How Trees Grow

The main parts of the tree are the leaves, the trunk and the roots. Each plays an important part in the growth and vitality of the tree. Trees grow bigger each year from two places: the buds and the cambium.

Buds—Most of the buds that grow on a tree are at the tips of branches and roots. From these, branches and roots grow longer each year, and produce new branches and roots. Trees also have adventitious buds in the bark along branches and roots. These buds lie dormant until the tree needs them. Sprouts from adventitious buds help a tree stay alive after a catastrophe where the tree looses the end of its branches (during a storm, for example, or after topping). These sprouts are weakly attached to the tree and generally undesirable, but they do play a role in the life of many trees.

Cambium—All woody plants have an actively growing layer of cells, called the cambium, that lies between the bark and the wood of the trunk and branches. From the cambium, the tree puts on a new layer of wood each year. This layer, or “ring,” covers over the old layers on the trunk, branches and woody roots of the tree.
Leaves—Trees produce all the food they need in their leaves. Through a process called photosynthesis, leaves use the green pigment chlorophyll, along with light energy from the sun, to turn carbon dioxide and water into sugar. The trees use sugar for energy and to produce wood. Through this process, trees take carbon dioxide (a pollutant) out of the air and turn it into oxygen and wood.

In the process called transpiration, trees move water solutions throughout the tree. To keep themselves cool, leaves release water vapor through pores. This keeps the area around the tree cool, too.

Trunk and Branches—These woody parts provide support for leaves and other branches. They are pathways for the movement of substances within the tree. The outer rings of wood are sapwood. Water moves up the tree through vessels in sapwood. Trees use wood in branches and in the trunk to store food for later use. Heartwood is the central, usually darker, less-active portion of a tree. Bark protects the cambium from harm like insulation and siding on a house protect it from rain, wind and cold. Food moves down the tree through the inner bark.

Roots—Large woody roots anchor the tree in the ground and store starch. They are a pathway for the movement of substances in the tree. From the soil, tiny absorbing roots take up water and minerals. These are carried up into the tree through woody roots. Trees shed small roots and produce new ones each year just as they do with leaves. Roots grow throughout the year, especially in the early spring and in the fall.

Roots may have a beneficial relationship with fungi called mycorrhizae. The fungus extends from the tiniest tree roots out into the soil to help the tree absorb water and nutrients. The tree provides the fungus with food and a place to live.

Trees go through annual cycles of growth. Roots are busy in the early spring and late fall. Leaves and twigs grow in spring and the tree adds wood all summer long.

What Trees Need

Light—Light from the sun provides the energy trees need to manufacture food.

Water—Trees need water to prevent wilting, produce food, move substances throughout the tree and for cooling.

Nutrients—Trees need 16 elements to grow. They get carbon and oxygen from air, hydrogen and oxygen from water, and everything else from soil. They need lots of nitrogen, phosphorus and potassium, and lesser amounts of sulphur, calcium and magnesium. They need a little bit of boron, chlorine, copper, iron, manganese, molybdenum and zinc.

Room To Grow—Tree roots need plenty of room to grow so they can anchor the tree, and take up water and minerals. Branches need room to spread and capture energy from the sun. Branches need space away from buildings, roadways, utility lines and other trees so they can grow to their natural size without injury or excessive pruning.

Well-Drained Soil—Trees need soil that drains and allows the free movement of oxygen, other gases and water. When soil pore spaces are full of water or are compacted, tree roots cannot get everything they need to function properly.
The Story in Trees: What Tree Rings Tell Us

Tree trunks grow bigger each year when the cambium adds a new layer of wood over the old layers. The cambium produces large cells in the spring and smaller cells during the summer. In many trees the early cells are light in color and later cells are dark in color. Since the trunk of a tree is round, the result is a pattern that appears as rings. We call these annual rings or tree rings. Since trees generally produce one ring for each year of growth, you can find the age of a tree by counting its rings.

Find out which were good years and which were bad years by looking at the relative width of the rings. Can you tell which years had good rainfall, warm temperatures and few insect or disease outbreaks? The wider the growth ring, the better the growing conditions were that year.

The presence of covered-over wounds provides information about previous fires, insect or disease attacks, and when and where branches grew. If your tree once got hit by a lawn mower and its bark torn, there is a record of it in your tree. Careful inspection reveals the age of the tree when each of these events occurred.

Dendrochronology is the study and interpretation of tree-ring patterns.
Living in Town

Urban Ecosystems

An ecosystem is a complex network of climate, soil, animals, microbes, plants and people. A lake, forest, prairie or watershed is an ecosystem. Although they are not natural, urban areas are ecosystems, too.

The vegetation in your community probably looks a lot different than the native forest or prairie that was there before European settlers came to Minnesota. Minnesota is an ecological transition zone where three distinctly different types of ecosystems meet: hardwood forest; coniferous (evergreen) forest; and prairie. Each ecosystem has climate, soils, plants, animals and microbes commonly associated with it. Each also has tree species which are adapted to its specific growing conditions.

Vegetation in an urban ecosystem has been altered by humans. As a result, urban areas typically have low species diversity, isolated groups of trees, poor nutrient cycling and confined rooting space. Add to these compacted and infertile soil, de-icing salts, pesticides, a lack of water and vandalism and the challenges that face plants in urban ecosystems seems insurmountable.

Rural ecosystems have their own share of seemingly insurmountable problems including fire, floods, drought and storms. Lakes fill in with vegetation over time, rivers change course. Over thousands of years, plants and animals have adapted and they survive. What is different in the urban ecosystem is that it is the activities of humans that have affected the order of things. It follows that it is the activities of humans that can restore the health of urban ecosystems.

In the urban ecosystem, humans need trees and trees need humans. Often our success in establishing trees, collectively called the urban forest, depends on our ability to imitate the conditions in which trees grow in their natural environment. We need to make trees feel at home.

If ecological health is a goal in our communities, we need to find ways to sustain a diverse population of trees and other plants. The first step is finding out what was natural in an area and what is left of it. Most natural resource managers consider the vegetation that was in an area prior to the 1850s as native to that area. You can find clues to what is native, such as very old trees or undisturbed soils, but to paint the whole picture, you need to do some research. In the section that follows is information that will help you research the vegetation on a site.

To find out what remnants are left of the native vegetation in your area, consult a forester or botanist. The Department of Natural Resources, through the County Biology Survey program, has surveyed many areas of Minnesota, including the Twin Cities, and mapped the remaining natural plant communities.

The next step is recreating conditions in which trees and other plants thrive. In Chapter Six we go into detail about how to establish trees in the urban environment.

Here are a few ways to ensure the ecological health of the urban ecosystem:

- Preserve areas of native vegetation
- Protect vegetation communities: trees with their companion shrubs, flowers and grasses
- Plant trees that are native to an area.
**Green History: How to Research the History of Vegetation on a Site**

With a little research, you can get an idea of what the vegetation was like on a site at some period in the past. For some types of projects, such as restoration of natural areas or historical sites, this is an essential step. For any project, understanding the vegetation history gives clues to what may or may not be successful in the future.

For restoration of natural areas, project planners usually want to know what was native to the site before European settlers arrived. Although affected by American Indian land management practices, especially the use of fire, our landscapes were not drastically altered until European settlers arrived and began logging and farming. Most of the landscape of Minnesota was altered by the mid 1900s.

Land alteration continues today. Urban sprawl threatens much of what remains of our natural plant and animal communities. Few places in Minnesota have not been farmed, logged, grazed, sodded or paved. If yours is a site with an intact native habitat, you have a special stewardship responsibility.

To do a quality job of restoring vegetation on a developed site requires research as well. These sites include historical parks and the grounds of buildings undergoing restoration. Each of these restorations should include a study of the vegetation present on the site as it is now, as it was originally designed, and at any other appropriate period of time. Restoration may require making some plant substitutions. European buckthorn was once used for hedges, but is now recognized as an inappropriate invasive exotic species that causes harm to natural areas.

Fortunately there are excellent resources available to guide you to an understanding of the green history of a site. Keep in mind that when we describe the vegetation on a site at a particular period of time, that it is like looking at a single frame on a film strip. It makes a fine snapshot, but you really just see part of the picture. Vegetation is not static. It is part of an ever changing system. In nature, plant communities go through stages of succession. In the absence of fire for example, oak savannah becomes an oak woodland. Oak woodland may become a forest of maple and basswood (linden) trees. When disaster strikes, the cycle repeats itself.

This is part of a page from the Map of Hennepin County, Minnesota, compiled by George B. Wright, U.S. Surveyor, in 1873. It shows the location of lakes and marshes. In this area, called the Big Woods, everything else is woodland.
Look for green history information in books and atlases, in biological studies, historical records and on the land itself. For some areas there are published books on native habitats. You may find useful information on the internet. A person who studies genealogy (family history) as a hobby can direct you to sources of good local information. A forester or naturalist may be able to interpret the history of a site by looking at the site itself.

To begin your research of a site you need to know its legal description. The entire state of Minnesota is divided into townships, each six miles square. Within each township, there are 36 sections. Each section is a square, one mile on each side. Each township has a unique description that tells where it is located relative to a particular point on the globe.

To find the legal description of a site, look in a county plat book or at a United States Geological Survey (USGS) topographic map. Your local library, city hall, county extension office, Soil and Water Conservation District office or Department of Natural Resources Forestry office may have a copy of each of these maps. In the future, you may be able to find these maps through the internet. Between 1847 and 1907, the United States Surveyor General surveyed the entire state of Minnesota. Surveyors walked along section lines and marked each section corner. As they went, surveyors made notes about the topography, soil quality, plant cover and the other natural features of the landscape. These original surveyors field notes help researchers learn the pre-settlement vegetation of an area.

The Minnesota Historical Society has some (but not all) of these original surveyors field notes. To see them, visit the Weyerhaeuser Reference Room at the Minnesota History Center in downtown St. Paul. Ask the librarian to direct you to the index of government documents in the State Archives and look up the U.S. Surveyor General. In the index you will find the reference number that you need to request the surveyors notes for the township in which you are interested. The staff will bring the handwritten books from the archives to the Reference Room.

Trees stood witness to some of the greatest events in history. A sycamore tree survived the bloodiest one-day battle in American history. It grows on the bank of Antietam Creek, in Sharpsburg, Maryland, where 23,000 men were killed or wounded on September 17, 1862.

This is a section of Marschner’s map. It shows the different types of vegetation that the original surveyors found near Lake Mille Lacs.
This excerpt is from the original field notes of the U.S. Surveyor General. At this location in Hennepin County, the surveyor found the land surface rolling, the soil first rate and timber of sugar maple, linden, elm and ironwood.

Your county surveyor may also have a copy of the original field notes. Contact your county courthouse to find out the name of the county surveyor.

A complete set of U.S. Surveyor General field notes for Minnesota is in the custody of the Secretary of State. You can request a copy of the field notes for the section where your site is located. Send a letter including the section, township and range of your site to the Business Services Division of the Secretary of State's office. There is a per-page charge for the information.

The information that U.S. Surveyor General surveyors gathered was compiled and mapped in 1930 by Frances J. Marschner. The United States Department of Agriculture (USDA) Forest Service published the map in 1974. There is a simplified version of the map in the publication *Natural Vegetation of Minnesota At the Time of the Public Land Survey, 1847-1907*, by the Minnesota Department of Natural Resources Natural Heritage Program.

The Natural Heritage Program is responsible for conducting research, taking assessment, and promoting wise stewardship of Minnesota’s native flora. At the heart of the program is a database on information on the state’s rare species and sensitive natural habitats. With the Nongame Wildlife program, they conduct the County Biological Survey, a systematic county-by-county inventory of threatened natural habitats and rare plant and animal species. One of the most useful products of this effort are large maps of each completed county, including those in the Minneapolis and St. Paul metropolitan area. Each map shows what remains of the natural vegetation that was present at the time of the land survey. It also shows what vegetation was once natural throughout the county. To see if the County Biological Survey is complete for your area, visit the DNR web site.

Local history books often include descriptions of the landscape or contain clues such as photographs or timber harvesting information. Old atlases may be helpful, as are old postcards and other photographs. Some of these references are available at your local library or county historical society. The Minnesota History Center has atlases and plat books on microfilm or microfiche in the Ronald M. Hubbs Room.

Two famous trees mark the historic site where Martin Luther King Jr. changed America forever. A high point of the civil-rights movement of the 1960s was a 50-mile civil rights march from Selma, Alabama, to the state capitol. A water oak and sycamore stand in front of Brown Chapel AME, the church where Martin Luther King Jr. gathered with his followers to begin the march.

Find information about the County Biological Survey at: www.dnr.state.mn.us
What's Out There

Take Inventory of Your Trees

To make wise decisions you need up-to-date information about your community and the trees that grow there. An inventory can give you the information you need. It is the basis for planning. Consider these examples:

- You want to plant street trees along Main Street. You do not know how many spaces are available, how big the spaces are or if overhead utility lines are a problem.

- You know that some trees in a park may not be safe, because you can see cracked and rotting branches in them, but you are not sure which are hazardous to people or property.

- You want to hire an arborist to prune the street trees in your town, but you do not know how much money you need to get the job done.

An inventory is a method of collecting and organizing information about trees. Use the information to plan for maximum public benefits at minimum expense. Before you conduct a tree inventory, decide what information you need to make decisions and manage trees. Once collected, inventory information becomes outdated quickly. For the best return on your investment, only collect information that you need. Without regular updates, an inventory has little value after about five years.

The first step is to gather whatever information already exists for your community. At city hall, ask for a copy of the city base map. If there is no base map available, a U.S. Geological Survey map will work. If the city has a plan (some cities do comprehensive planning), try to get a copy, especially of the maps. On a map, draw the landscape features of your community. Include parks, rivers, unique features, highways, streets, land use and so on. As you add features, a picture of your community emerges. You will see how your community fits into the surrounding landscape. Along with the tree inventory, the map can help you identify opportunities.

Once you define its objective, choose a type of inventory. To make a simple windshield survey, drive along each street and count the number of trees and the number of empty tree planting spaces. For a detailed, state-of-the-art inventory, hire a professional forester to survey each tree individually. Your inventory will probably fall somewhere in the middle. Collect this minimum information about each tree:

- Species
- Location such as address
- Size in diameter
- Site characteristics such as the amount of space between the curb and the sidewalk
- Condition.

The scope of a tree inventory is determined by community goals. Examples of additional information that may be useful are:

- Tree maintenance needs
- Presence of overhead electrical lines
- Safety problems such as low hanging branches over streets or sidewalk
- Sidewalk damage.
Take Care of Your Trees

Would you like your trees to live long, healthy lives? Maintenance is the key. Trees need a little extra care when they grow out of their natural habitat. In some situations, it is amazing that trees survive the daily onslaughts to their health and longevity. There are things we can do to prevent or lessen the effects of these factors on tree growth. Give trees regular care throughout their lives.

Water

Your established tree needs the equivalent of at least one inch of rainfall per week. If there are drought conditions, they need additional watering. Before you water a tree, check to see how dry the soil is by putting your finger into the soil under the mulch. To make fast work of checking soil moisture, invest in a soil moisture meter. Inexpensive meters are available at garden supply stores. Choose one with a probe long enough to reach through the mulch and a few inches into the soil.

If the soil is dry, add water. To water with a hose, lay it on the ground and turn it on low. Let the water run awhile and then move it to another spot under the canopy of the tree, but away from the trunk. A half-hour to one hour is usually enough for a medium sized tree.

Don't over-water. If your soil is clay or is compacted, you need less frequent watering--don't drown your tree! Sprinkler systems installed to water grass can harm trees. The installation process cuts roots and causes tree decline. The frequent watering needed to keep grass green during the summer can keep tree roots soggy and unhappy and may kill the tree. If you have a sprinkler system, plant water-loving trees and aim the sprinkler heads away from the trunk of each tree.

Inspect

Look at your trees closely once in a while to catch problems at the early stages. The earlier you catch them, the easier they are to control. When you check trees for problems, look for:

- **Symptoms of insect, disease or other injury:** holes, spots, discolored or missing bark, change in leaf shape, change in leaf color, reduced number of leaves, branch dieback, cracks or splits in trunk or branches

- **Signs of insects or diseases:** bugs, egg masses, webbing, fungal fruting bodies such as spores and conks, oozing sap, holes or wounds in trunk or branches

- **Environmental "stressors"** that will have an adverse impact on plant growth: changes in drainage patterns, construction, overhead or underground utility work, lawnmower wounds, weed whip wounds, lawn chemicals, rodents, too exposed, not enough space, vehicle and pedestrian traffic over root system.

Control Problems

Once you identify something that is causing problems for your plants, look for a solution by reading publications or by consulting a plant professional. Publications are available through the extension service, from local tree inspectors and on the internet. Control the problem by using appropriate cultural, mechanical or chemical control measures or by removing the source of the damage.
Control Weeds

Use mulch to control most weeds around established trees. Pull by hand any weeds that show up. As you pull, don't let soil get mixed into the mulch or your weed problem will multiply. If you spray weed-killer (herbicide) onto weeds that grow in the mulch around a tree, do it on a calm day and use great care to spray only the weed, not the tree. If you use weed-killer to maintain your lawn, stay away from trees and shrubs. A broadleaf weed-killer doesn't know the difference between a maple tree and a dandelion.

Mulch

Mulching is good for established trees for the same reasons that it is beneficial for new trees. Mulching areas under large trees can also solve the problem of poor grass growth where turf must compete for sunlight, nutrients and water. Use a mulch of shredded bark or woodchips that is about four inches thick. Keep the mulch about six inches away from the base of each tree or shrub.

To prevent root damage, use an herbicide such as Round-up to kill turfgrass under an established tree. See the sidebar for herbicide alternatives. Do not use a rototiller near established trees—they harm roots. We do not recommend the use of landscape edging near trees unless it is the type that sits on the soil surface.

Wrap

To protect the south side of thin-barked trees, such as lindens, maples and crabapples, from winter sunscald, use a light-colored guard such as paper tree wrap. Protect the trunk from the ground to the first branch. Wrap in the fall and unwrap each spring until the tree develops rough bark.

Remove Stakes and Ties

One growing season is the limit for stakes and ties. If they have been on your tree for longer than that, take them off. Stakes and ties can harm a tree directly by damaging its bark. They can harm a tree indirectly by affecting the growth of the tree trunk. Blowing around in the wind cues trees to stiffen up and grow thicker in the trunk.

Fertilize

Hold on! Now that we have your attention, what we really want to say is that your tree probably does not need fertilizer. Established trees only need fertilizer if they show symptoms of a nutrient deficiency. Rule out other problems first. We urge caution because when over applied, fertilizer can cause more harm than good. Fertilize young, vigorous trees, but hold back if your trees are past adolescence.

Prune

For established trees, prune to remove dead and damaged branches, and to eliminate hazards such as low-hanging branches. Remove branches that obstruct a desirable view or that rub on another branch, building or structure. If branches are near electric utility lines, call your electric utility to prune them. Train your young tree to have a single central leader (trunk) with well spaced, strong side branches. Plan to do most pruning during the winter when trees are dormant.
## Tree Maintenance Calendar

<table>
<thead>
<tr>
<th>January</th>
<th>February</th>
<th>March</th>
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<tbody>
<tr>
<td>Winter pruning</td>
<td>Winter pruning</td>
<td>Winter pruning</td>
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<tr>
<td>Hazard tree inspection</td>
<td>Hazard tree removal</td>
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<tr>
<td><strong>April</strong></td>
<td><strong>May</strong></td>
<td><strong>June</strong></td>
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<tr>
<td>Wash salt off trees in grates and on medians while the ground is still frozen</td>
<td>Plant trees</td>
<td>Inspect depth of mulch</td>
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<tr>
<td>Remove sun protectors from tree trunks</td>
<td>Finish planting bare root trees before their buds break open</td>
<td>Order mulch as needed</td>
</tr>
<tr>
<td>Stake tree planting locations</td>
<td>Water weekly as needed</td>
<td>Water weekly as needed</td>
</tr>
<tr>
<td>Finish pruning trees by the 15th</td>
<td>Celebrate Arbor Month</td>
<td>Inspect for insects and diseases</td>
</tr>
<tr>
<td>Start planting trees when the frost is out of the ground</td>
<td>Do not prune trees</td>
<td>Control weeds</td>
</tr>
<tr>
<td>Celebrate Arbor Day</td>
<td></td>
<td>Plant B&amp;B and container grown trees</td>
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<td></td>
<td></td>
<td>Do not prune oak trees</td>
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<td><strong>July</strong></td>
<td><strong>August</strong></td>
<td><strong>September</strong></td>
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<tr>
<td>Water weekly as needed</td>
<td>Water weekly as needed</td>
<td>Water as needed</td>
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<tr>
<td>Control weeds</td>
<td>Control weeds</td>
<td>Remove stakes and ties from trees planted before fall of the current year</td>
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<tr>
<td>Inspect for insects and diseases</td>
<td>Inspect for insects and diseases</td>
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</tr>
<tr>
<td>Add mulch as needed</td>
<td>Inspect new trees</td>
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<tr>
<td>Prune for clearance over streets and sidewalks and near signs</td>
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<tr>
<td><strong>October</strong></td>
<td><strong>November</strong></td>
<td><strong>December</strong></td>
</tr>
<tr>
<td>Water young evergreen trees before the ground freezes</td>
<td>Inspect rodent guards before the snow flies--be sure that there is no way for mice to crawl in through the bottom</td>
<td>Winter pruning</td>
</tr>
<tr>
<td>Fertilize trees as the leaves fall</td>
<td>Begin winter pruning after trees are bare of leaves</td>
<td></td>
</tr>
<tr>
<td>Install sun protectors on young trees with thin bark</td>
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</tbody>
</table>

Based on Landscape Calendar and Maintenance Activities by Heartwood Forestry.
Done correctly, fertilization can help maintain trees in a vigorous condition and increase their resistance to insect and disease problems and environmental stresses.

Done incorrectly, fertilization causes stress in trees and encourages growth of harmful pathogens.

Should I Fertilize This Tree?

Established trees which show no deficiency symptoms do not need to be fertilized. Young trees may benefit from the application of fertilizer the second autumn after planting and occasionally after that. Tree experts recommend fertilization to treat some specific tree problems such as nutrient deficiency.

Plant Nutrients

The major elements in fertilizers used for landscape plants are nitrogen (N), phosphorus (P) and potassium (K). Nitrogen is one of the most important elements for plant growth and is the most commonly deficient element because it moves around easily in the soil. A deficiency of nitrogen leads to yellowing of the leaves and reduced tree growth. A deficiency of phosphorus causes purple leaf coloration, small leaf size and early leaf drop. A deficiency of potassium leads to yellowing and death of leaf edges and tips, and branch dieback. Although most fertilizer formulations include phosphorus and potassium, most soils in Minnesota contain both in adequate quantities for plant growth. Sandy soils, which may be deficient in potassium, are an exception.

Iron and manganese are micronutrients that are important for plant growth and may be unavailable to plant roots in alkaline soils (pH above 7.0). The deficiency of these micronutrients leads to chlorosis or yellowing of leaves. Tree species which are susceptible to iron chlorosis include river birch, silver and red maple, and pin oak (particularly Eastern pin oak). Soil compaction and root injury may cause plants to exhibit symptoms of iron or manganese deficiency regardless of soil pH. Avoid chlorosis problems by planting species that tolerate alkaline soil if a soil test reveals alkaline conditions.

We recommend that you test soil before fertilizing a tree or shrub. Soil tests provide useful information about soil pH and major nutrients. In addition, look for plant symptoms as an indicator of whether or not a tree needs to be fertilized. Short annual twig growth, many dead branches, thin leaf canopy, reduced leaf size, light green or yellow-green leaf color, and early fall coloration or defoliation may indicate a nutrient deficiency.

When to Fertilize

When we do fertilize, we prefer to do it in the fall after the leaves drop off. Early spring, before leaves emerge, is our second choice. Avoid fertilizing trees during the summer unless they are under regular irrigation. Fertilizing at this time of year may encourage new growth which may not have time to harden off adequately before cold weather sets in. It may also encourage some diseases, such as fireblight.

Plants which show symptoms of stress should only be fertilized with an organic, slow release material which is low in nitrogen.

How to Fertilize

Complete fertilizers containing nitrogen, phosphorus and potassium come in organic and inorganic forms. Organic fertilizers such as manure and compost release nutrients slowly as they decompose. This reduces root burn and helps condition the soil. They usually contain a low amount of nitrogen and are more expensive than synthetic fertilizers.
In addition to carbon, oxygen and hydrogen that trees get from air and water, they need these nutrients from soil:

- Nitrogen
- Phosphorus
- Potassium
- Sulfur
- Calcium
- Magnesium
- Boron
- Chlorine
- Copper
- Iron
- Manganese
- Molybdenum
- Zinc.

Apply fertilizer throughout the area under the canopy of a tree. Use a soil auger, crow bar or pipe to make holes about 2' apart, 12" deep and 1" wide in a grid pattern as shown. Start the holes a distance out from the trunk equal to twice the diameter of the trunk. Calculate the amount of fertilizer you need and divide it equally among the holes. Water well the area under the tree.
Example Calculation

You want to fertilize a mature shade tree at the rate of 2 pounds of actual nitrogen (N) per 1,000 square feet of soil area.

You drilled holes under the tree’s branch spread and beyond. The area measures 35 feet by 35 feet (1,225 square feet)

You have a 40 pound bag of fertilizer with a formulation of 15-5-5 (N-P-K). Since 15 percent of the weight of the bag is nitrogen, it contains 6 pounds (.15 x 40 pounds) of actual nitrogen. At a rate of 2 pounds of nitrogen per 1,000 square feet of area, this bag contains enough fertilizer for 3,000 square feet of area.

Since you want to apply nitrogen at the rate of 2 pounds, per 1,000 square feet of area, you need a little less than 2½ pounds of nitrogen to cover the area under your tree.

You decide to use about 17 pounds (2½/6 x 40) of this fertilizer and divide it equally among the holes you drilled.
Prune Trees

The pruning you do when your tree is young affects it throughout its life. Tree branches do not move and they usually do not change direction, so little problems grow into big problems. Trees in unnatural places, like on a boulevard, do not grow the same as their cousins in the natural forest. Trees in the natural forest grow close together. Lower branches do not get a lot of sun. They stay small and eventually die. The strongest trees make it to maturity. Life in town is different. It is up to people to prune trees so they grow up strong and healthy.

Has it been a long time since your tree was pruned? Take a look at your trees.

A young tree needs pruning every year or two. Older trees need pruning at least once every five years. Too often, tree owners delay pruning until a tree looks unsightly. Then they prune for appearance. The result may be a tree that looks okay, but is full of defects that set the stage for storm damage and premature death. Even worse is the old technique of topping trees, which leads to trees full of defects and decay. Prune your tree for safety and tree health first. Consider appearance after that.
Prune trees for safety and health first. Prune for appearance after that.

**Pruning Priorities**

**For Safety**
- Remove dead, damaged or broken branches
- Remove weakly attached branches
- Train your young tree to have one main trunk by pruning off branches, called double leaders, that turn up and compete with it. Train it to have well-spaced, well-attached side branches
- Remove branches that interfere with the sidewalk, the street or other human needs
- Remove branches that grow toward electrical power lines. Keep in mind that trees are good electrical conductors. If branches are near electrical lines already, contact your electrical utility. Let professionals, with their special equipment handle branches that are near lines.

**For Health**
- If two branches cross or rub, remove the least desirable branch
- Remove diseased and low vigor branches, suckers and watersprouts
- Prune low, temporary branches, so they stay small. That way they won't leave a big wound when they are finally cut off
- If a branch rubs on a sign, a wire, a building or anything else that might damage the bark, remove it or prune it back to a side branch that is growing in a different direction
- Thin branches for good structure, air movement, light penetration and/or weight reduction

**For Appearance**

Before you prune for appearance, consider these questions:
- What is the natural shape and character of this tree?
- What is the function of this tree? If a tree is supposed to slow the winter winds or block an unsightly view, do not remove the lower branches that do that job. If a tree is supposed to frame a view, not hide it, remove any branches that are in the way (A word of caution here: Be patient and let your young tree get tall enough before you remove lower branches). You can remove selected branches from the crown of the tree to allow a view of something as long as you do not remove more than one-fourth of the foliage of the tree.

Common problems that pruning can solve.
- Look for girdling roots. You may want to cut them before they strangle the tree.
You can tell the difference between a strong branch attachment and one that is weak. Learn to recognize branch collars and never damage one with a pruning cut. Plan which branches to remove so that over the years your tree develops well spaced side branches. For a strong tree, the side branches should be less than one half as wide as the main trunk.

Before you prune, inspect your tree from the top down and plan the work. Remember tree safety and health come before appearance. Make pruning cuts with respect for the tree's natural defense system. Make cuts at branch unions. Leave branch collars. Use sharp tools and make smooth cuts. There should not be any loose bark around the cut. Use three cuts to remove any branch that is too big to hold in your hand.

When you must cut a branch back to a side branch, it should be large enough to become the new leader. Select a side branch that is at least one third as wide as the branch that you will cut off.

Check your work. Look at the places where you pruned off branches a year ago. If you see a donut-shaped ring of callus tissue around the wound, you made a proper cut.

There is usually no need to cover tree wounds with wound dressing. Trees do just fine all by themselves. If you must cover a wound (as in oak trees wounded April 15 to July 1) use a thin coating of latex paint. In the spring, sap will flow from pruning wounds on a maple or a birch. It is not harmful to the tree.

Try to leave trees alone when leaves are forming or falling. During these times, the tree is busy doing other things. It does not have energy to deal with pruning wounds. Winter, while trees are dormant, is a great time to prune trees. Removing dead branches is always beneficial to a tree regardless of the time of year.

A strong branch union is U-shaped and has a ridge of branch bark running through it.

A weak branch attachment has a narrow, V-shaped union. Bark turns into the crotch and is trapped between the branches.
Removing dead and damaged branches is all that is usually needed for a mature tree that has had regular care throughout its life.

**Pruning Prescription for a Young Tree**

- Prune every one to two years
- Most pruning will involve removing live branches. Limit pruning to one fourth of the live branches per year
- Look specially for branches that turn up and compete with the leader (trunk) of the tree. Remove the competing branches or head them back to slow down their growth
- Leave lower branches on the tree for several years. Since tree branches stay in the same place all their life, you must remove the low, temporary branches as the tree gets taller. Keep them small relative to the trunk until it's time for removal
- Select the main side (scaffold) branches. They should be well spaced along the trunk: about 1½ feet apart on large maturing trees. For small maturing trees, such as crabapples, 6-8 inches is adequate
- Remove broken, split or rubbing branches, and those that interfere with the tree trunk or the main branches.

**Pruning Prescription for a Middle Aged Tree**

- Prune every two to four years
- If you need a ladder or a chainsaw, hire a professional arborist
- Remove fewer live branches than you would on a young tree
- Continue to prune as for a young tree to develop a strong trunk and well spaced, well attached branches
- Remove problem branches

As the height of the tree increases, remove lower branches in the bottom one third of the tree. This is important where low branches may grow to interfere with streets, sidewalks, signs, buildings or other human needs. Consider the natural form of the tree and the job it is supposed to do in the landscape.

How to prune a double leader. USDA
Pruning Prescription for a Mature Tree

- Hire a professional arborist to prune the tree every five years

- Get the dead out. Expect to remove a lot of dead branches and only a few live ones. Never remove more than one fourth of the live foliage in a single season

- Some old, dead branches have collars that are grown out along the branch. Remove only the dead branch, leaving the live collar uninjured.

Pollarding and espalier pruning are specialty training systems that are beyond the scope of this manual. Both are acceptable methods of training trees, so long as they are implemented properly and the tree owner is willing to do the annual or bi-annual maintenance that they require FOREVER. Pollarding is not the same as topping.

Pruning Prescription for a Storm Damaged Tree

- A seriously damaged tree may need replacement

- Hire a professional arborist to prune the tree if there are broken or cracked branches higher than you can reach from the ground or if you need a chainsaw

- Properly prune dead, dying, broken or cracked branches

- If you must leave a branch whose end is broken, remove only the broken part without cutting into the undamaged part

- Remove loose bark, but use care not to disturb live bark that is still attached to wood

- Wait one growing season to prune for appearance

- Never top a storm damaged tree!

Tree branches do not move up the tree as it gets taller. They stay in the same place all their lives.

Look for root damage after a windstorm. A leaning tree with a slit in the soil or a mound of soil opposite the direction of lean may mean that tree roots are severed. It is a dangerous situation and requires the immediate removal of the tree.

More Information:

- Work With Existing Trees, pg. 68
- When Your Trees Need Trimming, pg. 135
Work With Existing Trees

Is This Tree Worth Saving?

Trees age right along with humans. While healthy trees are desirable and add value to commercial and residential property, declining and dead trees decrease property values and may be a liability. Before deciding whether or not to remove a large, living tree, consider these key points:

What kind of tree is it?

Some types have a long life, attractive form, strong wood and other characteristics which make them a desirable part of the landscape.

Is the tree structurally sound?

Some types of trees are brittle, have poor branch unions or other structural defects, such as decay or cracks, which make them potentially more hazardous. Not all trees with a defect fail and not all trees that fail are defective. Storm and construction damage may cause previously sound trees to become hazardous.

Where is the tree located?

If the tree is interfering with utilities, roads, walkways or buildings, or if it is in the way of a construction project, it may need to be removed. A tree with a defect may be hazardous if located near a target (house, play area, patio, parking area or street) upon which it could fall and damage a structure or injure people.

Does the tree have historic or sentimental value?

If the tree or the site was involved in an historic event that is of significance to local citizens, efforts should be made to retain the tree. If the tree was planted as a memorial, it may be undesirable or difficult to remove it.

Protect Trees From Construction Damage

Construction damage is one of the biggest killers of mature trees. Grade change involving soil fill or removal, soil compaction, root cutting, trunk wounds and changes in soil drainage patterns all harm existing trees. Some trees must be sacrificed when building on a wooded site; however, much of the tree injury which occurs could be avoided by following some simple guidelines:

- Go over the site with a professional arborist or forester before any equipment appears on the site
- Determine which trees should be retained and mark them clearly
- Meet the building contractor on site to discuss building and utility placement and agree upon which trees are to be protected
- Protect designated trees with a sturdy barrier of snow fencing; to protect the root system, this barrier should be placed at a minimum distance from the trunk of one foot per inch of trunk diameter
- Instruct all workers on the site regarding the reason for the barriers and that the barriers are not to be violated or removed
- Pile soil and building materials away from protected trees
- Place parking and driving areas away from protected trees
- Avoid putting more than 3-4 inches of fill dirt over the root system of a tree in any one year. If fill must be applied, use a porous soil rather than clay subsoil. Temporary fill dirt should be removed within two months of application or the tree will be harmed. If more than four inches of fill must be added or removed in order to landscape the lot, consider a retaining wall or the addition of a drainage/aeration system around the tree's root system.

- Before excavating close to mature trees cut roots cleanly with a vibratory plow to reduce root tearing.

- Have underground utilities put in a common trench, if possible.

- Tunnel directly under the trunks of large trees instead of cutting major roots to put in utility lines.

- Place footings for decks and holes for fence supports where they will do the least harm to tree roots.

- Healthy, young trees will withstand construction injury better than mature, established trees. Oaks are particularly sensitive to construction damage. Take extra care when building or remodeling on a site containing these valuable trees.

The tree which moves some to tears of joy is in the eyes of others only a green thing which stands in the way.

William Blake
A target is something that a tree might hit if it falls over or breaks apart for any reason. Common targets are people, structures, benches, picnic tables, children's play equipment, high-speed roads and utility lines.

If a tree dies, plant another in its place. Linnaeus

More Information:
• Should I Fertilize This Tree? pg. 60
• Prune Trees, pg. 63

• To improve the health of trees affected by construction damage, prune dead and dying limbs, aerate compacted soil, water trees well (unless drainage is poor) and mulch the root system with 4 inches of wood chips

• Prior to construction, fertilize trees with a complete, slow-release, fertilizer. Use a fertilizer which has the same or less nitrogen than phosphorus and potassium. If trees are severely damaged, do not fertilize until the trees show signs of recovery.

• WATER! Drought stressed trees are the trees most likely to die during or after construction activities.

Is This Tree Hazardous?

Inspect trees annually for hazardous conditions. Keep in mind that large, older trees and trees damaged by storms are often more dangerous than young, sound, uninjured trees. Fast-growing tree species and those which tend to form double-trunks and V-shaped crotches with included bark should also be examined more often for problems. Trees which have suffered construction damage, have root or trunk wounds, or are growing on severely compacted soil should also be examined, particularly if the crown of the tree is off-color or thin. Look for these warning signs of a hazardous tree:

• Dead tree

• Cavities or decay in the trunk, branches or at the soil line, woodpecker holes or shelf fungi

• Cracks in a large branch; cracks where the branches meet the trunk; cracks in the main trunk, particularly if they occur on opposite sides or extend into the ground

When looking for hazards, consider the history of the tree. Was it was ever topped or wounded? Trees tend to grow wood over their wounds, so internal defects are not always obvious. If you doubt the soundness of a tree, consult a tree professional. If there is no target present (see sidebar) dead or decayed trees, or tree trunks, can be preserved for wildlife habitat.