two names, such as *Magnolia grandiflora* (southern magnolia). Table 3 shows an example of the classification structure for the loblolly pine, a gymnosperm, and the Southern red oak, an angiosperm. The definitions in table 4 are often used to describe trees found in urban areas.

Table 2. Definitions of classification taxonomy

Classification	Definition
Kingdom	All living things are classified into kingdoms (e.g. plants and animals). Trees are in the plant kingdom.
Division	This is the first category of the plant kingdom and is based on the plant's means of reproduction. Trees, in the Spermatophyte division, reproduce through seeds.
Class	Trees are then divided into two classes, Gymnosperms and Angiosperms, by the method they use to develop the seeds used for reproduction. Gymnosperms, such as conifers, produce an open seed on a structure such as a cone. Angiosperms are flowering trees that have seeds enclosed in an ovary.
Order	Trees are further classified into orders according to certain other characteristics of seed reproduction. Angiosperms are divided into two major groups, monocotyledons and dicotyledons, based in part on the number of primary leaves (one or two) present in the seed plant. The *Sabal palmetto* is an example of a monocotyledon. Most trees are dicotyledons, such as members of the walnut or oak families.
Family	A group of closely related trees, usually including one or more genera (plural of genus) make up a family. The rose family, Rosaceae, is a family in the dicot group, and includes cherry, apple, and pear trees.
Genus	A collection of closely related species is a genus. The species usually are structurally similar or have common ancestry. Examples are the cherry and plum trees that are a genus, *Prunus*, of the rose family.
Species	A collection of individuals with characteristics so similar that they suggest common parentage, a species is a tree distinct and unlike others. The black cherry, *Prunus serotina*, is a species of the genus *Prunus*. Species is the basic, and probably most important (Dirr 1990) unit of taxonomy or classification of a tree.

A monotype exists when there is only one type of tree in the order, family, or genus. The Oriental ginkgo (Gingko biloba) is a monotype because the order has only one family, and the family has only one genus, and the genus has only one species.

Table 3. Classification structure of the loblolly pine, a gymnosperm, and a southern red oak, an angiosperm

Classification	Loblolly Pine	Southern Red Oak
Kingdom	Planta	Planta
Division	Spermatophyta	Spermatophyta
Class	Gymnospermae	Angiospermae
Order	Coniferales	Dicotyledeae
Family	Pinaceae	Fagaceae
Genus	*Pinus*	*Quercus*
Species	*Pinus taeda*	*Quercus falcata*
Common name	loblolly pine	southern red oak

Table 4. Definitions related to tree species identification

Term	Definition
Hybrid	A tree produced by crossing two different species is considered a hybrid. Hybridization has been used to create new variations of a species for urban areas. An example is the *Cornus.kousa* x *florida.celestial*, a hybrid of the Kousa dogwood and the flowering dogwood that was developed for greater resistance to disease.
Variety	Within a species, a tree that has distinctive but minor differences from other trees of the same species is a variety. These differences are inheritable and can be reproduced from seed (Dirr 1990). A variety that is significantly different from the standard species is often the beginning of a new species. Variations in the color of the leaves or flowers or a difference in the fruit will distinguish one variety of a tree from others in the species.
Cultivar	Trees that have been cultivated to produce specific, distinguishing characteristics are cultivars. These specimens retain the features created in the development of the cultivar, but they usually can only be reproduced by grafting to maintain the characteristics. This method of reproduction distinguishes it from a variety, although the term cultivar and variety are often used interchangeably (Dirr 1990).
Clone	A population of trees that develops asexually from a single tree is a clone. Sassafras and sweetgum are trees that reproduce as clones.
Natives	Trees that are indigenous to a particular region or environment are considered to be native. This usually suggests that the species originated in the region and has a certain compatibility with it. A native tree, however, may not be compatible in urban locations in that region because of modifications to the habitat, including soil, water, and nutrient cycles.
Exotics	Trees that are not native to the area in which they grow are considered to be exotics. Exotics may be resistant to local insect and disease problems, but may also bring in unexpected and undesirable insect and diseases. They may also become invasive. Exotics become naturalized when they grow and reproduce in an area.

Naming Trees

Naming trees with Latin names is the second component of tree taxonomy. Each species has a scientific Latin name that is used universally. However, every tree also has one or more common names by which it is known in various parts of its range.

Scientific Name

A system of standardized Latin names for plants was developed in the 18th century and is now used throughout the world as a universal system for naming trees. The complete scientific name for a tree consists of three parts:

- Genus; for the loblolly pine it is *Pinus*
- Species; for the loblolly pine it is *Pinus taeda*
- The full or abbreviated name of the person or persons who originally described the species; the full name of the loblolly pine is *Pinus taeda* L (L. is the initial for Linnaeus, the Swedish botanist of the 18th century).

Common Name

The common names of trees often reflect their major characteristics, such as the red maple. Names, however, may originate from other sources, such as the location where the trees grow naturally. Examples are swamp white oak and river birch, trees that grow in low-lying or riparian areas with moist soils. Some of the sources of common tree names are:

- Habitat - swamp white oak, river birch
- Distinctive feature - weeping willow, bigleaf maple
- Locality or region - southern red oak, southern magnolia
- Use - sugar maple, paper mulberry
- In commemoration - Douglas fir, Englemann spruce
- Adaptations from other languages - frijolito, hickory

Using common names of trees often leads to confusion when talking with other people. Two trees, like two humans, may share the same common name while actually being quite dissimilar. Trees may also have multiple names. For example, *loblolly pine* is known in various parts of its range by 25 other names, including juice pine and bull pine. The American Joint Committee on Horticultural Nomenclature has attempted to adopt one common name for each species (Harlow and others 1979).

Refer to the "For More Information" section for a list of resources on scientific and common names of a trees.

Checking Your Understanding of the Classification and Naming of Trees

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

1. Why is the classification of trees useful? What is the basic unit of classification that you need to be most familiar with when talking about trees?

2. What are the two major classes of trees? What distinguishing characteristic determines the class a tree belongs in, and why is it important?

3. How can the common names of trees help you select a tree for planting, and where can you find the common and scientific names for a particular tree?

Answers are at the end of the unit.

Tree Identification

The identification of trees is the third aspect of tree taxonomy or classification. Trees are classified into groups primarily by their fruits and flowers, but the leaves and twigs are usually more accessible for identification. Tree identification in urban locations requires knowing many trees because of the numerous exotics that have been introduced from around the country and the world. The most important features to look for in identifying a tree are:

- leaves
- twigs and stems
- bark
- flowers
- fruit and seeds
- cones

Trees are identified by several different methods. Parts of a tree may be compared to illustrations in a manual, although this can be time consuming. A better way is to use keys specifically designed to aid in identifying trees.

Keys
Keys are tools that lead the user through the steps of identification based on the features of the tree. The key often focuses on the fruit or flower since this is the primary means for classifying trees. However, keys have also been developed for other features such as leaves, stems, buds and bark.

Using a key involves making choices at each step in the outline provided. It begins with general, easily observable features and works through to increasingly detailed traits. To do this successfully requires practice, experience, patience and familiarity with the scientific terminology used. A key is intended only to help in tree identification, and should not be the only means used in doing the job (Dirr 1990).

Publications and other resources for identifying plants are listed in the "For More Information" section at the end of this unit.

Leaves

One way to identify a tree is by its leaves. Leaves have many distinguishing characteristics and these characteristics can be used for identification. Each of these features will be defined and illustrated in this unit:

- Part
- Type

- Shape
- Arrangement on the stem
- Venation
- Shape of apex and base
- Margin
- Surface

Leaf parts

Knowing the parts of a leaf will help with tree identification (figure 1).

- The lamina is the blade or broad part of the leaf.
- The leaf is attached to the twig with a supporting stalk called a petiole. It may be either short or long, grow in a variety of different shapes, and may not exist in some trees. Some petioles enclose next season's bud in the base. When the leaf is attached directly to the twig, rather than to the petiole, it is said to be sessile.
- Stipules are a pair of small, scaly or leaf-like organs that may be attached to the twig on either side of the petiole. Some stipules will leave scars that are visible on the twig in the winter. Plants that have stipules are called stipulate, while those without them are called estipulate.

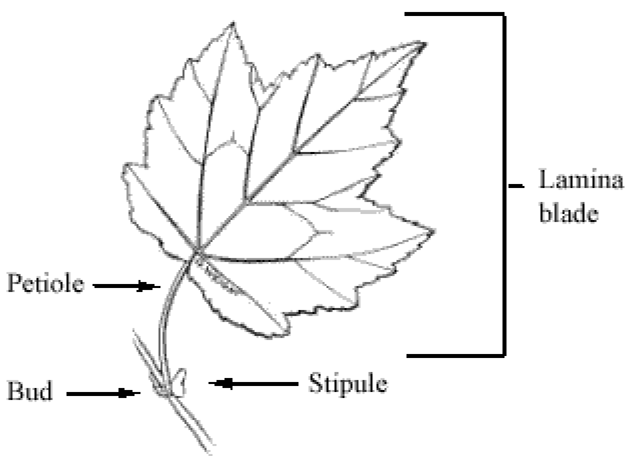


Figure 1. Parts of a simple leaf. (Illustration by Gene Wright)

Leaf types

Determining the type of leaf can be the first step in tree identification. There are two different leaf types, hardwood and softwood.

- Hardwoods can have either a simple or a compound leaf. A simple leaf has a single blade or lamina, as shown in figure 1. A compound leaf has two or more blades that are called leaflets. The stalk to which the blades are attached is called a rachis**.** The arrangement of the leaflets on the rachis determines the particular type of compound leaf. There are several types of compound leaves, which are described in figures 2,3,4, 5 and 6.

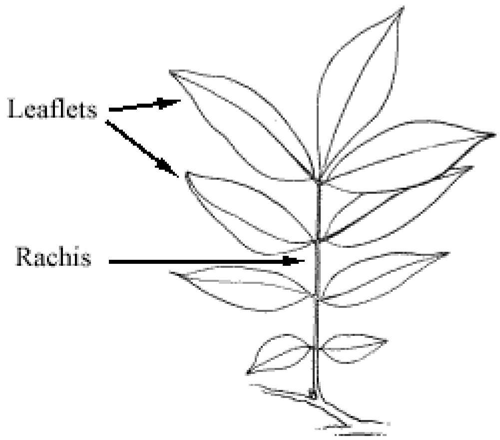


Figure 2. A pinnately compound leaf has leaflets arranged laterally on the rachis. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

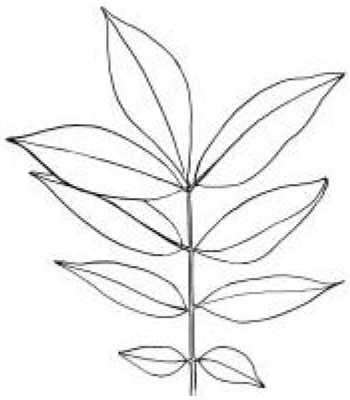


Figure 3. A leaf with an odd number of leaflets on the rachis is called an odd pinnate leaf. A boxelder tree has odd pinnate leaves. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

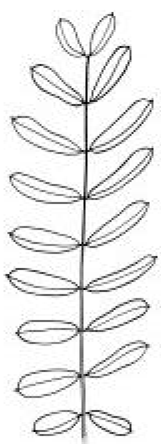


Figure 4. A leaf with an even number of leaflets is called an even pinnate, such as the hornless common honeylocust. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

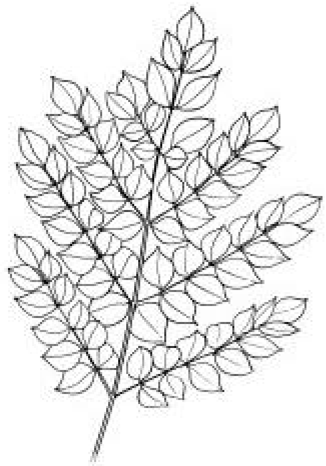


Figure 5. A bipinnately compound leaf has multiple leaflets attached to a leaf-bearing stalk off the rachis, such as the Kentucky coffeetree. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

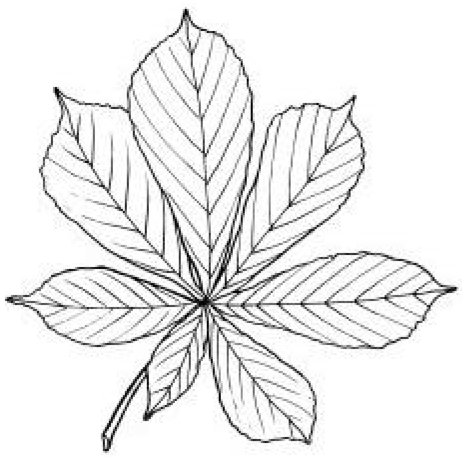


Figure 6. A palmately compound leaf has each leaflet attached to a common point, such as the Virginia creeper. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

- Softwoods, such as conifers, usually have different leaf types than hardwoods. Not all softwoods have evergreen foliage. The three types of softwood leaves are awl-like (figure7), scale-like (figure 8), and needle-like (figure 9).

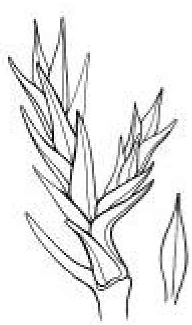


Figure 7. Awl-like needles are elongated, taper to a fine point, and are usually sharp to the touch. Many Junipers have awl-like shaped foliage. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

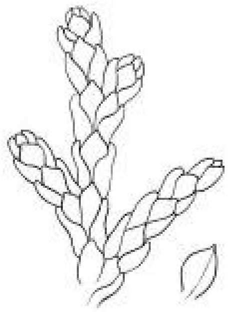


Figure 8. Scale-like foliage overlaps like the shingles on a roof or the scales of a fish. This type of foliage often feels soft when touched. The eastern redcedar has this type of foliage. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Figure 9. Needle-like foliage, like that of the pine family, is found on several evergreen genera and species. Needles may be flat or angular in cross-section. The number of needles and the length of the needles may also help in identification. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Leaf shape

The shape of the leaf is very useful in tree identification and is usually the same on all trees in a species. Determined by the outline of the blade of the leaf, there are several different shapes, some of which are shown in figure 10. Leaflets on a compound leaf may have two different shapes, depending whether they are located on the side or tip of the stalk.

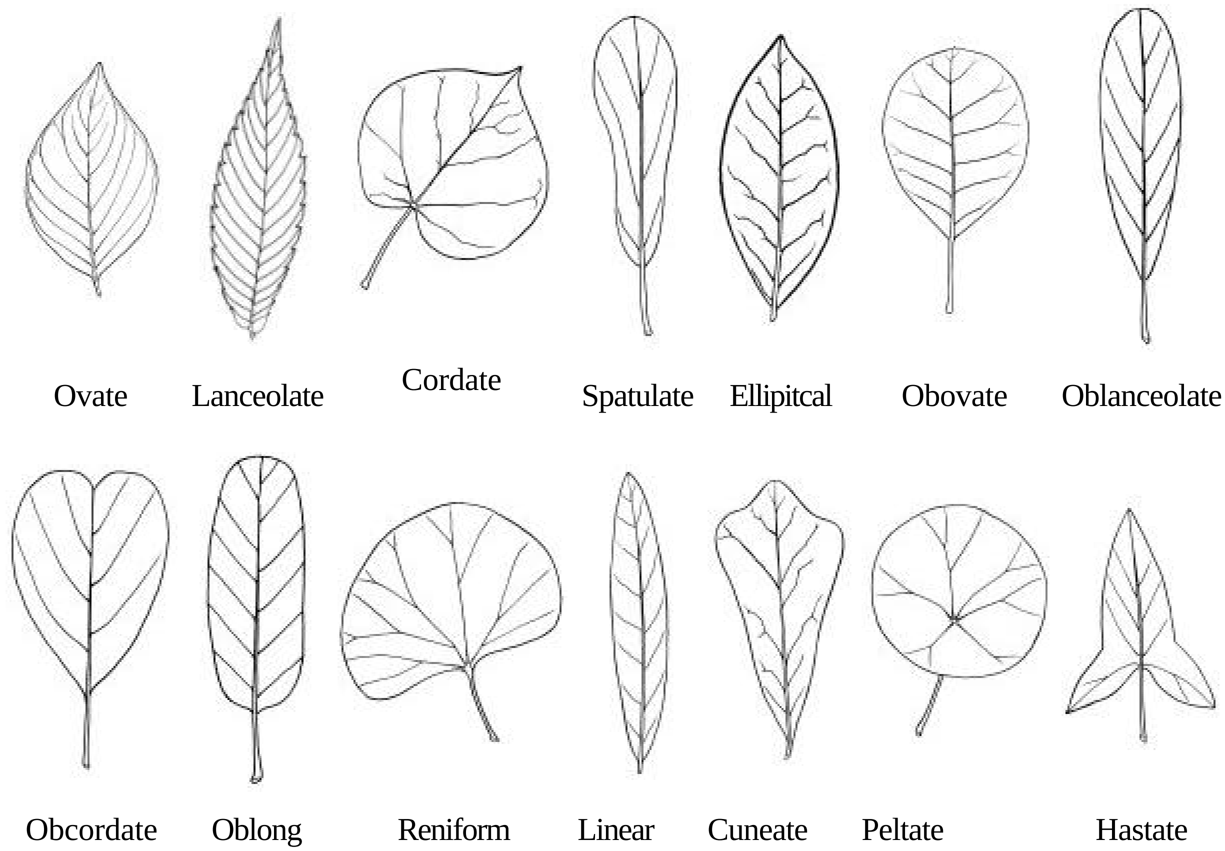


Figure 10. Examples of different types of leaf shapes. (Illustrations adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Leaf arrangement

Observing how leaves are arranged on a twig may assist in tree identification. Hardwood leaves are arranged in one of three ways, opposite (figure 11), whorled (figure 12) and alternate (figure 13).

Figure 11. Opposite leaf arrangement refers to leaves that are even with each other on opposite sides of the twig. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

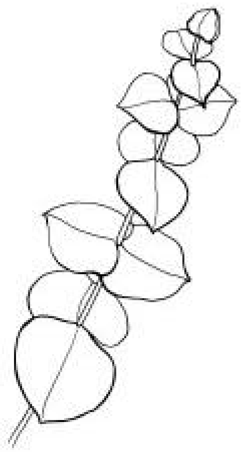


Figure 12. Three or more leaves found at the same node, or bud, on a twig are whorled. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

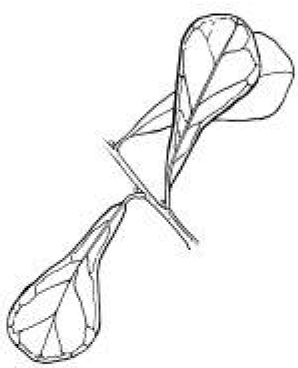


Figure 13. Alternate leaf arrangement occurs when one leaf is attached at each node, arranged in a spiral pattern around the twig. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Leaf venation

The venation, or the pattern of the veins, may help in identifying hardwood trees. The four primary venation patterns are pinnate (figure 14), palmate (figure 15), parallel (figure 16), and dichotomous (figure 17).

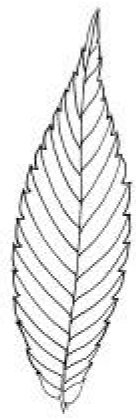


Figure 14. Pinnate venation has a prominent central vein that extends from the base, where the petiole attaches to the blade, to the apex or tip of the leaf. The overall effect is that of a fishbone. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

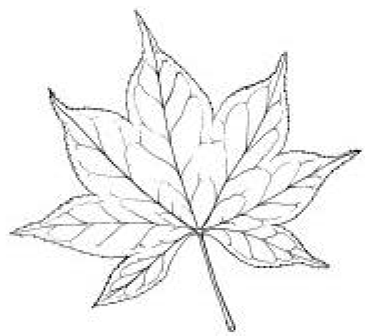


Figure 15. Palmate venation is when three or more veins branch from the base of a leaf. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

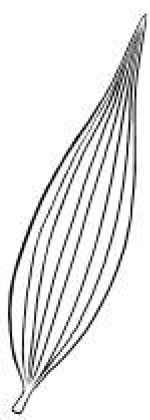


Figure 16. The veins run parallel to each other along the length of the leaf in parallel venation. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

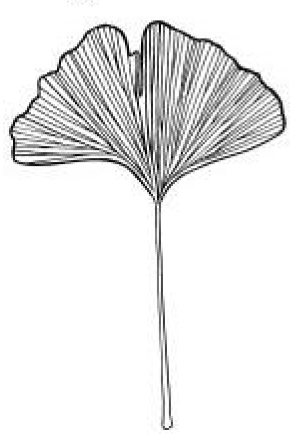


Figure 17. With dichotomous venation the veins extend for a distance forming a "Y" type pattern. It is found in a limited number of leaves. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Leaf apex and base

The tip of a blade that is farthest from the petiole, or stalk, is called the apex. The part of the blade nearest to the petiole is called the base. Examples of common shapes for apices and bases are shown in figures 18 and 19.

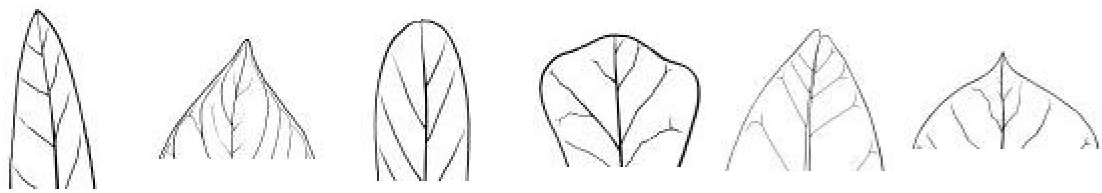


Figure 18. Common shapes for apices of leaves. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

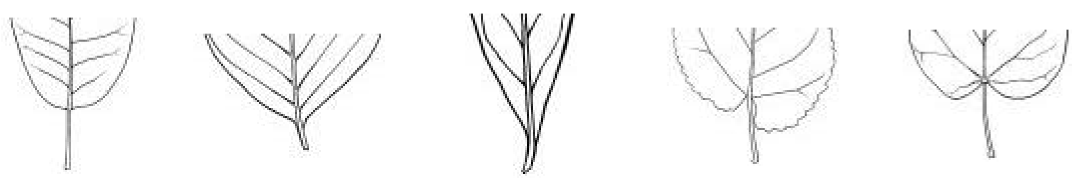


Figure 19. Common shapes for bases of leaves. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Leaf margin

The edge of the leaf is called the margin. The margin is distinctive and may serve to assist in separating closely related forms. Examples of leaf margins are shown in figure 20.

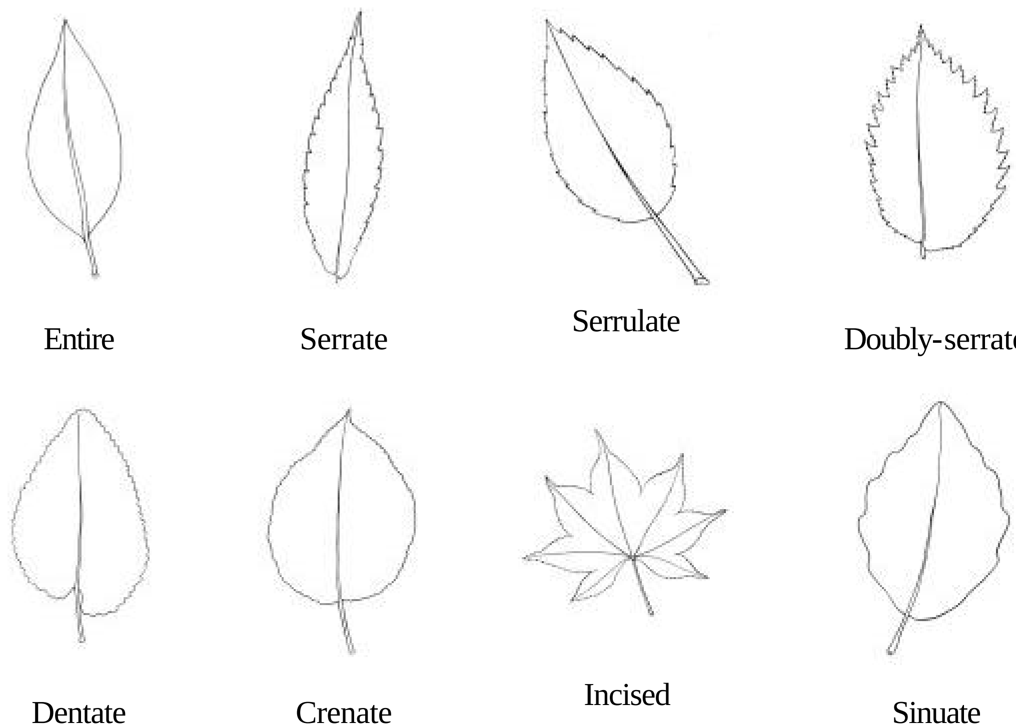


Figure 20. Examples of different types of leaf margins. (Illustrations adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Leaf surface
The surface and texture of the leaf are other means of identification. The hair, resin glands, waxes, blooms, and scales provide valuable clues in naming a tree. The texture of the leaf may feel like leather or like paper.

Twigs and Stem

Twigs are useful in identifying trees except for a short period during the spring when the buds are opening and shoots are elongating on these small branches. Several features of twigs, including buds, leaf scars, lenticels, pith, spurs, thorns, spines, and prickles, can help describe them (table 5 and figure 21). Other factors to consider are color, taste, and odor. The color of the bark can be an most important feature on young stems.

Table 5. Twig characteristics that help with identification

Characteristic	Description
Buds	• Are one location of growth tissue in a tree. • Are usually visible on the twig. • May be either lateral, on the side of the twig, or terminal, at the tip of the twig. • Are scaly or naked, smooth or fuzzy.
Leaf scars	• Are where a leaf falls from the twig. • Vary in size and shape. • Have one or more minute dots or patches that show where the ruptured strands of vascular tissue passed from twig to leaf.
Lenticels	• Are small, normally lens-shaped patches on the stem that facilitate gas exchange. • May be wart-like.
Pith	• Is the central portion of the twig. • Is usually lighter or darker than the wood that surrounds it. • Varies in color. • Is star-shaped or pentagonal in oaks, triangular in alders, terete or cylindrical-like in ash and elms, and chambered in walnuts. • Varies in composition; in most cases is solid, spongy, or hollow.
Spurs	• Are dwarfed twigs with some internodal development. • May grow for several years. • Produce the fruit on many apple varieties
Thorns, spines, and prickles	• Pointed structures that project from the sides of a twig; are important features in some species. • Thorns are modified twigs. • Spines are modified stipules. • Prickles develop from surface tissue and are easily removed.

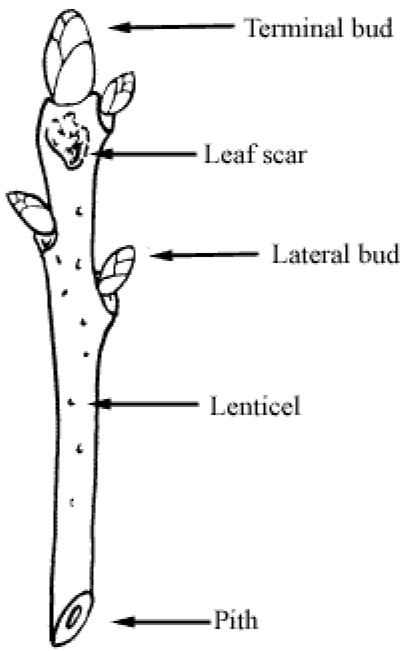


Figure 21. Characteristic parts of a twig that help in the identification process. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Bark

Bark is one of the most important features for tree identification because of its year-round accessibility. It is especially useful when the tree's leaves and twigs are inaccessible or unavailable during the fall and winter. The shape of the bark is characteristic of some species, for example, the small, rectangular plates on flowering dogwood. Bark on young trees differs from that on more mature trees. Experience is the best way to learn bark characteristics. Table 6 describes bark characteristics that can be used for identifying mature trees. Typical bark textures are illustrated in figure 22.

Table 6. Bark characteristics that help with identification

Characteristic	Description
Shape or general appearance	The shape of the bark is often characteristic of some species, for example, the small-rectangular plates on the flowering dogwood.
Texture	The feel of the bark, such as the smoothness of cherry trees or the layering or plating of white oaks, is important.
Thickness	The thickness of the bark can vary within a species as well as between species.
Color	Bark color varies with age, location, site, and light conditions.

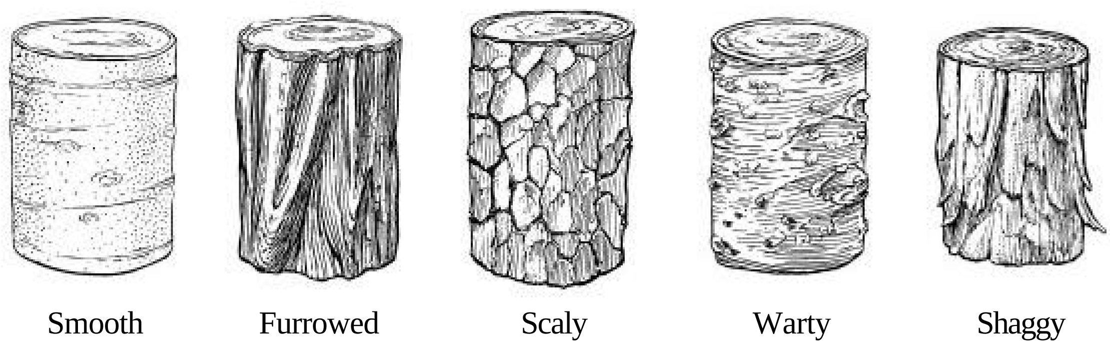


Figure 22. The differences in bark can be helpful in tree identification. (Illustrations by Gene Wright)

Flowers

Flowers are best feature for identifying trees, but are available only for a short period each year. Leaves, twigs, and bark are usually available for identification, but if there is doubt about a certain tree, the flower is the surest way to identify it.

Although not always noticeable to the casual observer, all hardwoods bear flowers. Some produce flowers annually, while others flower less often. Flowers are modified leaves that have undergone change to the point that they have become or support the reproductive organs of the plants.

Complete and incomplete flowers
A complete flower has four parts (figure 23). An incomplete flower is one that lacks any of these four parts.

- Calyx (composed of sepals)
- Corolla (composed of petals)
- Stamens
- Pistils

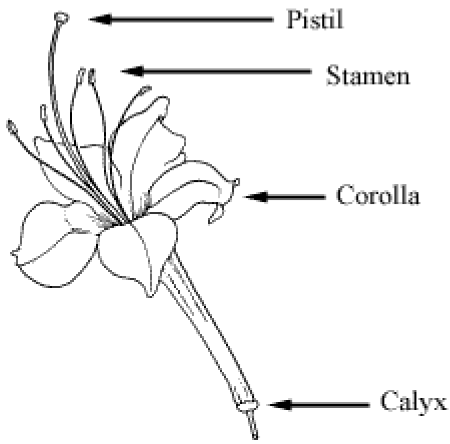


Figure 23. A complete flower has all four parts. (Illustration adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Perfect and imperfect flowers

A perfect flower includes actively functioning organs of both sexes but may lack sepals or petals. The stamen is the male reproductive structure, and the pistil is the female reproductive structure. A perfect flower may be either complete or incomplete.

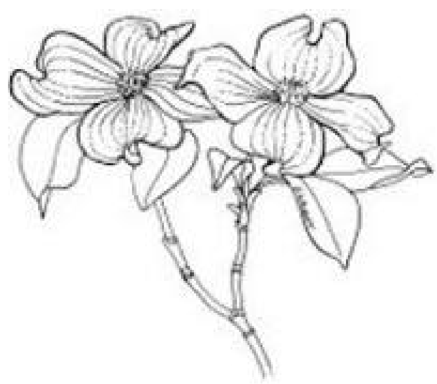
A flower lacking either functional stamens or pistils is imperfect. These flowers may also be known as unisexual flowers, meaning they are either pistilate (female) or staminate (male). These may occur on the same tree, or the male and female parts may be on separate trees, as in the gingko.

Arrangement of flower blooms

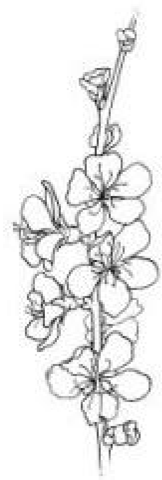
Flowers bloom in different arrangements (figure 24).

- Individual or single bloom flowers are typical of many woody plants, for example the magnolia.
- A cluster or an inflorescence is a collection of individual flowers arranged in a specific pattern (Dirr 1990). One that blooms at the end of a central stalk, or rachis, is referred to as a determinate flower. The dogwood tree has a determinate flower. If the flowers open progressively from the base to the apex or from the outside to the center in flat-topped clusters, the flower is indeterminate. The flowering crabapple has an indeterminate flower.

A flower at the end of a twig is a terminal flower. An inflorescence that appears in a leaf axil, or bud, is described as axillary. Flowers may also appear from separate flower buds, which are normally located near the tips of the twigs.



Determinate



Indeterminate

Figure 24. The characteristic inflorescence of a flower is helpful in identification. (Illustrations adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Fruits and Seed

Another key to identifying a hardwood is its fruit or seed. A fruit is the seed-bearing organ of the plant. Using fruit is somewhat limited, however, because some trees do not bear fruit and others do so only for a short time or at irregular intervals. Fruits develop from flowers. Solitary flowers that have a single pistil produce a single fruit. A cluster of flowers with multiple pistils produces a cluster of fruit or a compound fruit. Some fruits have only one seed, others develop many seeds. In most species, pollination and fertilization must occur for fruit to develop. Fruit development can take from a week or two in elms to two growing seasons in red oaks. Examples of different types of fruit are shown in figure 25.

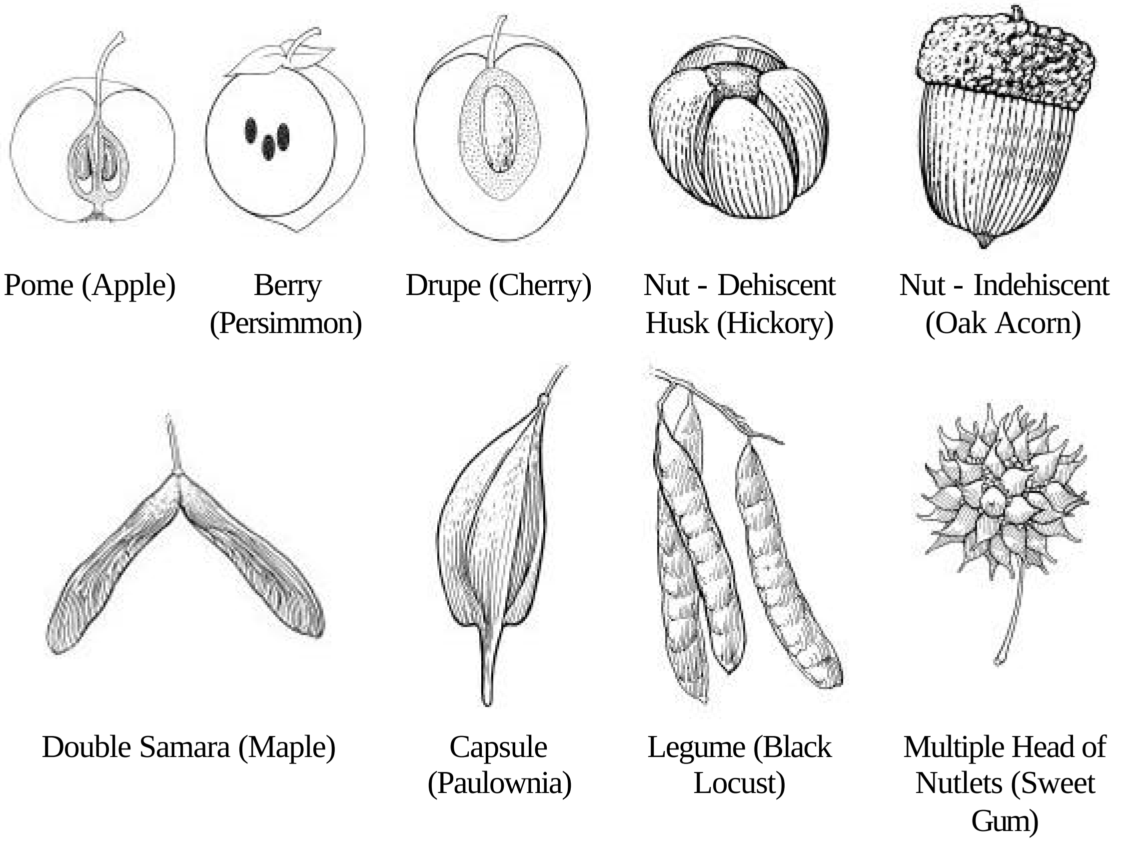


Figure 25. The type of fruit a tree produces can be used in identification. (Illustrations adopted from "Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses" (Dirr 1990); Illustration drawn by Gene Wright)

Seed production and germination depend on many factors, such as temperature extremes, conditions of the tree, and presence or absence of competition. Seed quality, including germination capacity, can vary greatly and is influenced by factors such as the tree's nutrient storage, availability of water, and temperatures and weather conditions.

Conifers do not bear fruit, they bear cones.

Simple fruits

Simple fruits develop in various forms. There are two basic types, dry and fleshy, each of which has a wide range of variations.

- The two primary forms of dry fruit are indehiscent, which do not split open at maturity, and dehiscent, which do split open when ripe. Indehiscent fruits are usually one-seeded with the seed enclosed in various types of coverings. Species with this type of fruit include maples and oaks. Dehiscent fruits are usually many-seeded and are enclosed in a covering that splits when the fruit is ripe, such as the redbud, magnolia, and rhododendron.
- Fleshy fruits are usually multi-seeded, the seeds are surrounded by a fleshy pulp, or pericarp, which is sometimes edible. These may be classified as a berry (blueberry and persimmon), drupe (cherry, plum, and holly), or pome (apple or pear).

Compound fruits

Fruits that develop from multiple pistils are called compound. Two types of compound fruit are aggregate and multiple.

- Aggregate fruits develop from a single flower that has many pistils (Dirr 1990) that form many fruitlets in a single mass, such as the magnolia or tulip tree.
- When several flowers together contribute to the development of a single fruit, it is called a multiple fruit (Dirr 1990). The fig tree and the mulberry produce examples of this type of fruit.

Cones

Seeds for softwoods (conifers) are found in cones. Most conifers are monecious. Monecious means that both male and female reproductive parts are located in separate structures on the same tree. A few conifers are dioecious; the male and female reproductive parts are on separate trees. Male and female structures are called cones or stobili (figure 26). Cones consist of an egg or pollen-bearing scales attached to the central stem. The scales may be arranged spirally or they may appear in pairs. Characteristics of three different types of cones are described in table 7.

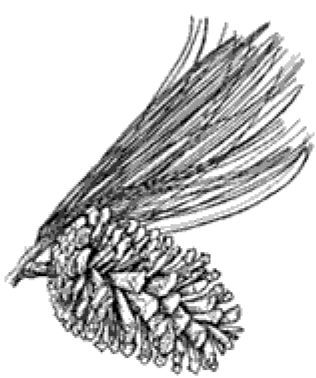


Figure 26. Seeds are produced on cones in conifers. (Illustration by Gene Wright)

Table 7. Types of cones

Type of Cone	Description
Pollen cones	• Are generally small, non-woody and short lasting. • Emerge from buds, release pollen, wither and drop within a few weeks. • Bear sacs on the bottom of each scale known as *pollen sacs* or *microsporangia*. • Release thousands of pollen grains when the sacs burst. • Are modifications of shoots, and the scales are modified leaves. • Are found in the mid- to lower crown.
Female cones	• Are larger than male cones. • Are usually woody. • May persist for many years. • Develop to maturity in one or more season and release their seeds in late summer to autumn. • Bear two megasporangia on the top of each scale which contains an ovule. This ovule develops into a seed following pollination and develops an embryo. • Are found in the upper crown of a tree in some species.
Seritinous cones	• These cones are closed tightly with pine tar. Heat from a fire is needed to open the cone. The sand pine and pitch pine have this type of cone.

Tree Form or Shape

Tree form and shape can be useful features for identification. There are two primary tree forms, excurrent and decurrent. Trees that are excurrent, such as conifers, have a dominant trunk with smaller side branches. This form gives the tree a conical or triangular shape. Trees that are decurrent, such as oaks, have spreading branches that give the crown a full, round appearance.

A tree may grow differently in various parts of its range so its appearance may vary. A tree that grows large in one part of its range may be shrub-like at the extreme limit of its range.

Remember to take into account the habitat and range of a tree, as well as its physical characteristics, when making an identification.

How the Urban Environment Influences Tree Identification

Tree identification in urban areas can be complicated. There are usually a large number of species in urban areas, including native and exotic trees. And various conditions associated with the urban environment may alter specific characteristics of a tree, such as changing the appearance of the leaves or bark that help in tree identification. Examples of site factors that may alter a tree's appearance include compacted soils, excessive soil moisture, and extreme temperatures.

The capacity of a tree to adapt to new conditions is a measure of its tolerance.

Size, Form, and Shape

In an urban environment, trees are often growing in very different conditions than those species growing in a rural or forested area. Trees in urban locations are often smaller and shaped differently than those in forests for several reasons.

Individual specimens

In urban locations, a tree is often planted as an individual specimen. This exposes it to more light and wind, and usually higher temperatures. Urban trees also will commonly have larger crowns and thicker and shorter trunks than the same species growing in a forest.

Range may change

It is important to remember that a tree's range may change as the environment is altered. One factor that may change the range is the loss of trees when an area is urbanized. Fewer trees may change the temperature and the flow patterns of wind and water. Another factor that alters the range of a species is its introduction to new areas. When a plant foreign to a region becomes established and reproduces, it is said to be "naturalized." These two situations may greatly extend the range of a tree or reduce it to the point of extinction. Planting a tree out of its natural range can also influence its form and shape. For example, planting river birches far from the river may change their appearance.

Soil conditions

Soil conditions, such as limited soil volume, compaction, drainage, poor aeration, and limited nutrients can influence sprouting and twig elongation may be shortened.

Pruning

Pruning can change the natural shape of a tree.

Changing the natural shape of a tree can make it more challenging to identify.

Leaves

The soil conditions at the site can also influence leaf size and color.

- Leaves may be stunted in size.
- Color may be altered.

Bark

The bark of a tree can also be influenced by the urban environment.

- In heavily shaded areas lichen may grow on the bark, changing the color.
- If the bark has been damaged by insects, rodents, or other pests identification in the winter may be difficult.

Flowers

Urban locations may affect the natural cycle of a tree's growth.

- Variations in light and temperature patterns may change the time of year that a tree produces new foliage, flowers, or fruits
- Soil fertility also influences the time that a tree flowers and the number of flowers produced.

Checking Your Understanding of Tree Identification

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

1. What parts of a tree can be used for identification? Are there seasonal limitations for the use of each of them? What part of the tree is most commonly used for identification? What part of the tree provides the surest means of identification?

2. What are seven major characteristics of leaves that can be used in identifying trees? Briefly describe each.

3. How can the urban environment affect your efforts to identify a tree?

Answers are at the end of the unit.

Case Study

What's in a Name?

It was wintertime, and cold and wet. The fact that the tree Tom had been asked to look at was in a bottomland made it seem even colder and wetter. Working in the local office of the State forestry agency, he had been asked by a construction company to make some recommendations about a large tree that was on their construction site. They wanted to save the tree if possible and needed to know what steps to take. The tree was more than 45 feet tall, but Tom was surprised that it had survived this long. From the shape of the tree and its bark, he identified it as a white oak. He wanted to help the construction company save the tree, but this was going to take a lot of work. In addition to the impact of the construction work in the area, the soil in which the tree was growing was moist, compacted, and poorly drained.

Tom's recommendations were extensive. A white oak needs moist, but well-drained soil. To maintain the health of this tree after the construction was over, he outlined a series of steps to improve the soil and the drainage at the site. This included aerating and amending the soil and, most importantly, creating a system to keep the soil well drained. In the meantime, he suggested fencing around the tree to protect it from equipment damage during the building. By spring the construction would be finished, and they would be able to implement the maintenance program Tom had suggested.

You and the Oak Tree

If you are called by the construction company, how would you identify the tree, and what recommendations might you make? On a separate sheet of paper, write what you would have done in this case, using these challenge questions as a guideline.

- How would you go about identifying the tree?
- What specific tree characteristics would you consider in making the identification?
- What physical site factors would influence your decision?
- Why is proper identification important?
- How would your recommendations relate to your identification?

The outcome of the real story follows this case study. After you have written the steps you would follow, compare your story with what really happened.

The Rest of the Story

The Switch

Two months later Tom was back at the site, going over plans for the drainage system. He wanted to make sure that water runoff from the site would drain away from the tree so that the soil amendments and aeration would continue to benefit the tree. There was just a hint of spring in the air, and Tom noticed that the tree was in bud, with just the first few leaves of spring beginning to grow. And wasn't he surprised! What he had identified as a white oak based on the bark characteristics was actually a swamp oak, growing exactly where is should be, in poorly drained bottomland. Somewhat sheepishly, he went to the construction managers to say that the concerns about keeping the soil drained were not necessary. The proper care of the tree would be much easier, since the tree was growing where it should. In this case, proper identification of the tree not only saved extra maintenance costs, but also probably saved the life of the tree.

A Tree by Any Other Name

- Were the characteristics that you used in identifying the tree different from Tom's? If so, what were they?
- What biological or environmental factors did you consider when making the identification?
- How might your identification affect things like the time and cost for the care and maintenance of the tree?
- What have you learned from Tom's story that can help with your work in urban forestry?

Next?

The information about tree identification in this unit is essential to the work you do in providing technical and educational assistance. Identification skills take practice and experience. Use the questions on this page to decide how you can improve these skills and your practice of urban forestry.

- How will you use the information about tree identification in your work? Think of specific times or purposes where it will be helpful.

- What are some ways that you can develop your skills in tree identification? In different situations, such as with a homeowner, on a construction site or in different seasons.

- What other sources will you want to use in developing your identification skills? These can include people and other references.

- How can you use your skills and information about tree identification to help others in developing and maintaining the urban forest in your community?

For More Information

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Checking Your Answers

Checking Your Answers for the Classification and Naming of Trees

1. Why is the classification of trees useful? What is the basic unit of classification that you need to be most familiar with when talking about trees?

The classification of trees has three useful purposes:

- Assists in the identification of trees. This provides a common language for talking about trees.
- Helps determine specific characteristics of a tree that are important in selecting a tree for a specific location, in diagnosing and controlling insects and disease, planning proper care and maintenance, and in dealing with hazard-tree problems.
- Provides an understanding of the inherited relationships among the species of trees.

The basic unit of classification for a tree is the species. This is the level of classification that puts all the trees with the same, distinguishing characteristics together. The scientific name of a tree made up of the genus and species name.

2. What are the two major classes of trees? What distinguishing characteristic determines the class a tree belongs in, and why is it important?

Trees are divided into two major classes based on the way that they develop the seeds used for reproduction. For this reason, the flower or cone that produces the seed and the seed itself are important in the identification of trees.

- Gymnosperms or softwoods - This class of tree produces an open seed on a cone or other similar structure. Most trees in this class are conifers, many of which belong to the pine family. Other trees in this class are cypresses, cedars, redwoods, yews, and gingkoes.
- Angiosperms or hardwoods - These are flowering trees that produce their seed in an enclosed ovary. They are often described as hardwoods. With many thousands of species, they live in a variety of climates with a great variation in size and form.

3. How can the common names of trees help you select a tree for planting, and where can you find the common and scientific names for a particular tree?

The common names of trees often reflect a primary feature of their growth habits, the region where they are commonly found, or the type of land in which they prefer to grow. Attention to these characteristics helps in selecting the proper tree for a specific location.

The same species of tree may have many different common names, with different ones used in different areas, but there is only one scientific name for each species. The publication *Standardized Plant Names* gives you both the scientific name and all the common names for each species.

Checking Your Answers for Tree Identification

1. What parts of a tree can be used for identification? Are there seasonal limitations for the use of each of them? What part of the tree is most commonly used for identification purposes? What part of the tree provides the surest means of identification?

The five main parts of a tree that can help in identifying are:

- Leaves are the most commonly used means for identifying a tree because they are available most of the time, and are often the most prominent and distinctive part of the tree. In evergreen trees, leaves are present year-round. In deciduous trees leaves are only available during spring, summer, and early fall.
- Twigs and stems can be used for identification except during the spring when bud growth and shoot elongation are taking place.
- Bark is one of the most useful identifiers because it is available when many of the other parts are not. Because there tends to be less lichen or moss growing on it in urban area, it can be very helpful for tree identification in cities.
- Flowers appear for only a short time, and therefore are limited in their usefulness for identification. However, because the classification system of trees is based on how trees produce seeds, flowers are the best feature for identifying a tree.
- The fruit and seed can also help in identifying a tree because they are important to the way trees are classified. However, they can appear at irregular intervals and are available for only a short time.

2. What are seven major characteristics of leaves that can be used in identifying trees? Briefly describe each.

- Types - The two different types of leaves are hardwood and softwood. Hardwoods can have either a simple or compound leaf. Softwoods can have a needle-like, scale-like, or awl-like type of foliage.
- Shape - The shape, or outline, of the leaf is usually typical of the species.
- Leaf arrangement - Leaves in hardwoods can be arranged in opposite, whorled, or alternate patterns.
- Venation of the leaf -The pattern of veins in hardwood leaves have four primary patterns: pinnate, palmate, parallel, and dichotomous.
- Leaf apex and base - The leaf apex is the tip of the leaf blade, and the base is the part nearest the petiole, or supporting stalk. Both have shapes common to a species.

- Leaf margin - The edge of the leaf is distinctive, and can be used to distinguish between similar looking leaves.
- Surface of leaf - The texture, or the way that a leaf feels, can help in identification.

3. How can the urban environment affect your efforts to identify a tree?

There are a number of conditions in the urban environment that may change the appearance of a tree. These may include:

- Soil conditions
- Light patterns
- Temperature patterns
- Moisture or water conditions
- Physical damage
- Pruning

Light and temperature conditions can change the time of year that a tree produces new leaves, flowers, and fruits. Site location may affect the form of the tree. Soil and moisture conditions may alter root growth, influencing tree growth and vigor. All these factors may change the appearance of the different parts of a tree used for identification, such as the leaves, twigs, and bark.

URBAN FORESTRY

A Manual for the State Forestry Agencies in the Southern Region

Unit: Urban Soils

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 9 units are on the web site (www.urbanforestrysouth.usda.gov). The other units will be added as they become available.

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 is an introduction to the importance of providing regular maintenance to the urban forest. The basic steps to preventative maintenance are discussed, such as fertilization, mulching, pruning and tree protection.

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.

Urban Soils

Table of Contents

Overview

Soil conditions greatly influence the growth and vigor of trees. Soil provides trees with water, oxygen, nutrients, and support for the root system. Roots need a healthy soil environment to grow in, and strong root development directly influences the growth of the above-ground parts of the tree. This unit begins with a definition of soil and descriptions of ways to identify soil composition. Next, the characteristics of soil essential for healthy tree growth are discussed. The last section reviews common problems found in urban soils and suggests techniques to prevent or correct them.

"Cooties!"
Will the Twain Ever Meet?

The State forestry agency had recently purchased a new refrigerated truck for transporting seedlings from the nurseries to locations around the State. Steve, the Urban Forestry Program Coordinator, was the first to use the truck when he took a truckload of red maple seedlings to a local, non-profit organization for a community tree planting. The next week Andy, a County Forester, was getting ready to take a truckload of seedlings to a reforestation project in the eastern part of the State. Soon he was back, teasing Steve, "The new truck is ruined! How can I possibly drive a truck that has been contaminated with urban dirt? The truck needs to be fumigated immediately!" Steve just smiled and said, "You never know. That urban soil might do the rural trees some good."

O land and soil, red soil and sweet-gum tree, so scant of grass, so profligate of pines.
Jean Toomer (1894-1967), Song of the Son, st. 2

Before You Begin

Soils perform a critical but often overlooked role in the growth and development of trees. This unit discusses many of the soil characteristics necessary for tree growth and examines specific soil conditions found in urban areas. Before beginning this unit, think about your own experiences with the different types of soil conditions you have found in your community.

- Describe some of the soil conditions that you have found when planting trees in various locations in your community.

- When working in your local area, have you found tree health problems that were directly related to the soil conditions? What types of problems have you identified?

- How do you think an understanding of urban soil conditions will help you when working with homeowners and local groups in your community?

Think about how information on urban soil conditions will help you in your job and use another page to write down some of your thoughts.

What Is Soil?

Soils are complex systems of solid matter, pore spaces filled with water and oxygen, and numerous bacteria, fungi, and other organisms (Harris 1992). Soils are also dynamic, constantly changing through interaction with other features of the environment. Soil is a mixture of four basic components:

- Inorganic materials (minerals), including rock, clay, silt, and sand, give structure to the soil.
- Organic matter, including living and decomposing organisms and plant parts, supplies nutrients and helps hold moisture in the soil.
- Air that moves through the pore spaces provides oxygen to the roots.
- Water and dissolved nutrients, important for a number of the tree's life processes, also move through the pore spaces.

A soil composed of 45% inorganic materials, 5% organic matter, 25% air and 25% water by volume is often said to be an ideal mix. This is the best mix for young trees, but soil requirements do vary by tree species. Soils that have been structurally or chemically altered by construction and other activities may not have the four components in the amounts needed for healthy soil.

Benefits of knowing about soils
Proper soil management is necessary for a healthy urban forest. There are many ways the information in this unit can be used to provide assistance (table 1).

Table 1. Examples of ways to use soil information when providing assistance and potential recipients.

Technical/Educational Assistance	Planning Assistance	Potential Recipients
• Site selection • Tree selection • Planting requirements • Tree maintenance • Diagnosis and treatment • Hazardous-tree identification • Soil erosion control	• Land management plans • Construction site plans • Erosion control plans • Water quality management • Recreation site management	• Local government • Land development companies • Engineers • Architects • Homeowners • Landowners

How is Soil Formed?

Soil is the surface layer of the earth in which plants grow. Below this surface is a layer of bedrock that is weathered by the environment over long periods of time, forming the parent material of the soil. Weather and small plants and animals continue to break down the parent material into smaller and smaller particles. Combined with organic matter, air, and water, these particles of parent material form soil. Soils differ greatly in composition and structure because of the physical processes involved in their formation at each location (tables 2 and 3).

Table 2. Physical factors that influence soil formation

Physical Factors	Description
Parent material	The parent material of soil can be weathered rock, volcanic ash, or sediments deposited by wind, water, or glaciers. Most soil characteristics are based on the geology of this parent material. Types of parent material include igneous, metamorphic, and sedimentary bedrock.
Climate	Water, temperature, and wind all contribute to soil formation by influencing the rate of weathering, mineral and element transport, and type and number of living organisms found in the soil.
Living organisms	Plants and animals add organic matter to the soil, physically altering its structure.
Landscape position	The location of a site in the landscape, such as the slope of a hill or bottom of a valley, influences soil formation. For example, during a rainstorm a hillside can lose soil and minerals to a lower elevation. This is one reason flood plains have rich soil.
Time	Soil formation is a continuous process, occurring over thousands of years.

What is the most common type of soil parent material in your area?

Table 3. Physical processes that influence soil formation

Physical Processes	**Description**
Additions	Anything that is added to the soil, such as organic matter or salts, is an addition. Additions can occur naturally or when amendments are added, such as fertilizer, construction material, and mulches.
Losses	Minerals can be washed out or leached from the soil, and both inorganic and organic matter can be lost through erosion.
Translocations	Soil materials may be transported from one site to another but not lost from the system. For example, soil eroded on a hill is deposited in a low-lying area below. As water moves through the soil and evaporates, it can leave salt accumulations behind.
Transformation	The chemical and physical properties of the soil can be changed over time. Microorganisms, for example, that feed on dead plant and animal matter transform it into humus.

Soil Horizons

Over time, soil is formed into different layers called "horizons." The arrangement and make-up of these horizons influence root growth and development. The thickness of each layer will vary, depending on site conditions. There are many types of horizons, but all are not found at every site. Below these horizons or layers of soil is the bedrock that forms the parent material of the soil. It may be close to the surface or hundreds of feet below it. Table 4 describes the four general horizons in a soil profile.

Table 4. Soil horizons

Horizon	Description
O horizon	This top layer or organic horizon consists of decaying plant material, called "humus." This horizon is usually darker than the other layers because of its organic content.
A horizon	The A horizon, below the O horizon, is the most productive layer of soil and is commonly referred to as "topsoil." Most of a tree's absorbing roots are found in this horizon. The A horizon is composed primarily of mineral material and is generally darker than the lower horizons because of the humus material that has been incorporated into it.
B horizon	This subsoil layer is formed by materials leached and otherwise moved from the A horizon, including clay, iron, aluminum, and organic material. It also contains soil particles from the lower parent material. The B horizon is generally lighter in color, denser, and lower in organic material than the A horizon
C horizon	This lowest layer of soil is composed of disintegrated parent material and other minerals.

Soil Profile

A soil profile is a vertical cross-section of a soil, showing the soil horizons. The soil profile may be altered by construction and other land disturbing activities, such as grading, cutting and filling, and cultivation. These activities can disrupt the soil horizons, for example the O horizon may be very thin or nonexistent. These changes or disruptions to the natural soil profile directly influence drainage, aeration and root penetration of the soil.

Knowing the soil profile and how it has changed is helpful in predicting potential drainage problems at a site.

Depth

Soil depth is generally defined as the distance from the surface of the soil to an impenetrable layer, such as bedrock, or to a water table. Buried construction materials, such as concrete and pavement, will also limit soil depth. Trees need soils that are deep enough to drain adequately and also to provide sufficient moisture, space for root development, and physical support. Naturally, deep soils usually hold more moisture than shallow soils.

Soil Series

Soils with similar profiles and properties are grouped into "series" to help classify and describe them. The names of series usually come from the geographical areas where they were first found and described and are modified by the texture of the surface soil (Harris 1992). Being familiar with the soil series can help in selecting a tree species and predicting its growth or in gauging the soil erosion potential in a specific area. Here are some examples of soil series that have different characteristics (U. S. Department of Agriculture Natural Resource Conservation Service):

Wilkes sandy loam
This shallow, well-drained soil occurs on narrow ridges and hillsides of uplands. The subsoil is brown, loamy, and less than 20 inches thick over bedrock. Permeability is moderately slow and available water capacity is low.

Chastain loam
This deep, poorly drained soil occurs on flood plains. The subsoil is gray and clayey, extending to a depth greater than 40 inches. The seasonal high water table is 0 to 1 foot. Flooding is common. Slopes are less than 2 percent. Permeability is slow and available water capacity is moderate.

What are the common soil series in your area?

Soil Surveys

Soil surveys are maps detailing information on soil type, texture, bulk density, water-table height, rock layers, hardpan, drainage patterns, percolation rate, slope, and vegetation. They can be useful in urban areas because of the information they provide about the parent material or bedrock that is the original source of the soil, if the soil has not been moved or disturbed. By identifying the parent material, it is usually possible to determine many properties or characteristics of the soil..

Contact the Natural Resource Conservation Service office for more information on soil series and surveys.

Checking Your Understanding of Soil

1.What are the four basic substances that make up soil?

2.What two layers or horizons of soil chiefly influence a tree's root growth? Where are they found?

3.How can a soil survey be helpful in an urban area?

Answers are at the end of the unit.

Soil Characteristics Important for Tree Growth

Understanding the basic physical, chemical, and biological properties of soil and their interaction helps to identify and correct problems that affect tree growth. Good soil conditions provide the water, oxygen, and nutrients necessary for a tree's growth and development. A number of soil characteristics are discussed in this section:

- Pore space
- Texture
- Structure
- Bulk density
- Aeration
- Soil moisture
- Nutrients and soil fertility
- pH
- Biological components
- Color
- Temperature

While each of these characteristics is important, it is the combination of them at a particular site that influences a tree's growth and vigor.

Soil conditions are often more important to a tree's health than above-ground conditions.

Pore Space

The space between soil particles is called pore space (figure 1). The size, number, and distribution of these pores influence how air, water, and dissolved nutrients move through the soil. There is no ideal percentage of pore space in soil because each tree species requires different amounts of air and water.

Pore space is easily diminished when soil is moved, disturbed, or compacted. This reduction in pore space also reduces the movement of air and water in the soil, which impacts root growth. There are two types of pores, macropores and micropores.

Macropores
These are large pore spaces between soil particles that are typically filled with air. They also allow water and dissolved nutrients to freely move through the soil.

Micropores
These are the small pore spaces that hold water and dissolved nutrients after excess water has moved through or drained from the macropores.

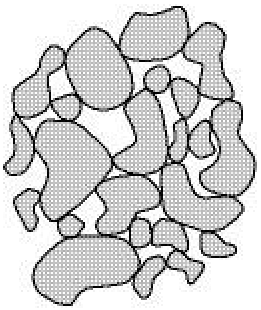


Figure 1. Pore space (white areas) is the area between the soil particles (dark areas). (Illustration adopted from International Society of Arboriculture Arborists' Certification Study Guide; Illustration drawn by Gene Wright)

Texture

Soil texture refers to the relative size (fineness or coarseness) and the proportion of the sand, silt, and clay particles in the soil. Sand particles are the largest and clay the smallest, with silt between the two in size (Harris 1992) (table 5). Soil texture influences soil fertility and the way air and water move through the soil. Knowing the soil texture at the site will help with evaluating drainage, aeration, and nutrient content..

Table 5. Characteristics of different soil textures

Soil Texture	Characteristics
Sand	Sandy soils typically have coarse texture, large pores, good permeability, good drainage, good aeration, and poor fertility. Soil is considered sandy if it is more than 45% sand.
Clay	Clayey soils have fine texture, small pores, poor permeability, poor aeration, poor drainage, higher fertility than sandy soils, and are easily compacted. If the soil averages 35% or more clay, the soil is considered clayey.
Silt	Silt is intermediate in texture between sand and clay. The soil is considered silty if more than 40% is silt.
Loam	Soils that have characteristics of all three textures – sand, clay, and silt – are called "loams." For example, a soil with 35% sand, 35% clay, and 30% silt is called a clay loam. Loamy soil usually has a good texture for growing a wide variety of trees.

Textural name

Soils are named by the dominant particle size – sand, clay, or silt. Soils that have the characteristics of all three types of soil particles are called loams. Because it takes less clay to dominate the characteristics of a soil, it takes only 20% clay to include clay in its name, such as sandy clay loam. Clay soil, however, needs to be at least 35% clay. The textural name of a soil can be found by using the soil textural triangle shown in figure 2.

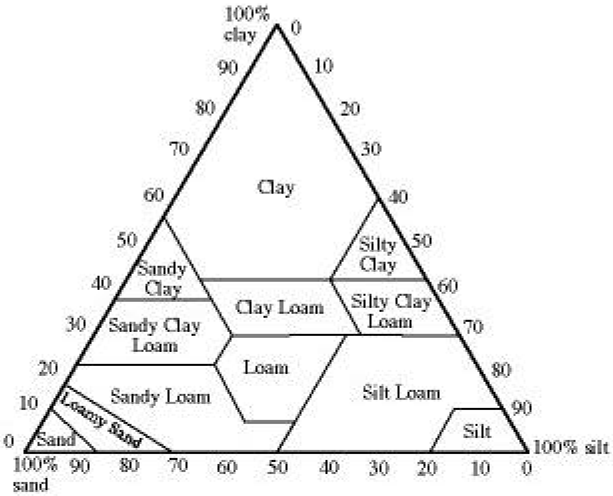


Figure 2: Soil texture triangle

Soil interfaces

Soil interfaces are abrupt changes in the texture of soil that can occur naturally such as through erosion or mudslides. They can also be caused by adding anything to the soil that is different in texture than the native soil. This can include bricks, other building materials, and fill soil that is a different texture. These interfaces interrupt the normal movement of water in the soil.

Construction debris is sometimes buried in the soil which can cause soil interface problems.

Evaluating soil texture in the field

Kneading the soil between the thumb and forefinger is a simple test to determine soil texture:

- Sand has gritty particles
- Clay feels sticky or slick
- Silt has flour-like or talc powder feeling

A more accurate analysis can be obtained by sending a sample to a soil laboratory.

Structure

Structure is the way soil particles – sand, silt and clay – are grouped or bound together. These clumps of soil are called aggregates, and between these clumps are pore spaces. A well-structured soil for healthy root growth has adequate pore space for water movement and gas exchange. There are different types of soil structure, such as crumb or columnar, based on the shape of the aggregate.

Soil aggregates are fragile and easily damaged. If soil is disturbed by such site activities as clearing or compaction, the aggregates can be crushed, which decreases pore space and increases such problems as drainage, moisture and nutrient flow, and resistance to root penetration. Calculating a soil's bulk density is a way to test for soil structure that is disturbed or compacted.

Bulk Density

Bulk density, the measure of the soil's weight per volume, describes a soil's mass, density, compactness, or how closely the soil particles are packed together. If a soil has a high bulk density then it is most likely compacted. Compacted soil has little pore space and poor soil structure, which limits air and water flow and root growth. Table 6 lists some common bulk densities that may be helpful for understanding the bulk- density measurement at a particular site (Harris 1992).

Table 6. Comparison of common bulk densities.

Type of Material	Bulk Density Measurement
Normal soils	1.0 to 1.6 grams/cm3
Soils with restricted root growth	1.4 to 1.6 grams/cm3
Bricks	1.4 to 2.3 grams/cm3
Soil commonly found at construction sites	1.7 to 2.2 grams/cm3

Check local soil survey for information about bulk densities in your area.

Testing for bulk density
The bulk density of the soil is tested by measuring a soil sample from the site. This can be done by using the core sampler test or by sending the soil sample to a laboratory.

- Core sampler test
  Insert a core cylinder of known volume into the ground to collect a soil sample. Oven dry the soil sample for 24 hours and then weigh. Calculate the bulk density by dividing the weight of the oven-dried soil sample by the volume of the sample.
- Laboratory test
  Contact the local Cooperative Extension Service or USDA Natural Resource Conservation Services for information about laboratory testing.

Bulk density tends to increase with the depth of the soil.

Root penetration
A root's ability to penetrate a given sample of soil can be tested by using a penetrometer. Resistance to penetration is measured as the probe is pushed into the ground. A penetrometer can be purchased through a forest products supplier.

Aeration

Soil aeration is both the movement of air within the soil and the exchange of air with the atmosphere. Aeration is important because root and shoot development depends on this normal exchange of gases, including oxygen, in the soil. During respiration, roots absorb oxygen from in the macropores and release carbon dioxide. Water moving through the soil macropores forces carbon dioxide out and atmospheric oxygen is pulled in. Aeration can be a problem in heavy clay, compacted, or water logged soil because pore space has been reduced or pores are filled with water. When there is poor soil aeration, anaerobic (no oxygen) soil conditions develop, the soil turns gray or blue and plant growth is limited.

Testing soil aeration
Testing the bulk density of the soil can also help determine if there is an aeration problem.

Most roots grow in the top 18 inches of soil where soil oxygen is most readily available.

Soil Moisture

Moisture in the soil is essential for healthy tree growth and development. It contributes to tree health in three different ways:

- Water from the soil replaces the water in the tree that is lost through transpiration.
- Essential nutrients for tree growth and development, such as nitrogen, phosphorous, and potassium, are dissolved in soil water and absorbed by the roots.
- Water is held by the soil and supplied over time to meet the needs of the tree. The water-holding capability depends on the soil type.

The symptoms for too much and too little water are the same, browning leaf edges.

How water moves through soil

Water can move in all directions in the soil: upward to evaporate from the soil surface, downward after rain or irrigation, and side-to-side when it cannot move downward because of bedrock, compacted soil, or saturated soil. Gravity and capillary action control how water moves in soil.

- Gravity
  Gravity pulls water downward through the macropores in the soil. This water is called gravitational water.
- Capillary action
  Capillary action is the force that pulls water in any direction. Pore size and the soil's ability to attract and hold water determine how much water is moved by capillary action.

How water moves through the soil is also influenced by the permeability, infiltration rate, and retention rate.

- Permeability
  Permeability is how easily water moves through the soil. In sandy soils, permeability is usually high because of the coarse texture and large pores. In clay soils it is low because the small pores reduce water's ability to move.
- Infiltration rate
  The infiltration rate is how fast water moves through the soil. Typically, the larger the pore size the faster the movement of water. Sandy soils have a high infiltration rate; clay soils have a low infiltration rate.
- Retention rate or water-holding capacity
  Retention is how well a soil holds water. The small pores of fine-textured soils (clays) tend to hold more water than coarse-textured soils (sandy).

Soil moisture

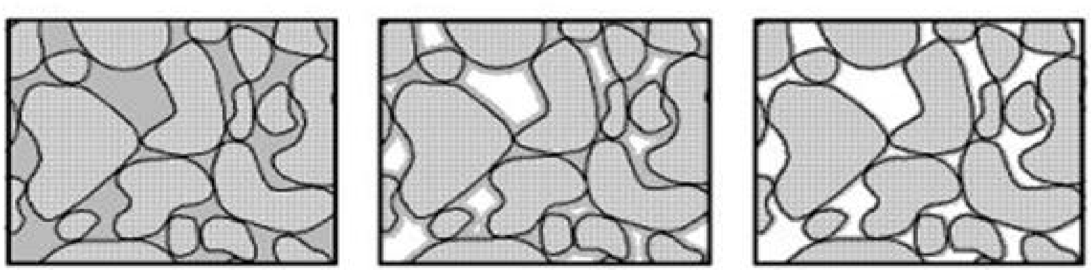
Typically, when water enters the soil, it fills up the pore spaces between the soil particles and forces air out of the soil. When the water flows out of the soil, it pulls air back into the macropores. The water that remains in the soil is in the micropores, and this is the water that is available to the roots. There are three different moisture levels in the soil, depending upon site conditions (figure 3):

- Saturation point
  When the soil pores are filled with water and the water is not draining away, the soil has reached the saturation point. The water forces all the oxygen out of the macropores. Without the soil oxygen, the roots will start to die. Flooding and over irrigation can cause soil to reach the saturation point.

- Field capacity
  Field capacity is reached when the water contained in macropores has drained away leaving water in the micropores available for aborption by the roots or for evaporation. For most trees, roots grow best when the soil moisture condition is at field capacity.

The difference between field capacity and permanent wilting point represents the water that is available for plant growth.

- Permanent wilting point
  Permanent wilting point or drought condition is when there is no usable water in the soil for a tree. This is the point where the tree cannot pull water from the micropores in the soil. When the tree reaches permanent wilting point, it usually starts to decline and die.



a) saturation point *b) field capacity* *c) permanent wilting point*

Figure 3. Soil moisture conditions (pattern areas are soil particles, dark areas are water and white areas are air). (Illustration adopted from International Society of Arboriculture Arborists' Certification Study Guide; Illustration drawn by Gene Wright)

Testing for soil moisture
Soil moisture conditions can be tested in at least two ways:

- By feel or appearance (table 7)
- By using a tensiometer or soil moisture meter - a probe that measures soil moisture. A tensiometer can be purchased from a forest products supplier.

Table 7. Testing for soil moisture by feel or appearance in sandy loam and clay loam soils (Harris 1983)

Soil Moisture Available for Trees	Sandy Loam	Clay Loam
Close to 0% (Little or no moisture available.)	Dry, loose; flows through fingers	Dry clods that break down into powdery substances
50% or less (Approaching time to irrigate)	Still appears to be dry; will not form a ball	Somewhat crumbly; will hold together with pressure
50% to 75% (Enough available moisture)	Tends to ball under pressure but will seldom hold together	Forms a ball; somewhat plastic; will sometimes stick slightly with pressure
75% field capacity (Plenty of available moisture)	Forms weak ball; breaks easily; will not become slick	Forms a ball and is very pliable; becomes slick readily if high in clay
At field capacity (Soil will not hold any more water (after draining)	Upon squeezing, no free water appears, but moisture is left on hand	Same as sandy loam
Above field capacity (Unless water drains out, soil will be water logged)	Free water is released after kneading	Can squeeze out free water

Nutrients and Soil Fertility

Trees require nutrients to survive and grow. Most nutrients occur in the soil as the result of the weathering of the parent material or the decomposition of organic matter. Nutrients also come from fertilizer, water, and air. These nutrients are either absorbed by roots, held by the soil in the pore spaces, or leached deeper into the soil. Thirteen of the 16 nutrients essential for tree growth are usually derived from the soil and three (oxygen, carbon, and hydrogen) are taken from air and water (table 8). Nitrogen is the nutrient most likely to be deficient in the soil. A lack of nitrogen often results in yellowing leaves. Additional information about nutrients appear in the *Tree Maintenance* unit.

Table 8: Nutrients found in the soil

Macronutrients	Micronutrients
Nitrogen Phosphorous Potassium Calcium Magnesium Sulfur	Boron Chlorine Copper Iron Manganese Molybdenum Zinc

Absorption is the process of taking elements inside, while adsorption indicates that the elements are incorporated on the surface.

Factors that influence nutrient availability and soil fertility

- Nutrients soluble in water
  The nutrients most available to the roots are those dissolved in soil water. However, in this soluble form the nutrients are more readily leached or washed down through the soil. At some soil pH levels nutrients become insoluble in water and therefore are not available to the roots.
- Leaching
  Leaching occurs when water washes nutrients down through the soil. Nitrogen and other elements tend to leach down from the root zone, making them unavailable for plant growth. Sandy soils tend to have a greater nutrient loss from leaching than clay soils.

Nutrients that can be adsorbed onto soil particle surfaces are less susceptible to leaching.

- Cation exchange capacity
  Soil fertility depends on the ability of the soil particles to adsorb nutrients on their surfaces. Soil particles are negatively charged and attract positively charged nutrients called cations, which include calcium, magnesium, sodium, potassium, hydrogen, and aluminum (figure 4). The soil's ability to attract and adsorb positively charged nutrients is called the cation exchange capacity. Soil particles that attract the most charged nutrients or cations will be the most fertile. Highly fertile soils have large quantities of the nutrients trees need for growth readily available. The fine-textured particles of clay soil are negatively charged and have

a greater cation exchange capacity than the particles in sandy soil. Thus, fine-textured soils are usually more fertile than coarse-textured ones. Nitrogen is negatively charged and so is not as easily attracted to soil particles, which explains why it is likely to be deficient in the soil. A laboratory soil analysis can reveal the cation exchange capacity of a soil.

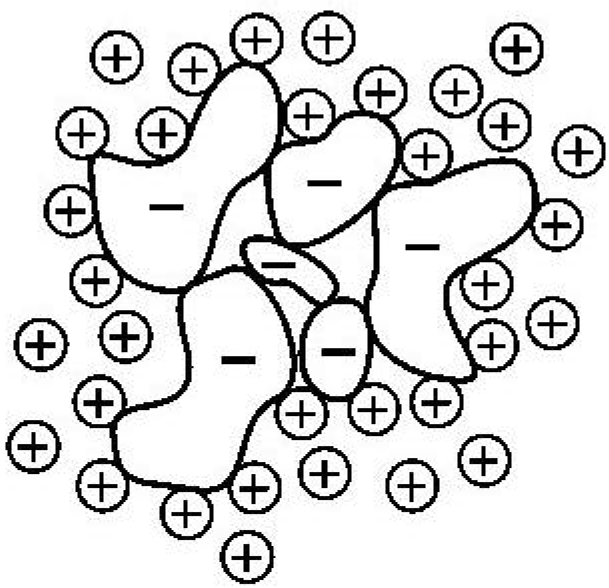


Figure 4. Cations are attracted to and held by negatively charged soil particles. (Illustration adopted from International Society of Arboriculture Arborists' Certification Study Guide; Illustration drawn by Gene Wright.)

- Nutrient cycling
  Nutrient cycling is the process of a plant absorbing nutrients from the soil to grow and then releasing them back to the soil when it dies and decomposes. In urban environments, nutrient cycling is often disrupted because plant debris is not left on the ground to decompose.

Testing for a nutrient imbalance
These are three ways to determine if there is a nutrient imbalance in the soil:

- Symptoms
  Some typical symptoms characteristic of a nutrient imbalance include yellow leaves, brown leaf margin, early or late leaf drop and irregular branching pattern.
- Soil analysis
  Soils are tested for pH and the amount of phosphorous, potassium, calcium, zinc, manganese, organic matter, and other nutrients. Soil test kits can be purchased from garden centers or forest products suppliers. A soil sample may also be sent to a laboratory for testing.
- Plant tissue analysis
  A plant tissue analysis can be conducted by a laboratory to test for minerals, nitrogen, sulfur, and carbon in tree leaves.

The results of an analysis will include information about fertilizer requirements or pH adjustments needed to increase the availability of nutrients.

Contact the local Cooperative Extension Service or Natural Resource Conservation Service for information on soil and plant tissue analysis.

pH

Soil pH is the measure of the acidity of a soil. This affects the availability of some nutrients in the soil and the activity of microorganisms. The pH scale ranges from 1 to 14. A pH of 7 is neutral, a pH above 7 is alkaline or basic, and a pH below 7 is acidic (figure 5). A pH range of 5.5 to 6.5 is often given as the most favorable for tree growth. However, some tree species grow better in acidic soils and some better in alkaline soils. At certain pH levels some nutrients become insoluble in water and are not available to roots. For example, in acid soils, calcium and magnesium are less available and in alkaline soils, iron, manganese, zinc, and copper are less available. It can be difficult to change the pH if there is a large volume of soil involved, but adding lime may raise the pH and adding sulfur may lower the pH.

Soil pH is an important consideration when selecting a species. Native species generally grow well in local soil, unless the soil has been disturbed.

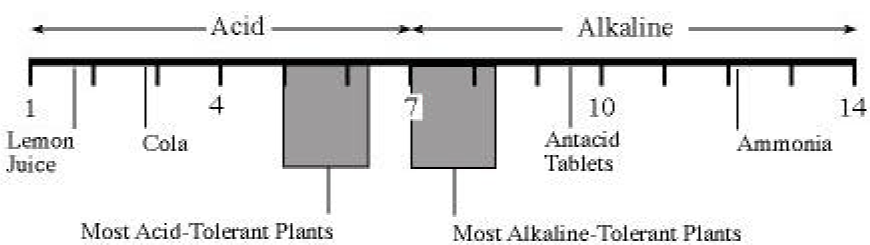


Figure 5. pH scale (Illustration courtesy of the Morton Arboretum, Tree Care Handbook; Illustration drawn by Gene Wright)

Testing soil pH

- Field test kit
  Soil pH can be tested with a field test kit that can be purchased at most garden centers or from a forest products supplier.
- Laboratory test
  Contact the local Cooperative Extension Service or Natural Resource Conservation Service for information on testing soil pH. The laboratory test report will usually include recommendations for type and amount of amendments needed.

Being familiar with soil pH can help in diagnosing tree health problems because pH levels influence nutrient availability.

Biological Components

There is a multitude of living organisms in the soil that affect its physical and chemical properties. These can both positively and negatively affect tree growth. Soil organisms are essential in improving soil properties because they provide organic matter, soil aeration, and expanded root surface area. However, some are hazardous to trees.

Plants

Types of small plants or microflora in soil include algae, bacteria, and fungi. Many of these help decompose organic matter, but some do cause plant diseases.

Mycorrhizae

Mycorrhizae are beneficial fungi that invade young lateral roots on most trees. Research indicates that the mycorrhizae increase the surface area of roots, increasing the potential for nutrient and water uptake. Trees with established mycorrhizal roots tend to be more vigorous than those without.

Animals

Many small organisms, such as earthworms and insects, decompose organic matter and increase soil aeration, which greatly benefits root development. Some soil organisms, such as some nematodes, parasitize and harm tree roots.

Color

Soil color often reflects the condition of the soil and its ability to sustain a healthy environment for plant growth. Changes in normal soil color may result from changes in the chemical and physical properties of the soil. This may occur with the addition of fill dirt or the dumping of waste.

- Dark soil near the surface is a common indicator of high organic content.
- Gray color usually indicates wet soil with high iron content.
- Gray or blue soil suggests there is an aeration problem due to wet soil conditions.

Soil color evaluation

One of the most widely used guides for soil color evaluation is the Munsell System. In a process similar to the one used to match paint samples, soils are assessed by comparing them with the color sample in the guide. The Munsell System or other color reference guides can be purchased from forest products suppliers.

Change in soil color may indicate potential site problems for trees.

Temperature

The temperature of the soil influences root growth by controlling the rate of the chemical and biological processes. The most favorable temperature for root growth depends on the species, but it is generally 70-83 degrees Fahrenheit. Roots are sensitive to extremes in soil temperature which can reduce root growth or damage roots.

Low soil temperature

- Slows the biological and chemical activities.
- Freezes the roots.
- Increases the weathering of soil through freezing and thawing.

High soil temperature

- Increases activity of disease-causing microorganisms.
- Dries out or desiccates the roots, causing them to become thin and light brown.

What locations in your community would you expect to have higher soil temperatures?

Checking Your Understanding of Soil Characteristics Important for Tree Growth

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

1.What three things can you predict by knowing the texture of the soil? Define each of the terms you listed.

2.What makes soils fertile? What type of soil is usually the most fertile?

3.What are three reasons soil water is important for tree growth?

4.Why is it important to know soil pH?

Answers are at the end of the unit.

Common Soil Problems in Urban Areas

Many activities in urban areas change the soil's physical, chemical, or biological characteristics. Some of the most common activities including construction, maintenance activities are discussed in this section, and possible solutions are suggested.

Construction can cause soil problems in urban areas because these activities often alter the soil profile and change soil characteristics.

- Impervious surfaces, such as buildings and roads, interrupt the natural exchange of gases, increase soil temperature, and alter drainage patterns. The heat-holding capacity of these hard surfaces increases the soil temperature.
- Heavy construction equipment and material storage areas compact the soil.
- Moving soil, such as grading, clearing, and excavating, influences drainage and aeration and causes erosion.
- Chemical spills, such as cement washout areas or painting sites, contaminate the soil.
- Removal of topsoil diminishes soil fertility.
- Use of fill dirt influences soil drainage, aeration, and fertility.
- Dumping or burying waste materials, such as dry wall and garbage, may change drainage patterns and contaminate the soil.

Other practices impact the soil conditions at a site.

- Poorly timed irrigation systems can cause soil moisture problems.
- Removal of organic matter influences soil fertility and moisture.
- Excessive herbicide or fertilizers contaminate the soil.
- Foot traffic from pedestrians and road vibrations compact the soil.
- Backyard chemical spills, such as gasoline and oil, contaminate the soil.

In urban areas these construction and other activities can disturb the original soil profile. Consequently, there are typically a wide variety of profiles. The O horizon may be 6 inches deep or it may be absent because leaves and other organic materials have not been left to accumulate on the ground. In construction areas the O, A and B horizons may have been removed or the B horizon might be on top of the A horizon. Debris in the soil or abrupt changes in soil texture can also change the soil profile.

Soil Compaction

Soil compaction is a major cause of tree decline in urban areas. Compaction occurs when a force, such as feet, vehicles, and even water from some sprinkler systems, creates pressure on the soil surface and compresses the soil particles. This force causes the soil aggregates to break into smaller particles, reducing the amount of pore space in the soil. The reduced pore space hinders aeration, water infiltration, and root penetration. A lack of soil oxygen and poor water drainage retard root growth, jeopardizing the health of the tree. Table 9 lists some common signs of compaction. Techniques to prevent compaction are listed in Table 10.

Construction activities often compact the soil.

Table 9. Signs of compaction

Sign	Description
Hard soil	If it is hard to penetrate with a shovel, the soil is probably compacted. Earlier cultivation may have produced a layer of hard soil 10-12 inches below the surface.
Standing water	Water standing on top of soil for long time may indicate compaction.
Excessive water runoff	This is a sign that there is low permeability or little movement of water through the soil.
Loss of vegetation or poor plant growth	Compacted soil does not allow the necessary air circulation and water infiltration into the root zone. A lack of sufficient water, nutrients, and oxygen to the roots causes declining tree health or death.
Bulk density	A high soil bulk density usually indicates compaction. The reduced pore space limits water infiltration, aeration, and root growth.
Surface crust	Development of a surface crust sometimes occurs with the compaction of fine-textured soils. This crust limits the infiltration of air and water to the soil and increases runoff and erosion. Surface crusts are usually found on soils subject to heavy foot traffic, such as playgrounds and footpaths.

Table 10. Techniques to prevent compaction

Technique	Description
Avoid wet soils	Always work with dry or moist soils, never with wet soils.
Limit travel routes and parking areas	Limit travel by both people and vehicles to a few paths, and do not park vehicles under trees. For pedestrian traffic, a raised wooden path can prevent compaction. Vibrations from construction equipment can compact the soil.
Apply mulch	Spread a layer, no more than 6 inches thick, of coarse mulch, such as wood chips or bark, on soil surface in the area likely to be compacted. The mulch should not touch the tree trunk. A thicker layer of mulch can be used temporarily during construction.
Use light weight vehicles	Try to use only lightweight vehicles with large, smooth, low-pressure tires.
Apply surface grating	Place metal grates over the planting site to prevent people from walking on it.
Know soil type	Find out the type of soil at the site. Fine-textured, clayey soils are more easily compacted than coarser, sandy soils.

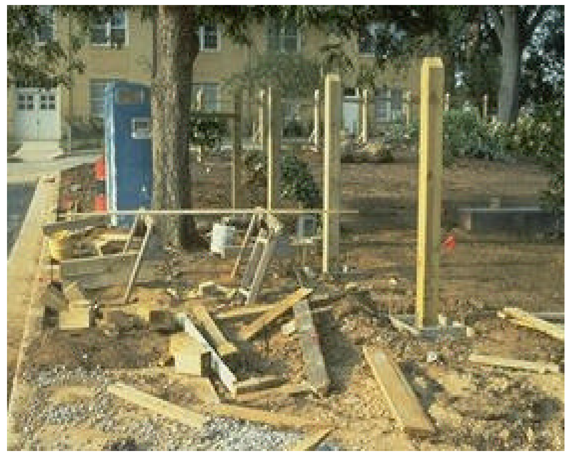
Solving compaction problems
Compaction is difficult to correct; however, Table 11 lists several techniques that may help solve compaction problems. The best option depends upon the conditions at the site, whether this is a new planting or an existing tree, and the available resources.

Table 11. Techniques for solving soil compaction problems for new and existing planting sites.

Techniques For New Planting Sites	Description
Soil mixing	Compacted soil can be mixed with a fully composted organic mulch to improve the soil quality, but up to 50% volume of soil is needed to make this technique useful.
Rototilling or grading	For a new planting site, the compacted layer of soil may be rototilled, disked, or graded to promote water infiltration.
Subsoiling or drilling hardpan	If there is a compacted layer of soil 1 or 2 feet below the surface, subsoiling or deep plowing with a plow or backhoe when the soil is dry may break up this impermeable layer. If subsoiling is impractical, holes can be drilled through the hardpan to provide drainage and better root penetration (Harris 1992). If there are existing trees near the site, care must be taken not to damage the roots.
Top Mulching	In both new and existing plantings, the organic content of soils can be increased by adding mulch on top of the soil. However, organic material takes many years to breakdown and combine effectively with the soil.
Techniques For Existing Planting Sites	**Description**
Core aeration	Pore space in compacted soil may be increased by removing small soil cores to a depth of about 3 inches.
Vertical mulching	Holes 1 - 2 inches in diameter may be drilled in the compacted soil and filled with perilite, vermiculite, or other amendment material.
Radial trenching	Trenches 6 - 8 inches wide and no deeper than the root system or depth of compaction can be dug with trenching equipment. The trenches are dug around the trunk of an existing tree in a bicycle-spoke pattern, extending from the trunk and backfilled with a mixture of soil and amendments.

Reduced Soil Aeration

Many soils in urban areas have poor aeration because of soil compaction and poor drainage. Aeration problems also occur when the soil is contaminated by salts and excessive fertilizer.

Storage of fill soil and construction material can reduce soil aeration.

Signs of poor aeration

- High soil bulk density
- Water-logged soil
- Standing water
- Gray or blue soil
- Foul smelling soil
- Poor plant growth
- Grade changes

Solving reduced soil aeration

Aeration problems can be prevented or corrected by many of the same methods described for reducing soil compaction. If poor drainage is reducing aeration, a drainage system may need to be installed.

Excessive Soil Moisture and Drainage Problems

Soils with excessive moisture have poor aeration because pore spaces are filled with water. Roots tend to grow near the surface in such soils. With poorly anchored roots, a tree is susceptible to wind throw. A tree may survive for a time, but the roots will eventually die and decay from lack of oxygen in the soil, leaving the tree without a way to absorb necessary water and nutrients. Too much water in the soil is often caused by construction and planting practices, such as the improper use of irrigation systems. However, some locations are naturally susceptible to saturated soil because of soil type, terrain, heavy rains, flooding, or a high water table. For example, soils with high clay content tend to have more drainage problems then sandy soils because they are more easily compacted. Table 12 describes some typical signs that drainage may be a problem at the site. Techniques to prevent compaction are listed in table 13.

Construction activities can alter drainage patterns at a site.

Table 12. Signs of drainage problems

Sign	Description
Water movement	A large amount of water flowing quickly over soil may indicate saturated soil conditions. This can also cause erosion.
Standing water	Water left standing after a rain may also indicate excessive moisture in the soil.
Soil type	The type of soil at a site influences moisture conditions. Sandy soils usually have a high infiltration rate with water moving quickly through, while clay soils tend to retain water.
Browning leaf edges	Edges of leaves turning brown may indicate too much soil moisture.
Root decay	Waterlogged soils can cause root decay.

Table 13. Preventing drainage problems

Technique	Description
Modify construction practices	When soil is moved or disturbed by activities such as grading, drainage patterns may be changed, affecting soil moisture conditions. Grade the soil during construction and landscaping so that no low spots are created at the planting site. Maintain the natural horizons during grading or filling so that infertile subsoil does not become the top layer of soil. Drainage problems can be avoided by minimizing the amount of soil compaction that occurs at a site. Keep debris, such as rocks and bricks, out of the topsoil to prevent interfaces or changes in soil texture. Impervious surfaces, such as concrete and asphalt, can inhibit water evaporation from a site. This can cause poor drainage and excessive moisture conditions.
Break up hard pan	Below ground soil layers that are impervious to or restrict water infiltration can cause problems. Hardpan that occurs within 30 inches of the surface should be penetrated. Tractor-drawn subsoilers can be used for large sites, while digging and drilling holes often work in smaller areas.
Use care in site and tree selection	For a location that is continually subject to excessive soil moisture, select a species that is tolerant of wet conditions. A site should have adequate soil volume to support the growth and development of the species selected. Avoid selecting a site where layers of rocks are near the soil surface, because there is little soil to absorb the water. Raised-bed planters are an option that elevates the tree's roots out of the saturated soil. At sites with poor drainage, select a species that is tolerant of wet conditions.
Adapt planting methods to site conditions	Plant the root ball so the crown is slightly above the soil level. Use coarse-textured fill material, such as sandy loam or loamy sand, to improve aeration and drainage. Do not use soil with a high clay content as fill material. Soil conditions that should be avoided include gravel under loam and sand on top of clay.
Regulate irrigation systems	Setting irrigation systems to deliver water based on need, instead of time, will help prevent excessive soil moisture.

Testing for drainage problems

Follow these steps to determine if there is a drainage problem (Gilman 1997):

- Dig a 12-by-12-inch wide hole and fill with water
- Drainage is good if the water drains from the hole in an hour.
- If the water takes from several hours to a day to drain from the hole, drainage is fair.
- If water stands in the hole for more than a day, there is either a high water table or poor drainage.

Solving drainage problems

Excessive soil moisture can sometimes be solved by providing proper drainage for the tree, but this can be difficult and often expensive to correct. Proper planting procedures and selecting a species adaptable to the site are the best means for dealing with excessive moisture that cannot be corrected without drainage techniques. As a last resort, a drainage system can also be installed, depending upon the site conditions and available resources. Table 14 describes three common techniques.

Table 14. Drainage systems

Technique	Description
Install drain pipe or tile	To eliminate minimal drainage problems, drain pipes or tiles can be installed to move the water away from the tree. Although tile is the traditional pipe for below-ground drainage in large agricultural settings, the cheapest and easiest material to use for small sites is plastic pipe.
Install perforated pipe	A perforated pipe wrapped with screening material may be installed if planting in extremely heavy clay or waterlogged soil. The size of the pipe depends on the amount of water that needs to be drained.
Dig a french drain	The French drain is a trench 2-4 inches wide cut from the wet area to a lower-lying dry area. It is filled with small gravel or large sand particles to a point slightly above the level of the surrounding soil. A pipe may need to be put at the end to carry water away from the tree.

Contact the USDA Natural Resource Conservation Service, engineer or landscape architect for additional information on installing a drainage system.

Low Soil Moisture

Lack of moisture in the soil is as harmful as too much water. Low soil moisture can be caused by high temperature, drought, high salt content, sandy soils, and improperly timed irrigation systems. Impervious surfaces can also prevent water from entering the soil. Signs that low soil moisture may be a problem include browning leaf edges and dry soil. Properly timed irrigation systems, watering during drought periods, and mulching can help prevent tree health problems caused by low soil moisture. Once the tree has reached the permanent wilting point from lack of water, it will be in a state of decline.

Nutrient Imbalance

Soils in urban areas may have a nutrient imbalance. If there are inadequate nutrients, tree growth and development will be affected. Often nutrient imbalances are caused by high pH levels, low soil fertility, or high salt content.

High soil pH

Urban soils may have a high or alkaline pH because construction materials, such as mortar and concrete, are often spilled or left on the soil. The addition of this calcium-based material, which is alkaline, raises the soil pH. Some species of trees need an alkaline soil, but other species can not tolerate a high pH level. A high pH may also cause chemical reactions with nutrients in the soil that render the nutrients unavailable to the tree. Iron, for example, becomes unavailable for a tree's growth processes when soil pH is alkaline. Sulfur may be added to soil to lower the pH. Tolerance to the local soil conditions needs to be considered when selecting a tree to plant in an urban area.

Low soil fertility

There are several common reasons for low soil fertility in urban environments.

- Topsoil and organic matter are often removed from a site during construction.
- Leaves are removed from the soil surface and not allowed to decompose. This reduces the amount of nitrogen, phosphorus, and other nutrients in the soil.
- Biological components and organisms are not as common in urban soils. This limits soil aeration and the addition of organic matter to the soil.
- Changes in soil chemistry may influence the availability of soil nutrients, interrupting the nutrient cycling process.

Top soil is often removed during land development.

High salt content

The salt level in soils may be elevated because of de-icing salts, excess fertilizer, or irrigation water high in soluble salts. This can be a problem, particularly in areas with low rainfall and extensive use of irrigation and fertilizer (Harris 1992). A soil that is high in salts has less water available to the roots. Sometimes salts can even draw moisture out of the roots. High salt levels can sometimes be reduced by leaching the salts with proper watering techniques.A symptom of high salt content in the soil is browning of leaf edges. If the soil does have a high salt content, select a species that is tolerant to high salts.

Soil Contamination

Soil can be contaminated by masonry, wood, paper, asphalt, paint, fuel, cement, oil, salt, or other materials. Contamination may occur across an entire site, such as an industrial property, or in spots, such as concrete washouts and refueling areas. This damage can also occur in the backyards of homes when cat litter or engine oil is dumped, or where there has been excessive use of pesticides and herbicides. Soil contamination often reduces aeration and water infiltration and sometimes may kill tree roots.

A change in soil color may indicate chemical contamination at the site.

Temperature Extremes

Temperature extremes can alter the chemical and biological characteristics of soils. Urban locations often have higher soil temperatures than rural areas because of the heat that is absorbed by and reflected from buildings, sidewalks, streets, and vehicles. This is the "heat-island" effect. Temperature differences also occur in a city because of the height of the buildings or directions of the streets (north/south or east/west). High air temperature raises the temperature of the soil. A lack of mulch and other debris on top of the soil also influences the soil temperature. Mulching is one of the easiest ways to reduce extreme soil temperature.

Erosion and Siltation

Site clearing and land grading are two construction activities that typically increase soil erosion. These actions change the soil profile and structure, affecting the stability of the soil aggregates and the water infiltration rate. Not only does the site lose soil, but the resulting sediment can interrupt the normal exchange of soil gases. The effects of erosion may be reduced by redirecting or reducing the flow of water.

Construction activities can cause soil erosion.

Signs of erosion

- Loss of soil at the site
- Visible roots
- Poor growth
- No basal flair of the trunk

Preventing erosion

- Establish vegetative buffers
- Install erosion fencing and geotextiles
- Minimize the area of disturbance
- Plant temporary vegetative cover
- Mulch

Checking Your Understanding of Characteristics of Urban Soil

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

1. What are three major problems caused by soil compaction? List two ways that compaction can be prevented and two ways to improve soil that is already compacted.

2. Selecting a tree species that tolerates excessive moisture is the best method for preventing problems in an area that consistently has wet soil. When excessive moisture is caused by other problems, what are three ways that it can be prevented?

3. When consulting with a property owner about an unhealthy tree, what are some soil conditions that you might look for or ask about?

Answers are at the end of the unit.

Case Study

Unearthing the Past

The local community center had finally received permission from the city to create a small park on a vacant piece of property. The plan was to plant a few trees, put in some park benches, and establish a neighborhood vegetable garden. The people living nearby had all agreed to pitch in to do the work and to share the vegetables they would raise. They thought it would be a simple project – just haul away the trash, pull up the weeds, rototill the soil, and plant some trees and vegetables. However, once the lot was cleaned, they discovered that it was not going to be that easy. The ground was rock hard from years of neglect, and people had used it to cut through the block for some time, creating well-worn foot paths. In addition, they could see the remnants of the foundation of the house that had once been there. The director of the community center called the local Clean and Beautiful commission for advice, and they suggested the forester with the State forestry agency would be able to help.

Greg, the local forester, came out to talk with the committee members in charge of establishing the park. They were in a hurry to get started because they wanted to get trees planted and the vegetable seeds in the ground before the weather got too hot. But Greg knew that he was not going to be able to solve all their problems in one morning.

Greg spent the rest of that morning walking around the property, stopping to look closely at the soil and existing vegetation, but most of all asking numerous questions. When had the house been built, and how long was it there? Was it a family residence? When was it torn down and why? Did the house have a separate garage? Where was the trash put? Did anybody remember the type of heating system it might have had? Had the property been used for anything else?

Thinking like a Farmer

You are the forester who has been asked to help these people get this vacant lot ready for planting. How would you go about doing this? Think about what you would want to know about the site, and the things that you might do to help develop the lot into the park the neighborhood wanted. Write your answers to the questions below, explaining your actions.

- What do you want to know about the property?
- Why is it helpful to know the history of the lot?
- How can you find this information?
- What specific information about the soil would you want to have and how would you go about collecting it?
- Once you have gathered all this information, what steps would you suggest the community members take to make this park a reality?
- What is the role of the community members in deciding which of your suggestions should be implemented?

After writing about the steps you would take to help these people prepare the soil for planting, read what Greg actually did.

The Rest of the Story

Looking for Clues

With as many answers to these questions as these people could provide from memory and city records, Greg decided there were several things that needed to be done, and he agreed to help them. The house had probably been built sometime in the 1920's and had been torn down about 10 years ago. He could tell where the foundation had been because of the grass growing there. But there were also areas, in addition to the compacted footpaths, in which there was no vegetation growing. One of these places he thought might be the area in which garbage and the coal ashes from the heating system in the house had been dumped. Another area that showed some evidence of a foundation was also without vegetation. He thought this might have been the garage, and that some oil and gasoline may have soaked into the ground.

The first thing he asked the committee to do was to have the soil tested for heavy metals and other contaminants. He also suggested a bulk-density test to determine the amount of soil compaction, and a core sample to see what was below the surface. He helped them get in touch with the local Cooperative Extension Service who could provide these services. Once they had all the test results, Greg was able to suggest steps to remedy the problems.

The test results showed some areas of contamination – low levels of lead, probably from paint chips around the foundation, as well as concrete washouts that raised the pH levels. The area used for trash showed a lower pH level, possibly because of coal dust in the soil. The levels of contamination were minimal, so Greg recommended removing and replacing the soil in those two locations and adding some clean topsoil.

After addressing the safety issues, Greg asked the committee members what their vision was for the park. With their suggestions, Greg proposed some ways these could best be incorporated into the existing site without too much additional work. A natural plan for the park would be to create permanent paths where the soil was so compacted that it would be difficult to restore. Trees could be planted and park benches placed where the top soil was put on top of the old foundation. After looking at the drainage pattern on the property, he suggested the vegetable garden be planted along one side, in an area that may have been a flower garden at one time. The soil analysis for pH and nutrient levels provided the committee with the information they needed for fertilizer requirements for the new trees and the vegetable garden.

With Greg's help, the park was beginning to be a reality, and Greg promised to come back in a few months to help harvest the corn and tomatoes.

Growing from the Ground Up

- What questions did you ask the committee members? Was there other information that you wanted to know that Greg did not think to ask about?
- Did you suggest the same type of soil tests and analyses Greg did? Were there other tests you thought might have been important?

- What other problems did you identify that might be found in a location such as this one?
- How similar were your recommendations for building the park to those that Greg made?

Next?

A healthy and vigorous urban forest depends in a large part on the soil in which the trees are growing. Information about these growing conditions is critical for making informed decisions about tree selection, planting, and maintenance in your community. These questions may help you make continued use of the material in this unit in your own work:

- In what ways can you use this basic information about soils to help you better identify urban soil problems in your area?

- What are some of the most difficult or critical soil problems that you know about in your community? What information from this unit and other sources can you use to help find the causes of and solutions for the problems?

- What other information sources are available to help you find out how to identify and correct urban soil problems?

- What are some of the ways you can use this information to help members of your community improve the health of urban trees?

For More Information

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U. S. Department of Agriculture, Natural Resource Conservations Service, National Soil Survey Center, Urban Soils

Checking Your Answers

Checking Your Answers about Soil

1. What are the four basic substances that make up soil?

Soil is a constantly changing mixture of four basic components:

- Inorganic materials
- Organic materials
- Air
- Water and dissolved nutrients

2. What two layers or horizons of soil chiefly influence a tree's root growth? Where are they found?

The O horizon and the A horizon are the two layers of soil that are most beneficial for a tree's growth.

- The O horizon contains the organic matter or humus that supplies the nutrients for growth and helps retain water in the soil.
- The A horizon is made up of mineral material and humus from the O layer. Most of the absorbing roots grow in this layer.

These two soil layers are not found at every site and may be arranged in different order, depending on the activity at the site. For instance, construction at a site may have removed one of the layers and changed the order of the other layers

3. How can a soil survey be helpful in an urban area?

Soil surveys can help identify the parent material of the soil. This is helpful in identifying other characteristics of the soil.

Checking Your Answers about Soil Characteristics Important for Tree Growth

1. What three things can you predict by knowing the texture of the soil? Define each of the terms you listed.

You can predict several things by knowing the texture of the soil. The texture will indicate the pore space, permeability, aeration capacity, water retention rate, and fertility of the soil. Because of the influence of texture on these soil characteristics, it is critical in selecting a species and site for planting.

- Pore space
  This is the space between soil particles through which air, water, and dissolved nutrients move. The large spaces are macropores. These are usually filled with air or are the spaces through which water drains. The small spaces that hold water and nutrients for absorption by the roots are micropores.
- Permeability
  The ease with which water moves through the soil is its permeability. Sandy soil with large pores has greater permeability than clayey soil with much smaller pores.
- Aeration
  Aeration is the process of providing oxygen in the soil for the roots to absorb. Since oxygen is carried through the macropores, a coarse-textured soil provides greater aeration of the soil then fine-textured or compacted soil, which has little oxygen available for the roots.
- Water retention rate
  The amount of water that the soil can hold is the water retention rate or holding capacity. Water is retained in the micropores for use by a tree. Fine-textured clays have more micropore spaces and thus hold more water than sandy soils.
- Fertility
  Fine-textured soils also have greater nutrient storage capacity than coarse-textured soils and are less susceptible to nutrient leaching. The smaller particles also have a greater cation exchange capacity (the ability to attract positively charged nutrients) than larger ones.

2. What makes soils fertile? What type of soil is usually the most fertile?

Soil fertility is determined by the amount of nutrients in the soil readily available to trees for growth. Soils that can attract and absorb the most positively charged nutrients are the most fertile. These nutrients include calcium, magnesium, sodium, potassium, hydrogen, and aluminum. Fine-textured, clayey soils are usually more fertile than coarse-textured, sandy soils because the fine particles are negatively charged and can attract and absorb more of the positively charged nutrients. Nitrogen is often deficient in the soil because it is negatively charged.

3. What are three reasons soil water is important for tree growth?

- It replaces water that a tree loses through transpiration. This is particularly important in hot weather.
- Nutrients necessary for growth are dissolved in soil water so they can be absorbed by the roots.
- Water stored in the soil provides a steady supply for a tree.

4. Why is knowing the pH of the soil important?

Soil pH is the measure of the acidity of the soil. Knowing the pH helps in determining the availability of nutrients in the soil and in selecting a tree for a particular location.

- First, the availability of nutrients depends on the soil pH. It is often the unavailability of nutrients, rather than the absence of them, in the soil that causes problems for trees. Many of the micronutrients needed by trees, particularly iron, are less available for absorption in alkaline soil (Harris 1992). Some nutrients, such as manganese and zinc, are insoluble in water at high pH levels, making them unavailable to trees. In acidic soils phosphorus may not be available.
- Second, each tree species has its own "best" soil pH for growth. Knowing the pH of soil helps in selecting the proper species for a site.

Checking Your Answers about the Characteristics of Urban Soil

1. What are three major problems caused by soil compaction? List two ways that compaction can be prevented and two ways to improve soil that is already compacted.

Soil compaction causes three major problems:

- Poor root penetration
- Poor soil aeration
- Low water infiltration rate

Soil compaction can be prevented in several ways:

- Find out the type of soil at the site to better understand how the soil will react to pressure.
- Cover the soil surface with a layer of mulch, no more than 4-6 inches thick, on the soil surface.
- Limit travel over the soil to designated routes.
- Work with dry or moist soils; wet soils compact more easily.
- Use light-weight maintenance equipment with large, smooth, low-pressure tires.
- Place metal grating over a planting site to keep people from walking on it.

Once soil becomes compacted, a number of options may help increase pore space and improve the quality of the soil:

- Drill small, 3-inch-deep holes for core aeration.
- Fill drilled holes with sand or peat moss to improve the texture of the soil.
- Rototill the compacted layer of soil.
- Drill holes into the hardpan (a hard layer 1 to 2 feet below the soil surface).
- Dig trenches in a bicycle-spoke pattern from the trunk of the tree and backfill with a mixture of soil and organic material.

- Mix fully composted organic mulch into the soil.
- Add mulch on top of the soil.

2. Selecting a tree species that tolerates excessive moisture is the best method for preventing problems in an area that consistently has wet soil. When excessive moisture is caused by other problems, what are three ways that it can be prevented?

Excessive soil moisture can be prevented or at least reduced through careful planting and maintenance:

- Prevent soil compaction so that water can move freely through the soil.
- Level the planting site so that there will be no low spots.
- Maintain the natural soil horizons during planting and try to eliminate debris that will change the soil texture.
- Use a coarse sand or loam soil for fill or mixing with existing soil.
- Plant the tree so that the roots are raised above the saturated soil.
- Monitor irrigation systems to make sure they are delivering only the needed amount of water.

3. When consulting with a property owner about an unhealthy tree, what are some soil conditions that you might look for or ask about?

You may already know many of the common characteristics of the soil in your area from the work that you do. However, every site has unique soil characteristics, and there are certain things that you always need to consider when determining if the soil is affecting a tree's health:

- Type of soil
- Soil texture
- Soil fertility and pH
- Amount of organic matter
- Soil temperature
- Soil compaction and causes of compaction
- Soil moisture conditions and causes of moisture conditions
- Soil drainage
- Soil contamination

These are only some of the conditions that you may ask when talking with a property owner, and you may have included others in your answer. The important point is to be aware of and consider each of the many different ways that the structure and characteristics of soil impact the growth of a tree.

URBAN FORESTRY

A Manual for the State Forestry Agencies in the Southern Region

Unit: Site and Tree Selection

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 9 units are on the web site (www.urbanforestrysouth.usda.gov). The other units will be added as they become available.

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 is an introduction to the importance of providing regular maintenance to the urban forest. The basic steps to preventative maintenance are discussed, such as fertilization, mulching, pruning and tree protection.

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.

Site and Tree Selection

Table of Contents

Overview

Guidelines for selecting the right planting site and tree are the focus of this unit. First, the reasons for planting a tree are discussed. Second, important factors to consider when selecting a planting site and some common types of urban planting sites are covered. Third, information is provided that will help in selecting the right tree for the site, which includes factors to consider when selecting a species and tree stock. This unit emphasizes the importance of planning when selecting a site and tree to avoid mistakes and future costs. It will also help you communicate more effectively with people in your community about selecting planting sites and finding the best types of trees for those sites.

Starlington Oaks

A Tale of Trees, Birds, and Downtown Streets

The residents of a small southern city were delighted by the Darlington oaks planted by the city's landscape department -- until a nearby group of starlings found them equally attractive. The trees protected the birds from predators and provided large amounts of roosting space. Since starlings form massive flocks during the winter, it was just what they needed.

After the starlings discovered the oaks, they descended on them each evening, to the human residents' dismay. Flocks of more than a hundred thousand birds created an unpleasant sound; in addition, the streets, sidewalks, and benches were covered with droppings.

Angry residents and business owners demanded action, and the landscape department tried to comply. Their attempts to drive the birds off included loud noises, explosives, and even water cannons. None of these efforts worked, although they all drew extensive media coverage that grew increasingly negative.

After three years, the oaks were pruned almost to stumps in an effort to make them less attractive to the birds. It worked; but the trees were no longer as attractive to the residents either.

We first knew you a feeble plant which wanted a little earth whereon to grow. We gave it to you; and afterward, when we could have trod you under our feet, we watered and protected you; and now you have grown to be a mighty tree, whose top reaches the clouds, and whose branches over spread the whole land.
Red Jacket (Sagoyewatha) Statement [c. 1792]

Before You Begin

This unit provides information useful in answering questions when you work with individuals or groups in the community to select a site and tree to plant. Think about how you can use this information in your work.

- What are some of the reasons trees are planted in your community?

- What are some of the common site characteristics you have found when planting trees in your area?

- What species are often recommended for planting in your community? Why are these trees often suggested?

On a separate piece of paper describe the urban forestry work you currently know about and how this work is a part of your job.

Asking the Right Questions

There are three important questions to ask before planting a tree.

- What is the purpose of the tree?
- What are the characteristics of the planting site?
- What are the characteristics of the tree?

Asking these questions before planting a tree can help insure the tree has the best chance for healthy growth, development, and survival. Planning ahead will also help to maximize the benefits while minimizing the costs associated with the tree. Some of the costs that can be minimized by proper site and tree selection include maintenance, removal, infrastructure repair, and liability.

Helping people to answer these three questions will help insure the growth of a healthy urban forest, prevent tree health problems, and minimize costs. There are a number of ways to assist communities in selecting the right tree and the right site (table 1).

Table 1. Examples of ways to provide site and tree selection assistance and potential recipients

Technical/Educational Assistance	Planning Assistance	Community Assistance
• Site selection • Tree selection • Unique planting sites • Planting requirements • Identification of healthy tree stock • Construction site evaluations • Tree inventories • Benefits and costs • Workshops and presentations	• Construction site planning • Soil management • Land-use management plans • Urban forestry management and planning • Urban wildlife management • Urban habitat management • Urban landscape programs	• Tree Boards • Individual homeowners • Business owners • Related professionals • Utility companies • Policy makers and elected officials

Why Plant a Tree?

The first question to ask when selecting a tree or group of trees for a given site is, what is the purpose of their being planted? Trees can serve various functions, and the list of "job descriptions" of trees in an urban environment is long. In some cases, their job may be to provide privacy or to screen an unpleasant site such as a landfill from public view; in other cases, people may want trees just for their shade or as adornments for their yards. Sometimes trees are used to direct pedestrian or automobile traffic. Communities may want trees to help prevent erosion, reduce storm-water runoff, and improve air and water quality. Some (but not all) functions of urban trees are listed below. At the end of this unit there is a *Tree Function Checklist* that can be copied and used as needed.

- Provide shade
- Provide seasonal color, flowers, and fruit
- Serve as a landscape accent
- Increase property values
- Decrease energy costs
- Improve air quality
- Reduce storm-water runoff
- Decrease soil erosion
- Improve water quality
- Create wildlife habitat
- Increase plant diversity
- Reduce wind speed
- Increase community pride
- Increase recreational opportunities
- Improve health and well-being
- Reduce noise levels
- Reduce glare
- Create buffer zones
- Provide screening
- Provide privacy
- Assist with pedestrian and traffic flow
- Enhance architecture design

Refer to the "Benefits and Costs of the Urban Forests" unit for more information on benefits of trees.

What are the Site Factors?

Knowing the characteristics of the planting site will help you determine whether the site will support healthy tree growth and development. The *Site Factors Checklist*, at the end of this unit, may be useful when evaluating site conditions. Some of the important site conditions to consider include:

- Soil characteristics
- Environmental conditions
- Planting space
- Site location
- Existing vegetation
- Land ownership and regulations
- Social influences
- Maintenance requirements

Numerous problems can be prevented just by checking the site conditions before selecting a species and planting.

Soil Characteristics

Soil conditions are among the most critical site considerations for tree growth and survival. The *Urban Soils* unit describes how to identify and test soil and ways to prevent and solve soil problems at a planting site. Specific problems can be identified by having soil tested at a laboratory. Some of the soil characteristics to consider when selecting a site are:

Soil texture

Soil texture influences soil fertility and the way air and water move through the soil. Find out the soil texture at the site.

- Heavy clay soil typically has poor aeration and drainage but high fertility.
- Sandy soil typically has good aeration and drainage, but poor water retention and fertility.
- Loamy soil typically has good aeration, drainage, water retention, and fertility.

Soil interfaces are abrupt changes in the texture that interrupt the normal movement of water in the soil. These changes can be caused by a variety of activities, such as erosion, mudslides, and the addition of fill soil, bricks and concrete.

Soil compaction

Because compacted soils are a major cause of tree decline in urban areas, this factor needs to be checked. Are there signs of compacted soil, such as hardness, standing water, or poor plant growth? If the soil is compacted the site may have poor soil structure, aeration, and drainage. A bulk-density test of the soil reveals the amount of compaction.

Construction activities can cause soil compaction.

Soil moisture and drainage

Soil moisture is influenced by various factors, such as soil texture and structure, precipitation patterns, hardpan, and soil interfaces. Poorly timed irrigation systems can also cause soil moisture problems.

- High soil moisture and drainage problems
  A simple way to test for drainage and compaction problems is to dig a 12 x 12-inch hole and fill it with water. If all the water drains away in one hour, drainage is good. If the water takes several hours to drain, drainage is fair. If water is in the hole for more than one day, drainage is poor or there is a high water table (Gilman 1997).
- Low soil moisture
  Causes of low soil moisture include high temperature, drought, or high salt content in the soil.

Soil nutrients, fertility, and pH

Since leaves and other tree litter are usually raked and not left on the ground to decompose, the soil may lack necessary nutrients and fertility may be low. Construction activities, such as removal of topsoil and cement wash out areas (where cement trucks wash their shoots with water), may also alter soil nutrient availability. Sometimes soil color is a clue to nutrient levels in soil. It is usually a good idea to send a soil sample to a laboratory to test the pH and nutrient levels.

Soil temperature

The temperature of the soil influences root growth by controlling the rate of chemical and biological processes. Temperature extremes can freeze or dry out roots. If the site is in a paved area, such as a parking lot, or is a container, soil temperatures may be higher than normal. Adding mulch to the planting area is one way to help maintain adequate soil temperature.

Soil contamination
Soil contamination may kill the roots. Does it look as if the soil has been contaminated by construction activities, chemical spills, excessive use of herbicides, or other disturbance? An unusual soil color or odd smell may indicate chemical contamination at the site.

Salt
Salt greatly influences tree physiology because it binds with important nutrients the tree needs, thus prohibiting the tree from absorbing those nutrients. Salt also absorbs water in the soil that the tree needs. Is the site located near the coast or near roads that are salted to melt snow and ice? Selecting a species tolerant to salt is usually recommended for these sites.

Environmental Conditions

To ensure the tree will grow and develop to maturity, it is essential to evaluate the environmental conditions at the site.

Light patterns
Consider the amount of sunlight, shade, and artificial light at the site, including the duration and directness of sunlight. How often is the tree in full sunlight or shade? Are there buildings or other trees shading the site? Are there artificial lights shining on the tree all night? Is there reflective light from buildings, streets and other structures? Light patterns can even change the dormancy and growth patterns of a tree. Visiting the site at different times of the day and season will help determine the light patterns and help in choosing a species appropriate to those conditions.

Buildings can shade trees.

Temperature extremes
It is important to know if a species can survive the temperature extremes at the planting site. The average minimum temperature can be determined from hardiness zone maps. Urban areas are usually warmer than rural ones because of the "heat island" effect, but

site-specific factors can cause even greater extremes. For example, trees planted next to a black asphalt road will have much hotter conditions and will probably need more water than those planted in the middle of a park or yard. Some sites are subject to early and late frost, such as ridgetops, large open spaces, low areas, and frost pockets.

Contact the Cooperative Extension Service or your local nursery for more information on hardiness zones.

Precipitation patterns
Precipitation patterns directly influence site conditions. How much rainfall does the site typically receive? When are the dry months? Is there a history of long periods of rain that can waterlog the soil? Snow and ice increases the weight on the branches and may break branches and cause other injuries. Select a species adapted to the precipitation patterns at the site.

Wind patterns
Strong winds may blow down trees and snap trunks and limbs. Constant winds increase the trees' need for water because of increased transpiration. Buildings in downtown areas can create a wind-tunnel effect and increase the wind speed in those locations. Are wind storms, tornadoes, or hurricanes common in the area? Sites exposed to strong winds should have adequate soil volume for good root development, and the tree species should have a structure and branch attachment that can tolerate windy conditions.

Refer to the "Tree Biology" unit for more information on branch attachment.

Air quality
Air quality problems vary depending on the location of the site, the size of the urban area, the kind of local industry, and the climate and weather patterns. Air pollution may damage foliage and impair photosynthesis. Is the planting site near a major road with large quantities of exhaust fumes? If major industrial polluters are located nearby, what are the chemical components of the pollutants? Some species can better tolerate specific pollutants than others. Is there anything about the local climate that contributes to or reduces air pollution, such as an inversion layer or constant winds?

Contact the U. S. Environmental Protection Agency for information on air pollution in your area.

Planting Space

Too often the amount of space a tree needs for growth of branches and roots is not fully considered. Imagine what the tree will look like when it matures and look for any potential problems with paved areas, structures, or utility lines. Gilman's (1997) planting space guidelines are listed in table 2. Coder (1996b) states that the following factors need to be considered when determining size of tree planting area: current tree diameter, annual growth, tree life span, and management objectives; he also recommends a 5-step process for determining size of the tree planting area.

Refer to the publication "Tree Planting Area Size: Futuring Resource Availability and Identifying Constraints" for more information on Coder's (1996b) 5-step process.

Table 2. Planting space guidelines (adapted from Gilman 1997)

Size of planting site		**Choose this size tree**
Size of planting site(square feet)	Minimum width of planting site	Maximum tree size at maturity
Less than 100 sq. ft	3 to 4 feet	Small (less than 30 feet tall)
100 to 200 sq. ft	4 to 6 feet	Medium (30 to 50 feet tall)
More than 200 sq. ft	greater than 6 feet	Large (taller than 50 feet)

Site Location

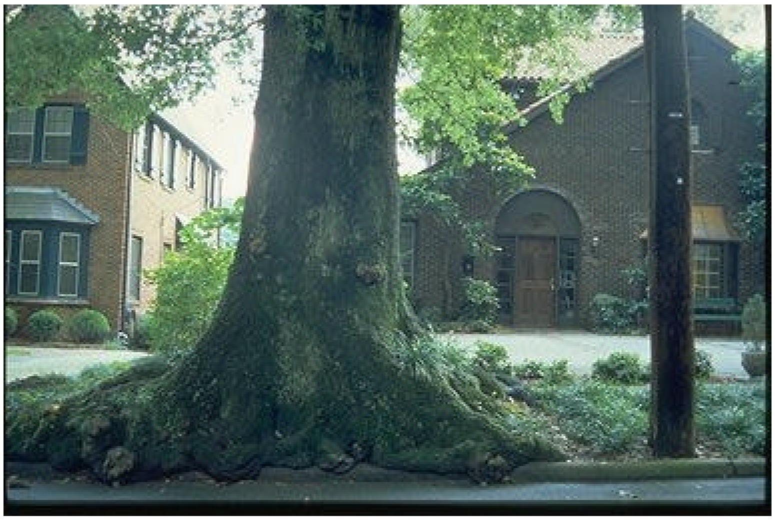
The site location offers clues on potential stresses that may impact tree health and maintenance. For example, a tree located on a downtown sidewalk will probably require more maintenance than one located in a park. Sites where there is pedestrian and vehicular traffic require special attention.

Streets, sidewalks, and other paved areas

If the site is located near a street, sidewalk, bike path, or other paved area several site factors must be considered.

- Pedestrian and vehicular areas
  For any site near where pedestrians or vehicles travel, tree species selection is critical. Species with thorns or prickly foliage or soft, messy fruit should be avoided. Trees with drooping branches will require frequent pruning. For public safety, it is always important that traffic lights, signs, and intersections not be obstructed by trees. Select a species tolerant to high salt levels in the soil if the site is located near a road where de-icing salts are used. Is the site located where the tree can be damaged by vehicles?
- Conflicts with roots and pavement
  Tree roots may grow under asphalt or cement pavement, which can cause the pavement to crack and buckle. Some communities have tried using root barriers and root training to avoid root-pavement conflict. There are different types of root

barriers, from cylinders to herbicide strips that are placed in the planting site. They are designed to physically deflect the roots away from the pavement. In some cases they do prevent root growth near sidewalks, but they may also limit tree growth. Root training is an option that uses chemical and physical barriers, deep fertilization, and irrigation or aeration structures to improve the soil conditions in the deeper soil horizons. If the barriers are successful, the roots will grow deeper, avoiding surface problems such as cracked sidewalks.



Sometimes there are conflicts with tree roots and pavement.

Structures

Trees need to be far enough away from buildings to allow for proper crown and root development (Gilman 1997). Trees that grow large, such as oaks, should be planted at least 15 feet from a building. Small and medium-sized trees may be planted closer to the building, but regular pruning may be required (Gilman 1997).

Utility lines

Utility lines for water, sewer, phone, electric, or cable may cause problems for trees. When selecting a site check for underground or above-ground lines that might interfere with the future growth of the tree.

- Above-ground utility lines
  If the site has above-ground utility lines, select a small species that will top out at least 5 feet below the wire, or select a species with a narrow crown and place it so it will not grow into the utility line (Gilman 1994).
- Below-ground utility lines
  The planting site should be located at least 12 feet from a major underground utility line for large trees (Gilman 1994). A common misconception about tree roots is that they actively grow into sewer and water lines. Roots will follow a path of least resistance and only grow into sewer and water lines that are broken.

Contact the local utility company to find out how to have all underground utility lines marked on the site.

Site activities
The type of activities, past, current, and future, on the site can help determine if this is a good planting site. Has construction occurred on the site that may have changed soil conditions? How many people or vehicles use the area around the site? Are there safety concerns, such as personal welfare or property damage? Does the tree need to be protected from compaction, vandalism, and injuries? Find out if there are any legal restrictions on how the property is used.

This type of information can usually be determined by visiting the site and talking with people who are familiar with it. The owner of the site or the local planning department are good resources for finding out about future plans.

Someone who is familiar with the site is a great resource for collecting site history.

Existing Vegetation

The existing vegetation at a site may reveal the current condition of the site. Is the vegetation healthy? How many different species are there? Could some of the species compete with each other? Are there any signs of insect and disease problems? Is there evidence of pesticide or herbicide applications? If the roots of the existing trees are visible above ground, expect the soil to be compacted or eroded. Existing natural vegetation also suggests species suitability, especially if native plants are being considered for planting.

Land Ownership and Regulations

It is always important to find out if the site is located on public or private property. For both private and public locations it is critical to find out the relevant zoning ordinances and other laws and policies that apply to the site. Some local tree ordinances may prohibit planting certain species of trees because they encourage exotic pests or are a nuisance to the people around them.

Find out what regulations a community has related to site and tree selection.

Social Influences

People's perceptions and feelings about trees must be taken into account when selecting a site and species. In some cases factors that influence public opinion have a historical basis; in other cases they may develop through an effort to promote civic pride or economic development. Communities may prefer a particular tree or be averse to another one because of the color of the flower or local tradition. Social influences to consider include culture, history, local identity, and safety issues. Local tree boards, garden clubs, civic clubs, and other organizations are good resources for finding out about social influences in the community.

Are there any social influences related to trees in the communities that you work with?

Maintenance Requirements

Too often trees are forgotten and not maintained after being planted. A tree requires proper care, especially in the early stages of its development, to prevent health problems. Are there adequate resources to maintain the tree?

- Is there someone or an organization responsible for maintenance?
- Are there resources, such as labor and equipment, to provide for watering, mulching, pruning, fertilization, protection, and other maintenance needs? Are there strategies to protect the tree from injuries?
- What are the qualifications of the personnel maintaining the trees? Do they have the necessary training and skills?

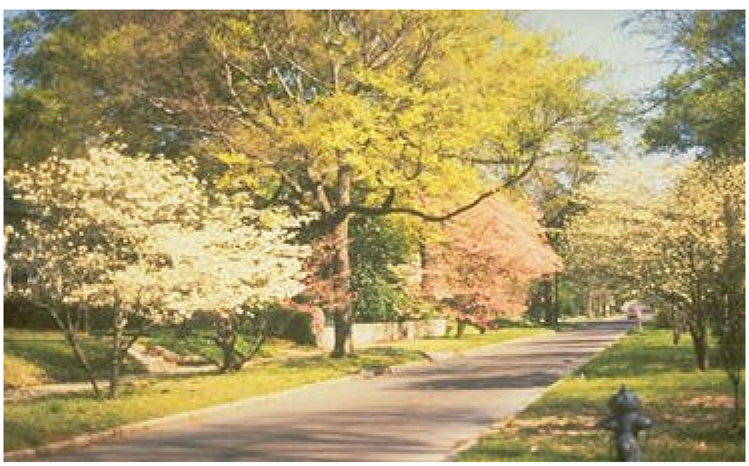
Types of Planting Sites

Several types of planting sites are unique to urban areas, including street lawn, tree pit, roadway, planter, and cluster planting. These sites may require special considerations when selecting a species and choosing a proper planting technique.

There are a variety of places to plant trees, such as residential and business yards, parking lots, empty lots, highway medians, parks, and courtyards between buildings.

Street Lawn

The street lawn, also known as the tree lawn, is the space between the curb and the sidewalk. Depending upon on the mature size of the planted tree, the street lawn should be at least 3 feet wide. If there is a choice, a street lawn is preferred to a tree pit because the street lawn has a continuous strip of soil. Do some checking before planting in a street lawn because of the potential conflicts with pavement, utilities, and local highway department guidelines.



Street lawns are one option for planting public trees.

Tree or Planting Pit

Tree or planting pits are small areas of soil within a sidewalk, parking lot, or other paved area. They are common in urban areas because often this is the only space available for planting trees. They also offer the advantage of softening the hardscape in urban areas. Trees planted in tree pits usually require special attention because of the unique growing conditions at the site (table 3).

Table 3. Factors to consider when planting in a tree pit

Factors	Description
Environmental stresses	In pits, trees are exposed to various stresses, such as drought or over watering, extreme temperatures, and wind. Because of these stresses, trees in pits often have a short life span. Regular maintenance and monitoring can help lengthen the life span of these trees.
Drainage and aeration	Drainage in the tree pit is critical. Normal drainage is disrupted when the backfill in the tree pit is different texture than the existing soil, such as sand on top of clay, or the bottom of the tree pit is compacted soil or rock.
Soil volume	There needs to be enough soil in the tree pit to support the growth of the tree. The volume of soil needed depends on the size of the tree. For trees up to 4 1/2 inches in diameter the tree pit is usually 3 feet deep. The pit should be at least 3 feet wide for a small tree and 6 feet wide for a large tree. If the pit does not have enough soil for the size of tree, the pit should be enlarged if possible by interconnecting tree pits or using adjacent lawn space or storm drain inlets. The larger the tree pit, the less chance there will be for tree root problems and better the chance for successful establishment of the tree.
Maintenance	Trees planted in pits require regular maintenance and monitoring because of the site peculiar conditions. Placing a cover or grate over the tree pit protects the soil from compaction.
Root control	Various root-control techniques may need to be used, such as root training or installing root barriers.
Hazards	Some of the hazards associated with tree pits include tree failure and reduced sight distance.

Tree pits are sometimes the only places available for planting trees in downtown and commerical areas.

Roadway

Tree plantings in the median and on the sides of the roads provide many benefits such as intercepting dust and particulate matter; reducing glare, noise, wind, and erosion; visually separating opposite lanes of traffic; and reducing mowing costs. However, trees near roadways can be damaged by vehicles, lawnmowers, string trimmers, herbicides, and de-icing salts.

Knowing the soil conditions near a roadway is essential to selecting a site. Drainage problems are common because the sites usually have disturbed soil that has been placed on top of compacted soil. It is also common to find construction rubble from road projects in the soil. Planning helps to avoid future problems with the trees and the pavement.

The State department of transportation usually has specific guidelines for plantings near roadways, such as species selection, planting distance from pavement, and distance between trees. It is important to work with them, especially during the planning phase.

Planter

Planters or containers are an option for sites where it is impossible to plant because of poor soil, lack of soil, underground utilities, or other factors. Planters can also be used for architectural design purposes. Tree planters come in various shapes and sizes and are made of plastic, wood, cement, or other composite materials. They should have thick walls, be light color, and be at least 18 inches deep with an adequate drainage hole. Factors to consider when using a planter are listed in table 4.

Table 4. Factors to consider when using a planter

Factors	**Description**
High maintenance requirements	Trees in planters need to be monitored frequently. Water requirements in the summer are critical. A container tree can die if it is not watered every one or two days.
Poor drainage	Drainage can be a problem. Water movement is limited in containerized soils, which can cause water logging. There can also be a buildup of fertilizer salts because there is limited leaching of dissolved nutrients from the soil.
Limited root space	Most containers do not provide enough room for adequate root development so selecting the proper size container for the species is important.
Temperature sensitivity	During cold weather the roots may freeze, or the container may crack and break. This is usually not a problem if the container is insulated or in warmer climates.
Short life span	Due to these stresses and limited growth space, trees in containers typically have a short life span.

Tree planters are one way to incorporate trees into areas that are difficult to landscape.

Cluster Planting

Cluster plantings, clumping, open-space planting, and urban tree islands are different names for planting groups of trees in a large space. In some areas this may be a better option than planting small trees in tree pits. Cluster plantings provide many benefits, such as reduced maintenance costs, shelter from weather extremes, and increased life spans for the trees. However, since the trees are located close together, insects and disease can move quickly from tree to tree. Overcrowding may also become a problem. Proper species selection is critical to avoid these problems.

Checking Your Understanding of Site Factors

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

1.What are the three main questions that need to be asked before selecting a site and tree for planting?

2.Soil is one of the most important factors to consider in selecting a planting site. What soil conditions should you take into account when selecting a species for a particular site?

3.What are some of the other factors, that need to be considered when selecting a planting site in an urban location?

4.What are three types of planting sites discussed in this unit? What are the most common problems associated with each?

Answers are at the end of the unit.

What Is the Right Tree?

Another question to ask before planting a tree is what tree will best satisfy the reasons for planting it and be suitable for the location where it is being planted. Trees vary greatly in the purposes they can fulfill and in their tolerance to the different conditions found at any one site. To select the right tree for the right site, both tree species and type of tree stock need to be considered.

Selecting a Tree Species

Trees may experience different types of stress and respond to stress in different ways (Coder 1996a). Some tree species can tolerate stress, such as poor soils and adverse environmental conditions, better than other species. Many of the same questions asked about the site also need to be asked about the species of tree. The *Selecting a Species Checklist* at the end of the unit can be used as a reference tool.

Future costs, such as pruning, insect and disease control, and repairing infrastructure damage, should be considered in selecting a tree.

Growth Factors

Several factors related to growth should to be considered when selecting a species.

Mature size and form
The mature size and form of the tree crown and root system are important because of potential interference with utility lines, pavement, structures, and signs. For example, it would be best to select a small or medium-size tree for a site located under a utility line.

Plant keys, listed in the "Dendrology" unit, can be used to determine mature tree size and form.

Growth rate
The reason for planting a tree may make the growth rate important in selecting the species. A fast growth is important for trees planted for shade or screening. However, some fast-growing species have weak wood and are prone to breakage. This makes the tree susceptible to storm damage and other hazards. Growth rate may affect how well the species compartmentalizes injuries.

Branching pattern
Alternate branching patterns are strongest and, therefore, preferable (figure 1). Some species grow this way naturally, and others can be trained to do this with early pruning.

The branching pattern is important when selecting at tree for a site that is subject to strong winds and storms.

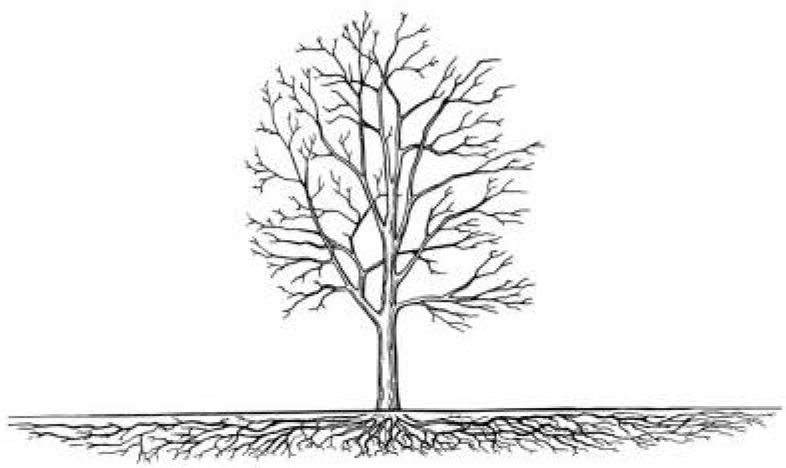


Figure 1. Alternative branching patterns are the strongest. (Illustration by Gene Wright)

Leaves
Most hardwoods are without leaves in the winter while evergreens have needles all year long. This is important when planting a tree to reduce energy costs for a building. There are positive and negative considerations about the leaves of different species, including fall color, thorns, or prickly foliage.

Flowers, fruits, seeds, and bark texture
Often a species is selected for the flowers, fruits, or seeds that it bears, or the texture of its bark. It is important to know the type of flower, fruit, and seed the tree produces, and how often this cycle occurs. The flowers, fruits, and seeds may be a source of beauty or food, or they may cause problems because of the litter, smell, or seeds they produce. This is especially true if the tree is near a sidewalk or road.

Soil Requirements

Each species of tree has different soil requirements but may adapt to a range of soil conditions. Some species can tolerate wet or compacted soils, while others are more drought tolerant. Species may also have different soil pH requirements and need different amounts of nutrients for healthy growth. If soil conditions are less than optimum for a specific species, it may be best to select either another site for the tree or another species for that site.

The web site "Urban Trees: Site Assessment, Selection for Stress Tolerance, Planting" is a good resource for list of tree species tolerant to different conditions.

Other Environmental Factors

Several environmental factors need to be considered when selecting a species. Future changes in the environment will also impact the growth and vitality of the trees planted.

Hardiness zone adaptation

Tree species have different tolerances to cold. Knowing the hardiness range for a species will help determine if it can survive the temperature extremes of winter at the site.

Wind and storm damage

For sites where wind and storm damage are a concern, a species with strong branch attachment and wood strength should be chosen. The species also needs a strong root system that will support it under these conditions.

Light requirements

Select a species that can tolerate the light conditions at the site (Gilman 1997).

- Sun-loving trees need at least 6 hours of direct sun.
- Partial shade or partial sun trees need 3-6 hours of sun.
- Shade-loving trees need less than 3 hours of direct sun each day or filtered sun.

Pollution tolerance

If air quality is a problem, the species should be tolerant to the type of pollutants that are in the area.

Insect and disease resistance

Insects and diseases should be considered in selecting a tree. The species selected should be resistant to those insects and diseases common in the area. Exotic species may not be tolerant to local insects and disease. Also, when planting exotic species consider the possibility of introducing insects or diseases damaging to native plants.

Fire resistance

Some species are more susceptible to fire than others. This is especially important in the urban-rural interface where homes and other structures are located near vegetation that burns easily. One option is to remove flammable vegetation and plant fire-resistant vegetation.

Maintenance Requirements

Some species of trees require more maintenance, including pruning, watering, fertilizing, and mulching, than other species. The maintenance requirements for a tree should match the resources, including time and money, available to care for the tree. Low maintenance trees may tend to live longer and stay healthy.

Types of Tree Stock

Trees are usually sold as seedlings, bare rooted, in containers, balled and in burlap (B&B), or as fabric bag stock. Trees may also be transplanted from one location to another. Factors to consider when selecting type of tree stock include site conditions and location, time of year, cost, and size of the tree. Each type of tree stock has its own advantages and disadvantages which are listed in tables 5, 6, 7, 8, 9 and 10.

Seedlings

Seedlings may be either potted or bare-root and are usually 1 to 2 years old.

Table 5. Advantages and disadvantages of using seedlings

Advantages	Disadvantages
• Light weight and easy to transport • Easy to do large scale plantings • Least transplant shock • Least expensive	• Susceptible to damage from lawn mowers, string trimmers, animals, and pedestrians • Small in size

Bare-Root Trees

Bare-root trees are grown in the field. There is no root ball because the soil is removed from the roots (figure 2). If the trees must be stored, the exposed roots should be covered with mulch or organic litter and kept moist. Bare-root trees are usually small, less than 2 inches in diameter.

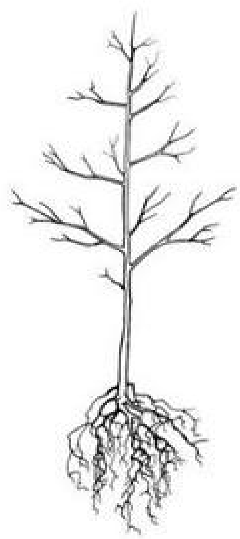


Figure 2. Bare-root trees should have a well-developed root system. (Illustration by Gene Wright)

Table 6. Advantages and disadvantages of using bare-root trees

Advantages	Disadvantages
• Smaller and lighter than ball and burlap or container trees • Tend to be inexpensive • Easy to ship and transplant because they are lightweight, but roots need to be protected • No kinked, girdled, or circling roots because they are grown in the field • No soil interface problems because the roots are bare	• Sensitive to changes in temperature, especially freezing • Roots should be kept moist at all times • Many of the fine roots are damaged • Should only be planted in the spring or fall

Container-Grown Trees

Container-grown trees are usually grown above ground in a container filled with lightweight, artificial soil or planting mix. Since the soil in the container is different from the planting site, root development may be restricted to the original dimensions of the container once the tree is planted. Another common problem with container- grown trees is circling, girdling, and matted roots (figure 3).

- Circling roots occur around the edge of the rootball inside the container. Trees grown in containers with vertical side ribs or copper-treated insides may have fewer problems with circling roots.
- Girdling roots are easily spotted at the top of the root crown where they ring and cover smaller roots. As they grow around the tree stem and other roots, these roots restrict water and nutrient movement in the trees. They can also cause the tree to be poorly anchored in the soil.
- Matted roots are small fibrous roots that form a dense web-like mass around the rootball, which may limit root growth.

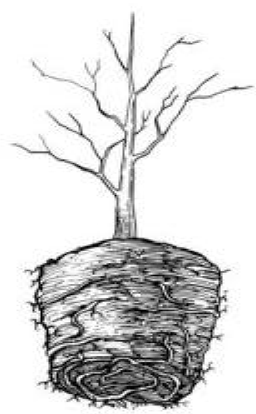


Figure 3. Container-grown trees may have circling, girdling or matted roots. (Illustration by Gene Wright)

Table 7. Advantages and disadvantages of using container-grown trees

Advantages	Disadvantages
• Can be transplanted any time of year • Easier to handle than ball and burlap trees because they are lightweight • Can be stored if watered frequently and protected from extreme temperatures and exposure • No root loss due to digging during transplanting • Larger than seedlings and bare-root trees	• Often have circling, girdling, and matted roots. • Need to be watered frequently. The small container sizes and type of soil used in the container often cause the soils to dry out.

Ball and Burlap (B&B) Trees

Ball and burlap trees are grown in the field at the nursery. When removed from the field, they are dug out with soil remaining around a portion of the roots. This root ball is then wrapped in a natural fabric, such as burlap, or synthetic material, and placed in a wire basket or wrapped in string (figure 4). Should be planted in the spring or fall.

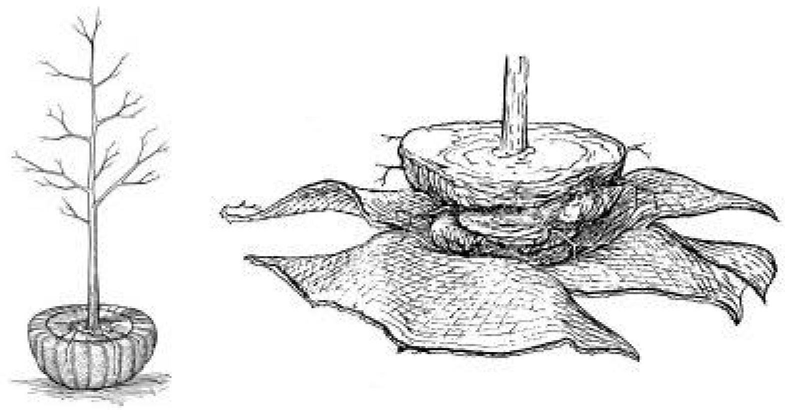


Figure 4. Wrappings and wire baskets must be removed from ball and burlap trees to avoid root development problems. (Illustration by Gene Wright)

Table 8. Advantages and disadvantages of using ball and burlap trees

Advantages	**Disadvantages**
• Better chance of survival than bare-root trees • Usually larger than bare-root trees	• Root loss when tree removed from nursery • Fabric and basket may be difficult to remove • May be difficult to handle due to weight of the root ball • If soil in the root ball is different from the planting site, soil drainage problems may develop.

Fabric Bag Trees

Trees are grown in the nursery, below-ground, in a non-biodegradable bag that is supposed to promote fibrous root growth.

Table 9. Advantages and disadvantages of using fabric bags

Advantages	Disadvantages
• Reduced loss of roots at the nursery • A more fibrous root system • A smaller root ball may make them easier to handle than container or B&B stock • Circling roots are not as common as in container trees.	• May require staking if crowded growing conditions in the nursery weakened the trunk. • Difficult to remove the fabric bag

Transplanted Trees

There are times when trees need to be transplanted from one location to another, for example mature trees that need to be relocated.

Table 10. Advantages and disadvantages of transplanting trees

Advantages	Disadvantages
• Option to save large trees that would be destroyed if not removed from a site • Creation of "instant" landscapes • Preservation of trees of special significance, such as historical trees	• Highest maintenance requirements of all tree stock • Expensive • High water requirements • May result in severe health problems or even loss of the tree if transplanted incorrectly or at the wrong time of year. • More than 90% of the root system may be lost in the transplanting process.

Selecting Tree Stock

Selecting a "good" tree that is healthy, attractive, and has the individual characteristics needed for the site can prevent numerous problems (figure 5). The publication, *American Standards for Nursery Stock*, by the American Association of Nurserymen, has specific information on how to select tree stock. General characteristics to consider are the tree's appearance and the source of the tree stock. Use the *Selecting Tree Stock Checklist* at the end of the unit as a reference tool.

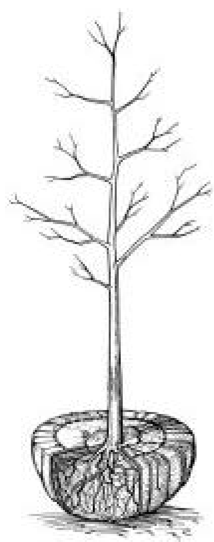


Figure 5. Characteristics of healthy, high quality tree - good taper on trunk, well developed leader, healthy bark, good branch spacing and distribution, and healthy fibrous roots. (Illustration by Gene Wright)

General Appearance

- A healthy, well balanced crown
- No signs of insect or disease damage

Trunk, Branches, and Bark

- Straight, single trunk is best
- Trunk centered and firmly attached to rootball
- Evenly distributed branches with wide angle of branch attachment
- No severe pruning cuts, scars, swollen or sunken areas, or wounds
- No insect or disease damage, such as borer holes
- No paint on wounds or cuts
- Usually smooth bark with no cracks, splits, or sunken areas
- Bright green underneath top layer of bark

Scratch a twig with your thumbnail to check color underneath the bark.

Healthy Leaves

- Green to dark green leaf color depending on the species and season
- No insect or pesticide damage, such as bare spots or discoloration

Roots

- Healthy, white roots with evenly distributed lateral growth
- Avoid buying a tree with circling or matted roots. However, if the tree has circling roots, cut them in several places to prevent them from becoming girdling roots. For matted roots, making two or three vertical slices into the rootball with a sharp knife, or loosen the roots carefully by hand.
- Girdling roots are detrimental to the long-term health of the tree and should be avoided when buying a tree.

Source of Tree Stock

Tree stock survives best if it is planted in the same climate and soil conditions in which it was originally grown. Find out where the tree was grown when purchasing stock for planting. For example, a tree grown in a Texas nursery may not adapt well to a site in Virginia.

Checking Your Understanding of Tree Selection

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

1.What are the six growth habits of trees you need to consider when selecting a tree species for an urban location?

2.Most types of tree stock have some characteristics that inhibit maintaining a healthy root system. What are the problems you need to look for when selecting tree stock?

3.What are three characteristics of a healthy root system and three characteristics of a well-developing trunk and branch system to look for when selecting tree stock?

4.What role do people play in the selection of trees in an urban area?

Answers are at the end of the unit.

Case Study

Don't Touch that Tree!

Wes coordinates the power company's routine cycle for trimming trees on the electrical transmission circuit. His contract crews are working in an historic section of town that he knows well. The neighborhood, in which many of the people have lived for 20 or more years, has an abundance of stately, old trees. These give the area a great deal of character and charm, but Wes knows that tree interference with utility lines is the number one cause of the frequent power interruptions in the neighborhood. He also worries about children climbing trees that may be in contact with live wires.

One of Wes' crews finds a gnarled pecan tree that has grown into the overhead power lines. The crew wants to take the tree down because, even though it has been drastically pruned in the past, new suckers continue to grow into the lines. The homeowner, Mrs. Welch, sees the crew and tells them, "You're not going to touch that tree!". Wes meets with her, and explains that the upper branches of the tree are in direct contact with the power line. This hampers normal inspection and routine repair, violates both federal and state laws that require a minimum clearance for power lines, and poses a safety risk to the public. Mrs. Welch remains adamant that she does not want the tree taken down, but accepts his suggestion to have a forester from the Forestry Commission look at the tree.

Wes asks his friend Victor with the local Forestry Commission for assistance. Wes tells Victor the power company will replace the pecan tree with another tree if Mrs. Welch agrees. Victor makes an appointment with her for the following day. Not being as familiar with the neighborhood as Wes, Victor decides to drive through it this afternoon. He finds the streets lined with large shade trees that form a comforting green canopy over the streets and yards. The problem tree is one of three pecan trees in Mrs. Welch's front yard, and there are two other hardwoods as well. Well-tended flowers grow across the front of the house. He begins to understand Mrs. Welch's reaction to the suggestion of removing the tree. Now he must decide the best way to solve the problem when he meets with her tomorrow.

You and Mrs. Welch and the Pecan Tree

You are the forester that has made the appointment to talk with Mrs. Welch. On a separate page, answer the challenge questions below, telling how you will handle this situation.

- Knowing that Mrs. Welch is upset about this pecan tree, how will you approach your meeting with her?
- What is the first thing that you will do or talk about?
- What options can you present to her to solve the problem?
- What purpose does the tree serve?
- What are the important site factors you need to observe?
- What species characteristics do you need to look for in the tree that will replace this one if she agrees?

After you have answered the challenge questions, read the rest of the story to compare your solutions with what really happened.

The Rest of the Story

Decisions, Decisions

Victor knew the situation was delicate and so he wanted to approach Mrs. Welch and the tree problem carefully. Meeting the next day, he found her eager to talk about the pecan tree. She had strong emotional feelings about saving the tree. Victor knew this was not the time to discuss options and decided to listen, letting her do most of the talking. He learned she had lived in this house for 25 years. She was unhappy with past trimming practices, which she thought had caused the present problem. She hoped the tree could be saved. Victor told her the tree would live, but he thought the more important question was "would it be safe?" He stressed that as long as the tree was there it would create problems with the utility wires. He provided some brochures that illustrating potential problems, with diagrams and information about the relevant laws.

He explained there were three options. One, leave the tree and let the power company continue to trim it every few years. Second, remove it. Third, remove it and replace it with a species that would not grow into the wires. He asked her to think about these alternatives and left additional brochures on tree selection.

The following week, when Victor called Mrs. Welch, she had decided to remove the tree. He offered his help in selecting a replacement. On this visit, they spent a great deal of time in the yard talking about various alternatives for the new tree. There were several factors to consider. She wanted a tree to provide shade in the summer like the others in her yard, and to fit into the look and character of the neighborhood. The tree, of course, had to meet both the practical and legal requirements for utility lines and public safety. Being near the street might also affect the growth of a new tree. During the primary growing season the yard would have a lot of shade, although drainage did not seem to be a problem. However, Victor did suggest it would be a good idea to have the soil tested for bulk density and for nutrient content. The pecan tree had a well-developed root system that had been able to overcome any problems that had developed over the many years it had grown there. Making sure the soil was not compacted and had the right nutrients available would help a new tree become established more easily. Victor knew he needed to consider the branching pattern and eventual height of the tree. Mrs. Welch also wanted a fast-growing tree to return her front yard to normal as soon as possible. He suggested several different species for her to consider. After some more thought, Mrs. Welch agreed to have the power company remove the pecan tree and replace it with one that she and Victor had chosen.

Two Tales to Compare

- Did you decide to approach Mrs. Welch in the same way Victor had? Why or why not?
- Were the options you presented the same, or did you have others?
- Did you take the same legal, site, and species factors into consideration as Victor did?
- Did you see other factors that should have been considered?
- Do you agree with the actual outcome? Why or why not?

Next?

This unit has provided basic information about site and tree selection. Use this page to write your own action plan for putting this knowledge into practice in your job. The notes you made at the beginning of the unit may be useful in deciding some of the important points. Answering these questions can assist you in planning your own professional development.

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

- What other sources will you use to learn more about tree selection in your area?

- What have you learned that you can use to help others in your community make good decisions in selecting the sites and species to plant in your area?

- What other steps will you take to further improve your skills and how may this benefit you in your job?

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Checking Your Answers

Checking Your Answers about Site Factors

1. What are the three main questions that need to be asked before selecting a site and tree for planting?

- What will be the function or purpose of the tree?
- What site factors need to be considered?
- What tree selection factors need to be considered?

2. Soil is one of the most important factors to consider in selecting a planting site. What soil conditions should you take into account when selecting a tree for a particular site?

Soil texture, compaction, moisture, and drainage are important characteristics to consider when selecting a planting site for an urban location. The volume of soil available at a planting site is also crucial to the type of tree that is planted. Urban soils may contain contaminants and impurities from building materials, pesticides, and other sources. Testing the soil is always a good idea.

3. What are some of the other factors that need to be considered when selecting a planting site in an urban location?

- Environmental conditions, such as light patterns, temperature extremes, precipitation patterns, wind patterns, and air quality.
- Planting space
- Site location components, such as streets, sidewalks, structures, utilities, and site activities
- Existing vegetation
- Land ownership and regulations
- Social influences
- Maintenance requirements

4. What are three types of planting sites discussed in this unit? What are the most common problems associated with each?

- Street or tree lawns
- Tree or planting pit
- Roadways
- Planters
- Cluster planting

Soil conditions -- the quality and the volume of soil available for the tree's growth – often present the greatest challenge to face in urban planting. Drainage and aeration problems, limited space for root growth, and possible soil contamination require special consideration when selecting a species for planting. Regular maintenance and monitoring will help improve the growth of trees in these urban planting sites.

Checking Your Answers for Tree Selection

1.What are the growth habits of trees you need to consider when selecting a tree species for an urban location?

The site conditions of an urban location, as well as the purpose of the tree, will influence the species that you select for planting. The growth patterns of the tree to consider include:

- Mature size and form of canopy and root system
- Rate of growth
- Branching pattern

Other characteristics of the tree, such as kind of leaves, litter from fruits and nuts, thorns, and maintenance requirements, are also selection factors.

2. Most types of tree stock have some characteristics that inhibit maintaining a healthy root system. What are the problems you need to look for when selecting tree stock?

There may be problems with the root system in most types of tree stock that you need to look for when selecting tree stock. In bare-root trees, including seedlings, many of the fine roots may be damaged or lost when the tree is removed from the ground, or they may dry out while waiting to be planted. The roots of container-grown trees may be kinked, circled, or matted, and may not have the space to develop properly. Grow-bag trees also may have circling roots. The fine roots of ball and burlap trees are better protected from drying than those of bare-root trees, but it is still possible that B&B trees may lose much of their original root system when removed from the ground. Large trees that are moved from one location to another are at the greatest risk for loss of roots when they are transplanted, often losing as much as 90% of their system.

3. What are three characteristics of a healthy root system and three characteristics of a well-developing trunk and branch system to look for when selecting tree stock?

Tree stock roots should be:

- white and firm in appearance
- evenly distributed around the trunk
- growing away from the trunk, not around or girdling the trunk.
- showing fibrous root development, but should not be dense or matted

The trunk and branches of tree stock should have:

- single, straight trunk.
- trunk firmly attached to the root ball.
- balanced growth pattern of branches around the trunk
- branches with wide angle of attachment
- no insect or disease damage
- no severe cuts or wounds in the wood
- bark that is not cracked or split.
- bright green color under the top layer of bark.

4. What role do people play in the selection of trees in an urban area?

People are the most constant factor in an urban area and a primary consideration when selecting a tree for several reasons. When they participate in the planting and caring for trees in their communities, they actively contribute to the health and survival of the urban forest. Many people view the trees in their yards and their neighborhoods as an important part of their lives. The likes and dislikes, opinions and feelings of these people are important. Communities may see trees as one way of creating an urban identity and as an economic benefit.

Appendix – Tree Function Checklist

Tree Function Checklist	
• Provides shade • Provides seasonal color, flowers, or fruit • Serves as a landscape accent • Increases property values • Decreases energy costs • Improves air quality • Reduces storm-water runoff • Decreases soil erosion • Improves water quality • Creates wildlife habitat • Increases plant diversity	• Reduces wind speed • Increases community pride • Increases recreational opportunities • Improves health and well-being • Reduces noise • Reduces glare • Creates buffer zones • Provides screening • Provides privacy • Assists with pedestrian and traffic flow • Enhances architecture design

Appendix – Site Factor Checklist

Site Factor Checklist

Soil characteristics
- Texture
- Compaction
- Moisture and drainage
- Nutrients, soil fertility, and pH
- Temperature
- Contamination
- Salt

Light patterns
- Sunlight
- Shade
- Artificial light
- Reflective light

Temperature extremes
- USDA Hardiness Zones
- Climatic extremes
- Location factors that influence temperature extremes
- Exposure

Precipitation patterns
- Amount of rainfall
- Flooding
- Drought
- Snow, ice, or hail

Wind patterns
- Constant winds
- Strong winds
- Storms
- Wind tunnel

Air quality
- Automobiles
- Industry
- Climatic variables

Planting space
- Size of planting site
- Maximum tree size at maturity
- Minimum width of planting site

Site location
- Streets, sidewalks, paved areas
- Structures
- Utility lines
- Activities

Existing vegetation
- Health
- Number of species
- Competition potential
- Insects or disease

Land ownership and regulations
- Public or private property
- Local tree or landscape ordinances
- Local regulations - zoning, ordinances

Social influences
- Culture
- History
- Local identify
- Safety issues
- Vandalism

Maintenance requirements
- Responsible person or organization
- Resources for maintenance and protection
- Qualifications of personnel

Appendix – Selecting a Species Checklist

Selecting a Species Checklist	
Species growth factors • Mature size and form • Growth rate • Branching pattern • Leaves • Fruits, flowers, seeds, and bark texture **Species maintenance requirements** • Pruning • Watering • Fertilizing • Mulching • Leaves and litter	**Environmental factors** • Species requirements for hardiness zone and temperature extremes • Species ability to withstand wind and storm damage (branch structure and wood strength) • Species requirements for light (sun loving, partial shade or sun, or shade loving) • Species tolerance to air pollution • Species resistance to insects and disease • Species resistance to fire **Soil requirements** • Species requirements for soil conditions

Appendix – Selecting Tree Stock Checklist

Selecting Tree Stock Checklist	
General appearance • Healthy crown • Good vigor with no signs of stress, insects, or disease **Trunk and branches** • Straight, single trunk • Trunk in the center of the rootball. • Trunk firmly attached to the rootball • Branches evenly distributed, without clustering • No severe pruning cuts, scars, swollen or sunken areas • No insect damage, such as borer holes • No paint on wounds or cuts **Healthy leaves** • Leaves green to dark green, depending upon species and season • No discoloration, spots, or other damage	**Bark** • Smooth bark with no cracks, splits, or sunken areas. • Bark bright green underneath **Roots** • Healthy white roots • No circling roots • No girdling roots • No matted roots **Plant material source** • Climate and soil conditions at nursery • No internal girdling or kinked roots in root ball

URBAN FORESTRY

A Manual for the State Forestry Agencies in the Southern Region

Unit: Tree Planting

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 9 units are on the web site (www.urbanforestrysouth.usda.gov). The other units will be added as they become available.

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 is an introduction to the importance of providing regular maintenance to the urban forest. The basic steps to preventative maintenance are discussed, such as fertilization, mulching, pruning and tree protection.

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.

Tree Planting

Table of Contents

Overview

This unit provides guidelines for planting a tree and caring for it afterwards. The first section emphasizes factors that need to be considered before planting. The next section includes information about planting season, commonly used planting tools, preparation of the planting site, and care of the tree stock. The last section covers various ways to help a tree survive the first few years after planting. This information will be useful for helping individuals and groups successfully plant trees.

It's the Whole Hole

That Sinking Feeling

The call was from a homeowner who said his maple tree was sinking. He was sure a hole was going to open up and swallow the tree. Sam asked the usual questions about the site and decided an inspection of the tree was in order.

The subdivision was an upscale, planned community about 10 years old. Mr. Parker said he had planted the silver maple in his backyard "the day we moved in." The trunk was about 7 inches in diameter and, as expected, it had a thick fan of surface roots showing through the grass. Sam also expected to find a cavity in the trunk or some damage at the base of the trunk that would explain why the tree seemed to be sinking. Instead, he found Mr. Parker was right. It did look as if a hole was getting ready to swallow his tree! However, the hole wasn't the work of any mysterious gremlins. Sam found the tree had been planted on top of the construction bury pit. The debris buried there had decayed, collapsed, and left the tree without any base support. He estimated the hole was at least 4 feet deep. The thick root mat, common to silver maple, had helped keep the tree standing upright under some very poor planting conditions. But now the "soil" the tree had been planted over was gone, so Sam recommended the tree be removed. He also suggested that Mr. Parker may want to contact an engineer to determine the extent of the bury pit before planting another tree.

"If you create a root zone environment in which the roots can thrive the top of the tree will take care of itself. "
Unknown Author

Before You Begin

Knowing proper methods for planting trees is essential to developing and managing the urban forest. Use these questions to think about how this information relates to the urban forestry work in your community.

- What are some of the recent plantings that have been done in your area? Do you know of planting locations, such as the median in a street or the swampy area of a homeowner's backyard, that caused problems?

- What are the most common reasons a tree does not survive in your area after being planted?

- What methods are often used in your community to help a tree survive after planting?

On a separate piece of paper describe the urban forestry work you currently know about and how this work is a part of your job.

Planting for Healthy Trees

Proper planting techniques help to increase the benefits a community receives from the urban forest. Using correct planting methods can improve tree health, increase life expectancy of the tree, reduce need for corrective tree maintenance, and increase the tree's ability to become established more quickly and with less stress. However, these benefits also depend upon several other factors that are emphasized in the *Site and Tree Selection* unit.

Site conditions
Before planting, find out the conditions at the site, such as soil characteristics, light conditions, and location of overhead cables.

Different types of tree planting sites
Planting in unique sites, such as containers, street lawns, or tree pits, may require special attention to provide adequate soil volume, prevent pavement from expanding or buckling, and avoid drainage problems.

Species selection
It is important to know if the species is tolerant to the conditions at the site. You must also determine if the site needs special treatment to accommodate the species selected.

Different types of tree stock
Types of tree stock, such as bare root and container, have advantages and disadvantages related to establishment. How does the type of tree stock impact how the tree is planted and the maintenance required? Does the tree meet the American Standard for Nursery Stock?

Transplant shock
Transplant shock refers to the stress caused by root loss when trees were dug up at the nursery. The small root system that remains cannot absorb and transport all the nutrients and water needed by the tree, which results in slow growth and vulnerability to insects, disease, and other problems. The degree of transplant shock depends on such factors as tree species, size of tree, quality of nursery stock, amount of root loss, and soil conditions. Proper site and tree selection and planting techniques can minimize transplant shock.

By checking the site conditions before planting you may be able to avoid costly delays.

Opportunities for Providing Assistance

Tree planting is a common activity in urban areas. Planting is done in many locations - yards, parks, street medians, and in commercial sites - by individuals, business people, and organizations for various reasons. As an employee of the forestry agency, you may often be asked to decide when, where, and how to plant these trees. Your knowledge of proper planting techniques and post-planting care can help trees survive. There are different ways the State forestry agency can provide assistance related to tree planting (table 1).

Table 1. Examples of tree planting assistance and potential recipients.

Technical/Educational Assistance	Planning Assistance	Community Assistance
• Proper site preparation • Selecting quality tree stock • Checking soil conditions • Minimizing transplant shock • Post-planting care and maintenance • Tree diagnosis	• Establishing planting guidelines for public spaces • Community planting and maintenance program • Survey of urban forest for planting and replacement needs	• Homeowners • Local governments • Developers and home builders • Businesses • Landscape architects • Non-profit associations • Neighborhood associations

Planting Guidelines

Certain steps should be followed when planting to help insure the successful establishment of the tree. The goal is to provide an environment that encourages root growth.

- Choose a planting season
- Select tools and equipment
- Prepare the site
- Prepare the tree stock
- Plant the tree

Choose a Planting Season

Fall or spring is the best time to plant trees because temperatures are moderate and water can be provided to support healthy root growth. Fall planting is usually recommended because it allows time for root growth before hot weather in the summer. In some areas of the south, winter planting is also an option. Weather conditions to avoid include extreme heat and cold, low wind-chill temperatures, and high winds that may cause drought conditions.

It is best to plant deciduous trees when they are dormant, before leaves appear in the spring or after leaves drop off in the fall.

Select Tools and Equipment

The proper tools for preparing the planting area depend on the size of the tree, the type of root system, the site, and the condition of the soil. The most common hand tool for planting trees is the shovel, but other tools may be needed and used. The following tools are often used on urban planting sites:

Shovel and sharpshooter

A round-point shovel is good for digging a hole and a flat shovel is good for shoveling dirt back into the hole. A sharpshooter, similar to an elongated, round-point spade, is recommended for removing trees from the ground and for root pruning. These tools work best when the blade is sharp. A dull blade breaks and bruises roots instead of cutting them.

Dibble

This durable instrument with a heavy steel blade and tubular steel handle will make a hole in almost anything. It is primarily used to plant seedlings, but is sometimes used as a prying tool.

Hoedad, maddock, or pick
A hoedad, maddock, or pick can be used to break up hard or compacted soil so it is easier to shovel.

Rototiller
A rototiller can loosen the soil, particularly if it is compacted. However, care must be taken not to injure roots of any existing trees.

Tree spades, backhoes, and other mechanical equipment
For large trees, tree spades, backhoes, and other similar types of excavation equipment are sometimes used. When using mechanical excavators, it is important not to dig too deep. Power augers are sometimes used to penetrate hardpans. These machines do create glazed, smooth sides in the planting area so it is necessary to roughen the sides to increase root penetration and drainage.

Preparing the planting site.

Prepare the Site

Proper preparation of the planting site is critical to good root development. In urban areas, site preparation may require special planning because of the type of planting site, such as street or parking lot plantings. Also, when preparing the site, you may find surprises when digging, such as construction bury pits or asphalt. These surprises can increase the time and resources needed for planting. Three steps for preparing the site are:

- Determine size of planting area
- Remove competing vegetation
- Prepare the soil

Determine size of planting area
Because most root growth occurs in the upper 12 inches of soil, the planting area needs to be shallow and wide to accommodate the development of the fibrous roots (figure 1). Three measurements to consider when determining the size of the planting area are:

- Width
  The planting area should be 3 to 5 times as wide as the rootball.
- Depth
  The planting area should be as deep as the root ball or slightly less. Planting a tree too deep is a common mistake that limits the soil oxygen available for root respiration, which can cause several problems including death of the tree.
- Volume
  There needs to be enough loosened soil in the planting area for adequate root growth. Often, the planting area is too small and there is not enough space to provide the needed loose soil. The soil volume needed for healthy root growth and support of a tree depends on tree species, size at maturity, expected lifespan, and environmental stress factors.

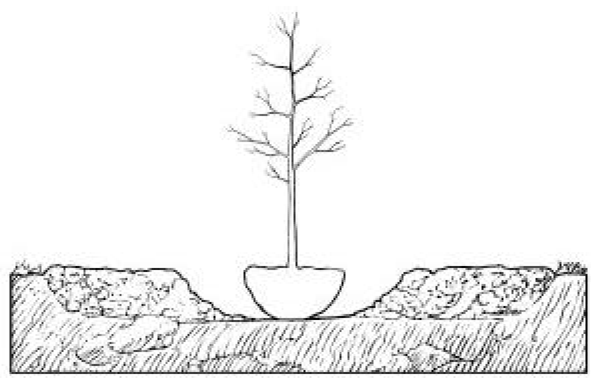

Figure 1. The planting area needs to be 3 to 5 times the size of the rootball to promote healthy tree growth.

Remove competing vegetation
Many planting sites have weeds, grass, liriope, and other competing vegetation that should be removed. There are several ways to eliminate competing vegetation. The best method depends on the location and requirements of the site and the resources available.

- Herbicides
  Herbicides kill grass and weeds about 10 days after application. It is important to apply herbicides according to the manufacturer's directions. In some situations a license is required to apply certain types of herbicide.
- Multiple tilling
  Multiple tilling can help control weeds and vegetation. One option is to till once or twice during the summer and fall and once again before planting. If heavy equipment is used, steps need to taken to prevent soil compaction, especially if the soil is wet. The critical root zones of nearby trees also need to be protected by not tilling too deep and too near.
- Plastic sheeting
  A sheet of dark plastic staked over the planting area for 2 to 3 weeks in the

summer kills the grass and weeds. The plastic needs to be opaque so light cannot penetrate it. Remove the sheet before planting the tree.

- Hand weeding
  Hand weeding is labor and time intensive, making it practical only for small planting areas.
- Stripping the sod
  Sometimes it is necessary to remove sod from the planting site. Some topsoil will be removed in doing this, so it may be necessary to bring in additional topsoil or compost.

Prepare the soil
The soil conditions at the planting site greatly influence a tree's ability to survive the planting process and its mature health and form. Problems with soil condition should have been identified during site selection and corrected before planting. However, this is not always possible. Refer to the *Site and Tree Selection* and *Urban Soils* units for specific information on identifying and correcting soil problems before planting.

The soil in the planting area needs to be thoroughly loosened to encourage root growth. However, to reduce the settling of the soil after planting, do not disturb the bottom of the planting area. If this soil is disturbed, it should be pressed down to decrease settling. Roughen the sides of the planting area to help the roots penetrate glazed soil surfaces.

Do not plant the tree too deep.

When preparing the soil, several factors should be considered:

- Soil moisture
  Good planting conditions require the soil to be moist. If the soil is too wet or too dry, avoid planting.
- Soil texture
  Digging in clay soil may be more difficult and require more time for planting.
- Soil compaction
  If the soil is hard to penetrate, a rototiller, hoedad, maddock, or pick can be used to loosen the soil.
- Soil temperature
  The soil needs to be warm enough, usually above 40 degrees, for root growth. Avoid planting if the soil is frozen.
- Soil interfaces
  Watch for rocks and construction debris when loosening the soil with tools and mechanical equipment.
- Soil amendments
  Do not add organic matter, fertilizer, or other soil amendments. Also, do not place gravel in the bottom of the planting area. These amendments can cause problems with soil moisture and root growth.

Call local utilities for location of underground cables and pipes before you start digging.

Prepare the Tree Stock

The importance selecting of healthy tree stock is discussed in the *Site and Tree Selection* unit. Once the trees have been delivered to the site, keep them watered and protected from extreme weather conditions. The stock may need time to adapt if the conditions at the site are much different from the previous growing conditions (Harris 1992). These are steps to take to maintain the health of the tree stock:

Inspection

The tree should have been inspected at the nursery to insure it meets the minimum standards for the *American Standard for Nursery Stock*. It should be inspected again at the site for damage from handling, transportation, or storage, with particular attention to the roots.

Handling

A tree should be picked up from the bottom of the container, root ball, or root-ball cage. Never lift a tree by the trunk. This causes the trunk of the tree to pull away from the roots. Dropping the tree may also damage the roots. Carefully transport the tree from the nursery to avoid damage to the branches, leaves, needles, bark, and roots.

Storage

Trees for transplanting usually should not be stored, particularly during the summer or winter, because the roots can dry out and die. Keep the roots moist, but not soaked. If trees, particularly bare-root trees, must be stored, "heel them in" by temporarily planting them and covering the roots with moist compost or sawdust. If they cannot be "heeled in", they should be kept in a cool place, away from asphalt or concrete. If trees are warmed up too quickly, they will break dormancy before planting.

Avoid exposing the trees to extreme temperatures, wind, or other harmful climatic conditions.

Removal of containers, wrapping and wrapping cords

The containers and wrappings should always be removed from the rootball just before planting to prevent soil from drying out (figure 2). Do not disturb the root ball or injure the roots when the container or wrapping is removed. Any dead, diseased, broken, twisted, or girdling roots should be cut with a sharp knife. Circling roots need to be cut in a few places to help keep them from becoming girdling roots. If there are matted roots, make two or three vertical slices into the rootball with a sharp knife, or loosen the roots carefully with your hands.

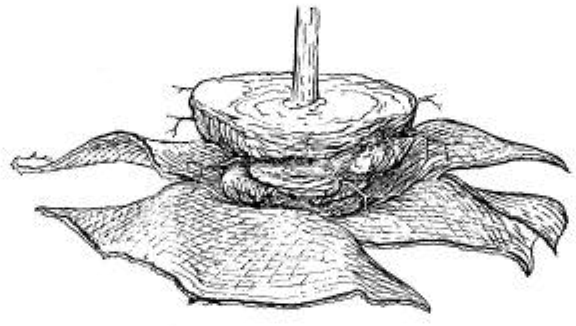

Figure 2. Wrappings need to be removed from ball and burlap trees.

Trees may be wrapped in a variety of materials. It is important to handle each of them properly so the health of the tree is not affected.

- Natural fabric wrapping
  Although natural-fiber burlap will eventually decompose in the soil, it should still be removed if it is possible to do so without damaging the rootball. If removing it appears risky, then try to cut back the top half of the rootball to encourage infiltration of water to the plant's roots.
- Synthetic fabric or plastic-coated burlap
  This fabric will not decompose naturally and therefore it must be removed to allow proper root growth and to avoid girdling roots. Shiny fibers indicate synthetic burlap.
- Wire baskets
  Wire baskets are sometimes used to hold the soil in place around the roots in larger trees. It may be detrimental to remove the basket from large rootballs before planting. In these cases, cut away as much wire as possible, at least the top 2/3 of the root ball, and bend back to the bottom of the planting area. This will help avoid growth and maintenance problems.
- Wrapping cords
  Remove all wrapping cords, especially nylon string or rope.

Tags and Labels
All tags and labels need to be removed from the tree to prevent girdling of branches and trunk.

Plant the Tree

Carefully place the bare roots or root ball in the planting area. In most cases, the root crown, where the roots end and the trunk begins, needs to be at ground level. Straighten the roots of bare-root trees to prevent circling, girdling, or crossing roots.

It is usually best to backfill with the same soil that came out of the planting area. When refilling, use your hands, shovel handle, or stick to press the soil around the roots to eliminate air pockets that can cause the roots to dry out. Avoid packing the soil too hard since this can reduce soil pores and cause compaction. Be careful not place soil over the root crown. While backfilling, apply water to settle the soil. Make sure the tree is straight.

Do not plant a $100 tree in a $10 hole.

Having a tree planting ceremony is a good way to promote special programs in the community.

Checking Your Understanding of Planting Guidelines

On a separate sheet of paper, answer these questions about the important points you need to remember:

1. Why is it important to know and be able to use proper planting techniques?

2. What are the guidelines to follow when planting a tree?

3. What should be your primary concern in preparing a site for planting a tree?

Answers are at the end of the unit.

Post-Planting Guidelines

The care a tree receives after planting is critical to its survival in an urban environment. Maintaining the proper soil moisture is the key factor in helping a tree become established. Here are some basic factors to consider in caring for a tree after planting:

- Water
- Mulch
- Pruning
- Fertilizing
- Staking
- Protection
- Regular monitoring and maintenance

Watering

The entire planting area needs to be watered within 2 hours of planting. Watering will help settle the soil and assure adequate soil moisture for root development. The amount and frequency of watering needed after planting depend on weather conditions (rainfall and temperature) and the time of year. The soil texture, type of tree stock planted, and size of the rootball also affect the amount of soil moisture needed by a newly planted tree. After the initial watering, it is also just as important to avoid over-watering the tree. Soil moisture needs to be monitored for the first few years until the tree becomes established.

A temporary berm may be constructed around the planting area to hold water in place during the first few years. This may be useful in open sites that require hand watering or in climates where rainfall is inadequate. However, if the site has poor drainage, do not build a berm. After the tree is established, the berm should be removed to promote watering and root development beyond the original planting area.

Do not let roots dry out!

Mulching

Applying 2 to 4 inches of mulch greatly benefits a newly planted tree by reducing turfgrass competition, reducing evaporation, and regulating soil temperature. However, the mulch should be kept away from the bark of the tree to prevent insect and disease problems. In some cases, using geotextile material instead of mulch works well for seedlings. Refer to the *Tree Maintenance* unit for more information on mulching, such as benefits, precautions, applications, and types.

Pruning

Pruning a newly planted tree, if done at all, should be limited to broken or damaged branches. However, sometimes pruning is required at certain locations, such as near a highway to allow for vehicle clearance. Pruning to shape or "train" new trees should be done after they become established, which generally takes at least one growing season.

Fertilizing

Trees should not be fertilized when they are planted because fertilization can cause new crown growth. There may not be enough roots to support the demand for water and nutrients for the new crown growth. Fertilizer can also "burn" the roots. Fertilizers may be used in site preparation, but only if the soil is in extremely poor condition.

Staking

In most cases, trees do not need to be staked because a well-planted tree with an adequate rootball can stand on its own without support. However, some conditions may warrant staking.

- Windy conditions
  If a tree is unstable in strong winds, staking can help protect it from blowing over. Also, if there are frequent high winds at a site, such as mountain ridges or ocean shores, staking may be needed.
- Sandy soil
  In sandy soil, trees tend to blow over and staking can prevent this.
- Small root ball
  Bare-root trees and those in grow bags sometimes require staking because they do not have large enough root balls to support the trunk.
- Leaning tree
  Staking can prevent some trees from falling over.
- Protection
  There may be situations where stakes can protect the tree from being damaged by lawnmowers, vandals, or traffic.

Disadvantages of staking
While staking can keep a tree standing, it can also cause damage.

- Weaker structure
  By protecting trees from the normal range of motion resulting from wind, trunk cells develop abnormally, weakening trunk structure. Staking limits the uniform development of reaction wood, making these trees more prone to blowing over as they age.
- Bark and trunk damage
  Staking wires can damage and wound the bark of trees.

Staking instructions

If staking is needed, here are some recommendations to help the tree survive (figure 3):

- Stakes
  Two stakes, one of either side of the tree, are usually adequate. Three stakes may be used on trees with trunks larger than 3 inches in diameter. Avoid using only one tall upright stake against the tree trunk because it can damage the bark and rootball of the tree. Stakes should not be set into the rootball.
- Ties
  Wires can harm the tree bark and trunk. Plastic webbing, polyethylene tape, inner tube, elastic cord, or other soft, flexible material make good ties. Protect the trunk with soft material, such as rubber tubing, lawn chair webbing, or soft permeable cloth. Using elastic cords as ties allows for more movement of the tree.
- Attachment
  The ties should be attached to the tree with a small amount of slack. This allows the tree to move in the wind and develop reaction wood for support in the trunk. A staking system that allows at least some movement results in a stronger trunk. The ties should be attached at the lowest position on the trunk that will hold the tree erect (Ingram, Black and Gilman 1991).

For more information on different staking techniques refer to the publication, "Trees for Urban and Suburban Landscapes."

- Removal
  Ties should be checked regularly to make sure they are not damaging to tree. Stakes and webbing need to be removed when the tree can stand by itself, usually after one growing season or less. Keeping the tree staked longer than one year may result in the bark eventually growing around the ties and girdling the trunk. Longer periods of staking also reduce the chance the tree will be able to stand alone.

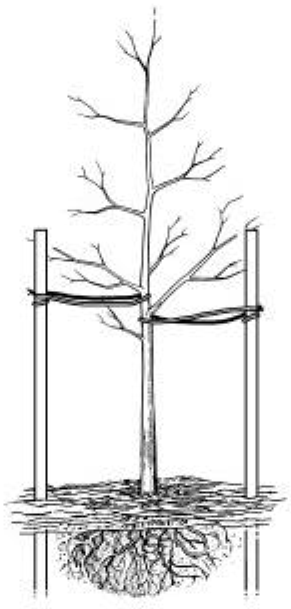

Figure 3. One example of how to properly stake a tree.

Protection

Sometimes trees need protection after they have just been planted.

Tree shelters

A tree shelter protects a young tree or seedling from animal, vehicle, lawnmower, and string trimmer damage. It is a light-colored, translucent plastic tube that fits around the trunk of the tree below the lowest permanent branch. Tree shelters are like mini-greenhouses and can protect the trunks from cold, windy weather.

Tree wraps and guards

Wrapping a tree's trunk with paper, burlap, or plastic is usually unnecessary and can actually harm the bark by increasing insect, disease, and water damage. Some young trees, especially those with thin bark**,** such as red maple, may need to be wrapped to protect them from sun scald. Sun scald (actually a freezing injury) occurs in winter when the temperature of a tree trunk increases during the day and then drops quickly at night. Such sudden drop in temperature can injure or kill the bark and cambium (Harris 1992). If a wrap is used, it needs to be removed during the first growing season to reduce the possibilities of insect and disease problems.

Refer to the publication, "Use and Misuse of Tree Trunk Protective Wraps, Paint, and Guards," listed at the end of the unit for more information on tree wraps and guards.

Protective grates

At some locations, especially those near sidewalks and roads, grates are used to protect the soil from being compacted. They are usually 3 to 5 feet in diameter and are placed at the same level as the pavement. If the soil level is well below the cover, the soil may be covered with gravel to decrease erosion from watering. Some communities require protective covers for safety reasons.

Staking

Staking, as stated earlier, is another way to protect the tree from damage by lawn mowers and string trimmers. However, remember to monitor and remove the stakes within one year after planting.

Regular Monitoring and Maintenance

Recently planted trees may suffer a great deal of stress. Trees need to be monitored regularly during the first 2 years, especially the soil moisture. Proper mulching helps maintain the necessary soil moisture. Tree shelters, wrapping, and staking need to be checked and removed as soon as possible, usually within the first year. Berms used for watering also need to be removed. Regular maintenance after planting will help ensure the healthy growth of the urban forest

Checking Your Understanding of Post-Planting Guidelines

On a separate sheet of paper, answer these questions about the important points you need to remember:

1. What is the most important maintenance requirement of a tree after planting?

2. List three reasons a tree may need to be staked. When a tree is staked, what precautions should be taken to prevent damage to the tree?

3. What are some of the reasons a newly planted tree may need to be protected in an urban environment? List two ways that you can do this.

Answers are at the end of the unit.

Case Study

Down Below

The zelkovas were here and ready to be planted in a grass median down a 2-mile stretch of a 4-lane highway. This was an important project for the local Tree Board because the highway was one of the gateway corridors into the community. They scheduled the planting for a weekend when traffic would be light, and asked Lawrence, a forester with the State forestry agency, to help with the planting.

The balled and burlapped zelkova trees were brought to the site early Saturday morning. The 3-inch caliper trees were so heavy they had to be rolled from the truck to the planting area and the wire baskets removed**.** The Tree Board members had their shovels and began planting the first trees about 40 feet apart. The first five trees went in without any problems -- everything was great. The planters even had a water truck there to water the trees.

But then, trouble. Denise was starting to dig the planting area for the 6th tree when her shovel hit asphalt. She tried another spot a few feet farther down the median -- asphalt again! Someone else went even farther down the median and also found asphalt.

The members of the Tree Board were devastated. Everything had been arranged for that day. The trees were expensive and had already been paid for. They had to decide quickly what to do and they asked Lawrence for help.

You and the Tree Board and the Zelkovas

Put yourself in Lawrence's position. What would you suggest they do? On a separate page, answer these challenge questions, explaining the recommendations you would make for solving this planting problem.

- There are volunteers, lots of tree stock, and equipment standing in the median on this busy highway on a Saturday morning.What are some of the things you need to decide first?
- The major question is what to do with the trees -- where and how should they be planted? What options do they have?
- What are some of the planning considerations in making this decision? Community issues? Planting issues? Volunteer issues?
- What about the trees while these decisions are made?
- The trees will need to be planted somewhere. What about after they are planted?

After you have answered the challenge questions, read the rest of the story to compare your solutions with what really happened.

The Rest of the Story

Asphalt Begone
They really didn't have any choice but to postpone the planting. Tree Board members apologized to the volunteers and sent them home for Saturday morning. After the volunteers left, there was a hasty meeting to decide what to do. Board members realized they had only two options -- try to find a way to plant the trees here or find another location. Since the median was located in one of major gateways to the city, they agreed this was where they wanted to plant the trees, if at all possible.

Lawrence thought it was possible and recommended they get a backhoe to dig out the asphalt under the median. He thought they would probably need dump trucks to take the asphalt to the landfill and topsoil backfilling the planting areas. He also suggested the Tree Board check into procedures for using a backhoe on a major highway because they might have to block traffic while using it. It might also be useful to check with the State highway department to find out the extent of the asphalt in this section of the median. They agreed to go ahead with arranging for the planting, even though it was going to be more expensive. While these arrangements were being made, they stored the zelkovas in an area protected from the weather and kept the roots moist.

The next weekend everything went just as planned. The volunteers and the water truck were back. A local construction company donated the use of the backhoe and dump truck. The City's Landscaping Division donated topsoil and mulch. After the trees were planted, Lawrence recommended the lower branches be pruned for truck clearance. The Tree Board had already arranged for one of their members to monitor the trees for the next few years.

Digging In

- Did you also decide to plant the zelkovas in the median? Why or why not?
- Were your planting suggestions (using the backhoe, bringing in topsoil, etc.) similar to the ones Lawrence made? If you made different suggestions, how might these have changed the plans for planting?
- Were your recommendations for caring for the zelkovas the same as Lawrence's? Before planting? For maintenance after planting?
- Considering this experience, what suggestions would you make to the Tree Board when planning future tree plantings?

Next?

This unit on *Tree Planting* has provided basic information about preparing the site, planting the tree, and post-planting care of the tree. The questions here will help you think about how this knowledge can be used in your work and will help you develop an action plan for applying it to planting practices in your area.

- What are some of the situations in your work where this information about planting will be most helpful?

- How can this information about planting trees be used to help develop and maintain the urban forest in your community?

- How can you use your knowledge of proper planting guidelines when working with community groups or organizations?

- What other resources are available for you to use when you have questions about planting in your specific area?

For More Information

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Checking Your Answers

Checking your Answers about Planting Guidelines

1. Why is it important to know and be able to use proper planting techniques?

Trees in an urban environment face many environmental conditions that make survival difficult. Using proper planting techniques helps maintain the urban forest in several ways:

- Helps the tree become established more quickly and with less stress.
- Improves the health of the tree and increases its life expectancy.
- Reduces the need for corrective maintenance as it grows.
- Icreases the benefits and reduces the cost of managing the urban forest.

2. What are the guidelines to follow when planting a tree?

A tree's survival and establishment are greatly increased when these guidelines are considered when planting:

- Select a season or time of year for planting that will ensure adequate moisture for root development and avoid extremes in temperature and other conditions.
- Select the proper tools and equipment for planting the tree.
- Prepare the site property to improve growing conditions.
- Handle the tree stock carefully before and during the planting.
- Use recommended planting methods.

3. What should be your primary concern in preparing a site for planting a tree?

Identifying and alleviating soil problems at the planting site is the primary concern in site preparation for tree planting. Soil conditions greatly impact a tree's ability to survive the planting process and problems should be corrected or minimized during site preparation. Soil testing can help identify problems and determine steps to solve them. At the time of planting, it is also important to loosen the soil to the depth of the rootball and to dig the area wide enough to provide space for adequate root growth.

Checking Your Answers About Post-Planting Guidelines

1. What is the most important maintenance requirement of a tree after planting?

Water is the primary requirement for a tree after planting and is the key to its survival. Many of the tree's roots may be lost during the transplanting process and new ones must be grown in order to absorb water and nutrients necessary for growth. An adequate amount of soil moisture, appropriate to the on site and weather conditions, is necessary for the tree to reestablish its root system. However, too much water can cause the tree to become stressed and die. Watering immediately after planting will help settle the soil around the rootball and relieve problems caused by water stress and transplant shock. Periodic watering should continue until the tree becomes established.

2. List three reasons a tree may need to be staked. When a tree is staked, what precautions should be taken to prevent damage to the tree?

These are some of the conditions that may require a newly planted tree to be staked:

- Windy conditions that can blow the tree down before the root system is established
- Sandy soil that will not hold the rootball in place until additional roots are established
- Small rootball that will not support the trunk
- Tree is leaning
- Nearby activity of people and machines. (However, other means of protection should be considered before staking a tree.)

Here are some precautions that need to be taken to prevent damage or injury to a tree that has been staked:

- Do not drive stakes into the rootball.
- Use a soft, flexible material for ties that will not damage the bark; wire should not be used. A soft, flexible material should also be used under the ties as additional protection for the trunk. Ties need to be attached so that some movement in wind is possible. They also need to be attached no higher than half way up the tree.
- Check ties periodically to make sure the bark is not growing around them.
- Remove ties and stakes as soon as the tree can stand alone so the tree can naturally develop the reaction wood that helps to support it.

3. What are some of the reasons a newly planted tree may need to be protected in an urban environment? List two ways that you can do this.

In an urban environment, trees are exposed to many different environmental conditions that may reduce the survival rate after planting. Some of these problems include damage to the tree tissue from people, animals, and machines, such as lawn mowers and trimmers, and damage to soil from compaction and drainage problems. Problems may also occur because the tree is not planted in its natural habitat, such as being planted alone rather than in a stand. This may require staking or protection of the trunk from sun scald.

- Several types of protection can be used for urban trees:
- Tree shelters protect the trunk from tissue damage.
- Staking may be necessary to support the tree until the root system is reestablished.
- Tree wraps protect tissue from sun scald.
- Grating may be used around the tree to protect the soil.

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

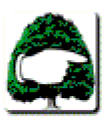
Some inorganic materials used for mulch include crushed rock, gravel, and polyester fabrics. These last a long time and protect better against weeds, seeds, and diseases then organic mulches. However, they do not add any nutrients, enhance the soil or aid in conserving moisture in the root zone. Landscape 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	• Poorly drained soil
• Sandy-textured root ball	• Clayey-textured root ball
• Planting in warm season	• Planting in cool or dormant season
• Dry weather	• Rainy weather
• Sunny days	• Cloudy days
• Windy days	• Calm days
• Container-grown and freshly dug field-grown nursery stock	• Hardened-off field-grown nursery stock
• Sloping ground	• Flat ground
• Warm climate	• Cool climate
• Southern or western exposure	• 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

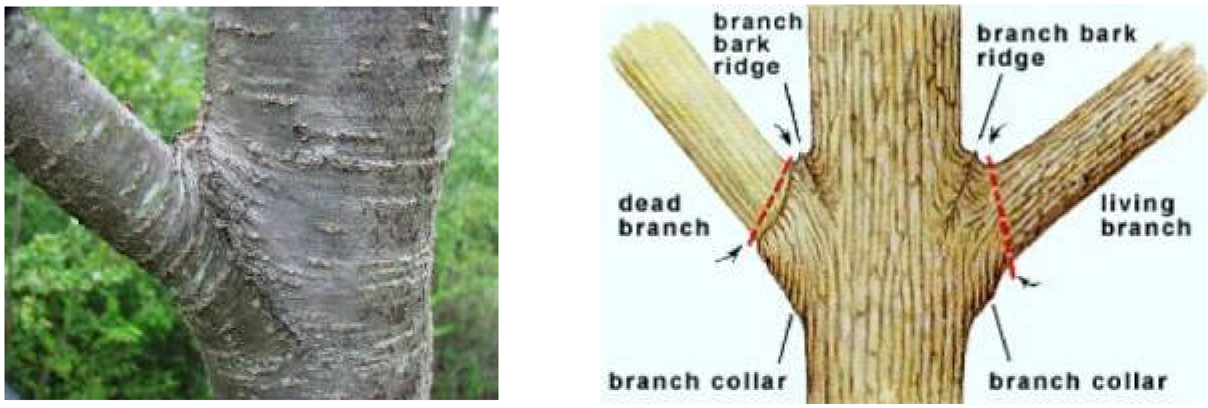


Figure 1. Identifying the branch bark ridge and branch collar is essential to pruning dead and living branches. Courtesy of USDA Forest Service Northeastern Area (Bedker and others 1995).

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).

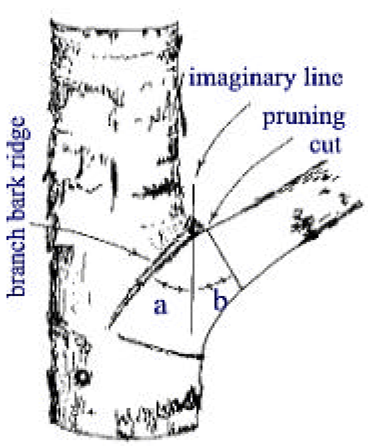


Figure 2. A branch with no visible collar. Courtesy of Edward F. Gilman, Professor, Environmental Horticulture Department, IFAS, University of Florida.

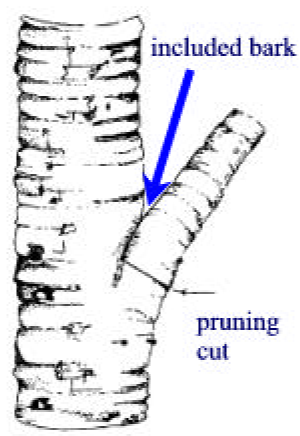


Figure 3. A branch with included bark and no visible collar. Courtesy of Edward F. Gilman, Professor, Environmental Horticulture Department, IFAS, University of Florida.

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).

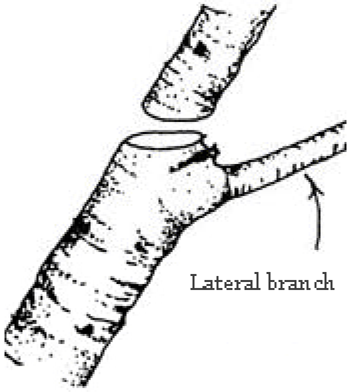


Figure 4. A reduction cut removes a stem back to a lateral branch that will assume apical dominance. Courtesy of Edward F. Gilman, Professor, Environmental Horticulture Department, IFAS, University of Florida.

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.

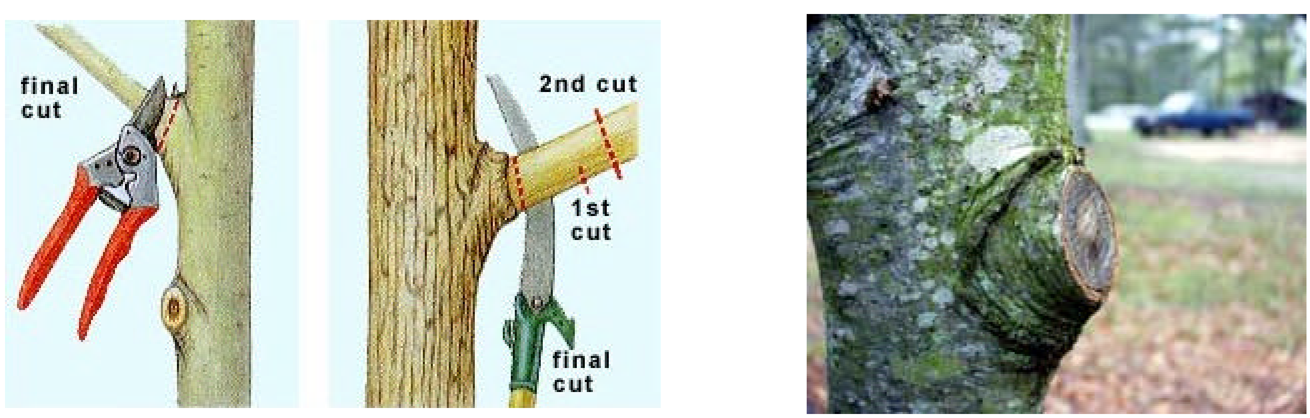


Figure 5. Three cuts to remove a limb more than one inch in diameter. Courtesy of USDA Forest Service Northeastern Area (Bedker and others 1995).

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?

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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.

URBAN FORESTRY

Trees and Construction

USING THIS MANUAL

The Urban Forestry Manual has been developed by the Southern Group of State Foresters and the USDA Forest Service, Southern Region as an educational manual for the employees of State forestry agencies. This manual provides the scientific, technical, and practical information needed to work with communities on urban forestry. Each of the 16 units (listed below) addresses a specific topic 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.

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

USING THIS UNIT

The Urban Forestry Manual consists of 16 units to provide you with the technical and practical information that will be useful for your work. Each unit 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 and 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 the 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 offer your solutions. There are no right or wrong answers -- only what you decide is the best course of action after considering all the information.

TREES AND CONSTRUCTION

Table of Contents

Trees and Construction

Overview

Land development and construction are having a major impact on the urban forest. Key to minimizing this impact is to work with developers, local government, and citizens to plan for tree protection, maintenance, and replacement during these activities. This unit first discusses how important it is to get involved in the land-development process. Then it reviews how construction activities damage trees. Methods of protecting trees before, during, and after construction are then discussed, with emphasis on tree-protection techniques. The last section discusses how site plans can be used as a tool for tree protection.

A "Beech" House In the Piedmont

Good Intentions

Here was a perfect setting for an apartment complex, and the developer knew the trees on the land would be an asset. In particular he liked the old American beech tree near the center of the property, and he decided to nestle an apartment building next to it. Decks were built around the tree, giving the apartments a "beech" outside their back doors. But the developer didn't realize the double whammy he was facing -- an old tree is more sensitive to changes and the American beech is even more sensitive than most species. His best intentions were not enough to keep the beech alive. Deterioration began early in the construction and each action just added one more "nail in the coffin." First, the tree was side-pruned to make room for the apartments, and roots were cut on one side when the foundation was excavated. Construction equipment was parked under the shade tree, compacting the soil on its "good" side and an irrigation system was installed. For a tree that liked moist, but well-drained soil, this beech was now getting a daily dip from the sprinkler system. Six weeks after construction was finished the beech died. The tree, because of its location within the apartment complex, had to be removed piece by piece; a costly procedure. The apartment may have come to the beech, but the beech couldn't survive its new neighbors.

We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect.
Aldo Leopold, Sand County Almanac

Before You Begin

This unit addresses ways you can help others understand the relation between trees and construction. Before you begin reading, take a few minutes to think about some of the current construction practices that affect trees in your community.

- What types of construction practices have you observed that impact trees?

- Have you driven through a community and seen land cleared of all the trees and other vegetation for a construction project? What were the effects of this on the surrounding land? Have you seen just the opposite, where trees were protected on the construction site?

- Have you or someone in your office tried to explain to a homeowner that the tree in their yard is dying because the roots were damaged when the home was built 3 - 5 years ago? What was their reaction?

Using this page, note how you think this information about trees and construction will assist you in your job.

Getting Involved

Getting involved in the land-development or construction process is essential to protecting and maintaining an urban forest. Protecting trees on the site should be considered and discussed throughout the land development or construction project – from the early design stages through completion. Getting involved in the beginning, during the design phase, usually allows more options for tree protection. To help you get involved and provide assistance, this unit will focus on these three areas:

- How construction activities impact trees
- Protecting trees before, during, and after construction
- Site plans – how they can be used as a tool

Opportunities for providing assistance

Many construction professionals, such as developers, engineers, architects, and road- building crews, may not be aware of how their actions can damage and kill trees. And natural resource professionals are not always aware of the concerns and issues of those in the construction profession. Understanding these different perspectives and issues associated with protecting trees on construction sites is important to successful tree protection. There are many ways to provide assistance related to trees and construction (table 1).

Table 1. Examples of ways to provide assistance, and potential recipients

Technical/Educational	Planning	Community
• Trees most suitable to save, remove, or transplant • Tree response to construction damage • Hazard trees • Site and tree selection • Tree diagnosis and treatment • Tree protection techniques • Incorporate natural resources into land development • Minimize impact to trees • Workshops and publications	• Construction plans • Land development plans • Government ordinances and regulations • Reviewing site plans • Ecological impact from site changes	• Developers • Builders • Engineers • Architects • Landscape architects • Contractors • Other sub-contractors • Homeowners • Neighborhood associations • Road building crews • Garden Clubs • Chamber of Commerce

How Construction Activities Impact Trees

Knowing how construction activities impact trees is critical to understanding tree protection, recommending tree-protection techniques, and communicating with people involved in the construction process. This section will begin by briefly describing how trees can be damaged above and below ground, as well as symptoms and signs of construction damage. However, the main focus of this section is on the different types of construction activities and how they affect trees.

Important point icon: Construction activities can impact established trees on a site, as well as trees planted after construction.

Above-ground and below-ground damage

Trees can be damaged both above and below ground by construction activities. The above-ground damage, such as bark wounds, is usually visible. Below-ground damage to the soil and root system is not always visible, and therefore is often overlooked or undetected.

Construction activities can impact trees in various ways:

Important point icon: Construction activities typically cause more damage below ground than above ground.

- Trunk and crown damage
  Construction vehicles and activities often cause trunk and crown damage, such as split trunks, broken limbs, stripped bark, and burned branches and leaves. Wounds to the trunk and branches become entrance points for insects and disease.
- Direct root damage
  Roots can be damaged both directly and indirectly. Direct root damage includes
  tearing, stripping, crushing, severing, and exposing roots. Trees that suffer direct root damage may lose their ability to absorb and transport water and mineral nutrients and can be prone to windthrow and insects and disease. Examples of construction activities that frequently cause direct root damage include clearing, grading, paving, and trenching for utilities.
- Indirect root damage
  Indirect root damage refers to changes in soil conditions that affect the roots. Indirect root damage often occurs when the normal exchange of gases in the soil atmosphere is interrupted resulting in a deficit of soil oxygen and increases in toxic levels of carbon dioxide and other gases. Other causes of indirect root damage include soil compaction, changes in soil moisture conditions and drainage patterns, soil contamination, changes in soil fertility and pH, sedimentation, and deposition of soil fill material. Construction activities that may cause indirect root damage are grading, vehicle parking and traffic, storage of materials, chemical leaking, and carelessly located concrete washouts.

Interesting point icon: Most tree roots are within the top 18 inches of soil and extend well beyond the spread of the tree canopy.

- Changes in exposure
  When trees are removed from a construction site, the remaining trees (which are either standing alone or on the outside edge of a stand) will likely have increased exposure to direct light and wind. Trees that receive more direct light for long periods may have sun-scorched leaves or wilt from dehydration. These trees are also more susceptible to broken limbs and wind throw.

Photo 1: Construction site showing damage to trees.

For More Information Icon: For more information on how to minimize the impact of these construction activities, refer to the "Tree Protection Techniques" section later in this unit.

Symptoms and signs of construction damage

Symptoms and signs of construction damage may not be noticeable for several years. Insects, diseases, and other causes are often blamed for the death of a tree, even though construction damage initially started the decline. How trees react to construction damage depends upon species, age, health, extent of damage, season, and site factors. The first visible symptom of construction damage usually occurs in the leaves, although each part of the tree eventually shows symptoms and signs of damage (table 2).

Action Icon: Find out how species in your community react to construction damage.

Table 2. Symptoms and signs of construction damage

Tree part	**Symptoms and signs of damage**
Crown	Slow rate of growth, staghorns, or dieback
Leaves	Wilted, scorched, sparse, undersized, distorted, chlorotic, browning leaf margins, premature autumn color, or premature leaf drop
Trunk	Wounds, bark removed, crown rot, absence of buttress flares, adventitious sprouting , suckering, and severe insect damage and disease
Branches	Dieback, slow growth rate, wounds, adventitious sprouting, or suckering
Fruits and flowers	Abnormally large crop or absence of fruit, flowering out of season

Different types of construction activities

The construction activities described in this section include:

- Clearing
- Grading
- Trenching
- Vehicles, pedestrians and materials
- Paved areas
- Concrete washouts
- Leaks and spills
- Bury pits and fires

Clearing

Site clearing is the removal of all unwanted trees and vegetation from the construction site. Because tree roots spread extensively, clearing with heavy equipment, such as a bulldozer, usually tears the roots of the remaining trees. The heavy machinery used to clear sites can crush roots and compact the soil. Trees being removed from the site may also fall and break branches or damage the trunks of the remaining trees. The remaining trees will also be more exposed to light and wind.

Removing vegetation from a site can change drainage patterns. Higher rates and volume of water runoff can cause soil erosion and sedimentation. The soil erosion that may result can undermine the roots of the remaining trees. And the sediment from the erosion, which is usually fine soil particles, can cause anaerobic soil conditions. Sediment can also affect water quality in nearby rivers, streams, and lakes.

Photo 2: Site clearing and grading.

Grading

Grading generally refers to moving soil. When soil is removed it is called "cutting" and when soil is added it is called "filling." Grading can alter the natural shape of the land, which may change the drainage pattern. The water table may also be lowered or raised by grading. Vehicles used for grading, such as graders, bulldozers, and backhoes, can compact the soil and injure the trunk and break branches of trees.

Interesting point icon: The redirection of runoff water toward constructed drainage ditches, drainage pipes, or impoundments can change soil moisture conditions.

Lowering the grade (cutting)

Often lowering the grade begins with removing topsoil, which may be stockpiled for later use or trucked to another site. Rough grading and excavation follow, and fine grading is done near project completion to improve site drainage and provide top dressing for landscaping. Direct root damage will most likely occur when soil is being removed from a site, such as leveling a piece of land for a building or excavating for a foundation. Removing topsoil can completely eliminate absorption roots and reduce soil fertility. Leaf litter is also often removed before installing formal landscaping. Lowering the grade can also inhibit nutrient cycling.

For more information: Refer to the "Tree Biology" unit for more information on roots.

Raising the grade (filling)

Raising the grade at a site can be permanent or temporary. When the grade or site elevation is raised permanently, such as a graded slope or behind a retaining wall, it is referred to as "permanent fill." When soil is stock-piled or stored for later hauling or use, it is called "temporary fill." Often temporary fill is stored around or near trees because it is convenient. Fill material can smother tree roots by limiting the normal exchange of gases between the soil and the atmosphere. The fill material may be of questionable quality depending on where it came from.

Fill material can be soil from the construction site or it can be trucked in from other locations.

Photo 3: Avoid placing permanent or temporary fill material around trees.

Trenching

Trenching is digging a ditch for the installation or maintenance of underground utilities such as gas, electric, water, sewer, and irrigation. A trench may also be dug for installing a silt fence (fencing material used to limit soil erosion). In housing developments, main utilities are generally placed beneath the roads, while service utilities to the home are located along the shortest and most direct path from the main utility to the home. Most damage to tree roots occurs during the installation and maintenance of service utilities. Root damage from trenching is not unique to newly developed areas, but also occurs in more established communities as a result of maintenance or the installation of utilities, such as fiber-optic line. Trenching can tear, crush, and sever roots. This not only reduces the water and nutrients a tree is able to absorb, but also decreases the tree's stability in high winds or wet soils.

Interesting point icon: A ditch as little as 2 inches deep in heavy clay soils can damage roots.

Photo 4: Trenching

Vehicles, Pedestrians, and Materials

Many construction sites have compacted soils because of the weight of heavy construction machinery, stored construction material, or repeated vehicle and pedestrian traffic. Compaction can also result from vibration caused by large grading equipment and pile drivers. Compaction can crush and tear fine roots, reducing the ability to absorb necessary water and nutrients. It can also cause indirect root damage by reducing soil pore space, which then diminishes the ability of the soil to absorb water and reduces the natural exchange of gases. Any mechanical equipment can also gouge the trunk or break branches.

For more information icon: Refer to the "Urban Soil" unit for more information on soil compaction.

Photo 5: Avoid storing construction equipment and materials under trees.

Paved Areas

Installing and maintaining paved areas, such as roads, parking lots, sidewalks, and curbs, can cause both above-ground and below-ground damage to a tree. Examples of how the construction of paved areas can injure trees include:

- Roots can be severed as soil is excavated for the paved area.
- Roots can be crushed when the soil is intentionally compacted under the areas to be paved.
- Roots can be killed if herbicides are used on the paving area.
- Soil moisture conditions can change if drainage patterns are altered, such as redirection of water flow and change in volume and rate of runoff.
- Soil pH may change due to concrete debris left in the soil.
- Soil temperature can be increased by reflected heat from pavement.

Concrete Washouts

Soil pH can dramatically change in locations where concrete contractors wash their concrete chutes after making deliveries. Mortar and cement, which are calcium based and therefore alkaline, raise the soil pH. A high soil pH can cause chemical reactions with nutrients in the soil, rendering some nutrients unavailable to the tree.

Leaks and Spills

Fuel, grease, paint, and other chemicals may leak or spill from storage tanks on the construction site. Field offices and trailers for subcontractors, such as painters, are often placed near or under trees. Spills of any toxic chemicals that kill the tree roots are fatal to the trees. Soil pH can also change because of leaks and spills.

Bury Pits and Fires

On some sites, construction debris, such as tarpaper, drywall, and paint cans, is buried. This debris may contain toxic materials that change the soil structure or alter pH. Also, if burn holes or debris fires are located too close to trees, flames and heat from the debris fire can scorch the trunks, leaves, or roots or even consume the tree in flames.

Checking Your Understanding of How Construction Activities Impact Trees

On a separate sheet of paper, list or write as short answers the important points you need to remember for each of these questions:

1. How can trees be damaged by construction activities? List the most likely causes for the each type of damage.

2. What problems may result from root damage?

3. Describe how clearing, paved areas, and concrete washout areas impact trees?

Answers are on page _____ at the end of the unit.

Protecting Trees Before, During, and After Construction

The most successful way to protect trees before, during, and after construction is through prevention. This can often be done by getting involved at the beginning of the construction project and providing on-site protection for the trees. This section addresses five subjects important to protecting trees on a construction site:

- Key players and their roles
- Land development process
- Site and tree evaluation

- Site plans
- Tree protection techniques

Key Players and Their Roles

Some of the key players involved in construction activities include the property owners, developers, general contractors and sub-contractors, architects, engineers, surveyors, landscape architects, natural resource professionals, local government, and the community. One of the best ways get involved is to talk with these people. Communication can be challenging due to the number of different people and professions involved in the construction process and the terminology used by the different professions. Find out what challenges they face related to working with trees and the natural landscape. Also talk with them about how construction activities impact trees. They may even be interested in a presentation, workshop, or field trip.

Important Point Icon: To have a successful project, tree preservation has to be a goal shared by everyone.

Property owner

The role of the property owner varies depending upon why he/she owns the property. For example, the property owner may be a couple building their first home or it may be a corporation building a large office complex. Typically, the property owner has the ultimate authority to determine what construction activities occur on the site.

Developer

The developer may be the property owner or his/her representative. The term "developer" usually refers to the person or business that has a financial investment in the property and whose primary goal is often to ensure that the project is a financial success. The developer may invest in the construction of large projects, such as shopping malls, or, if it is a small project, such as one home, the developer may be referred to as the builder. The developer will typically hire consultants, such as engineers and landscape architects, to develop construction site plans (drawings that show the layout of a proposed project) for the project and to facilitate getting permits from the local government. The developer may oversee all construction activities at the site or he/she may hire a general contractor or other consultants to oversee construction. Although many developers realize that trees add value and beauty to the property, the cost of protecting and preserving trees is often their immediate concern.

Interesting point icon: Inclucing tree protection clauses in construction contracts is one way to increase the level of awareness and compliance.

General contractor and sub-contractors

A general contractor coordinates the construction activities, such as land clearing, erosion and sediment control, grading, paving, utility installation, framing, landscaping, parking lot striping, fence installation, concrete installation, and painting. The general contractor is typically concerned about getting the project completed on time and within budget. General contractors hire and supervise "sub-contractors" that specialize in specific areas of work, such as painters and electricians. Sub-contractors report and get paid by the general contractor. The general contractor is usually responsible for any communication with the sub-contractors.

Architects

Architects design buildings guided by what the property owner or client desires, as well as by local government standards and building codes. Architects may be concerned about how the tree will affect the building, such as view, sun and shade, or design.

Engineers – civil and structural

Civil engineers design roads, sidewalks, utilities (water, sanitary sewers, and storm sewers), and retaining walls. They are usually concerned about storm-water management, soil erosion, roadways and intersections, site distances (clear views for seeing traffic, traffic signs and pedestrians), grading and drainage, and steepness of slope. Civil engineers can also prepare preliminary plats (simple drawings of property boundary or outline) for industrial, commercial, and residential subdivisions, as well as overall site plans for various types of developments. Structural engineers design retaining walls, bridges, structural framing plans, and foundations for buildings and large utility poles and signs.

Surveyors

Surveyors are responsible for title, deed, and easement research, boundary surveys, topographic surveys, and construction-phase staking and layout services. Surveyors can also design and prepare preliminary plats for industrial, commercial, and residential subdivisions.

Landscape architects

Landscape architects plan the entire arrangement of a site, including the location of buildings, plazas, streets, parking lots, open spaces, grading, storm drainage, utilities, storm-water management areas, natural/undisturbed areas, and buffers. They may design many of the same features as engineers. The landscape architect often develops the project's site plans, in cooperation with the other design and engineering professionals. A landscape architect usually develops landscaping and tree protection plans.

For more information icon: Refer to the section on "Site Plans" later in this unit for more information on landscaping and tree protection plans.

Natural resource professionals

Natural resource professionals, such as soil scientists, arborists, wetland ecologists, biologists, archeologists, urban foresters, and timber management experts, can be involved in the construction process. They may consult on issues related to the natural resources on the site, such as site conditions, tree health, wetland delineations or mitigation, threatened and endangered species, and historical or cultural artifacts. Soil scientists are the most commonly utilized natural resource professional. They conduct soil surveys for septic system planning and design; many are also qualified to delineate wetland areas. Soil surveys and wetland delineation are usually required by local, state, and federal regulations.

Local government

The local government often has a role in the construction process. This role varies, depending upon the community, because each local government has their own regulations for land development and construction. To work effectively with local government, find out the following information.

- How the local government regulates land development and construction activities by contacting the administration, planning, building inspection, public works, public utilities, or other departments. What is the land-development or construction process that the local government requires a property owner or developer to follow? How does the process for construction activities differ between private property and public property? Refer to the following section on *Land Development Process* for more information.
- What role does each local government department, such as planning, public works, and public utilities, play in construction activities that impact trees?
- What permits, such as a land-disturbance permit, does the local government require?
- What local ordinances regulate activities that effect trees? Get copies of the ordinances and become familiar with the terminology and the regulations.

FMI Icon: Refer to the "Public Policy and Urban Forestry" unit for more information on local government and the land development process

Community

The community plays a key role in the development of a project. What are the community's needs and what is its reaction to the project? Communicating with community residents can help anticipate reaction to a project and also help create a positive public image for all those involved in the development.

Interesting point icon: Trees can be a "hot button" item for communities.

Land Development Process

The land development process is different in every community – drastically different in some communities. The best way to become familiar with this process is to get involved and talk with the key players, especially the property owner/developer and those in the local government. The local government typically has mandated a process that ensures compliance with local, State and federal regulations. Even though the process is different in every community, two steps common to the land development process are 1) project team is formed and develops construction documents, and 2) construction documents reviewed for by local government.

Action icon: Identify where there are opportunities are for getting involved in the construction process.

Project team is formed and develops construction documents

The property owner and/or developer assemble the project team, usually consisting of the property owner, developer, general contractor, architects, engineers, surveyors, landscape architects, and natural resource professionals. When the project purpose and scope are identified, the project team starts gathering site data, conducting site analysis, and developing preliminary design alternatives. From those alternatives the property owner/developer selects a final design. Based on this final design, the site master plans and other construction documents are developed. When the project team completes the required formal applications for permits and construction documents, they are submitted to the local government for review.

If the project is going to require rezoning (changing the land-use classification of the property), variances (an appeal to change existing zoning requirements), or other modifications to local ordinances, the project team may have to go through other processes, such as the rezoning process, to obtain approval from the local government. Refer to the *Urban Forestry and Public Policy* unit for more information on the rezoning process.

Construction documents reviewed by local government

The formal applications for permits and site plans are reviewed by the appropriate local government departments, such as planning, public utilities, public works, transportation, building and inspections, fire, and engineering. The local government may require permits for land-development activities include building/construction, grading, sewer and water, soil erosion and sedimentation, land disturbance, and certificate of occupancy. During the review process, the local government looks for a variety of factors, such as compliance with local, State, and federal regulations, as well as impact on soils, drainage, topography, wetlands, capacity of public facilities, stormwater runoff and adjacent properties. Sometimes State government, such as the department of transportation or division of natural resources, and the federal government, such as Corp of Engineers, are also involved in the review. After the review process, the local government either approves or sends the application back for revision. This part of the process, revision, generally involves negotiation and compromise between the developer and local government. When approved, the local government will issue permits, as appropriate, and make site visits during construction and a final inspection to assure compliance to the approved plans and local codes and standards.

Interesting fact icon: A land disturbance permit may authorize clearing, dredging, grading, excavating, transporting, and filling, as well as overall site development.

Site and Tree Evaluation

The primary purpose of the site and tree evaluation is to identify trees at the construction site to save, remove, and/or transplant. Ideally this should be done at the very beginning of the project, when the project team is gathering site data, conducting site analysis and developing design alternatives. Look for opportunities to incorporate existing natural resources on the site into the design of the project. However, if site plans or construction drawings have already been developed, use the information from the site and tree evaluation to determine how construction activities will affect trees and look for ways to minimize that impact and modify the construction drawings.

A site and tree evaluation will describe the characteristics of the trees as well as site conditions. With this information it will be easier to select good quality trees that have the best chance of surviving after construction. Because it costs money to protect trees on the construction site, as well as to remove them after construction, it is important to select trees and design a project that will foster tree survival. Some things to be considered when evaluating the trees and the site include:

Tree age

Large, mature trees afford instant canopy, but young trees are usually more resilient to construction disturbance. For young trees selected to remain, ensure adequate space, both above and below ground, for growth. It is also generally recommended to save trees of various ages.

Tree value

Why are these trees important to this site and what benefits do they provide? Look for trees that have significant value, such as specimen quality, unique characteristics, historic significance, or ecological importance. Sometimes a tree has special sentimental value in a community.

Tree health

Select trees that are growing vigorously, have good structure and form, and no show severe insect or disease problems. Healthy trees have a better chance of surviving construction disturbances than unhealthy ones. If the tree has deadwood, thinning crown, leaning trunk, split trunks, root damage, and/or severe insect or disease problems, it may need to be removed.

Tree species

Different tree species react to construction damage in different ways (Coder 1996a). Look for those species that have the best chance of surviving after construction is completed. Try to save a diversity of species so the site will be more resilient to future insect and disease problems.

Critical root zone

The best way to protect trees on construction sites is to avoid disturbing the roots within the critical root zone. Generally, the critical root zone of a tree extends well beyond the spread of its branches. The critical root zone is a function of tree size, health, and how the species responds to construction damage. For example, the critical root zone of a young, vigorous red maple (tolerant to construction damage) is much smaller than that of an old, declining yellow poplar (low tolerance for construction damage). The size of the critical root zone should be adjusted according to the specific tree and site factors.

Groups of trees

Preserving stands of trees or "tree save" islands is encouraged because groups of trees often tolerate construction disturbance better than individual trees.

Transplanting trees

If a good quality tree needs to be removed because it is located where construction activities are planned, look for opportunities to transplant it to another location on the site. This works best for small trees, less than 10 inches diameter at breast height. Be sure that the appropriate equipment is used to transplant the tree.

Photo X (We have photos of tree spade – if we need it.)

Site conditions

What are the site conditions and how will they change during and after construction? Examples of factors to consider when evaluating the site include:

- Soil characteristics
- Wind and light patterns
- Slopes
- Drainage
- Rivers, creeks, and streams
- Structures and pavement
- Utilities

Site Plans

Site plans, also called construction documents, provide detailed information about existing conditions at the site and proposed plans for the project. These plans are drawings used during the construction process to visually illustrate project design and construction activities scheduled at the site, such as clearing and grading, control of erosion and sedimentation, water management and drainage, location of utilities, traffic engineering, hardscape (such as buildings and roads), and landscape. The site plans should also include information on trees to save, remove, and transplant, as well as location, species, and critical root zones of trees that remain on the site. They are the most important source of information for the major players in the project. Because site plans illustrate the planned changes at the site, they can be used to predict the impact those changes will have on trees and identify ways to prevent or minimize the impact. Things to do while site plans are being developed and reviewed include:

- Design the project to incorporate the existing natural landscape. Identify those natural areas that offer the most environmental and economic benefits to the project design and the site. Also, look for ways to minimize damage to natural features that can be assets to the project, such as using a wetland area as a storm retention pond.
- Determine what construction activities will impact trees and identify ways to minimize these impacts.
- Identify the critical root zone on the site plans to define the limits of disturbance for the tree protection areas. If it appears that some of the construction activities will impose on the critical root zone, suggest ways to modify the site plan. For example, a sidewalk may be moved to protect nearby trees.
- Similarly, modify the design, for example, by moving a parking lot to save a significant group of trees. The costs for the modifications need to be weighed against the value of the trees to be saved.
- Decide if it would be more cost effective to remove and replace a tree rather than saving it.

For more information icon: There is more information on site plans later in this unit.

Tree Protection Techniques

Various techniques can be used to protect trees from construction damage. Some of these techniques can be incorporated into the design while others can be applied on-site. Communicating with the property owner, developer, and general contractor about the significance of protection measures before, during, and after construction can foster acceptance. As mentioned earlier, identify the key players and their roles and look for opportunities to increase awareness and understanding of the relation of trees to construction. Refer to the Appendix for a checklist, *Minimizing Impact of Construction Activities,* which can be copied and used as a quick reference.

The following section discusses some of the common measures used for tree protection:

- Organize site activities
- Minimize land disturbance
- Trench before clearing and grading along limits of disturbance
- Account for underground utilities
- Adapt to pavement
- Install protective tree fencing around the critical root zone
- Mulch in the critical root zone
- Insure quality of fill material
- Prune branches for vehicle clearance
- Maintain trees
- Restore site

Important point icon: The best tree protection technique is prevention.

Organize site activities

Specific areas for construction activities, such as those listed below, should be identified and located outside, and sometimes far away from, the critical root zone. These areas can be identified on the site plans and marked on-site with signs.

- Vehicle and equipment parking areas
- Material storage areas
- Debris burn holes and bury pits
- Temporary offices, such as trailers
- Grease and fuel stations
- Concrete washout areas
- Temporary fill areas
- Chemical disposal

Important point icon: Avoid nailing building permits and other related signage onto the trunks of the trees.

Minimize land disturbance

Look for ways to minimize the amount of land-disturbing activities, such as clearing and grading.

- Leave natural areas and groups of trees

Leaving some of the site as a natural area and saving groups of trees can reduce the amount of clearing and grading.

- Tight grading contours and terracing

  Any grade change, either cut (reduce grade) or fill (increase grade), affects root and tree survival. A rule-of-thumb is that the steeper the grade the less area will be disturbed. Tightening grade contours and terracing are both techniques that can be used to make a slope steeper and decreasing the land that has to be disturbed. An engineer can recommend the best way to make the steepest slope possible while maintaining stability.

Photo 6: Terracing - Comparison illustration/photograph of how more trees were saved with these techniques.

- Retaining walls

  Retaining walls allow for a change in grade without any sloping. They can also be used to maintain a natural grade where a cut or fill is required. Some things to consider about retaining walls include the cost of construction, possible root damage to remaining trees, and potential changes in drainage patterns.

Photo 7: Retaining wall.

Trench before clearing and grading along limits of disturbance

Roots of trees to be protected trees are often fused or tangled with those of other trees that are being cleared from a property. Removal of the latter trees can damage the remaining ones by tearing and breaking these fused roots, jeopardizing the survival of the remaining trees. Cutting a 2-foot deep trench along the edge of the clearing will insure a clean cut of the roots and minimize the damage. Ideally, this trench should be outside the critical root zone of the protected trees. These trenches should be back filled with loose fill material and mulch to encourage new root development for the protected trees.

Account for underground utilities

Trenching for underground utilities (sewer, gas, water, cable, and electrical lines and pipes) may tear and cut roots of trees. Trenching may even be done after the tree protection fences have been removed from the site, cutting the roots of trees being saved. During the design phase of a construction project consider different options for accommodating underground utilities to minimize damage to trees.

- Relocate utility line

  If the utility line or trench is located too close to the critical root zone, recommend that the line be moved farther away.

- Use one trench

  Sometimes several utilities lines can be placed in the same trench rather than digging a separate trench for each utility line. However, this practice may be limited by local code.

- Tunneling

  Instead of trenching for utilities, tunneling beneath tree roots is another option. Tunneling involves using boring equipment to tunnel, bore, or push pipes and conduit underneath the roots of the tree. Some of this equipment can even bore through solid rock. Tunneling can minimize the impact on the critical root zone.

Photo 8: Tunneling & excavation

- Hand excavation

  In some instances, the value of the tree justifies hand excavation for utility lines. With hand excavation try to dig beneath any root exceeding2inches in diameter. While this method is labor intensive, the value of the tree may warrant it.

Adapt to pavement

Sometimes site plans or site limitations require the installation of pavement near or within the critical root zone of trees. Although this is not recommended, there are several things to consider when attempting:

- Pavement location

  Look for opportunities to re-locate the pavement outside the critical root zone. For example, curve the sidewalk around the tree instead of going straight through the critical root zone.
- Sub-grade compaction

  The soil underneath any pavement needs to be compacted before installing the pavement. Compaction prevents the soil from settling, which may cause the pavement to crack. The amount of soil compaction depends upon the load-bearing requirement of the pavement. For example, a road requires more sub-grade compaction then a sidewalk. If compaction is expected near or within the critical zone of trees, try to use a minimum amount of sub-grade compaction in that area.
- Permeable pavement

  Most paved or poured surfaces are not permeable. However, porous pavement allows the natural exchange of gases, nutrients, and water between the soil and the air and reduces the depth of disturbance. Porous materials available include interlocking blocks, bricks, porous cement and hollow brick pavers filled with soil and planted with grass.
- Soil modifications

  Researchers are currently developing new soil mixes that are load-bearing yet still allow for root penetration below the pavement surface.
- Herbicides

  Sometimes herbicides are used under the pavement to prevent vegetation from growing. Make sure the herbicide is not sprayed near the critical root zone of protected trees.

Install protective tree fencing around the critical root zone

Physical barriers, such as fencing that separates trees from construction activities, can protect trees on sites. Barriers are most useful when they are highly visible, sturdy enough to withstand the natural elements, and have signs to identify the tree protection area. These barriers should be installed outside the critical root zone. Protective tree fencing can be purchased from forestry and building suppliers and catalogs.

Photograph 9: Trees surrounded by protective tree fencing.

Mulch in the critical root zone

Parking of construction vehicles, contractor traffic, and material storage under trees can be anticipated in wooded areas on construction sites. To minimize soil compaction and root damage from these activities, spread a minimum of four-inch thick layer of wood-chip mulch over the critical root zone. Additional mulching may be warranted in heavy traffic areas. A good source for mulch is the natural debris generated from clearing vegetation from the site. In addition to preventing compaction, mulching conserves moisture, reduces erosion, moderates soil temperature extremes, increases fertility, reduces runoff, and reduces competition from grasses and weeds.

Important point icon: Mulching is one of the most important ways to prepare trees for construction.

Insure quality of fill material

If fill material is going to be stored near the critical root zone and the source of the fill material is unknown, it may be worthwhile to test the fill material for contaminants.

Prune branches for vehicle clearance

Pruning branches can increase the clearance between the trees and any proposed structure or construction equipment, preventing unnecessary damage to branches.

Maintain trees

Several tree maintenance activities can minimize the impact of construction activities.

- Fertilizing

  Fertilizer applications before construction begins can enhance the trees' vigor and ability to withstand stresses. It also helps the trees resist insects and diseases that result from site disturbances. Fertilization after construction can help a tree recover its vigor if it has suffered damage; however, use caution with the amount and timing. For construction-damaged trees, a slow-release organic form of nitrogen fertilizer is recommended because a quick-release fertilizer can create burst of vegetative growth that a damaged root system cannot support. The use of high-pressure, soil-injection fertilizer may be recommended on sites with compacted soils.

For more information icon: Refer to the "Tree Maintenance" unit for details on fertilization applications, methods, and rates.

- Pruning

  Pruning of dead, diseased, or broken branches may be desirable before construction. Avoid pruning live plant tissue from a construction damaged tree because this can accelerate the tree's decline. However, if the roots have been severed, pruning may be recommended to reduce the possibility of windthrow. Pruning deadwood is recommended only when all of the deadwood is evident, which may take from one to several years.

- Watering
  Before, during, and after construction, monitor soil moisture conditions and water as necessary.
- Aerating
  Vertical mulching is recommended for trees in preparation for construction to improve their vigor. Holes, 1 to 2 inches in diameter, may be drilled in the compacted soil and filled with such porous material as sand, perilite, vermiculite, or other material. After construction, compacted soils and areas of fill or sedimentation in the critical root zones of trees should be aerated to allow for exchange of air between the soil and the atmosphere (refer to the *Urban Soils* unit). These practices may help supply adequate oxygen to the soil essential for growth of the tree. However, it is best to prevent soil compaction through project planning and on-site protection.

Restore site

When construction is completed, try to restore natural conditions within the critical root zone of protected trees.

- Remove erosion sedimentation and fill material
- Remove construction and concrete washout debris
- Remove contaminated soil
- Improve site drainage
  Site drainage can be improved by removing minor fill and correcting any interrupted or redirected flow of water.
- Installing landscaping
  It is important to consider pre-existing site conditions when installing final landscaping. For example, trees that were once in natural areas do better with a natural forest ground cover than with turf or other plant materials that may be natural competitors. It is also important to consider how the site's exposure to sunlight may have changed.
- Install irrigation systems with care
  When irrigation systems are installed, the trenching can cut tree roots and kill the trees. This can be avoided during the design phase by locating the irrigation system outside the critical root zones. Also, soil-moisture problems for the trees can be caused by irrigation systems that are timed for the landscaping located beneath the trees, such as turf and flowers.

Site Plans

Site plans are an important tool for tree protection. As mentioned earlier, site plans are drawings that illustrate the design and construction activities for a project. Site plans are drawn to visually communicate the written information that is in the specifications (specifications are written instructions that explain construction activities; they can be a separate document or included in the site plan). A site plan can include information on the existing and proposed features and structures at the construction site. A review of the site plans will reveal construction activities that can impact trees. Information found on site plans can include:

- Property lines
- Structures
- Roads, parking lots, sidewalks, and other paved areas
- Retaining walls, fencing, light poles, park benches, and other such features
- Topographical features, such as contour lines and drainage swales
- Natural resources, such as bodies of water and trees
- Plant material
- Tree protection areas
- State water buffers
- Grading areas and drainage
- Utility locations
- Recreational areas
- Parking and building setbacks
- Easements and rights-of-way
- Erosion and sedimentation treatment

To maximize tree protection in the planning and development process, you must know how to read a site plan. Refer to the Appendix, *How to Read a Site Plan*, for information on the basic elements of a site plan.

Important point icon: Site plans reflect standards and requirements, such as soil erosion control treatment, that the local government requires for its review and permitting process.

Types of site plans

Different types of site plans are used to illustrate specific parts of a construction project. The types and number of site plans usually depend upon the complexity of the project; complex projects will typically have more than one type of site plan. These plans are all interrelated and they are the primary communication tools used by developers, builders, and subcontractors. Also, the information in site plans sometimes overlaps. Reviewing site plans helps ascertain the impact of construction activity on trees. Site plans can be modified as needed, although changes may increase the cost of the project. The next section briefly describes and illustrates the different types of site plans:

- Master plan
- Base sheet or existing site plan
- Demolition plan
- Layout plan
- Grading and drainage plan
- Erosion and sediment control plan
- Utility plan
- Planting or landscape plan
- Tree protection plan

Interesting point icon: There is no standard method for labeling site plans and there may be different names for the same plans.

Important point icon: Several types of site plans may be combined on one plan sheet, especially for small or less complex projects.

Master Plan

The master plan shows how the site will look when the project is finished (figure 1). (Some of the other common names used to describe the master plan are general site plan, final master plan, final site development plan, illustrative site master plan, and preliminary plat.) Typically, the master plan is on one sheet, showing the overall design of the project. For large or complex projects, the details are drawn on separate site plans for each component, such as the grading and drainage plans. The master plan may show the general location of existing and proposed trees, including their relation to each other and to structures. However, more detailed information from other site plans is needed to protect trees from construction damage.

Interesting point icon: For most subdivision projects, there will be a preliminary plat, which is similar to a master plan in that it shows overall design but also proposed lot lines, easements, setbacks, and roads.

Figure 1. A master plan for a housing development. (Courtesy of Rick Raymond and Associates, P.C.)

Base Sheet or Existing Site Plan

The base sheet or existing site plan includes information on existing features of the site as well as features of the adjacent property that may affect the site (figure 2). This plan usually includes topography, property lines, setback lines, easements, trees, structures, utilities, and drainage. It may also include information on existing trees on the site, such as species, size and condition. This plan can help determine which trees are to be saved or removed.

Figure 2. This is a base sheet or existing site plan that shows the location of trees. (Courtesy of Rick Raymond and Associates, P.C.)

Demolition Plan

The demolition plan shows existing features that are to be removed. Demolition work can endanger trees, especially since heavy equipment is usually involved.

Layout Plan

The layout plan illustrates the existing plus the proposed features of the site, such as property lines, easements, setback lines, structures (size and location), and plant material (figure 3). Layout plans can show the distance between existing and proposed structures and existing trees. This information can help determine if there is a suitable distance between the trees and the structures, and if the trees may be affected during and after construction.

Figure 3. Sometimes the demolition and layout plans are combined into one plan. (Courtesy of Rick Raymond and Associates, P.C.)

Grading and Drainage Plan

The grading and drainage plan shows the existing and proposed grade and drainage changes on the site (figure 4). On the grading plan it is critical to note how the grade changes may impact trees that will be protected. When drainage and grading activities are complicated, there may be a separate plan for each.

Grading and drainage plans furnish important information related to tree protection:

- Grading limits
- Location of retention ponds
- Spot elevations, including all proposed buildings and site improvements
- Direction of water flow
- Grade changes
- Areas and amounts of cuts and fills
- Location of storm drain structures and pipes
- State waters and floodplain

Figure 4. Grading and drainage plan. (Courtesy of Rick Raymond and Associates, P.C.)

Erosion and Sediment Control Plan

The erosion and sediment control plan shows the proposed structural and vegetation treatments that will be used to control and prevent erosion and sedimentation (figure 5). The types of information usually found on these plans, such as notes, construction schedules, soil types, limits of clearing and grading, existing drainage patterns and topography, and proposed grading, are helpful in developing tree protection measures.

Figure 5. Erosion and sediment control plan. (Courtesy of Rick Raymond and Associates, P.C.)

Utility Plan

The utility plan often shows the proposed and existing utilities or service lines, such as water, gas, electric, telephone, cable, sanitary sewer, and storm drainage (figure 6). It should also show the connection of these utilities to the main service lines off the site. The legend on this plan is critical because each utility has its own symbol. The general contractor usually contacts the individual utility owners to arrange the installation of service lines. Location, grouping, and routing of private utility service lines should be pre-planned and coordinated with all utility owners and the site designer before beginning any site work.

The utility plan is useful in identifying which trees may be affected by utility installation and in deciding whether the utility companies need to tunnel under the roots of trees. Utility lines should be located on the tree protection plan or planting plan. There should be a warning note on the plan to contact all utilities before digging or bringing in heavy and/or tall equipment or planting trees.

Figure 6. This utility plan illustrates proposed locations for gas (G), water (W), power (P), and fire hydrant (FH). (Courtesy of Rick Raymond and Associates, P.C.)

Planting or Landscape Plan

The planting or landscape plan shows the existing and proposed plant material (figure 7). It includes a legend or key to the plant list (common and scientific names), size, spacing, mulch, and special instructions, such as plant installation requirements and any special soil amendments. This plan can be a guide to the suitability of the tree species for the site and the proper planting space needed by the trees relate to structures and other trees. It should also provide a maintenance plan for the trees.

Figure 7. Planting or landscape plan. (Courtesy of Rick Raymond and Associates, P.C.)

The planting plan may also include irrigation plan to show the layout and size of the irrigation lines, types of sprinkler heads, back-flow preventers, timing box, and the water and electrical sources. The irrigation plan can also help determine the effect of the system installation on existing trees.

Tree Protection Plan

The tree protection plan should contain all the information necessary to protect the trees on the site (figure 8). This plan can help ensure the survivability of existing trees on a site, reduce future maintenance requirements, and prevent the development of hazard trees. A tree protection plan may include:

- Locations of critical root zones, specimen trees, and stands of trees, as well as tree species, size and health
- Trees to be removed
- Locations of structures, streets, driveways, sidewalks, parking lots, and utilities
- Methods of tree protection (details of tree fencing, signage, erosion control, retaining walls, tunneling for utilities, limits of amount of fill, aeration systems, trenching, transplanting, staking, pruning, fertilizing, and mulching)
- Designated areas with signs for parking, materials storage, concrete washouts, equipment fueling and servicing, debris burn areas, and debris burial holes
- Construction limits of clearing and land disturbance
- Notes detailing specific conditions set in the contract, such as fines for any damage to trees to be saved

Figure 8. Tree protection plan. (Courtesy of Rick Raymond and Associates, P.C.)

Interesting point icon: Some projects will have an As-Built Plan which illustrates how the project was actually built.

Checking Your Understanding of Protecting Trees Before, During, and After Construction

On a separate sheet of paper, list or write as short answers the important points you need to remember for each of these questions.

1. How can site plans be used most effectively to minimize the impact on trees during the construction process?

2. How can grade changing, utility line placements, and paving be planned to minimize the impact on the trees at the site?

4. What are some of the points you think would be helpful to communicate in a discussion with those involved in a local construction project?

Answers are on page _____ at the end of the unit.

Case Study

Planning a Grand Entrance

Jimmy, a forester in the local office, was contacted by two brothers, owners of a development company, who had questions about plans for a subdivision, Three Oaks, they were going to build. They were concerned about the impact the entrance road would have on a stand of trees. Jimmy set a meeting for two weeks before clearing and grading were scheduled to begin.

The master site plan showed a narrow, 12-acre tract, zoned for 1/3-acre lots (figure 9). At the proposed entrance there were five large oaks situated around an old home site. Three of these trees formed a triangle near the entrance while the other two were farther away, closer to the main road. The developers told Jimmy that the two trees closest to the road would be removed because the main road was being widened and a turn lane into the development was being added. The brothers' main interest was to find a way to route the entrance road through the middle of the triangle of trees without damaging them.

The trees they wanted to leave were two southern red oaks about 20 inches in diameter and one water oak about 24 inches in diameter. These trees were mid-size and had good form and sound structure.

Figure 9. Three Oaks Subdivision Master Plan.

In the Planning Triangle

Put yourself in Jimmy's place and think how you would respond to the developers. Can you offer a solution that will satisfy them and help the trees survive? On a separate page, write your answers to the challenge questions below, explaining how you will handle this situation. See how your answers compare with the recommendations that Jimmy actually made in the *Rest of the Story*.

- What options for constructing the road would you offer? Is it possible to construct the entrance and save the trees?
- What type of construction activities might the site plans show that would occur in the entrance area?
- How would you evaluate the trees suitable for preservation?
- If the trees were to remain, what steps would you suggest to avoid direct root damage?
- Are there steps you would suggest to protect the trees before and during construction?
- What should be done after the entrance is completed?

The Rest of the Story

Keeping His Fingers Crossed While Hoping for the Best

Using the site plans that had already been developed, Jimmy gave them a list of actions they could take to insure minimum tree damage from grading the land for the road, placing utility lines, and using construction equipment in the area. He suggested that a loop road around the trees (a single lane in on one side of the triangle and a single lane out on the other side) at least 40 feet away from the base of the trunks would minimize the impact on the trees. He also recommended that they look into using porous pavement for the loop road and he gave them brochures on different types that are available. Changes in some of the site plans, primarily the utility and landscape plans, would need to be made. While the main utility lines could be trenched and laid under the entrance road, this area would need electricity for the sign and security lights. Jimmy suggested that for the short distance from the main power line to the center of the trees it would be preferable to tunnel under the roots of the trees. He also gave them instructions for preparing the trees for construction, including mulching and fertilizing to improve the vitality of the trees. Site restoration was also discussed and it was suggested that leaving the entrance as a natural area would be best for the trees. The developers told Jimmy that because the space for the entrance was so narrow, building the loop road would "cost" them two lots for building homes. Jimmy suggested that perhaps the lots could be rearranged so that only half a lot on each side of the entrance would be "lost". After some more discussion, the meeting ended.

Jimmy did not have any further contact with the developers after that meeting. However, about a year later he happened to be in the area and drove by the subdivision to see how the entrance had been built (figure 10). The triangle of trees appeared to be doing well. The entrance sign for Three Oaks was placed just forward of the trees and a park bench was in the shade in the center of the triangle. While this may seem like a win-win situation for the forester, developers, and homeowners, the planned long-term care of these trees will be the real success story.

Figure 10. Three Oaks Subdivision As-Built Plan

Being Pleasantly Surprised

- Were your suggestions similar to the ones Jimmy made? Were there other options that could be considered?
- If you suggested a different solution, what advantages did it offer?
- If the developers had not been willing to change their minds about building the road through the trees, how would you have responded?
- What could Jimmy have done differently?
- What have you learned from the experience Jimmy had with these developers?

Next?

Trees that have been damaged or died because of construction activities present one of the most common problems found in urban forestry. With the basic information offered in this unit, think about how you will be able to help resolve some of these problems in the future.

- What are some of the specific benefits and costs associated with protecting trees during construction you have observed in your community? How can you use this information in talking with developers, builders, and homeowners in the future?

- How can your knowledge of the construction practices in your community help you to better address the issues concerning urban forestry?

- What are some of the ways you can communicate information about construction activities and the impact on trees to people in your community and help them use it in their planning?

- What other sources of information are available on protecting and caring for trees during construction activities?

For More Information

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Checking Your Answers

Checking Your Answers about How Construction Activities Impact Trees

1. **How can trees be damaged by construction activities? List the most likely causes for the each type of damage.**

- Trunk and crown damage
  While it is often unintentional, careless actions on a construction site may may damage trunks and crowns. These activities can include mechanical equipment hitting the trunk or breaking branches of a tree, using tree trunks as signposts, improper pruning of branches for equipment clearance, and locating burn pits too close to trees.
- Direct root damage
  Roots may be cut, torn, or stripped, when the land is cleared and graded and when trenches are dug for utility lines.
- Indirect root damage
  Some construction activities do not actually touch the roots, but can still cause damage to the root system of a tree. Some causes of indirect root damage include fill material or sedimentation that smothers the roots, concrete washouts and bury bits that change the chemical properties of the soil and changes in drainage patterns that alter soil moisture conditions.
- Exposure
  The trees that remain on a construction site are often exposed to different sunlight and wind patterns than they had been before, particularly if they had been located within a large stand of trees. They may receive more sunlight, causing wilting or sun-scorched leaves and increasing their need for water. They may also be more susceptible to windthrow since they are no longer protection from the wind. Trees that are now on the edge of a tree stand, because nearby trees were removed, may also have root damage.

2. **What problems may result from root damage?**

Root damage can -

- Limit the roots' ability to absorb water and nutrients from the soil and therefore cause slow growth rate or dieback
- Increase the risk of insect and disease damage
- Increase potential for windthrow
- Kill the tree

3. **Describe how clearing, paved areas, and concrete washout areas affect trees?**

- Clearing all unwanted trees and vegetation from the construction site, which is done with heavy equipment, can tear and crush roots, and damage branches and trunks of remaining trees, and compact the soil. Removing of vegetation often increases water runoff, causing soil erosion, sedimentation, and changes in drainage patterns.
- The installation and maintenance of pavement can crush, cut, and kill roots and change soil moisture conditions, pH, and temperature.
- Soil pH can dramatically change where concrete contractors wash their chutes after making deliveries. Cement, which is calcium-based and therefore alkaline, raises the soil pH. A high pH may cause chemical reactions with nutrients in the soil, rendering some soil nutrients unavailable to the trees.

Checking Your Answers about Protecting Trees Before, During, and After Construction

1. How can site plans be used most effectively to minimize the impact on trees during the construction process?

Site plans can be used most effectively before and during construction to plan and provide protection for the trees on a project site. Because they present information on existing conditions and proposed plans for the site, they are an important resource. The different types of site plans offer a variety of information that is helpful in tree protection, such as where clearing and grading will occur and where utilities will be installed. Site plans need to be reviewed and modified, if necessary, to minimize the impact on trees. A tree protection plan is important because it provides all the necessary information for tree protection and removal. Identifying the critical root zone on site plans is one way to define the limits of disturbance.

2. How can grade changing, utility line placements, and paving be planned to minimize the impact on the trees at the site?

- Reducing the amount of grading on the site is one of the best ways to prevent damage to trees. If grading near the critical root zone is necessary, options include using steep, narrow contours, and terracing. Both of these techniques can create a steep but stable slope or grade. Retaining walls may also be used to maintain the natural grade behind the wall, while making the necessary grade changes or cuts in front of it.
- The placement of underground utility lines is subject to several options. These should be explored when a problem is first identified on the site plan and before construction begins. The possibilities include relocating the utility line, placing several utility lines in one trench, tunneling beneath the roots of the tree, and, in cases of valuable trees, digging the trench by hand to lay the utility line.

- The best way to avoid pavement problems is to locate the pavement outside the critical root zone of trees. Other options include changing the area of pavement, using porous paving materials, and using soil modifications under the pavement.

3. What are some of the points you think would be helpful to communicate in a discussion with those involved in a local construction project?

Each construction project is different. The location and features of the land, the type of building project, and the people involved all contribute to the uniqueness of any construction project. Communicating with the people involved in the project is of primary importance. This includes property owners, developers, local government, community, and others associated with land development and regulations. The actual conversations that you have with these people depend on characteristics of the project, but certain points that may be helpful to include are:

- The need for early involvement of representatives from urban forestry in the planning process
- The importance of advance planning to maximize the benefits of the natural features, including trees, and lower the costs
- The necessity for each group (developers and builders, community, and local government) to understand the needs, goals, and values of the other groups as well as the values and role of urban forestry
- Development of a site and tree protection plan that allows reasonable and thoughtful decisions about which trees to save, which ones to remove, and which ones to be replaced during site restoration
- The importance of developing a tree protection plan that can be included in the site plan
- The types of problems that can occur before, during, and after construction that may affect a tree's health and the steps that can be taken to alleviate them.

Appendix – Minimizing Impact of Construction Activities

These are examples of different techniques that can be used to minimize the impact of construction damage to trees. However, remember that communicating with the key players and knowing their roles, conducting a site and tree evaluation, and reviewing and modifying site plans are essential to successful long-term tree protection.

Clearing

- Organize site activities – identify areas for debris-burn holes and parking
- Reduce amount of land disturbance – leave natural areas and groups of trees
- Install protective tree fencing around critical root zone
- Trench along limits of disturbance
- Apply mulch in critical root zone
- Prune branches for vehicle clearance
- Maintain trees

Grading

- Organize site activities – identify areas for temporary fill and parking
- Minimize amount of land distrubance – leave natural areas and groups of trees and use tight grading contours, terracing and retaining walls
- Install protective tree fencing around critical root zone
- Apply mulch in critical root zone
- Trench along limits of disturbance
- Insure quality of fill material
- Prune branches for vehicle clearance
- Maintain trees
- Restore site

Trenching

- Install protective tree fencing around critical root zone
- Locate trench outside critical root zone
- Place all utilities in same trench
- Tunnel beneath tree roots
- Hand excavate around roots
- Apply mulch in critical root zone
- Prune branches for vehicle clearance
- Maintain trees
- Restore site

Vehicles, Pedestrians and Materials

- Organize site activities – identify areas for parking and material storage
- Install protective tree fencing around critical root zone
- Apply mulch in critical root zone

- Prune branches for vehicle clearance
- Maintain trees
- Site restoration

Paved Areas

- Organize site activities – identify areas for parking, material storage, concrete washouts, and debris bury pits
- Minimize amount of sub-grade compaction
- Locate paved areas away from critical root zone
- Install pervious pavement
- Use soil mixes that are load bearing yet allow root penetration
- Keep herbicide sprays away from critical root zone
- Install protective tree fencing around critical root zone
- Apply mulch in critical root zone
- Maintain trees
- Restore site

Concrete Washouts

- Orgnize site activities - identify specific areas for concrete washouts and parking
- Install protective tree fencing around critical root zone
- Apply mulch in critical root zone
- Maintain trees
- Restore site

Leaks and Spills

- Organize site activities - identify specific areas for chemical disposal
- Dispose of hazardous chemicals properly
- Install protective tree fencing around critical root zone
- Apply mulch in critical root zone
- Maintain trees
- Restore site

Bury Pits and Fires

- Organize site activities - identify specific areas for bury pits and fires
- Dispose of debris properly
- Install protective tree fencing around critical root zone
- Apply mulch in critical root zone
- Maintain trees
- Restore site

Appendix – How to Read a Site Plan

A site plan provides visual information about the development and construction plans at a particular location. This appendix explains the different parts of a site plan and some of the terms that are commonly used in a plan. Learning to read site plans takes time and experience, but becoming familiar with some of the common elements in site plans is the place to start. Figure 11 is an example of a site plan for a construction project.

Figure 11. A typical site plan. (Courtesy of Rick Raymond and Associates, P.C.)

Standard Format

Most site plans have a standard format, such as size, title, page numbers, and symbols. This same format should be followed for all the sheets in the project. Most site plans are printed on 24" x 36" paper.

Title Bar or Title Block

The title bar or block, usually located on the bottom, right-hand corner or edge of the plan, lists the important information about the project (figure 12). The title bar may include:

Figure 12. Title bar or block. (Courtesy of Rick Raymond and Associates, P.C.)

Project title and location

The project title and location are always listed in the title bar.

Contracting company's name

The name of the company developing the site plans and the professional responsible for the site plans are listed in the title bar.

Interesting point icon: The client's name, address, and phone number may also be located near the title bar or in the site plan notes.

Version and dates

Check to see if the site plan is the draft or final version. Final site plans must be signed and sealed by the appropriate registered professional as required by each State. This could be an engineer, landscape architect, and/or surveyor. Site plans are often revised; the last revision date indicates the correct version.

Scale

Always check the scale on each drawing. The scale used for the drawing reveals the size of the project. The scale should be consistent from sheet to sheet within the site plan; however, sometimes one or more of the sheets will have a different scale. Scales can also be checked with field measurements because the scale may not be exact on the plan. Different types of scales used on a site plan include an engineering scale, architect scale, and not-to-scale (table 2).

Interesting point icon: A large scale has a small number (1"=10') and a small scale has a large number (1" = 100').

Table 2. Different types of scales.

Type of Scale	Description

Engineering scale	An engineering scale may involve increments of 10 feet, for example 1"=10' (one inch equals 10 feet), 1"= 20' (one inch equals 20 feet), 1"=50' (one inch equals 50 feet), or 1" =100' (one inch equals 100 feet), depending on the size and detail of the particular site. This type of scale also includes decimals of a foot on the drawings.
Architect scale	Building plans and detailed site plans may use an architect scale. This scale typically ranges from 1/8" = 1' - 0" (one-eighth inch equals one foot and zero inches) to 1-1/2" = 1' - 0" (One and one half inches equals one foot and zero inches). The architect scale shows fractions of an inch on the drawings.
Not-to-scale (NTS) or No scale (NS)	Some plans may not list a scale. If this is the case, it should read "scale = NTS" or "scale = NS." On some plans where there is no scale, the distance between two or more items may be written on the drawing.

North arrow

Before reading the plan, use the north arrow to orient it and yourself to the site. If the north arrow is pointing to the top of the plan, then orienting the plan is usually easier than if it points to the left, right, or bottom of the plan. The north arrow may be located somewhere else on the site plan and not in the title bar or block.

Sheet number

Sheet number refers to the number of sheets (drawings) in the project plan. Some project plans consist of one sheet that illustrates the project design. Large or complex projects usually have several sheets. Each sheet illustrates a specific part of the project, such as the grading plan. The cover sheet of the project plan should show the project title, site location, index of sheets, and other important information.

Legend or Key

The legend or key defines symbols or lines on the plan (figure 13).

Figure 13. Site plan legend or key. (Courtesy of Rick Raymond and Associates, P.C.)

Match Lines

Match lines may be found on each sheet of a multiple-sheet project and are used to help match the sheets with each other. They are located on the edge of each sheet.

Note Area

The note area is a place for notes or additional information related to the site plan. Examples of information in the note are:

- Call the utility company before digging.
- No tree shall be removed without the written approval of the landscape architect or city arborist.
- Prune all broken branches before planting.

Limits of Construction or Development

Limits of construction are often on the site plan to separate construction areas from adjacent areas. For example, the limit of construction may follow a property line. Or there may be grading limits on the site plan that indicate the soil cannot be disturbed by either cut or fill beyond a certain limit. Usually, the erosion and sediment control and tree protection plans include a symbol for the limits of construction.

Contour Lines

Contour lines show the topography or terrain at a site. All points on the same contour line are at the same elevation. The contour lines reveal the location of slopes, depressions, ridges, cliffs, and other topographical features on the site. Existing contour lines are usually dashed and proposed contour lines are solid. In most cases, contour lines are numbered, indicating the height above sea level. Each fifth contour line is usually drawn darker than the rest and is called the index contour. Numbered contour lines make it easier to determine the contour interval.

Interesting fact icon: A contour line of a given elevation will close on itself, but not necessarily on the site plan.

Key point icon: To read contour lines correctly you need find the contour interval.

Contour interval

The contour interval shows the vertical distance between contour lines. The contour interval is generally 1, 2 or 5 feet and is usually noted on the plan. When the interval is not given, the interval can be determined by reading the contour line numbers and referring to the scale of the plan. The contour interval usually remains the same throughout a site plan; and variations should be noted on the plan. It is essential to determine the correct contour interval to avoid mistakes.

Reading contour lines

Correctly reading the contour lines on a site plan reveals the changes in the terrain and the effect of these changes on the existing trees. Contour lines divulge information about drainage patterns, the grade around a tree, the amount of cut or fill around a tree, flood planes, steep grades, sinkholes, and potential areas for directing retention or drainage flow. Here are contour characteristics to look for in a site plan (figure 14):

Figure 14. Contour lines. (Courtesy of Rick Raymond and Associates, P.C.)

- Uniform slope
  If the contour lines are evenly spaced, the slope will be uniform in shape.
- Steep slopes
  The closer the contour lines the steeper the slope. Contour lines that are close together or converging to form one line indicate a steep slope, wall, or cliff.
- Spot elevations
  Spot elevations, indicated by a "x" sign in front of the number, are critical elevation points that indicate high and low points on the site. Knowing these numbers assists in determining how water flows across the site.

- Depressions
  Hatch lines across a contour line indicate some type of depression, such as a burrow pit or sinkhole.
- Stream valleys
  Contour lines point up stream valleys.
- Ridges
  Contour lines point down ridges.

Baselines

Baselines, which you will sometimes find on layout plans, are thick, horizontal or vertical lines that are starting or reference points for staking and surveying purposes. They are usually determined from the property line or centerline of road or corner of an existing building. The baselines can be used to find other features on the site, such as the location of a specimen tree.

Road Centerlines

Existing, and sometimes proposed, road centerlines can also be used as a baseline or reference point for other locations on a site plan.

Detail Sheet

Detail sheets are enlarged or exaggerated drawings to illustrate parts in a plan that require more detail. Detail sheets can show the location of tree roots and the directions for tunneling drainage pipes beneath the roots. A planting detail can describe the placement and installation of a tree. Some of the different types of detail sheets are:

Sections

Sections on a detail sheet typically show the cross section view of sidewalks, underground utilities, retaining walls, and other structures (figure 15). A cross section detail is a good way to illustrate what is being impacted both above and below ground.

Figure 15. Cross section view of a road right-of-way with utilities. (Courtesy of Rick Raymond and Associates, P.C.)

Elevations

Elevation detail sheets illustrate the above ground side or vertical view of the site or specific part of the site (figure 16).

Figure 16. Elevation view for lake access steps. (Courtesy of Rick Raymond and Associates, P.C.)

Profiles

Profile sheets allow the site to be visualized from a vertical perspective or scale. The vertical scale is often exaggerated to show even minor grade changes. They are used primarily in road and utility construction.

Road profile

The road profile illustrates how the roadbed will be cut or filled to meet its finished grade (figure 17). The road profile is a cross section view, but it is the view of the entire road, not just one part of the road. This information helps determine the impact of the construction on trees located near the road.

Figure 17. Road profile. Note the areas where cut and fill have to occur because the finished road grade is different from the existing road grade. (Courtesy of Rick Raymond and Associates, P.C.)

Utility profile

The utility profile illustrates the locations, heights, and depths of the utilities, both above and below ground. This information can be used to show tunneling under the tree roots (figure 18).

Figure 18. Utility profile. (Courtesy of Rick Raymond and Associates, P.C.)

URBAN FORESTRY

A Manual for the State Forestry Agencies in the Southern Region

Unit: Urban Wildlife

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 9 units are on the web site (www.urbanforestrysouth.usda.gov). The other units will be added as they become available.

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 is an introduction to the importance of providing regular maintenance to the urban forest. The basic steps to preventative maintenance are discussed, such as fertilization, mulching, pruning and tree protection.

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.

Urban Wildlife

Table of Contents

Overview

As areas in this region become increasingly urbanized, land that wildlife once had to itself must now be shared with people. So, it is important to understand the relationship between the urban environment and wildlife so that you can offer recommendations to homeowners, planners, developers, and others on general wildlife issues.

This unit begins by defining urban wildlife and describing its needs. Then ways the various species have adapted to living in an urban area and the characteristics of urban wildlife habitats are discussed. Finally, suggestions for encouraging or discouraging wildlife are given.

Give Me Liberty!

A Peaceful Solution

Early this spring Ray, the county forester, got a call from Jane, a homeowner, asking him to look at a couple of liberty elms she said were not growing. Upon examination Ray found that the local deer were using the trees as a sort of salad bar and had pruned them back severely. He checked with the Cooperative Extension Service's wildlife biologist who offered no easy solution short of shooting the deer, which was not an option for Jane, the property owner. Ray hit on the idea of building cages around the trees to keep the elm-munching critters away long enough for the little trees to get a bit of growth. Over several days, Jane and Ray constructed two frames 3 x 3 feet across and about 6-feet high from ½-inch PVC (poly vinyl chloride) pipe. They wrapped chicken wire around each frame and secured it with small cable ties. The tops were left open, and there was space at the bottom to allow for weeding and other maintenance. How well these odd structures work will not really be known until around this time next year. Meanwhile, Jane has a lot of fun telling her friends at work about her adventures in caging her wild elms.

A tree that may in Summer wear
A nest of robins in her hair
Joyce Kilmer, *"Trees"*

Before You Begin

This unit provides information useful in answering questions about urban wildlife issues when you work with individuals or groups in the community. Think about the wildlife in your community and how you can use this information in your work.

- What kinds of urban wildlife habitats are in your community?

- What do you know about the needs of urban wildlife where you live and work?

- How will your understanding of the habitat and problems associated with urban wildlife help in the management of the urban forest?

On a separate piece of paper describe the wildlife in your area, and think about how this information will assist you in your job.

Wildlife in Urban Areas

Urban wildlife is any wild creature that lives in an urban environment or an urban-rural interface, including birds, reptiles, amphibians, mammals, fish, insects, and worms. There are native species, such as squirrels, millipedes, and cardinals, and non-native species, such as pigeons and starlings. Our shift from a rural to an urban society has caused many changes in land use across the country as farms, forests, and grasslands become subdivisions and shopping centers. These changes greatly impact the habitat that wildlife depends on for food, water, cover, and living space.

The challenge is to work within the community to enhance those parts of the urban environment that contribute to wildlife survival and diversity while eliminating or minimizing as many of the negative aspects as possible. Participating in the planning process, especially in situations where urban and rural areas come together, can help prevent unnecessary destruction of wildlife habitat. Working with property owners and the public can encourage appropriate wildlife. Methods to discourage nuisance wildlife can also be recommended. There are various to provide assistance related to urban wildife (table 1).

Table 1. Examples of urban wildlife assistance and potential recipients

Technical/Educational Assistance	Planning Assistance	Potential Recipients
• Native plants and animals • Urban wildlife habitat • Needs and habits of urban wildlife • Urban environmental and contamination problems • Tree protection techniques • Techniques to encourage wildlife • Techniques to discouraging wildlife	• Establishment and maintenance of urban wildlife habitats • Protection of natural wildlife corridors • Water management program • Maintenance of native vegetation • Habitat management to control nuisance wildlife • Comprehensive planning	• Local nature groups and associations • Developers and home builders • Businesses and homeowners • Parks and recreation boards and staff • Rural landowners • Neighborhood associations

The Benefits and Costs of Urban Wildlife

Urban wildlife can add to the enjoyment of everyday life. Watching a squirrel grind away on a nut or listening to a dove coo offers moments of relaxation. Wildlife provides opportunities for observing and photographing animals that live near and in urban areas. Urban wildlife also serves as an educational stimulus by stirring people's curiosity about the natural world. Wildlife in the urban environment can also cause problems by destroying property, carrying disease, producing unsanitary waste, and conflicting with human activities. Wildlife that is forced to live in urban areas may displace other species of animals that are already living there.

Urban wildlife can provide many benefits in an urban setting, including recreation.

Four Basic Needs

Wildlife has four basic needs: food, water, cover and living space.

Food

Plants, whether in a backyard, a park or a large urban forest, are vital food sources for wildlife. Trees and other vegetation provide fruit, nuts, foliage, bark, and roots as part of the diet of many animals. Decaying wood is also a source of food for many small organisms, such as earthworms, millipedes, and mites, that are in turn eaten by animals higher on the food chain. Each animal is an important link in the food chain, with the existence of some species dependent on the presence of others.

Water

Wildlife species must have fresh water to live. Wildlife can find water in various places, such as puddles, gutters, birdbaths, ponds, creeks, wetlands, lakes, and rivers. In some urban areas, water pollution from pesticides, fertilizers, oil, and other materials may adversely affect wildlife.

Cover

Cover provides a place of safety for wildlife. Examples include tree litter, grasses, shrubs, understory trees, and tree canopies. Some wildlife species prefer cover adjacent to open spaces, while others prefer cover near a river. In some areas, development has changed the natural areas that provide cover, so wildlife must adapt to the new environment, migrate to more habitable surroundings, or perish.

Living space

All animals need living space. This is the place where an animal finds food, water, cover, and a place to reproduce. The size of the living space varies with each species. For example, a house sparrow requires less living space than a migratory bird. The amount and type of living space influence which animals live in an area. Williamson (1973) found that inner-city neighborhoods with few trees had exotic bird species, such as pigeons and house sparrows, while suburban areas with many trees supported more native species. He attributed this difference to the amount of vegetation available for cover.

Desirable urban wildlife can be encouraged by knowing their specific habitat needs and managing for those needs.

How Wildlife Adapts to an Urban Area

Habitats are always changing due to land development, floods, fire, and other occurrences. Species of wildlife that adjust easily to a variety of habitats are called habitat generalists. Generalist species in urban areas adapt to living near humans and to utilizing artificial habitats. Conditions or characteristics that enable many species to live in an urban community include cover, nocturnal behavior, and diet. Knowledge of how animals adapt to a new environment helps in managing them.

Cover

Many places in urban areas offer shelter for wildlife. Parks, greenspaces, and backyards are places where animals often find cover. Property owners can encourage specific types of wildlife by constructing birdhouses and small ponds and planting dense ground covers. Other wildlife can be more opportunistic; finding cover in places rarely visited by people. Attics and backyard storage sheds sometimes offer unintentional cover for animals. Warehouses, sewers, railroad yards, and the lofts and rafters of large buildings may also provide shelter and breeding places for many species.

Nocturnal behavior

Wildlife species that are nocturnal (night animals) or have secretive behavioral patterns have obvious advantages that help them survive. Because owls, raccoons, opossums, skunks, and rodents move around at night, they often exist in surprising numbers but remain unknown to many people in the community.

Diet

Animals that eat both meat and vegetation can take advantage of a wide variety of foods. Many urban homeowners encourage certain types of wildlife by feeding them in their backyards. Other species, such as raccoons and opossums, have successfully adapted to the urban environment, learning to survive on pet food left outside and food discarded by humans.

The National Wildlife Federation's "Backyard Wildlife Habitat Program" can provide information for creating an urban wildlife environment.

Characteristics of Wildlife Habitat in Urban Areas

Wildlife habitats exist everywhere within a community and its vicinity. They include parks, natural areas, golf courses, airport grounds, industrial parks, schools, hospitals, churches, cemeteries, backyards, university campuses, railways, roads, streams, and rivers. Some species take advantage of man-made structures, while others adapt to the existing ecosystems in urban areas. Several common characteristics of urban environments that influence wildlife habitats are described below. Each of these factors is important to consider in planning for wildlife in urban areas.

Fragmentation

Habitat fragmentation occurs when streets and highways, shopping centers, and other large-scale developments are built. The change in land use breaks up large habitat areas into many small ones, which influences the types and numbers of animals that can now live in these smaller habitats. Fragmentation creates more edge habitats, along the edge of a forest but decreases the forest's interior habitats. Such fragmentation benefits species that thrive on habitat edges, such as deer and skunks, but is detrimental to animals that live in interior habitats, such as bobcats and wood thrushes (Barnes 1998).

Corridors

Corridors are areas that wildlife, such as migratory birds and mammals, use to move from one location to another. Natural corridors, such as rivers and streams within a city, are valuable for wildlife. There are also human-made corridors, such as railroads, utility rights-of-way and greenways that can connect nature preserves, parks, and other sites. However, these corridors need to be wide enough to provide food, water, and cover for the wildlife (Barnes and Adams 1999). Land development can disrupt corridors, such as when a migration route is interrupted by an interstate highway.

It is fairly common is to see a deer crossing a road.

Changes in Soil and Vegetation

Most of the soil in an urban environment has been disturbed by land development such as grading and paving. These activities can change soil conditions, influencing the plant species that can grow there. And, in turn, this influences the wildlife habitat at the site. Changes in habitat may occur when—

- forests are cleared during land development.
- native vegetation is removed, mixed, or replaced with exotic or undesirable species, which may impact the density and diversity of the vegetation.
- drainage patterns and soil conditions are changed.

Poor Water Quality

Various forms of waste, including industrial chemicals and fertilizer nutrients, found in urban streams, lakes, ponds, wetlands, and rivers can damage aquatic wildlife, such as insects, fish, and salamanders. The increased amount of impervious surfaces, such as roads and parking lots, increases storm-water runoff that may increase in sedimentation and change nutrient levels in the water.

Loud Noises

Loud noises in urban areas, such as mass transit systems, automobiles, and airplanes, can disturb wildlife although wildlife usually adapts to these noises.

Structures

The urban environment is full of artificial structures used by wildlife: buildings, bridges, highway overpasses and underpasses, culverts, radio towers, utility lines, and light fixtures. These structures may provide cover and a place to reproduce for many species, for example the nighthawk that nest on the roofs of buildings and the painted turtle that survives in artificial impoundments. Some of these, such as utility lines and locations near highways, can also be dangerous for animals.

How do these factors affect the wildlife in your community?

Encouraging and Discouraging Wildlife

Wildlife management is basically habitat management to encourage or discourage animal populations. There are several ways to encourage appropriate wildlife or to discourage nuisance species.

Wildlife management begins with habitat management.

Enhancing Wildlife Habitat

Encouraging wildlife consists largely of providing food, water, cover, and living space for specific types of animals. Techniques that can enhance wildlife habitats in urban areas include the following.

Plan cooperatively

Cooperation between planners and developers during the initial phases of development is perhaps the best way to assure the enhancement or preservation of wildlife habitat. Identifying critical wildlife habitats so that they can be considered for preservation through comprehensive planning or acquisition of land is the first step toward protecting the land that is most valuable for wildlife. It is important to work cooperatively with the community to preserve identified areas, such as natural ponds, lakes, and wetlands, from development.

Land can be developed to include open green spaces and undisturbed areas.

Preserve native vegetation

Try to use native vegetation whenever possible. During land development, as much as possible of the native vegetation suitable for habitat should be left undisturbed, particularly trees and shrubs. Exotic vegetation that has displaced native plants can be removed to encourage native plant growth.

Reduce turf grass
Replace turf grass with trees, shrubs, and flowers.

Create buffer strips
Buffer strips of vegetation can be created along the banks of natural waterways. These habitats serve as corridors for wildlife and help control soil erosion. Different animals require different amounts of space, so the width of the buffer strips depends on the species that will be using the area.

Encourage habitat diversity
Different wildlife species require different habitats (figure 1). The urban forest can contain a variety of tree species of different ages and heights, creating a multi-layered system of vegetation, including ground cover, understory, and canopy. Plant species can be selected to encourage specific types of wildlife, such as species with different flowering and fruiting seasons.

Retain snags
Snags (dead trees and limbs) should be allowed to remain in the urban forest if they do not endanger people or property.

Utilize sand and gravel pits and quarries
In formerly rural areas, sand and gravel pits and quarries are sometimes common. These have potential for fish and wildlife habitat as well as recreational opportunities.

Make use of storm-water basins
Properly designed storm-water detention areas can function as wildlife habitat. The USDA Natural Resource Conservation Service can assist in designing storm-water basins.

Contact the U.S. Fish and Wildlife Service, State Department of Natural Resources or Cooperative Extension Service for assistance with managing urban wildlife.

Discouraging Nuisance Wildlife

Habitat management can also help control individuals or populations of wild animals that damage property, threaten human health and safety, or otherwise become nuisances. Eliminating one or more of the needs of wildlife (food, water, cover, or living space) will usually induce the problem animals to leave. Four basic ways to control unwanted wildlife are habitat modification, exclusion, repellents, and, as a last resort, elimination. Often a combination of methods is most effective. Ideally, the approach should be safe, selective, effective, and humane.

It is often easier to prevent nuisance animals than deal with them after they arrive.

Habitat modification

- Plant alternative species
  Animals are attracted to certain kinds of plants, particularly well-fertilized ones in urban areas. Planting species known to be unattractive to a particular type of nuisance animal may serve as a deterrent. However, in times of extreme weather conditions, drought, or overpopulation, the animals will eat even those plants that otherwise they would reject.
- Design and modify buildings
  Design and construct buildings to avoid places likely to be occupied by unwanted house sparrows, starlings, pigeons, bats, and other undesirable species. These places include exposed beams, ledges, unscreened ventilation holes, and other nooks, holes, and crannies. In existing buildings, screen beams, ledges, and other openings to prevent access by birds, squirrels, bats, and other animals. Install heavy screen or other devices on chimneys to deny access to raccoons, squirrels, and birds.
- Trim and thin trees
  Large roosts of starlings, grackles, and blackbirds may be reduced by trimming or thinning trees where they roost.
- Squirrel-proof feeders
  Bird feeders that are counter balanced or in some other way "squirrel-proofed" can reduce pilfering by squirrels.
- Secure garbage cans
  Outdoor garbage containers need to be tightly covered and secured to prevent raccoons, dogs, rats, and other animals from invading them.

Learn about various animal-resistant plants in your area from your local Cooperative Extension Service.

Exclusion

- Install fencing or wire netting
  Entire areas or individual trees can be protected with fencing or netting. Where deer are a problem, consider installing deer-proof fencing around the property. Screens or individual guards around young fruit trees can prevent damage by rabbits. Fencing can also be used to prevent beaver damage to trees.
- Use noise makers
  Loud noises typically scare off wildlife, but this may only be a short-term solution. For example, noise machines and firecrackers have been used to scare sparrows from buildings and trees, and wind chimes can discourage woodpeckers from pecking on the side of a house. A tape recording of "seagulls" in distress has been used successfully to ward off gulls, grackles, and crows.

Nuisance wildlife can be discouraged.

Repellents

Offensive tastes, smells, or feel typically repel animals. Repellents can be homemade or purchased commercially. Some are applied directly to the plant leaves, creating a bitter taste when eaten. Others are simply placed in the general area where the animals feed. There is disagreement about the effectiveness of these methods.

Trapping

As areas become urbanized, animals lose their living space, and natural enemies that control population in the wild are often lacking. Under these circumstances, it may be necessary to physically remove the animals when other means have failed. Live trapping and removal of the animals to another area is one option. This may, however, only transplant the problem. Some animals need to be trapped and eliminated because they are dangerous or diseased.

Trapping, poisoning, and killing animals, particularly game species, should be done only with legal authority. Property owners need to contact county or state officials before taking any action. The local health department should also be contacted if animals are suspected to be rabid.

Dealing with nuisance wildlife can result in negative public relations. Are you prepared to deal with this situation and communicate the necessary information to the community?

When humans change rural landscapes into urban ones, many types of wildlife find a livable habitat within this altered environment. For the most part, people who live in urban areas find it beneficial to share this environment with wildlife, except for the occasional nuisance species or individual. Foresters can enhance the interaction between humans and wildlife by learning how to improve and increase habitat for wildlife and educating the public on how to maintain a quality environment.

Checking Your Understanding of Urban Wildlife

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

1. How do you define urban wildlife? What native species live in your area, and what exotic or non-native animals are also present?
2. What does an animal need to survive in an urban setting?
3. As habitats change from rural to urban, what adaptations have some animals made to survive?
4. What are two ways you might suggest to encourage urban wildlife, and what are two ways that you would try to discourage unwanted wildlife?

Answers are at the end of the unit.

Case Study

It Is Always Greener on the Other Side

Donna is a forester with the State forestry agency. She recently received a request from the homeowners association of a planned community about 20 miles outside a major southeastern city. Among the many attractive features of the area are open and forested natural areas. Most people who move here appreciate the benefits of living in a forested area and usually are happy to share this environment with animals such as rabbits, deer, and raccoons. Recently, a colony of beavers moved into one of the stream valleys.

Chances are, the humans would not have been too upset if the beavers had stayed out of people's yards. However, the beavers began cutting down trees in the yards of residents along the west bank of the stream while largely ignoring the trees on the east bank. Not surprisingly, the attitudes of the homeowners on either side of the stream were quite different. People on the relatively unscathed east side adopted the position that beavers were an integral part of the natural environment that had attracted them to this community and should be able to chew on any tree. People who lived on the west bank regarded these zealous aquatic woodcutters as oversized, flat-tailed nuisances with no respect for private property. One group of neighbors was threatening to dynamite the beavers, while the other group threatened to sue the dynamiters. In an effort to resolve the issue, Donna was called in to help devise a solution to the beaver conflict.

You and the Beavers and the Neighbors at Odds

You are the forester who has been asked to help resolve the problem with the beavers. What would you propose? Decide what solution you would offer and then write your answers to the questions below, explaining your solution.

- Knowing that tempers are hot, what is the first thing you would do?
- What options can you offer to the homeowners?
- Are there legal issues you may need to consider?
- What are the main things you hope to accomplish with the solution you are proposing?

After you have answered the challenge questions, read the rest of the story to compare your solutions with what really happened.

The Rest of the Story

It was a Done "Deed"

As often happens with beaver problems, tempers were running high. Donna knew she had to act fast. She called both sides together for a meeting and asked the wildlife biologist from the State forestry agency to attend. A wildlife story such as this one does not always end happily for all parties involved, but this one did. The solution that Donna proposed was accepted by both groups of neighbors, quickly implemented, and it worked!

The first order of business was accomplished when all the neighbors agreed that a peaceful outcome was best -- as long as it kept the beavers out of *their* yards. The solution Donna then worked out with the community was simple, but it did require waiving the neighborhood covenant against fences. It was decided to "deed" certain portions of the natural habitat to the beavers. A green, welded, wire fence was installed along the stream bank to prevent the beavers from entering people's yards. The same fence was also used to encircle and protect some of the specimen trees within the newly defined beaver zone. Both sets of neighbors were content with this solution, and within two years the beaver colony moved farther downstream.

Note: No one ever figured out why the beavers only attacked the trees on the west bank of the stream.

Beaver to Beaver Comparison

- How did your solution compare to what the neighbors actually did?
- If you suggested something different, what did you see as the advantages that your solution offered?
- This particular encounter between homeowners and wildlife ended positively. Have you ever been in a situation in which the results were not positive? How have you handled it?
- What could you recommend to property owners that might prevent a similar situation?

Next?

Understanding the relationship between the urban environment and wildlife is important in planning for and managing the urban forest. The questions on this page will help you incorporate this knowledge into your work with the local community.

- How will you use this information to help the people in your community solve problems concerning urban wildlife?

- What are some of the characteristics and location of wildlife habitats in your community? How can this knowledge help to better manage the urban forest?

- What is the best way for you to communicate this information to the community and help them use it in their planning?

- What other information will you need to improve your understanding of urban wildlife in your area?

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Urban Wildlife Resources

Checking Your Answers

Checking Your Answers about Urban Wildlife

1. How do you define urban wildlife? What native species live in your area, and what exotic or non-native animals are also present?

Urban wildlife is any wild animal that lives in an urban environment or in an urban/rural interface. Examples include birds, reptiles (such as snakes and turtles), amphibians (such as frogs), mammals, fish, rodents, insects and spiders, and worms.

Native species may include the gray squirrel perhaps the most common wild mammal in North America (Miller 1988). What other species have you listed for your area? Non-native species may include the pigeon, commonly found in downtown areas, and the house sparrow, found in neighborhoods. What other non-native animals have you come across in your work?

2. What does an animal need to survive in an urban setting?

An animal has four basic requirements for survival, whether in an urban or rural location:

- Food
- Water
- Cover or shelter
- Living space

3. As habitats change from rural to urban, what adaptations have some animals made to survive?

Some animals have adapted to urban conditions by modifying their living and eating habits.

- Cover – Man-made structures often provide shelter and breeding places.
- Nocturnal behavior – Feeding and moving about at night is a means of protection for the animals.
- Diet – meat and vegetation diet, being fed by humans, and taking advantage of a wide variety of foods allow animals to take advantage of whatever food sources are available at any particular time.

4. What are two ways you might suggest to encourage urban wildlife, and what are two ways that you would try to discourage unwanted wildlife?

Habitat management is the key to encouraging or discouraging wildlife in an urban location. There are a number of specific things that make an area better for wildlife:

- Working with others during land development planning for the preservation of natural habitat
- Preserving and planting native vegetation
- Creating and preserving buffer strips and corridors for animals
- Reducing turf grass and replacing it with trees, shrubs, and flowers
- Ensuring a wide variety of plant species, flowering and fruiting seasons, heights and ages of trees
- Using natural and man-made elements of the land, such as snags, gravel pits, and storm-water basins, for wildlife habitat

To discourage wildlife, eliminating one or more of the needs of wildlife (food, water, cover or living space) will usually cause the problem animals to leave. There are four primary ways to control unwanted wildlife, each offering different options:

- Habitat modification
  -planting alternative tree species
  -modifying buildings, including screening
  -trimming or thinning trees to remove roosting or nesting places
  -using squirrel-proof bird feeders
  -securing garbage cans
- Exclusion
  -fencing
  -netting
  -using noise or other distractions
- Repellents that create
  -a bitter taste
  -an unpleasant odor
  -an uncomfortable touch or feel
- Elimination
  -live trapping for relocation
  -elimination because of health concerns |
  -other means of removal based on legal considerations

URBAN FORESTRY

A Manual for the State Forestry Agencies in the Southern Region

Unit: Urban Forestry and Public Policy

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 9 units are on the web site (www.urbanforestrysouth.usda.gov). The other units will be added as they become available.

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 is an introduction to the importance of providing regular maintenance to the urban forest. The basic steps to preventative maintenance are discussed, such as fertilization, mulching, pruning and tree protection.

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.

URBAN FORESTRY AND PUBLIC POLICY

Table of Contents

Overview

This unit is an introduction to understanding public policy and how it relates to urban forestry. First, it describes why public policy is important and the role each level of government has in setting public policy that affects urban forestry. The second section focuses on local government and the role of Tree Boards because here is where most urban forestry policy is created and implemented. The next section reviews public policy tools with an emphasis on tree ordinances, which can used to address urban forestry issues in a community. Finally, trees in civil matters are briefly discussed.

The Ordinance Vacuum

The Good, the Bad and the Ugly

Back in 1990, a group of citizens in a university town decided it was time to have a tree ordinance. The group was comprised mainly of university faculty and staff. They worked hard to develop an ordinance that addressed tree protection on public property. They debated whether they should include private property and decided to go for the whole thing. When they presented the ordinance to the city commission, the homebuilders and business council came out in force to oppose it. The homebuilders were furious – they had just found out about the ordinance and they had had no input into its development. Tempers were hot and it was not a good night for the citizens group or the ordinance. The city commission forwarded the ordinance to the natural resource committee for further study, where the ordinance died. Even though the citizen group meant well, creating the ordinance in a vacuum created so much ill will that it was 8 years before the community could even talk about drafting another ordinance.

Law is merely the expression of the will of the strongest for the time being, and therefore laws have no fixity, but shift from generation to generation. Henry Brooks Adams, 1838-1918, American Historian

Before You Begin

Many activities related to urban forestry are influenced by public policies that have been decided at some level of government. Take a few minutes to consider how policies may affect the urban forest. Think about a recent rezoning request for an apartment complex, planned development, or shopping center that may have required clearing a large area of land.

- What effects do such policy decisions have on the urban forest?

- What groups and organizations are involved with local government issues related to urban forestry?

- What governmental policies impact efforts to maintain trees and the urban forest?

Why is Public Policy Important?

The urban forest is influenced and managed by public policies set at many levels of government. Public policy is a broad term and difficult to define. However, it can generally be defined as some action taken by government to resolve issues of public concern. Many of these policies may not mention urban forestry specifically but they can still affect trees in a community. Managing the urban forest involves knowing about these public policies and how they work. It also requires working with groups and making decisions about issues that cross-governmental, community, and ownership boundaries. There is public policy at all levels of government (Federal, State and local) in the United States that can impact the urban forest. Examples of different forms of public policy include legislation, regulations, resolutions, programs, appropriations, administrative practices and court decisions.

Public policies are solutions to public issues and they are often controversial.

Federal Government

The Federal government can directly influence urban forestry by means of financial support and technical assistance, such as the 1990 Farm Bill that authorized funding for the Urban and Community Forestry Assistance Program. The Federal government indirectly impacts State and local government through decisions made by Federal courts and by Federal regulations. For example, local governments must follow safe drinking water and air quality standards established by the Federal government. The Federal government becomes directly involved with local governments when they are out of compliance with a Federal mandate, accept Federal funding, or when assistance is requested.

State Government

State government also influences urban forestry by means of financial support, technical assistance, and legislation. Examples of financial support include allocated funds for urban forestry staff or projects within a specific State agency. Technical assistance refers to a State agency's ability to help local governments, communities, organizations, or citizens in their efforts to improve and maintain the urban forest. A legislative example is enabling legislation that gives local governments the authority to pass local laws and ordinances. Within the State government there are departments, agencies, divisions, or commissions that may have policies related to urban forestry.

Environmental protection

The environmental protection or related department has regulatory authority to protect water and air quality. This may include policies that address erosion control, non-point-source pollution, buffers, rivers, and tree protection. Sometimes the environmental protection responsibilities will be under a natural resources department.

Natural resources
This department usually oversees issues related to natural resources in the State. It may also deal with natural resource planning on regional scales and oversee public open space. In some States, environmental protection, State forestry agencies, and mining and reclamation are within the natural resources department.

Fish and wildlife
Fish and wildlife departments typically are responsible for managing, protecting, and improving habitat for fish and wildlife in the State. They may also be involved in managing urban wildlife.

Forestry
State forestry agencies protect and manage the State's forest resources and provide assistance related to forestry, forest health, fire protection, urban forestry, and conservation education; they also may encourage voluntary implementation of forestry "best management" practices. They often formulate policy on forest-related issues.

Transportation
Transportation departments plan and oversee road building and maintenance. They may also establish regulations related to tree plantings and maintenance along highways and near billboards on State and Federal roads.

The State transportation department may have policy that impacts trees in a community.

Community development
The community development departments oversee a variety of issues that may include community planning and development, tourism, emergency management and historical sites. Urban forestry is often involved in many activities related to community development.

Licensing
The State may require foresters, urban foresters, or arborists to be licensed to legally practice. Licensing may be the responsibility of the Secretary of State's office or a licensing department.

Find out what state agencies or departments oversee activities that may impact urban forestry issues.

Local Government

Local government generally refers to cities, towns, counties, or parishes. Local governments enact laws to protect the health, safety, and general welfare of the community. While the local government may not have the broad influence that the Federal and State governments have, it does significantly affect policy related to urban forestry. Local governments traditionally have principal responsibility for managing and conserving urban forests and public open spaces. This responsibility may include planning, generation of revenue, staffing, implementation and enforcement of ordinances, and responding to the needs of the public.

Sometimes local units of government, such as city and county, are combined or consolidated.

Special districts

Special districts are another unit of local government that may influence the urban forest. While most special district governments are created as school districts, some are established for other purposes, such as soil and water conservation, fire protection, parks and recreation, sports, tourism, downtown revitalization, health, historic preservation, and transportation. Managing the urban forest will usually involve working with special districts.

Quasi-governmental agencies

Sometimes an urban forestry issue may involve not just one but several communities in a region. There may be region-wide commissions or authorities, such as regional planning commissions or councils of governments, that serve as quasi-governmental agencies to address issues that cross local government boundaries. These quasi-governmental agencies facilitate coordination among local governments on issues that affect all the communities in the area, such as land use, transportation, utilities, and the environment.

Find out it there are any region-wide commissions or authorities that address natural resource issues.

How Local Government Works

Most urban forestry policy is created and enforced at the local government level. Each local government has its own structure and processes for conducting business. Therefore, to work effectively with local government, it is important to become familiar with its particular structure and processes.

- Identify local government officials and staff
- Understand how local government is managed and administrated.
- Understand the roles commissions, boards, and authorities play.
- Understand the budget process and how resources are allocated.
- Determine how local policy is created and implemented.

It is especially important to understand the local level of government because that is where most urban forestry policy is created.

Officials and Staff

To work successfully with a local government, the key officials and staff need to be identified. Knowing their individual responsibilities, as well as their relation to other officials and staff, will facilitate your working with them.

Find out who the key government officials and staff are in the communities where you work and what responsibilities they have.

Mayor

Most communities have a mayor. The mayor is an elected official whose responsibilities and duties vary tremendously from community to community. In some communities, the mayor manages the daily operation of the government, and is sometimes referred to as a "strong mayor." In other communities, the mayor is merely the ceremonial head of the city and may preside over council meetings, and thus is referred to as a "weak mayor."

City council, city commissioners, or county commissioners

Council members and commissioners are residents of the community who are elected into office to represent specific wards, districts, parishes, or citywide areas. Members of these groups are usually political leaders and decide on city policies and legislation. Some city councils, city commissions, or county commissions work by committee, assigning members to various committees, such as transportation, planning, or parks and recreation, to address issues related to those topics. They usually meet weekly or monthly to discuss and vote on management and public policy issues, such as staffing, budget, ordinances, or resolutions. Ordinances are laws passed by local government, such as speed limits. Resolutions are usually used for special or temporary events, such as recognition of Arbor Day.

City manager

In addition to the mayor, there can be a city manager, especially where there is a "weak" mayor. The city manager often oversees the daily operations of the local government and supervises the department or division heads.

Department heads
Department or division heads oversee the daily operations within their specific departments, such as planning and zoning, parks and recreation and public works.

Department staff
Each department has a staff that reports to the department head. For example, the planning department may have a land-use or transportation planner and the public works department normally has a road-building crew. The landscaping staff may be in the public works department. Nearly every local government has someone responsible for tree care. The responsibilities of this person depend upon the community's size, available funding, and commitment to urban forestry. For example, one community may have someone who merely removes tree limbs from the streets, while another community might have a comprehensive urban forestry program and department. The person responsible for trees in the community may be called a tree care or landscape manager or city/county urban forester or arborist. They may also be a department head. This person can oversee a wide range of activities such as conducting tree inventories, implementing and updating the urban forestry management plan, maintaining the trees on public property, serving as primary resource on tree-related issues, providing training and educational information to staff, citizens and others, and responding to inquiries related to trees in the community.

The local government urban forester oversees the management of trees located on public property.

Management and Administration

Most local governments have several departments or divisions that are responsible for the daily operations and services in the community. Any one of these departments may have tasks that influence urban forestry in a community. So it is important to identify what departments have responsibilities for issues related to urban forestry and to understand how these departments operate as well as their concerns and problems. Look for opportunities to encourage cooperation among the different departments and ways to involve them in urban forestry. For example, the economic development department might be working on a main street program featuring downtown street tree plantings while at the same time the public works department plans to widen the same downtown streets to improve the infrastructure. Every local government is different, but here are examples of municipal departments or divisions whose responsibilities and activities impact urban forestry:

Local governments can contract with private companies for services, such as road building and tree maintenance.

Public works
The public works department usually oversees water and sewers, roads, transportation, traffic engineering, physical plant maintenance, and trees on public rights-of-way. If this department is responsible for landscaping, it may enforce the tree ordinance. This department's activities, such as building and maintaining roads and sidewalks, can also damage trees.

Parks and recreation
This department manages local parks, recreation programs, open spaces, greenways, and possibly landscaping. The tree ordinance may be the responsibility of this department.

Planning and zoning
The planning and zoning department oversees several activities that relate to urban forestry, such as land-use planning, zoning, and issuing permits for land disturbance and development. This department may also be responsible for the administration and enforcement of the tree ordinance, particularly if the ordinance addresses tree conservation on development properties.

Economic development
This department looks for opportunities to improve and promote the economic development of the community. It may be involved with activities related to urban forestry, such as revitalizing the downtown area and tourism. Sometimes economic development may be part of the planning and zoning department.

Arts and cultural affairs
The arts and cultural affairs department encourages arts and sponsors cultural affairs activities, such as Arbor Day ceremonies. These duties may be handled by the parks and recreation department.

Sanitation
The sanitation department usually oversees garbage disposal, public landfills, sewage, and water. Urban-tree residue recycling or disposal often requires communication and interaction with this department. These responsibilities may be part of the public works department.

Emergency management
The emergency management department plans for and responds to natural disaster emergencies, such as hurricanes and ice storms.

The emergency management department often has policy related to responding to natural disasters.

Meet with department heads and staff to learn more about their responsibilities and procedures.

Commissions, Boards, and Authorities

Local citizens may be appointed or elected to advise or assist the local government in developing policy on particular issues. Citizen-appointed groups are often referred to as commissions, boards, or authorities. They often serve as a direct line of communication between the citizens and elected officials. Most of these groups work as volunteers; however, sometimes they are compensated for their time. These groups afford citizens the opportunity to become involved in public policy. Some communities have several commissions, boards, and authorities while others have few or none. Here are several examples of commissions, boards, or authorities that often deal with issues related to urban forestry:

Tree Boards

One of the main responsibilities of a Tree Board is to advise the local government on issues related to urban forestry. The board may also oversee the local urban forestry program. Refer to the “Tree Board” section later in the unit for more information.

Planning commissions

The planning commission typically makes recommendations on land-use issues to the elected officials. Commissioners often base their recommendations on information received from the local government planning department.

Local governments often have franchises with companies to provide gas, electric, telephone and cable services – the activities of these companies can damage trees.

Zoning boards

The zoning board’s role is similar to that of the planning commission, but it establishes zoning districts and hears appeals on rezoning issues.

Parks and recreation commissions or boards
These boards often advise and oversee the local government's involvement in issues related to parks and recreation, particularly on planning, management, and budget.

Clean and beautiful commissions
These commissions coordinate public education efforts related to the cleanliness and beautification of the community, such as tree plantings, gateway beautification, and recycling programs. They may exist as non-profit organizations and not actually be part of the local government.

Transit boards
The transit board usually has jurisdiction across multiple units of government to oversee transportation–related issues. Building and maintaining roads can kill or damage trees.

Utility boards
Some communities have boards for city-owned utilities, such as sewer and water. The installation and maintenance of these utilities can impact trees.

Airport boards
A concern of airport boards is to ensure there is no conflict between tree heights and airplane glide patterns.

Find out what commissions, boards, and authorities oversee activities that related to urban forestry in the communities where you work.

Budget

Every community has a different process for developing the government budget. The local government typically develops a budget based on projected income and recommendations from department heads. Usually, the city manager or mayor presents the annual budget to the city council or county commission. Often public hearings are held during the budget process to solicit feedback from citizens. Before the city council or commission casts the final vote, various community groups communicate with the council/commission on issues important to them.

Find out who makes the budget decisions and when citizens have an opportunity for input into these decisions.

Sources of revenue
Local governments generate income from several different sources:

- Real estate or property taxes
- Bond revenue
- Sales Taxes
- User fees, such as sewer, water, and sanitation
- Special benefit assessments, such as parking meter fees, toll roads, and transit fares
- Special taxes, such as taxes on hotels, motels, and entertainment

- Transfers from other governments, such as Federal and State government grants
- Impact fees, such as a fee charged for a proposed development's impact on public infrastructure
- Donations

Some local governments are very creative in finding sources of revenue for the urban forestry program. For example, some communities allocate a portion of the hotel and motel tax allocated for tree-maintenance activities.

Raleigh, North Carolina uses impact fees on residential development to pay for parks and greenways.

Expenditures
There are two general categories of expenditures in a local government budget. Funds for urban forestry can come out of either one of these categories.

- Operating budget
  Operating expenses typically include staff salaries, overhead, equipment, and maintenance. Usually, the revenue available for operating expenses is constant and secure.

- Capital budget
  Capital expenditures are for improving the city's infrastructure, such as buildings, roads, and sewers. Usually, the revenue available for capital expenses is variable and not secure. However, in some communities, such as Austin, TX, a percentage of the capital budget is allocated to trees and landscaping.

Local Public Policy

Creating local public policy is usually a complex, political process, so it is important to understand how local governments operate in the communities where you work. Every community has a different process for creating and implementing local public policy. Steps may commonly include:

Issue or problem is identified
Policy if often created when a need or issue is perceived within the community. Usually, an elected official, city manager, local government department or attorney, citizen group, or individual citizen initially defines the need or issue. Also, the media can draw attention to a particular issue.

Issue is recommended for study and further development
If the local elected officials, such as the city council, recommend studying the issue, they will usually either assign it to a committee, local government department, or a group of citizens or they may study the issue themselves. Whoever is studying the issue gathers information and participates in work sessions to find ways to address the issue.

Policy is drafted
Once all the information has been collected, an appropriate policy is drafted and

presented to elected officials. The drafted policy may be a new one or integrated into existing policy as an amendment, revision, or addition.

Elected officials vote on policy
The policy is presented at a meeting of the elected officials. The elected officials vote to approve, reject, or hold the policy for further study.

Policy implemented
If the elected officials vote to approve, the policy is implemented.

Policy evaluated
A process for evaluating the policy should be developed.

Find out what process the local government has for creating local policy.

Example of the creation of local public policy
A community may become concerned that the street trees are in decline and dropping limbs, creating a public hazard. The mayor appoints a Tree Board to explore the adoption of a tree ordinance to define the local government's responsibilities for maintaining and caring for the public's trees and reducing hazards. The Tree Board collects general information on hazard trees in the community and looks into how other communities address this issue. The Tree Board drafts an ordinance that addresses the handling and prevention of hazard trees in the community. The ordinance is presented at a city commission meeting, and the commission votes to approve. The Public Works Department, as stated in the ordinance, starts implementing the policy.

It is at the local level of government that citizens have the best opportunity to influence public policy.

Tree Boards

Tree Boards or tree commissions are comprised of a group of citizens appointed by local government officials to support the community's urban forestry program. Tree Boards are often created in response to a crisis, such as a natural disaster, rapid land development, or insect/disease epidemic. Sometimes communities create a Tree Board because they recognize the need to improve or maintain the urban forest. A Tree Board is commonly formed by tree ordinance, executive order or resolution, or citizen initiative.

Tree Boards often coordinate tree planting programs.

Tree ordinance

Tree Boards are often established by the local tree ordinance. In this case, the local government develops a legal charter for the Tree Board defining the Board's authority and responsibilities.

Executive order and resolution

Tree Boards can also be created by executive order of the mayor, chief executive officer, county chairperson, or other local government official. The city commission or council can also create a Tree Board by adopting a resolution.

Citizen initiative

Citizens who see the need for such an organization in their community can form a Tree Board. Sometimes the citizen initiated board is established when the local government is unable or unwilling to create a Tree Board. Some of these Tree Boards evolve into non-profit organizations.

The State forestry agency usually offers technical and educational assistance to Tree Boards.

What is the Role of the Tree Board?

A Tree Board's responsibilities vary from playing only an advisory role to actually implementing policy. There is no limit to what Tree Boards may do because of the wide variety of issues in a community, ranging from concern for individual and historic trees to the loss of trees from land development. Table 1 lists examples of some possible roles a Tree Board may play in a community.

Table 1. Possible Tree Board roles and their descriptions

Role	**Description**
Advisory	Advise and provide technical assistance to local officials, non-profit organizations, businesses, or homeowners on issues related to trees, such as policy, planting, maintenance, inventory, and management.
Coordination	Coordinate various urban forestry activities in the community, from tree planting projects to educational programs.
Recruiting citizen support	Encourage the grass-root support that is critical to the development and success of an urban forestry program.
Liaison	Function as a liaison between local and State government officials and the citizens of the community.
Fund raising	Assist with raising funds to support the urban forestry program.
Public education	Foster educational opportunities, such as workshops, training, and conferences, for homeowners, businesses, homebuilders and developers, road maintenance departments, and others. Prepare an annual report of Tree Board activities to be distributed to citizens, local government officials, and the media.

The publication, "A Handbook for Tree Board Members," by G.W. Grey is a good resource.

Tree Board By-laws

Tree Boards often operate under by-laws or a charter that define their mission and responsibilities. The by-laws should be developed to meet the needs of the community and should be reviewed regularly to verify that they still meet the needs of the community. Several components are common to the by-laws of a Tree Board.

Contact your State urban forestry coordinator for copies of Tree Board by-laws.

Purpose or mission statement
The by-laws or charter should clearly state the purpose and mission of the Tree Board in the context of the needs of the community. A clearly stated purpose and mission statement may avert future problems arising from Tree Board actions.

Membership
The by-laws should specify the number of Tree Board members, how they are to be selected, necessary qualifications, and term of office. Tree Boards are generally comprised of members of the community who represent a cross-section of neighborhoods, interests, and professions.

- Selecting members
  Two important criteria should guide the selection of Tree Board members: Each member needs to have the desire and motivation to be on the Tree Board. And the membership should be broad based to enhance the Board's credibility and influence. Often having board members whose experience and background are not related to trees, such as engineering, planning, legal, media, and finance, can be helpful. Usually the mayor or city council is involved in selecting and appointing members. Tree Board members are often volunteers and not paid for their work.

- Define roles
  It is also advisable to define the roles of individual Tree Board members and develop job descriptions and maybe even a set of guiding principles, including decision-making rules to help steer them.

Responsibilities
The Tree Board's responsibilities vary from community to community and those responsibilities need to be stated in the by-laws.

- The Tree Board's jurisdiction needs to be determined. For example, is the Tree Board responsible only for trees located on public property or for both public and private trees?

- Determine whether the Tree Board will have only an advisory role or policy implementing role. Based on the defined role, the Tree Board will be responsible to the mayor, city council or commission, city manager, or department head.

Operational
The operational section of the by-laws includes information on how the Tree Board will operate, such as choosing officers, keeping records, quorum requirement, meeting times, and information dissemination.

Checking Your Understanding of Local Government and Tree Boards

On a separate sheet of paper, answer these questions about the important points you need to remember:

1. Why is it important to understand the role local government has in urban forestry public policy?

2. How can citizens assist the local government in developing policy?

3. What is a Tree Board? List examples of what Tree Boards can do for a community.

Answers are at the end of the unit.

Local Public Policy Tools

A range of public policy tools can be used to meet the vision, goals, and objectives for the community's urban forest. Understanding these tools is important because their application impacts the community's forest. Think about how these different tools can be used to maximize the benefits and minimize the costs of the urban forest. The public policy tools that will be discussed in this unit include:

- Comprehensive plan
- Land-use plan
- Ordinances
- Variances
- Subdivision regulations
- Land-development permits
- Performance standards or controls
- Urban growth boundaries
- Transfer of development rights
- Acquisition of open space
- Conservation easements
- Conversions
- Landowner tax incentives

A common denominator of these tools is that they require collaborative planning. This is a process where people work together, including landowners, industry, regulatory agencies, citizens, and other interested parties, to address problems, issues, or concerns. These diverse interest groups work collaboratively to understand the issues, resources, needs, and perspectives. Together they develop a plan to meet future needs of the community. Refer to the Working with the Public unit for more information on collaborative planning.

Comprehensive Plan

A comprehensive plan is a written document and map intended to chart a community's future. The plan typically includes guiding principles, goals, objectives, standards, and policies that will help the community attain its vision for the future. Usually, comprehensive plans cover a 20-year period, but that varies from State to State. They often include information on issues important to the community's development, such as past and future population, economics, employment, housing, schools, transportation, natural resources, and parks. The comprehensive plan can identify potential locations for trees, greenspace, or sensitive areas. Also, the plan should identify the best locations for less desirable land uses, such as a landfill. Local governments will use local public policy tools, such as zoning ordinances, subdivision regulations, and building codes, to implement the comprehensive plan.

Contact your State government to find out what agency is responsible for comprehensive planning.

Components of a comprehensive plan

Comprehensive plans are usually comprised of several chapters or components. Many of these chapters address specific issues in the community, such as land use and transportation, and contain information that is related to the urban forest.

- Population
  This component of the plan supplies historical, current, and projected population numbers for the community.

- Land use
  The land-use plan guides development of real estate in the community and recommends how the land should be used. It contains information on the estimated acreage and densities for each land use type and guides future zoning decisions and the planning for infrastructure. The land-use plan is discussed in detail later.

- Transportation
  The transportation plan addresses issues related to moving people and commodities in the community, such as the future location, character, and extent of highways, rail, air, and port facilities as well as bicycle and pedestrian paths.

- Natural resource and historic resources
  This is a plan for protecting natural and historic resources in the community. Examples of natural resource issues that may be addressed include trees, sensitive natural areas, topography, wetlands, water and air quality, wildlife, and stream buffers. The plan often includes information on historic neighborhoods, landmark buildings, and other historical resources.

- Community facilities and utility
  This plan determines the most appropriate future location, character, and extent of public lands, buildings, facilities, and utilities. It often addresses open space, park and recreation facilities, stormwater runoff, and land near streams and rivers.

- Housing and community development
  This plan attempts to assure a decent residential and economic environment for all citizens. It often contains information on age, type, condition, and location of housing, as well as the community's economic base and labor force.

The comprehensive plan addresses natural resources in a community.

The comprehensive planning process

Many States require that local governments develop or revise their comprehensive plans periodically, such as every 5 years. Usually, the local government-planning department, regional planning commission, or consultant hired by the local government is responsible for developing a comprehensive plan. Because public participation is important to the process, there will often be public hearings to receive public input. Many communities follow these four steps when developing or revising a comprehensive plan:

- Inventory or assess resources
  Collect information on factors important to the community's growth, such as population, employment, housing, traffic, parks, and natural resources. Included should be historic, current, and future projections for each of these factors.

- Develop guiding principles, objectives, and goals
  Based on the inventory of resources, future projections, and public input, the community develops guiding principles, objectives, and goals.

- Develop implementation strategy
  The implementation strategy includes short, medium, or long-term actions to reach the objectives and goals. It can also include policy statements to guide implementation of the plan.

- Revision
  As the community grows and changes, comprehensive plans are often modified to meet the new demands of the community. A review process should be built into the plan.

Get involved with regional and local comprehensive planning process.

Land-Use Plan

Regulating how land is developed and used is one of the most common components of public policy at the local level. Land-use planning can control the type of use, density of use, aesthetic impact of use, and impact of use on cultural and social values of a community. It is a tool that local governments can use to determine the best use of land to meet the community's long-term needs and goals. The local government will use other public policy tools, such as ordinances, to implement the land-use plan. Some communities have no land-use plan while others strictly regulate land use.

Land-use classifications

The land-use plan classifies the different types of land use in the community. Each type of land use is subject to specific regulations on how the land can be developed and used. Land use classifications may include:

- Agricultural, rural, and undeveloped
- Residential, single family, duplex, and multifamily
- Corridor business and neighborhood
- Downtown
- Commercial, office, and institutional
- Light and heavy industrial

Two types of land-use plans

The land-use plan typically includes a written report and a map that describe the goals and objectives for real estate development in the community. There are two basic types of land-use plans, a current land-use plan and comprehensive land-use plan.

- A current land-use plan illustrates the current land-use classifications in the community
- The comprehensive land-use plan illustrates how the community wants real estate to be developed in the future

The local government planning office will usually have land-use or zoning maps that illustrate different types of land use in the community.

Ordinances

Ordinances are public policy tools used to protect the health, safety, and welfare of the community. Ordinances can be purely administrative, such as establishing a tree board, or they can establish rules that must be complied with, such as topping of trees on public property will not be allowed. The local government can only pass ordinances on issues that the State government through enabling legislation allows them to regulate.

Communities can have a wide variety of ordinances that address issues such as land use, trees, parking lots, erosion, stormwater, and noise. Ordinances typically have standards that the property owner must comply with. For example, the parking-lot ordinance may require a minimum size area for tree planting or the zoning ordinance may prescribe maximum building height. Some ordinances regulate on a site-specific basis, such as protecting stream banks or shoreline on a specific project. Other ordinances may regulate on a non-site specific basis, such as protecting the water quality or watershed of a region. Ordinances can be effective tools for implementing the comprehensive plan. Following is a list of the most common types of ordinances that may affect trees in the community.

Tree ordinances
One of the more common types of ordinances adopted by communities today is the tree ordinance. Often they are enacted in response to changes caused by rapid land development. Tree ordinances range in complexity from simple tree-replacement standards to more comprehensive ones addressing natural resource issues. For example, a basic ordinance may protect the public from hazard trees on public properties while a comprehensive landscape and tree preservation ordinance may apply to private land as well. Tree ordinances can also require the developer to submit a tree-protection plan with the other site plans as part of the overall development and building-construction process. More information on tree ordinances can be found later in this unit.

Zoning ordinances
A zoning ordinance regulates how land is used in the community, and this influences the urban forest. Examples of issues that a zoning ordinance may regulate include building height, amount of open space, population density, off-street parking, visual clearance, landscape strips, shoreline excavation, and erosion and sedimentation. The zoning ordinance divides the community into various districts, based on land-use classifications. These land-use classifications, such as agricultural, commercial, or multifamily, set standards or codes on how land can be used in each classification. For example, standards for structure height for land zoned as commercial would probably be different than for land zoned as single-family. Also, a property owner could not build a multi-family housing unit on property zoned for agricultural use. There are different ways that the zoning ordinance can be used to facilitate tree protection.

- Rezoning
  There is generally a process whereby a property owner can request the local government to change the zoning for the property. For example, a developer may request that a piece of property currently zoned for agricultural use be rezoned for multi-family, residential use. Rezoning property often requires an application to the local government, public notification and hearings, and local government review, recommendations, and a decision to approve or disapprove. The local government may require the property owner to meet certain conditions before the rezoning is approved. For example, the property owner must comply with the tree ordinance or provide a 25-foot undisturbed buffer along the property line. The property owner can appeal and file for reconsideration of the zoning decision.

In some communities, landowners must comply with the tree ordinance as a condition for rezoning.

- Bonuses or incentive zoning
  This is where zoning regulations are relaxed as an incentive for the developer to provide public amenities. For example, a developer will offer certain amenities, such as leaving community open spaces or developing at a slower pace, in exchange for permission to build at a higher density.

- Density or cluster zoning
  Density or cluster zoning allows modification of lot sizes and frontage requirements on the condition that other land in the development is used for parks, open space, schools, or other public need.

Landscape ordinances
Landscape ordinances usually regulate landscaping, plant material, and design. They may also address screening, sun control, or air quality.

Timber harvesting ordinances
Many communities have timber harvesting ordinances that regulate where and how timber harvesting can be done. Sometimes these ordinances will include best-management practices, prevent timber harvesting in residential neighborhoods, and limit where hauling trucks can travel, to prevent damage to road surfaces and bridges from the excessive weight.

Parking-lot ordinances
Parking-lot ordinances establish landscaping requirements in parking lots. This may include regulating the amount of and width of landscape area, types of plant material, planting procedures, and screening requirements.

The landscaping in this parking lot was designed based on a parking-lot ordinance.

Erosion and sedimentation control ordinances
These ordinances regulate the amount of erosion and sedimentation that will be tolerated on a site. They often control the type of land disturbance activities permitted, existing and proposed vegetation on the site, and types of erosion and sediment control devices to be used.

Storm water management ordinance
Stormwater management ordinances are concerned with the amount of stormwater runoff, stormwater detention areas, and vegetative buffer strips.

Water quality ordinances
These ordinances regulate activities that occur in or near watershed areas, lakes, rivers,

streams, and wetlands. Water quality ordinances may address watershed protection, riparian buffers and other similar issues.

Sign ordinances
Sign ordinances regulate signs in the community, for example their dimensions, location and visibility.

Find out what ordinances impact trees.

Variances

A variance is when a standard in an ordinance is waived or exempted. For example, a property owner requests that the local government modify or waive the standard in the tree ordinance specifying size of trees planted. The property owner submits an application to the local government which reviews it and decides whether to grant the variance. A variancecan also be requested as part of the rezoning process. Reducing road width to allow more room for sidewalks and tree growth is an example of a variance request.

Subdivision Regulations

Subdivision regulations establish design standards for when subdividing land into smaller lots. Subdivision regulations can address a variety of issues, such as type of development, road width, construction of sidewalks, utility rights-of-way, water and sanitary sewer facilities, easements, and design. Usually, subdivision regulations require site plans for the subdivision to be approved by the local government before land disturbing activities, such as excavation and clearing of vegetation, can occur. If one of those site plans is a tree protection plan, tree protection can be addressed early on in the planning process.

Land-Development Permit

Many communities require property owners to apply for a land-development, disturbance, or demolition permit before they can begin any land-disturbing activities, such as clearing, grubbing, grading, excavating, transporting, and filling. Linking the tree ordinance to the land-development permit is useful for regulating site-specific activities. For example, the tree ordinance may require that a tree-protection plan be submitted with the application for a land-disturbance permit along with other site plans. The ordinance may also require that the local government urban forester or arborist inspect the site.

A land-development permit is often required before any land disturbing activities can begin.

Every community has a different process for obtaining a land-development permit. However, steps to acquire a permit may include:

- Property owner submits an application for a land-disturbance permit and site plans, as required by the local government. The tree ordinance may require that a tree-protection plan be submitted with the other site plans.
- Local government departments review the application and site plans to assure they meet appropriate local and State standards, such as standards for erosion control, stormwater runoff, road construction, number of parking spaces, and tree preservation. Conditions for rezoning would also be reviewed.
- The local government will often inspect a site before the land disturbance permit is granted. This inspection may include evaluating the tree protection methods by the urban forester or arborist.
- Local government either approves or requires revision of the permit application.
- If the permit is approved, the property owner can begin the land disturbance activities.
- The local government conducts follow-up inspection

Austin, Texas has had a tree preservation ordinance since 1983 and it is tied to the land development permit.

Performance Standards or Controls

Performance standards or controls require a shift in focus from how the land is used to how it performs, for example they focus on outcomes, not prescriptions. Some might call this an "ecosystem" based approach to managing natural resources. Performance standards can be developed for energy conservation, carbon sequestration, air quality, water quality, stormwater runoff, erosion and sedimentation, wildlife, and other related issues. The community sets a standard it wants these natural processes, such as air and water quality, to adhere to. Land development is then conducted in such a way that the natural processes maintain this standard. For example, given the proposed changes at the site, drainage and detention structures are built so the rate and volume of water leaving the site are the same as before development.

Technology, such as remote sensing and geographic information systems, can be used to help understand how land development is going to impact the natural processes. And with this information, future performance controls can be developed. This technology can help in developing performance standards specific to issues that the community wants to address.

Marion County, Florida has an ordinance that uses performance standards.

Urban Growth Boundaries

Another tool is the establishment of urban growth boundaries. An urban growth boundary encourages growth inside the boundary, while maintaining the forest, agricultural, and open space areas outside the boundary. This limit could be based on geographic features within the community or an arbitrary boundary line drawn on a map. Communities have used various techniques to encourage development inside the boundary and to facilitate the conservation of land outside the boundary:

- Limit the development of services, such as sewers and water, outside the boundary.
- Offer tax incentives for developers to build inside the boundary.
- Maintain the boundary through zoning. For example, property zoned as agricultural could not be rezoned.
- Acquire or conserve open space outside the urban growth boundary.
- Transfer development rights from a property located outside the boundary to property located inside the boundary.
- As with most of these public policy tools, flexibility is important.

Portland, Oregon adopted an urban growth boundary in 1980, that is considered one of the more effective in the country.

Transfer of Development Rights

Transfer of development rights occur when the development rights of a property are severed from that property and made available for transfer to another property. The owner of the property who sells the development rights retains ownership but cannot develop. The owner of another property may purchase the rights, allowing the receiving site to be developed at a higher density. This is particularly useful where urban growth boundaries exist. The owners of land outside the boundaries can transfer and sell their development rights to developers inside the boundaries, which would give the latter permission to build more profitable projects at higher densities.

Montgomery County, Maryland has successfully used transfer of development rights to preserve agriculture land along its urban fringe.

Acquisition of Open Space

The acquisition of open space and sensitive land is an effective, non-regulatory practice. Land trusts, often non-profit or quasi-governmental organizations, maybe charged with purchasing, holding, and managing land for conservation purposes. Land trusts participate in a broad range of land acquisition activities, including resource inventory, planning, fund raising, financing, public education, and outreach. Funding for land acquisitions can come from contributions, grants, local bonds, and impact fees.

Conservation Easements

A conservation easement is a legal agreement between a property owner and the local government or land trust to limit the type and amount of development on the property. Conservation easements may be tax deductible.

Conversions

Conversions involve converting abandoned or derelict urban land into public open space, greenspace corridors, or redevelopment. Common examples include the "Rails to Trails" program, creation of "pocket parks" on vacant urban home sites, and regional parks on abandoned industrial properties. This also includes redeveloping abandoned urban land rather than developing agricultural or forest land. Often the cost of acquiring this land is minimal, but its restoration could be cost prohibitive, especially on sites often referred to as "brownfield developments," where cleanup costs, such as removing contaminated soil, might be involved.

Landowner Tax Incentives

Landowner tax incentives offer preferential taxation under which the land is assessed only for the value of its agricultural or open-space use and not for any alternative development value. In some States, a property owner can apply for and receive a conservation-use valuation for agricultural or timberland property. This is particularly useful when used in conjunction with urban growth boundaries.

Tree Ordinances

A tree ordinance is an important public policy tool that can be used to help achieve the community's vision for its urban forest. The tree ordinance sets standards and guidelines for managing the urban forest. A tree ordinance can address a variety of issues:

- Establish a Tree Board or commission
- Specify standards for planting, pruning, and maintenance
- Prohibit topping trees
- Require the licensing of private tree-care firms
- Require permits for removal of trees
- Require submission of a tree-protection plan with other site plans
- Require protection of trees during construction activities
- Require inspection of tree-protection techniques before, during, and after construction activities
- Establish landscaping standards for developing properties
- Establish the principle that trees are part of the city infrastructure
- Specify cooperation among departments and agencies

Types of tree ordinances

There are different types of tree ordinances; some are comprehensive while others address only one specific issue. The type of tree ordinance that a community develops reflects issues in that community.

- Street tree ordinances typically establish standards for managing trees on public property.
- Tree -protection or conservation ordinances are often enacted in response to rapid land-use changes that resulted in the loss of trees. These ordinances will often set standards for tree protection or replacement on construction sites.
- Landscaping ordinances establish standards for landscape design and plant material.
- View ordinances regulate the planting and removal of trees in certain areas to protect the view.
- Historically significant tree ordinances establish standards for protecting historically significant trees in the community.
- Exotic or undesirable tree species ordinances establish standards for planting and removing exotic or undesirable species.

Go to the local government web site and search all articles in the city code using the word "tree."

Keys to Successful Tree Ordinances

It is essential that a tree ordinance meet the needs of the community it is being written for. Too often a community will copy an ordinance that was successful in another community and later find that it does not meet its needs. An ordinance may be more flexible if it emphasizes what needs to be done rather than describing "how" to do it. A community that is developing or revising an ordinance, can do several things to help ensure success of the ordinance.

One of the best references on writing tree ordinances is the "Tree Conservation Ordinances" manual, written by Chris Duerksen, and distributed by the American Planning Association and Scenic America.

Establish broad base of support
It is extremely important to establish a broad base of support by identifying and involving those in the community interested in urban forestry. Such support will increase the credibility of the tree-ordinance development process. The list of supporters could include people and organizations involved in land development, landscaping, tree care, non-profit organizations, local businesses, local government, universities, utilities, and others. Individual citizens interested in urban forestry can be key players. Try to be inclusive so everyone has a vested ownership in the tree ordinance. Talk with people and find out what problems and concerns they have related to urban forestry. Address these problems and concerns early in the process so they do not continue to be problems in the future. By working with key players you will be able to identify potential resources to help develop the ordinance.

Become familiar with local government
As stated earlier, learning about the local government – officials and staff; management and administration; roles of commissions, boards, and authorities; budget process; and how local policy is created – is crucial to developing an ordinance that meets the community's needs.

History of trees in the community
Knowing what has happened in the past can provide valuable insight into how to proceed to the future. What is the history of trees in the community? Does the community have a tree inventory or management plan? Has there been a previous attempt to pass an ordinance? If so, what were the key issues and why did the attempt fail? Talk with previous Tree Board members about how to successfully develop a tree ordinance. Go to the public library and local planning department to find out if there are any records on the history of trees in the community.

Identify important issues
The community needs to identify what urban forestry issues need to be addressed—a needs assessment. For example, hazard trees, loss of tree cover, and stormwater runoff may be issues identified as important in one community. Make sure all the key players have an opportunity to identify issues. The "Purpose" section of the ordinance will be based on these issues.

Use educational materials, workshops and training as a tool to communicate information about the ordinance.

Political, economic, and market forces
The political, economic, and market forces in the community are also important. What is

the political climate in the community? In many communities, ordinances are enacted because of citizen pressure on elected officials. In some communities the economic and market forces are driving developers toward more natural-resource-sensitive development. In these communities, ordinances might just provide the developer with the incentive to incorporate tree protection into the overall planning process. A tree ordinance also puts all developers on the same playing ground because it requires uniform application.

Developers often name housing and apartment complexes after trees.

Find out what legal issues are important
Before a community starts developing a tree ordinance, it is essential that the Tree Board, local government, or legal advisor look into the legal aspects. A good understanding of the legal issues is important because the validity of several sections in the ordinance, such as the purpose, authority, definitions, standards, and enforcement, may be tested in court. If this happens, the test may be related to enabling legislation or the issue of "taking."

- Enabling legislation
  A community may need authority or enabling legislation from the local or State government to develop and enforce tree activities. Enabling legislation gives a community police power to protect the health and welfare of the citizens. A community can rely on different types of State enabling legislation to implement a legal tree ordinance. For example, most States have laws protecting environmental conditions, such as soil conservation, water quality, and wildlife habitat and land-use activities, such as planning and zoning. Some states even have specific legislation enabling communities to adopt tree ordinances.

- "Taking" issue
  "Taking" refers to the constitutional right to own property and not have that property "taken" for public use without compensation. Ordinances may impact what property owners can and cannot do on their land; therefore, the issue of "taking" needs to be considered when developing an ordinance.

Determine how the ordinance is going to work
A key consideration in developing a tree ordinance is determining how the ordinance is

going to work. Look for ways to integrate the ordinance into existing local government regulations. For example, a tree protection ordinance could be linked to the land-development permit and rezoning process.

One of the best ways to make the ordinance work successfully is to link the ordinance to existing local government programs and processes.

Develop administrative standards, as a separate document

Administrative standards can be a separate document that is referenced in the local ordinance code, assuring that an administrative approach instead of a regulatory approach will be used. Administrative standards allow the local government, such as the urban forester or arborist, the flexibility to negotiate what measures need to be taken. An advantage to administrative standards is that they allow for flexibility and negotiation.

A tree ordinance needs to be flexible to allow for negotiation and compromise.

Monitoring

The ordinance needs to be monitored or reviewed regularly to make sure it is accomplishing its original intent.

- Establish the principle that trees are part of the city infrastructure
- Specify cooperation among departments and agencies
- Is the ordinance too comprehensive or complicated?
- Can adjustments be made to make it more effective?
- Are there any enforcement problems that need to be modified?
- Has the ordinance had a positive or negative impact on economic land development in the community?

Ordinance Structure

Ordinance structure refers to the content and organization of the ordinance, such as purpose, definitions, and enforcement. Listed below are examples of sections that may be found in an ordinance.

The ordinance needs to be structured to best accomplish the community's intended goals.

Purpose

This section states why the community values trees, the benefits they provide, and what the ordinance is trying to accomplish. This section needs to be based on enabling legislation to prelude its legality being tested. For example, a community may base their purpose on "trees improving water quality and reducing soil erosion" if there is enabling legislation related to erosion control and water quality.

Authority

This section of the ordinance states what legal authority the local government has to adopt a tree ordinance. Usually, the legal authority can be set by State and/or local legislation. Some ordinances have been invalid because they did not have the legal authority to be established.

Applicability
This section specifies who and what activities must comply with the ordinance. For example, the ordinance may apply to all activities on public property or all activities that require a land-disturbance permit. This section should also spell out any exemptions to the ordinance. For example, small residential lots and agricultural areas may be exempt from complying with the tree ordinance.

Definitions
This section defines the terms used in the ordinance. It needs to be considered carefully to assure clarity because definitions may be a factor in a court case.

Creating and establishing a Tree Board
Some tree ordinances will include a section establishing a Tree Board or commission. Often the Tree Board's duties and responsibilities, terms of office, and other relevant information are included in this section.

Standards
This section of the ordinance describes the minimum standards required to comply with the tree ordinance. There are many different types of standards that can be used in tree ordinances, some of these are described in Table 2. The standards selected should be based upon the issues and needs in the community.

Look at tree ordinances from other communities to see how they have written their standards.

Table 2. Descriptions of some of the general standards that may be used in tree ordinances

Standard	**Description**
Tree planting	These standards typically describe how to prepare the planting area, planting techniques, and post-planting procedures.
Tree care	These standards cover activities that will improve tree health and protect trees from construction damage, such as pruning, fertilization, mulching, and watering. Techniques to prevent soil compaction and reduced aeration are also covered.
Tree species	These standards state what species should and should not be planted in a given situation.
Tree selection	Tree selection standards describe how to select healthy tree stock.

Transplanting	Transplanting standards describe procedures on how to transplant trees.
Tunneling for utilities	These standards describe requirements for utility installation and maintenance near trees, and suggest alternatives to trenching through roots such as tunneling.
Aeration system	These standards describe how to determine if an aeration system is needed and includes instructions on how to install a system.
Design	The design standards can require that a tree protection plan be submitted with the land-development permit. These standards are often linked to the land-development process.
Minimum tree coverage or replacement	A minimum tree coverage requirement could be measured as canopy cover, number of trees per acre, or minimum basal area (square foot of tree area measured cross section at diameter at breast height) of trees per acre.
Encroachment	Encroachment standards can include techniques to be used during clearing, trenching, and grading to prevent damage to the protected root zone.
Landscape strip and buffer	These standards list requirement for landscape strips and buffers, such as widths of strips, curb stops, parking lot landscape islands, species selection, and percent coverage in trees.
Special	Special standards can apply to unique characteristics of a site, such as a vegetative buffer along a stream tributary within the property boundaries.

Enforcement
This section describes how the ordinance is going to be enforced. It should include information on who is responsible for the enforcement, define what constitutes a violation, and describe the process for issuing fines, penalties, and appeals. The appeals process should allow flexibility, negotiation, and compromise.

Effective date
This section establishes the date when the ordinance goes into effect. The ordinance will be effective in its current format until revised.

Conflicts and severability
This section addresses how the tree ordinance relates to other ordinances in the community. For example, if the tree ordinance were in conflict with a traffic safety ordinance, this section would describe which ordinance prevails over the other. The severability section assures that if one section of the ordinance is disallowed through court process, that section stands alone and doesn't void the entire ordinance.

Tree Protection or Conservation Ordinances

Currently, the demand to enact tree-protection or conservation ordinances is at an all time high in the South. When helping a community develop a tree-protection ordinance, certain issues should be considered.

Integrate the ordinance into existing local government regulations
When developing a tree-protection or conservation ordinance, look for ways to integrate the ordinance into existing local government regulations, such as the land-development and rezoning processes.

- Land-development permit process
  If the tree ordinance is linked to the land-development permit process, the property owner will need to comply with the tree ordinance in order to obtain the land-development permit. As part of the overall land-development/disturbance permit process, the tree ordinance can require that a tree-protection plan be submitted with the other site plans required to obtain a land-development permit. Comparing and/or integrating the tree-protection plan with the other site plans, such as the utility and grading plans can adjust site plans adjusted to actively protect the trees.

Refer to the "Trees and Construction" unit for more information on site plans.

- Planning and rezoning process
  Linking the tree ordinance to the planning and rezoning process allows tree protection to begin early in the design stage of the project. For example, the tree ordinance may require property owners to comply with the tree ordinance as a condition of rezoning a property. Or, if the ordinance were concerned with establishing and maintaining street trees, subdivision regulations could prescribe construction standards including roads and rights-of-way, and appropriate locations for both utilities and trees to prevent costly re-design.

Tree ordinances can require that tree protection fencing be placed around trees.

Tree replacement standards

Historically, tree protection ordinances have established requirements for tree replacement based on preexisting site conditions; for example, a diameter-inch of tree must be replaced for every diameter-inch lost. However, a standard based on preexisting site conditions is not recommended because this system breaks down when applied to heavily wooded sites or sites totally devoid of trees. A preferred method may be to establish minimum tree coverage standards (presented in table 2). Minimum tree coverage can be based on what is necessary to begin restoring ecological function, such as control of storm water runoff. These standards can be applied with flexibility when working with developers in deciding which trees to protect and where planting might be more appropriate.

Compliance and enforcement

There are various ways to ensure compliance with a tree protection ordinance:

- Permit process
  The permit process is the first and best way to ensure compliance. For example, if the developer does not comply with the ordinance, the building permit will not be issued. The permit process can also regulate the removal, planting, and pruning of trees on public or private property.

- Certificate of occupancy
  The ordinance can require that the project meet the ordinances minimum standards before a certificate of occupancy is issued on newly constructed buildings.

- Performance bonds
  A developer is sometimes required to post a bond to ensure compliance with the tree ordinance. Bonds are particularly useful when the developer is ready to occupy a building, but it is not planting season. A bond is issued in lieu of planting until planting season. Sometimes performance bonds are used to ensure survival of newly planted trees for a specific period of time, for example 2 years.

- Stop-work orders
  Many communities have the authority to temporarily rescind permits or stop development if a developer is in violation of an ordinance. Such stop-work orders can be costly to the developer and so they can be an effective enforcement tool. Generally stop-work orders are used as a last resort before using legal enforcement.

- Legal enforcement
  Legal enforcement is where a developer is issued a citation for non-compliance or violation of a tree ordinance. These violations are generally treated as misdemeanors and result in fines by the court. Usually, the fines go to the court but occasionally they go to the urban forestry program. Although the courts do offer legal enforcement, this last resort effort usually accomplishes little for the

urban forest. Even when it gets to this point, it is better to negotiate a resolution outside of court.

Trees in Civil Matters

Civil law suits over trees are occurring in courts across the United States. These lawsuits can involve a wide variety of parties, such as homeowners, private landowners, utility companies, private tree companies, homebuilders associations, and local governments. The rights, duties, and liabilities of these parties related to trees are documented in civil law (Merullo and Valentine 1992). Litigation about trees is a complex subject and constantly changing due to these court cases. Civil laws that impact urban forestry are generally related to the following topics:

- Property owner's (private and public) responsibility for hazards, safety, and liability.
- Ownership when a tree straddles a property line.
- Compensation if the value of trees is diminished or lost due to accidents, poisoning from pesticides, or vandalism.
- Compensation as the result of "taking" of trees due to rights-of-way acquisitions, road improvements, and utility construction.
- Trimming trees near billboards.

Go to a law library, city public library, city hall, or county courthouses or go on the Internet to find out what State and locals laws apply to urban forestry.

Checking Your Understanding about Local Public Policy Tools

On a separate sheet of paper, answer these questions about the important points you need to remember:

1. Why is it important to get involved with the comprehensive planning process?
2. Describe factors that are important to developing a successful tree ordinance.
3. Why would it be beneficial to link the tree protection ordinance with the rezoning and land development permit process?

Answers are at the end of the unit.

Case Study

The Big Picture

Sam, a local forester, has been advising the Tree Board of a growing southern city on various issues. The mayor of the community recently returned from a national convention for mayors where she attended a workshop on urban growth management. She announced to the Tree Board that she wanted to expand their responsibilities to address broader natural resource and open space issues. She also asked the Tree Board to change its name to “Commission on Natural Resources and Open Space” and write a new charter. She wanted this new commission to serve as an advisor to the mayor, city council, and planning commission on these issues.

The Tree Board was excited about the mayor’s sudden interest in addressing broader natural resource issues, but the members were a little unsure of how to go about doing this. They knew that Sam had contacts with other natural resource agencies in the State and they thought he might have information to help them.

You and the Mayor and the Tree Board

Put yourself in Sam’s place assisting the Tree Board. Think about how you would help the Tree Board respond to the Mayor’s request. Use the questions below to help you get started:

- What resources do you think would help the Tree Board? Have other communities been in a similar situation?
- What challenges do you see the Tree Board facing?
- How will the elected officials respond to the mayor’s wanting to broaden the responsibilities of the Tree Board?

The outcome of the real story follows this case study. After you have written the steps you would follow, compare your story with what really happened in “The Rest of the Story.”

Rest of the Story

Communication is Key

The first thing the Tree Board did was create a steering committee to tackle this new venture. They asked Sam to serve on the committee. Sam agreed to participate but he also recognized that this expanded focus was beyond his area of professional training and expertise. He knew that he could provide assistance related to trees but that other resource experts would also need to participate. He recommended that someone with the State's Department of Natural Resource also be on the steering committee. Sam offered to coordinate a workshop on broader natural resources issues if the committee members were interested. He also said he would make some phone calls to find out how other communities had addressed this same issue.

The Steering Committee recognized that the proposed expanded responsibilities would require cooperation with city departments that oversee activities related to natural resources in the community. And before they could even begin identifying issues, they had to understand how these departments worked and how their activities impact natural resources. So the steering committee interviewed department heads (Public Works and Planning) to learn what they do and how they work. They found that not only did Public Works and Planning Departments have regulations that affected natural resources, but so did the Parks and Recreation Department. They also realized that there were "turf" battles among the different departments that prevented the departments from working well together.

Through their research they found that there were several ordinances, such as landscape, erosion and sedimentation, parking lots and signs that addressed issues related to trees. Based on all the information they collected, the steering committee wrote a new charter and developed a host of recommendations, ranging from the revision of local development standards to the establishment of quasi-governmental organizations to acquire public land for open space and to address issues that go beyond the city limits.

But when the Steering Committee presented its recommendations to the mayor and city council, the city council members were not enthused about broadening the role of the Tree Board or its recommendations. It was then that the Steering Committee realized they had made a big mistake by not keeping the city council members informed throughout the whole process. So, the Steering Committee made appointments with individual city council members to discuss the recommendations and to get their input and support. After many meetings and much discussion, the recommendations were revised and the city council members voted to adopt the new charter and further study its recommendations.

Politics – You Can't Live With It and You Can't Live Without It

- What resources do you think would have helped the Tree Board? Where would you find those resources?
- Were the challenges you listed different from the ones this Tree Board was having?
- How have you dealt with contentious issues within a community?

For More Information

Books and Resources

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Wenger, S. 1999. A review of the scientific literature on riparian buffer width, extent and vegetation. Athens, GA: Office of Public Service and Outreach, Institute of Ecology, University of Georgia.

Wenger, S.J.; Fowler, F. 2000. Protecting streams and river corridors: Creating effective local riparian buffer ordinances. Athens, GA: Carl Vinson Institute of Government, University of Georgia.

Web Sites

American Farmland Trust
http://www.farmland.org

American Planning Association
http://www.planning.org

Center for Watershed Protection
http://www.cwp.org/

International Society of Arboriculture, Guidelines for Developing and Evaluating Tree Ordinances
http://www.isa-arbor.com/tree-ord/

Louisiana State University, School of Landscape Architecture
http://www.design.lsu.edu/greenlaws

USDA Forest Service, Southern Region, Urban Tree Ordinance Index
http://www.urbanforestrysouth.usda.gov/ordinances/index.htm

Univeristy of Georgia, Institute of Ecology, Office of Public Service and Outreach
http://outreach.ecology.uga.edu

Next?

There will be many opportunities for you to assist communities with public policy issues related to urban forestry. Think about what you need to know to participate in the development and implementation of public policy that impacts urban forestry.

- What specific information do you need about communities to help you understand public policy issues related to urban forestry?

- What people in your community, including government officials, individuals, and local organizations, are involved in the development and implementation of public policy?

- What are some of the communication skills that will help you work with government officials and community groups? What are some of the ways you can practice and improve these skills?

- What are some of the resources within your State you can use to find out more about public policies that relate to urban forests and urban ecosystems?

Checking Your Answers

Checking Your Answers about Local Government and Tree Boards

1. Why is it important to understand the role local government has in urban forestry public policy?

The local government has primary responsibility for managing and conserving a community's urban forest, which may include planning, funding, staffing, implementing, and enforcing ordinances, and responding to needs of the public. It is at the local level where policy decisions, such as zoning and tree ordinances, directly impact the urban forest.

2. How can citizens assist the local government in developing policy?

There are many opportunities for citizens to participate in local government policy.

- Run for office, such as mayor or city commissioner
- Volunteer or be appointed to a commission, board, or authority
- Be a member of a committee that is studying a policy issue
- Participate in public meetings and offer input into the budget process
- Bring an issue to the attention of the community and elected officials
- Be a member of a Tree Board

3. What is a Tree Board? List examples of what Tree Boards can do for a community.

A Tree Board is comprised of citizens who give support to the local government's urban forestry program. Responsibilities and activities of Tree Boards vary from community to community. Examples of possible roles include:

- Advise and assist the local government, organizations, and citizens.
- Coordinate urban forestry activities
- Recruit citizen support for programs and activities.
- Serve as a liaison between local government and citizens.
- Raise funds for programs and activities.
- Sponsor educational opportunities for local government, organizations, and citizens.

Checking Your Answers about Local Public Policy Tools

1. Why is it important to get involved with the comprehensive planning process?

The comprehensive planning process involves developing long-range vision, principles, and goals for the community. The local government then establishes regulations, such as ordinances, to implement the comprehensive plan. If natural resources and trees are incorporated into the comprehensive planning process, regulations, such as tree ordinances, will be enacted to address those issues. Getting involved with the comprehensive planning process is one way to prevent problems related to urban forestry rather than react to them.

2. Describe factors that are important to developing a successful tree ordinance.

Many factors are important in developing a successful tree ordinance:

- Establish a broad base of support to assure the credibility and ownership of the process.
- Become familiar with the local government.
- Knowing the history of trees in the community can help prevent previous mistakes and identify resources.
- Knowing the important issues in the community will help determine the purpose of the ordinance.
- Knowing the political, economic, and market forces can help prevent problems and identify opportunities.
- Verify the legality of the ordinance.
- Determine how the ordinance is going to work.
- Allow negotiation and flexibility by using administrative standards.
- Regularly monitor the ordinance.

3. Why would it be beneficial to link the tree protection ordinance with the rezoning and land-development permit process?

Since the local government already has a land-development process in place, it is best to use that process when developing the tree ordinance. The main benefit of linking the ordinance to the rezoning and land-development permit process is that tree protection can be considered early in the design stage instead of after the fact.