SULIS: Sustainable Urban Landscape Information Series

Trees and Turf: Are They Compatible?

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Description/Purpose

Trees and turfgrass are commonly planted together in today's landscapes. However, they tend to be incompatible and interfere with one another, above ground and below. The negative effect of turf on tree growth has been well documented for forest trees and fruit trees. Turfgrass can severely retard tree seedlings planted in lawns, golf courses, cemeteries, and along roads. However, the landscape industry has been reluctant to challenge the public's expectation of designing landscapes with manicured lawns right up to the base of every tree.

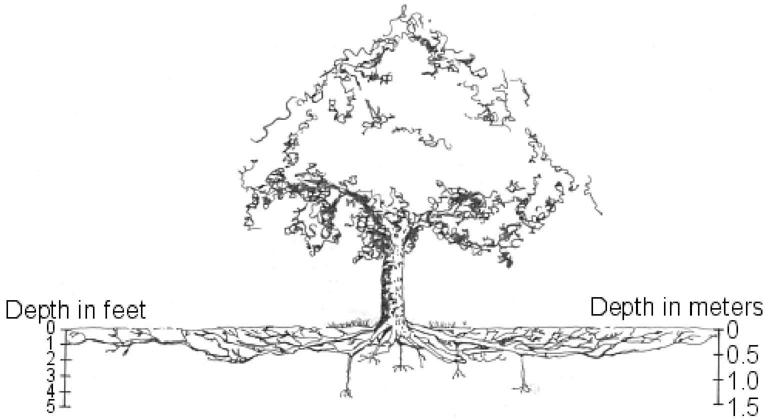
Interference

Interference = competition + allelopathy
"Interference" is the combined harmful effect of plant competition (for nutrients, water, and light) and allelopathy (one plant inhibiting the growth of another).

Competition

Turfgrass competition reduces tree root development. The root systems of trees and turfgrass compete for space underground. Several studies have shown that tree root development is reduced by grass competition. Urban situations usually restrict trees' lateral root spread with foundations and pavements. Poor aeration or drainage of clayey soils prevents root development in deeper soil layers. Reduction of fine tree roots by competing turfgrass compounds the problem. A tree with a poorly developed root system has a reduced ability to absorb moisture and nutrients from the soil.

There is a misconception about the location of tree roots: most absorbing roots are in the upper few inches of soil (as shown in the illustration below, *Harris, Clark, Matheny*). The root systems of trees are quite shallow, and they spread well beyond the dripline when unrestricted. It is a myth that a tree's root system is an underground mirror of the crown.



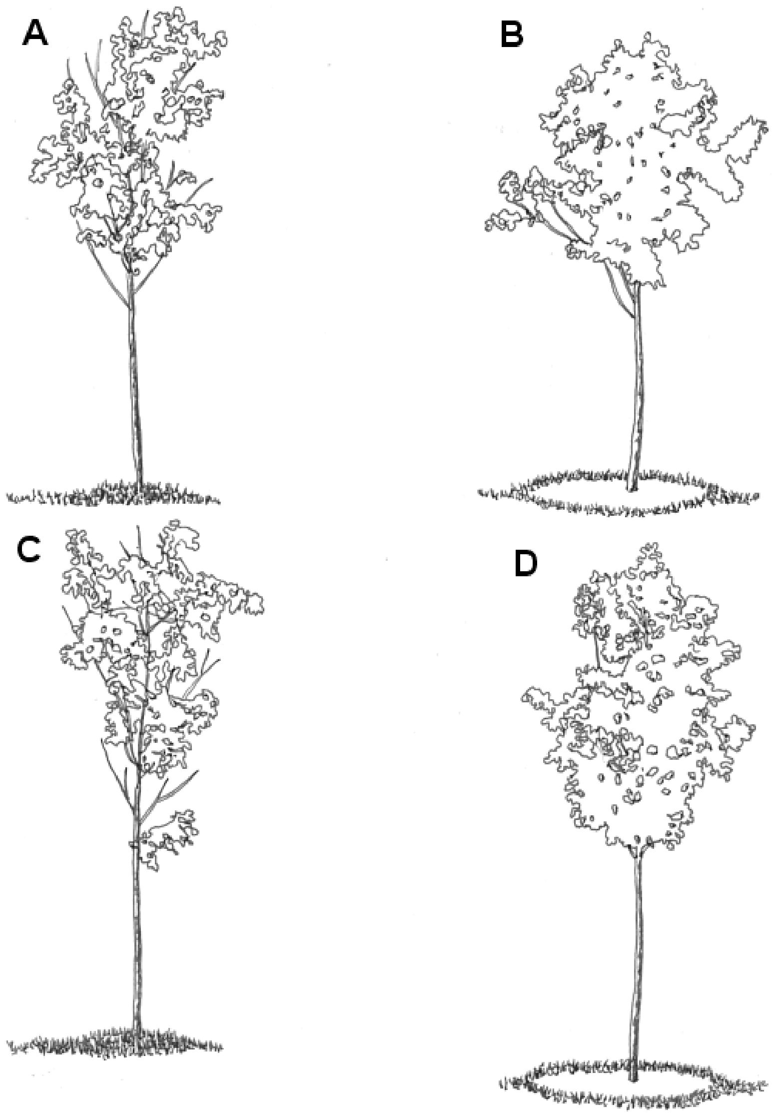
Roots will grow where the conditions are best for root growth; in most cases, that is near the soil surface. Oxygen, nutrients, and moisture are usually best near the surface, so the roots of trees, turf, and other plants share this space.

Mulch newly planted trees and shrubs.
Research has shown that trees growing in a mulched environment have better growth and less stress than those growing together with turf. Landscaping with mulch around trees is a practical alternative to grass. Where plain mulch is not acceptable, plantings of shrubs and perennial groundcovers would be less competitive than lawns.

What mulch does:

- Eliminates competition from grass and weeds and reduces the need for herbicides
- Retains soil moisture and reduces the need for irrigation
- Moderates soil temperature
- Increases organic matter in the soil and improves soil fertility as the mulch decays
- Reduces "mower blight" (wounds made by mowers and weed whips)
- Prevents wind and water erosion
- Mulch rings are a means of visually and physically grouping trees together

Mulching newly planted trees and shrubs.
A study (*Green & Watson 1989*) conducted by Morton Arboretum staff at the College of DuPage campus tested the effects of turfgrass and mulch on a plot of forty newly planted, bare-root 'Green Mountain' sugar maple trees. After five years, the study concluded that mulching resulted in significant increases in diameter growth, crown development, and root development.



Typical trees from each of the following treatments:

A. Lawn over entire root zone

B. 8-foot diameter mulch circle

C. 8-foot diameter tilled area with turf replaced

D. 8-foot diameter tilled area with mulch

(Adapted from Green and Watson, "Effects of turfgrass and mulch on the establishment and growth of bare-root maples").

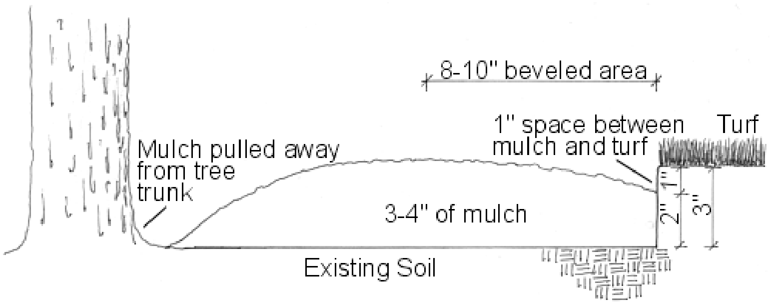
When mulching newly planted trees:

- Apply a 4-inch depth of mulch from near the trunk to 12 inches beyond the root ball
- Enlarge the radius of the mulch ring 12 to 24 inches per year for at least 3 years, while each tree or shrub establishes a new root system - this will stop grass growth in the areas where the roots are developing and assist root growth
- A coarse, porous mulch, such as wood chips, allows better rain or irrigation penetration
- Keep the mulch from direct contact with the tree trunk to prevent disease or rodent problems

Mulching benefits established trees, too.

A field study at the Morton Arboretum in Lisle, Illinois, showed that after only two months, elimination of grass around 20-year old trees resulted in a 113% increase in fine root density in sugar maples, and increases of over 30% in green ash and littleleaf lindens. Root density increased even more when an organic mulch cover was applied.

A soil "wall" can be used instead of landscape edging. It is more effective at keeping mulch from falling into turf (*illustrated below*), while also preventing turf roots from growing into the mulched area. This method lasts about three years, and can be readily enlarged without having to remove and re-install edging.



Make a 3-inch vertical slice or cut into the turf and bevel it back 8 to 10 inches to the top of the soil line in the mulched area. This slice will be backfilled with mulch to about one inch from the top.

Trees and turfgrass compete with one another for their shared needs.

- Water or soil moisture
- Nutrients
- Light

Competition for Soil Moisture Soil moisture can cause both trees and turf to become stressed. Stressed plants are predisposed to pest and disease problems. While trees and turf are struggling, weeds with low moisture requirements establish themselves.

Numerous studies have shown that grass competition reduces, and mulch increases, the height and caliper (trunk diameter) of trees as compared to trees grown in bare soil. Nitrogen and water can also reduce the negative effects of the grass on the tree growth. Mulching around trees is one of the best ways to manage water stress.

Timing can be everything. Trees and shrubs require ample water for new top growth in early spring, a time when soil moisture levels are usually at their peak. Competition for water from turf or cover crops at this time of year is usually minimal and less likely to affect a tree's shoot growth. However, competition for soil moisture later in the growing season -- when most caliper growth occurs - can be problematic for trees; turf competition limits caliper growth.

Proper watering is important, since turf and trees have quite different irrigation needs. Turf responds to frequent and shallow watering, which encourages surface root formation in trees. Frequent, shallow watering of trees can lead to tree root rot diseases and poor tree root health, especially in poorly drained soils. Trees prefer deeper, less frequent watering.

Competition for Nutrients Turfgrass competition can reduce the growth, fruit set, and flowering of trees. Where tree roots and turf roots share the same soil volume, it is impossible to fertilize the turf without also fertilizing the trees. However, studies have shown that turf roots will take up the majority of fertilizer applications when sharing soil space with tree roots. Since turf roots tend to respond quicker to soil fertility and colonize faster, they usually have the advantage.

In high-maintenance turf areas, with heavy nitrogen applications to maintain high turf standards, tree roots benefit from the windfall supply of nitrogen. However, the data relative to supplementary fertilization to overcome turf competition in other landscapes are mixed. Trees may need minerals or nutrients aside from nitrogen. For example, chlorosis of pin oak trees may be an indication of iron deficiency, especially in alkaline urban soils. The key to any fertilization program is to base it on the plant's needs (following soil or foliar analyses). Cost-effectiveness is another consideration, as the most economical method of fertilization - surface application - favors turf development.

There is evidence that excess fertilization can predispose trees to other problems, particularly insect problems. Triggering trees to produce vegetative growth can direct fewer reserves to defense and storage. Furthermore, the lush new leaves may attract certain leaf-feeding pests, while the allelopathic chemicals that deter those pests may be reduced. Find more information on fertilizer recommendations for trees, existing turfgrass, and new turfgrass.

Competition for Light Trees and turf both need light to grow. Shade from tree canopies is a major stress factor for turf. The competition for light leads to increased root competition, reduced turf density, reduced vigor, decreased food reserves, increased invasion by shade-loving weeds, increased susceptibility to pest problems, and reduced tolerance to drought, heat, cold, and wear. Stressed grass also has a reduced capacity to recover from traffic and wear. Shade-tolerant grasses are not the answer, because they tend to be less tolerant of foot traffic and wear.

Shade reduces **light quantity, quality,** and **duration**:

Light quantity:

- The quantity of light that penetrates the tree canopy to the turf will depend on the height and spread of the trees. Tall trees cast long shadows. Trees with dense canopies (e.g., sugar maple) block more sun than trees with open canopies (e.g., honeylocust). Under open canopies, snow and ice melt more quickly and turf can come back sooner in the spring.
- Trees that grow on the south and east sides of turf block the morning sun, which is critical to turf growth.
- Dense canopies reduce air circulation and increase humidity, which in turn can lead to turf diseases, such as powdery mildew or dollar spot.

Light quality:

- Tree leaves absorb violet/blue and orange/red wavelengths of light from the spectrum, leaving the green/yellow wavelengths, or "yellow shade," for the turf.
- Blue light is important for turf growth. Lack of blue and red light causes thinner glass blades and weak root development.

Light duration:

- The size and location of trees in comparison to the angle of the sun affect the duration of sunlight on the turf.

The plant that was established first - tree or turf - has the advantage. Sequence of establishment may be a factor. Most studies involve planting trees in established stands of turfgrass. But what happens when the sequence is reversed? In one study (*Whitcomb and Roberts*), silver maple and honeylocust established prior to seeding of common Kentucky bluegrass had a significant negative effect on the root- and top-growth of bluegrass, but the bluegrass had no effect on the tree roots. The study conjectured that a combination of competition and allelopathy accounted for this result.

Using cover crops as an alternative to bare soil or turf under trees is a sustainable means of reducing competition. Conventional nursery practices are aimed at the profitable production of quality nursery stock, rather than promoting sustainability. Conventional nursery field management practices include:

- Cultivation of bare soil (4- to 6-inch depth), using a walk-behind tiller, approximately once each month during the growing season, or 3 to 5 times);
- Hand-hoeing in the 4-inch area surrounding each tree trunk
- Pre-emergent herbicides (such as oxadiazon) applied each spring, using a walk-behind spreader.

Cover/companion crops and integrated pest management are alternative practices, especially in sustainable landscapes, where environmental considerations are a priority. They are less labor intensive and more eco-friendly than conventional practices.

Cover crops, such as 'Wheeler' winter rye (*Secale cereale* 'Wheeler') and companion crops, such as 'Norcen' bird's-foot trefoil (*Lotus corniculatus* L. 'Norcen') have been used instead of turfgrass or bare soil in tree nurseries. They stabilize soil, help maintain soil moisture, reduce fertilizer requirements, and improve accessibility of equipment, especially in wet conditions. Rye suppresses weeds (allelopathically) and does not significantly reduce tree growth. The bird's-foot trefoil is less able to suppress weeds and reduces tree growth a bit more.

A recent study (*Calkins and Swanson*) at the nursery facility at the University of Minnesota compared conventional and alternative field management systems and their respective impacts on tree growth. Six common tree species were the study subjects: 'Red Splendor' flowering crabapple (*Malus* 'Red Splendor'); 'Marshall's Seedless' green ash (*Fraxinus pennsylvanica* 'Marshall's Seedless'); 'Skyline' thornless honeylocust (*Gleditsia triacanthos* var. *inermis* 'Skyline'); 'Northwood' red maple (*Acer rubrum* 'Northwood'); Techny white cedar (*Thuja occidentalis* 'Techny'); and Black Hills spruce (*Picea glauca* var. *densata*). Five field treatments were used: 1) cultivation (3 to 5 cultivations per year); 2) herbicide management (oxadiazon); 3) 'Norcen' bird's-foot trefoil companion crop; 4) 'Wheeler' winter rye cover crop/mulch; and 5) grass sod (20% 'Ruby' red fescue and 80% 'Eton' perennial ryegrass). In general, herbicide management and cultivation resulted in the most vigorous growth and best quality trees. The rye cover crop/mulch treatment was nearly as successful, with only slightly reduced plant performance. The grass sod and trefoil proved to be too competitive.

Research has shown that honeylocusts (*Gleditsia triacanthos* var. *inermis*) grow more vigorously in bare soil than with groundcovers; however, honeylocusts grown in bare soil are more susceptible to Nectria Canker (*Nectria cinnabarina*). The reason for the disparity was freezing stress, caused by temperature extremes in the unprotected soil.

Cover crops and mulch reduce the need for pesticides and chemicals, both of which have several drawbacks. Broadleaf weed killers can injure or kill trees if high enough dosages are applied, since trees are broad-leaved plants. Growth regulator herbicides (dicamba or 2-4-D) are systemic, which means that they move through the plant. Weed-and-feed fertilizers contain herbicides that can damage trees. Symptoms of herbicide damage to trees include cupped foliage, twisted shoot tips, interveinal chlorosis, wilted leaves, marginal leaf chlorosis or necrosis. The extent of tree injury usually is not readily apparent. Most often, damage is not permanent, but young trees can be killed outright from accidental exposure.

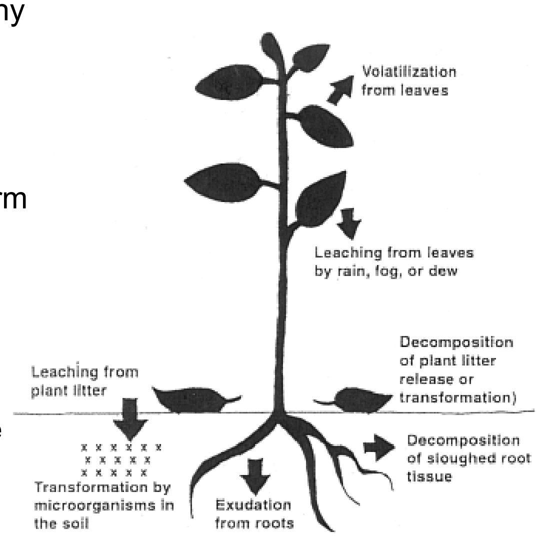
Allelopathy: "Chemical warfare" Among Plants

Allelopathy is the inhibition of the growth and development of one plant by another. Plants communicate with each other in a variety of ways. Trees and turf release natural herbicides ("allelochemicals) that inhibit the growth of their neighbors and keep other plants from growing too close.

Plants use allelopathy as a means to guard their own space and protect their resource. Allelopathy is a strategy to reduce competition. For example, one way for a tree to protect its root space is to make other trees' roots die off using allelopathy. The tree can then pull more water from the soil for itself.

Many trees are known to have allelopathic effects on the germination or development of other plants (e.g., pine, planetree, maple, hackberry, eucalyptus, sumac, and others). Black walnut (*Juglans nigra*) is the classic case. Juglone, the toxin produced by black walnut trees, inhibits the growth of many trees, shrubs, and herbaceous plants, such as basswood, birch, pine, hackberry, rhododendron/azalea, cotoneaster, potentilla, and members of the nightshade family (tomato, potato, green pepper, eggplant).

How does allelopathy help plants? Inhibitors may be present in any part of the plant, although roots and leaves are the most consistent source since they contain large amounts of metabolites. These metabolites are released in a variety of ways:



Environmental routes of entry [*Chick, Kielbaso*].

- **Volatilization**. Allelopathic trees release a chemical in a gas form through small openings in their leaves. Other plants absorb the toxic chemical and die.
- **Leaching**. All plants lose leaves. Some plants store protective chemicals in the leaves they drop. When the leaves fall to the ground, they decompose and give off chemicals that protect the plant. Fall foliage tends to release more potent allelochemicals than fresh, spring foliage. Water-soluble phytotoxins may be leached from roots or aboveground plant parts or they may be actively exuded from living roots. Rye and quackgrass release allelopathic chemicals from rhizomes or cut leaves.
- **Exudation**. Some plants release defensive chemicals into the soil through their roots (see Table 1 for a list of allelopathic plants). The released chemicals are absorbed by the roots of nearby trees. Exuding compounds are selectively toxic to other plants. Exudates are usually various phenolic compounds (e.g., coumarins) that tend to inhibit development.

Table 1. Some allelopathic plants, the chemicals they produce, and the plants they affect.

Allelopathic Species	Type of Chemical	Affected Species
Trees:		
Sugar Maple	Phenolics	Yellow Birch, White Spruce
Hackberry	Coumarins	Herbs, grasses
Eucalyptus	Phenolics	Shrubs, herbs, grasses

Black Walnut	Juglone (Quinone)	Pines (Austrian, Scots, red, white), Apple, Birch, Black Alder, Hackberry, Basswood, Azalea, et al.
Juniper	Phenolics	Grasses
Sycamore (Planetree)	Coumarins	Yellow Birch, herbs, grasses
Black Cherry	Cyanogenic glycosides	Red Maple, Red Pine
Oaks	Coumarins,	Herbs, grasses
Other phenolics		
Sassafras	Terpenoids	Elm, Silver Maple, Boxelder
Balsam Poplar		Green Alder
Southern Red Oak		Sweetgum
Shrubs:		
Laurel -- Kalmia angustifolia	Phenolics	Black Spruce
Manzanita	Coumarins,	Herbs, grasses
Other phenolics		
Bearberry	Phenolics	Pine, Spruce
Sumac	Phenolics, terpenoids	Douglas fir
Rhododendron	Phenolics	Douglas fir
Elderberry	Phenolics	Douglas fir
Forsythia intermedia		Kentucky Bluegrass
Other:		
Goldenrod, Aster	Phenolics, terpenoids	Sugar Maple, Bl. Cherry, Tulip Poplar, Red Pine
New York Fern	Phenolics	Black Cherry
Bracken Fern	Phenolics	Douglas fir
Shorthusk Grass	Phenolics	Black Cherry
Clubmoss	Phenolics	Black Cherry
Reindeer Lichen	Phenolics	Jack Pine, White Spruce
Tall Fescue	Phenolics	Sweetgum, Black Walnut, White Ash
Red Fescue, Kentucky Bluegrass		Azalea, Barberry, Forsythia, Flowering Dogwood, Yew
Colonial Bentgrass		Azalea, Barberry, Yew, Forsythia
Perennial Rye		Apple, Forsythia, Flowering Dogwood
Foxtail, Smooth Brome		Populus spp.

Allelopathic chemicals act in a variety of ways. Some retard growth or inhibit germination by disrupting cell division. Some interfere with respiration and other energy-transfer processes. Many affect plant nutrition by inhibiting water and nutrient uptake. In some instances, allelopathy prevents the establishment of a plant or kills established plants, but most often it simply reduces plant growth.

Allelochemicals may be absorbed directly from the air, but most must pass into the soil before being absorbed. In the soil, the chemicals may be deactivated by adsorption onto clays or organic matter, or they may be decomposed by microorganisms.

The soil is important in allelopathic interactions. The level of toxins in the soil is affected by soil types, drainage, aeration, temperature, and microbial activity. For example, clay soils drain poorly, and toxins do not leach readily. By contrast, coarse, well-drained, sandy soils tend to maximize leaching. In one study (*Fisher 1978*), juglone from black walnut damaged and sometimes killed red and white pine on wet sites, but on dry sites juglone had little effect. Toxin-sensitive plants may be at higher risk when planted in heavy soils.

Potential benefits of allelopathic plants:

- The brightest hope for allelochemicals is that they will act as natural weed killers or pesticides, substituting for chemicals, and promote sustainable agriculture.
- Plants that will suppress tree growth may, in the future, reduce the cost of pruning or herbicide applications in conflicts between trees and power lines.
- Use of allelopathic cover crops (*e.g.*, rye) for weed suppression can decrease reliance upon herbicides.
- An understanding of plant/chemical relationships could reveal practical benefits of "companion planting," a practice endorsed by organic gardeners, which is currently valued less than if it were based on science-based research.

Allelopathy is another factor -- along with competition -- that complicates the mixing of tree and turf. There is no chemical control available to stop the potential toxicity of one plant toward another. The only practical controls are physical separation and planning ahead to prevent the interaction of incompatible plants.

Summary and Recommendations

Familiarity with the types of plants most likely to produce toxic effects as well as the site conditions likely to contribute to adverse plant interactions can help to avoid problems with allelopathy and tree/turf competition. The problem is not turf per se; rather, it is where turf should and should not be used in landscapes.

Recommendations for landscape designers:

The challenge for landscape designers is to design attractive landscapes without placing turfgrass next to trees.

- Group trees together in a shared, mulched bed (the mulch beds don't all have to be round; try pleasing geometric or free-form shapes).
- Experiment with mulch materials: pine bark, cypress mulch, pine needles, wood chips, compost, etc., to maximize plant health and create aesthetically pleasing landscape.
- Select trees and plants that are allelopathically compatible.
- Use well-drained, loam soils for ornamental plantings or replace compacted clay soils prior to planting to lessen the levels of soil toxins.
- Use shade-tolerant ground covers, such as *Pachysandra terminalis, Diervilla lonicera,* or *Ajuga reptans*, in place of turfgrass around trees.

Recommendations for the nursery industry:

For the mutual benefit of trees and turf and to minimize landscape maintenance, use sustainable alternatives to conventional planting and maintenance practices:

- Use mulch and/or cover/companion crops instead of turfgrass or bare soil around trees to minimize competition, maximize tree growth, and conserve resources.
- Use integrated pest management techniques to handle disease and insect pests instead of automatic reliance on chemicals.

Recommendations for golf courses, parks, and other large grounds areas:

- Manage shade by proper tree placement and species selection and by tracking shade patterns. A computer-aided system, such as SunSeekertm, helps to determine what trees to remove, what limbs to prune, and where to plant trees in turf areas for specific recreational purposes, i.e., greens, tees, lawn bowling, etc.
- Educate ground maintenance crews about the proper use of weed whips and mowers to deter tree wounds.
- Maintain trees in groups. Individual trees are harder to work around when maintaining turf and are more likely to be injured by equipment or people.
- Use mulch around trees to control weeds and minimize moisture competition between trees and turf.
- Experiment with mulch types to find one that is compatible with landscape plants and recreational users.
- Use root barriers to redirect tree root growth or to prevent root penetration.
- Understand the biological differences between trees and turf.
- Maximize growing conditions while minimizing conflicts through good planning and plant selection.

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