

Part I: Right Tree... Wrong Place

Many of us lament that trees planted today in urban landscapes seem doomed to a short and often much abused life.

Usually, the first deadly sin perpetrated against an urban tree is planting the right tree in the **WRONG** place. Trees can't just get up and walk away when they outgrow their living space or when they find themselves caught in some other unhealthy situation. Therefore, it is critical to select the right tree for each particular site. The conditions and characteristics of the site should be matched as closely as possible with a tree species that can fully appreciate those conditions and characteristics. Every tree should have the potential to mature gracefully within the boundaries of the urban infrastructure in which it is planted.

Trees come in many different shapes, sizes, textures, and colors. Predicting the mature size and appearance of a tree is relatively simple, it only takes a little research. As with all life forms, a tree's form, mature height, and structure are determined largely by its genetics. Each species has characteristics that are unique yet wholly predictable. Choosing a tree based on its

juvenile appearance is unrealistic and almost guarantees that neither the tree nor the property owner will be satisfied with the outcome. It is crucial to know what to expect at maturity. There is no such thing as a bad tree, but too often, good trees are set up for a fall through haste and ignorance.

TREE SIZE AND SHAPE

Selecting the right tree for the right location begins with knowing the overall height and canopy span the tree is expected to achieve. Choosing a tree that matures at the desired height not only reduces maintenance costs, but it also reduces the number and severity of pruning events necessary for managing the tree. For example, when overhead utilities are involved, trees that mature over 20 feet tall should not be planted any closer to power lines than a distance equal to their mature height to avoid potentially dangerous situations.

Underground space is another important consideration that is often taken for granted. When space is available, tree roots will often spread 2 to 3 times farther than the canopy of the tree and to depths of 3 feet and more. In all cases, a tree should have a minimum of 8 square feet of planting space to support root growth.

In new landscapes, it is a good practice to plant a mixture of fast and slower growing trees. Fast growing trees provide quick shade, but tend to have shorter life spans due in part to weaker wood, splitting, and reduced compartmentalization response. Slower growing species tend to have denser, harder wood and a higher investment in both immune system response and compartmentalization. A good mix ensures the best of both worlds, instant gratification and longevity.



Photo credit: Harold Nicholls

Whether to plant evergreen or deciduous may be another consideration. A deciduous tree strategically planted near the southwest corner of a building can measurably reduce energy needs by providing shade in the summer and then allowing solar energy to penetrate during the winter months.

In many locations, water use is now an issue. Communities that do not receive a great deal of rainfall should be stressing the use of low water use species. High water use plants and trees run the risk of being neglected and even cut down when drought conditions arise.

Attention should also be given to the individual habits of a species. Berries, thorns, seed pods and even shedding bark may be considered a nuisance under some situations.

Can you just imagine a conversation between a couple of Palo Verdes gossiping about the single old Ironwood growing downstream in the wash?

"Well sure she has a high propagation rate thanks to all those human seed gatherers, but did you know that virtually all her children have become urban trees?"

"Augh! You don't say. The poor thing!"

"Heaven help the little buggers. They don't stand a chance!"

SITE CHARACTERISTICS

Soil type, pH and climate should play a major role in selecting the right tree for the right location. Natives and other species that are well suited to the conditions of the landscape will be less stressed by environmental concerns. As with people, stress plays an important role in tree health and immune system response. Trees that are not well adapted to the conditions at a particular site are much more likely to suffer pest infestations and/or develop chronic disease. Native species are not only adapted to the local environment, but they will typically possess innate mechanisms for coping with pests and disease. As an added bonus, native species will provide an attraction and habitat for the local wildlife.

All of this information and more is readily available in books, brochures, online and in handouts from extension offices and local water authorities.

Like humans, trees are incredibly complex, living organisms. Since trees have the potential to live with us throughout our natural lifespan and for untold generations to come, shouldn't we be putting as much time into their selection as say a spouse? Before you utter those fateful words, "till death do us part", you should know the potential of the tree you are selecting and insure that it is compatible with your needs and expectations.

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Part II: Structural Defects

Choosing the appropriate species for a particular planting site (as discussed in Part I) effectively avoids committing the first deadly sin of urban tree care. Avoiding the second deadly sin involves choosing individual trees that are properly structured and in good health.

There are many reputable nurseries that follow best management practices (BMPs) for growing and pruning nursery trees. In fact, many growers are often responsible for the on-going research that contributes to the development of BMPs. Conversely, there are a number of “tree mills” that sacrifice quality for quantity, sometimes willingly, but most often unknowingly. In either case, it falls upon the consumer to determine the value of the product.

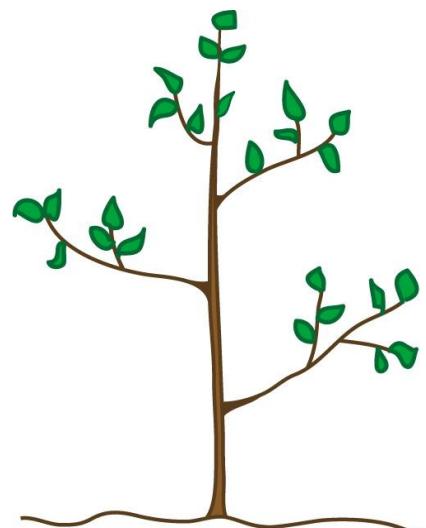
Trees should be selected based on their health and structure. For the purpose of this article, structure will be defined as the overall shape of the tree, its trunk, branches and roots, and the nature of the branch attachments. A tree’s structure is determined by both genetics and environment (i.e., nature vs. nurture). With the exception of those involved in the development of new varieties, most of us have no control over the genetic tendencies of a given tree. With regard to commercially grown trees however, many aspects of the environment are under human control and/or influence.

In order to understand what may constitute a structural defect in a commercially grown tree, it is important to compare and contrast the differences between naturally and commercially growing trees.

NATURALLY GROWN

Typically, trees that grow in the wild develop a healthy structure by carefully managing the limited resources in their natural environment. For every investment, there needs to be a return, and co-dominant and over-crowded branching is less likely to occur since every branch and leaf surface must be judiciously placed to maximize contact with solar rays. In a natural environment, available resources such as water and nutrition must be carefully allocated to provide for continued growth, as well as plant protection (e.g., compartmentalization, immune system response, etc.) and emergency food stores.

Very young trees that are developing naturally often appear spindly and sparsely branched. While this youthful structure may not appear to be very attractive, it is being directed by a DNA blueprint resulting from millions of years of successful evolution. Branches are spaced both vertically and radially around the central leader in a pattern designed to develop a mature individual that is structurally sound and self-engineering to withstand the environmental forces placed upon it.



Natural structure of a young tree.

COMMERCIALLY GROWN

Often, these trees receive an excess of resources. The issue is further compounded by the fact that commercially grown trees are not always given optimal space for growth. In other words, while they may be receiving an overabundance of water and nutrition, space and sunlight are at a premium. This artificial environment is often the cause of structural defects such as overcrowding, codominance, and ultra-acute angles of branch attachment ($<45^\circ$ angle) that are far less common in a natural setting.

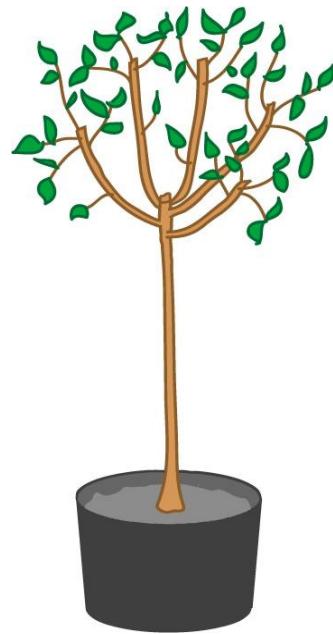
Unfortunately for the trees, some growers circumvent the natural development of structure by heading (cutting off) the central leader of the tree. This harmful practice results in the sprouting of multiple, dormant buds from the location



Closely spaced trees that receive abundant resources produce acutely angled branch attachments.

of the heading cut. Left uncorrected in the landscape, this condition results in an excessive number of branches originating from a single attachment point and is subject to weak attachments, overcrowding, included bark, and eventually catastrophic branch failure. In a nursery, heading results in a compact, dense canopy that more closely resembles a miniature mature tree.

To add insult (and further injury) to injury, young trees that have been headed are commonly stripped of their lower (juvenile) branches. Together, these two harmful practices lead to a lovely pint-sized version of the unenlightened consumer's "ideal tree". Of course, the premature removal of juvenile branches deprives the developing trunk of a convenient carbohydrate source, resulting in a weak and spindly trunk that is unable to support the heavy canopy that was the result of the heading cut. Thankfully, this can all be fixed by strapping on a nursery stake... not!!!!



A "headed" tree without juvenile branches.

In addition to canopy structure, healthy root structure is crucial to the survival of any tree. In nature, roots are likely to spread outward 2-3 times the diameter of the canopy, firmly anchoring the tree in the surrounding soil. With the exception of field grown trees, many urban trees are started in small containers and re-potted as they grow. It is critical that these trees are moved to a larger container and root-pruned (if necessary) before they become root bound or girdled. Girdling occurs when roots reach the container edge and turn inward, forming an entangled ball. As the roots enlarge in the landscape, this structural defect acts like a ball in a socket, allowing the tree to roll over in the soil. Unfortunately, girdling roots are common in urban trees, and once in the landscape, usually impossible to correct.

Sometimes, girdling roots are visible at the root crown, but often they are hidden inside of the root ball and difficult to detect. One test involves grabbing the trunk of the tree and gently rocking the container. If the soil cracks in a circle around the root crown, this is an indication that the roots may be girdled. Another test involves removing the nursery stake (if present). If the tree trunk arches over like half of the golden arches, then the tree has a weak trunk, but if the tree falls over as if hinged at the soil line, then it is probably girdled.

Avoiding the second deadly sin of urban tree care simply means being a knowledgeable and demanding consumer. Support reputable growers by refusing to purchase trees that are unhealthy and structurally unsound.



Trees develop healthy structure by properly managing the limited resources in their natural environment.

SELECT TREES THAT	AVOID TREES THAT
In the most natural state possible	Are supported by a nursery stake, or check that they can stand straight without being staked
Uniform and full canopy	Sparse or uneven canopy
Display good structure <ul style="list-style-type: none"> Strong central leader and intact terminal shoots Juvenile branches spaced throughout the trunk Branches evenly rotated around the trunk Have branches with wide angles of attachment ($>45^\circ$) Any pruning cuts were performed properly 	Structural problems <ul style="list-style-type: none"> Codominant branches Overcrowded branches Branches with acute angles ($<45^\circ$) Excessive branching from a single attachment point Crossing branches Included bark Improper pruning cuts
Appear healthy <ul style="list-style-type: none"> No mechanical damage or wounds No signs of pests or disease Foliage is a healthy color 	Appear weak or unhealthy <ul style="list-style-type: none"> Mechanical damage or other wounds Signs of disease or pest problems Discolored foliage
Are appropriately sized for the container	Have pot bound/girdling roots
No signs of pot bound/girdling roots	Have tree wrap (remove this to see if it is hiding wounds)
Have a visible root collar	Are planted too deeply, soil covering the root flare
	Multitrunked
	Are at the end of the rows with south/west exposures*

REFERENCES

Originally published in *Southwest Trees & Turf*,
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Part III: Planting Too Deep

After all that research to find the tree species that is best suited for the planting site (Part I) and all that time well spent at the nursery choosing a perfectly structured tree (Part II), finally it's time to settle the tree into the ground. What can go wrong here? Dig a hole, pop the tree in, sprinkle a little water and you're good to go. Right?

Unfortunately many things can, and often do, go wrong during the tree planting process. The biggest and most common deadly sin committed here is planting the tree too deep. Trees that are planted too deep will often die in six years or less. As with all of the deadly sins, it helps to contrast urban tree care practices with what happens in a natural environment.

In nature, a seed falls on the ground and under the right conditions, begins to germinate. Growth that occurs below ground naturally differentiates into the root system and growth that occurs above



A tree that is planted too deep resembles a telephone pole stuck in the ground.

ground becomes the stem and branches that will eventually form the trunk and crown of the tree. As with human stem tissue, once cell differentiation takes place, there is no going back. Roots are roots and stems are stems.

Roots are well designed to flourish in a moist environment of soil and organic matter. Like the mucous membranes in our own bodies, roots thrive under damp, wet conditions. In contrast, the stem, specifically the bark tissue, is much like our own skin. Remember what happens to your fingers and toes when you stay in the swimming pool too long? The skin softens and is easily abraded by the sides of the pool. The same thing happens when a tree is planted too deep. The buried bark tissue is softened by moisture and then abraded by soil particles. In addition to abrasion, the excess moisture also promotes decay in the stem. Once the protective bark layer is compromised, there's opportunity for a multitude of serious problems to occur. Soil pathogens are free to enter and infect the vascular tissue of the tree. Fungal organisms may attack the damaged tissue, and as decay progresses, phloem tissue will be compromised until the roots can no longer receive the necessary carbohydrates that are manufactured by the canopy. Their food source is effectively cut off!

Sometimes trees that have been planted too deep fail to thrive from the very beginning. But more often, the canopy flourishes and the tree appears healthy and vital until seemingly overnight the canopy quickly declines. This can be explained by the fact that while irreversible damage is occurring below ground at the root crown, the canopy continues to have all of the water and photosynthates it needs to thrive and grow. The damage only becomes obvious when the starving and neglected

root system deteriorates to the point that it can no longer absorb enough water to support the canopy. This typically occurs in late summer, during episodes of high heat and low humidity. The frantic tree owner will often report that, "the tree just died overnight!" If questioned though, it is likely that the owner will recall that the tree had appeared stressed during the hotter months of the preceding years. Once massive canopy dieback occurs in response to water deficit, the damage has usually progressed past the point of no return and the tree is often lost.

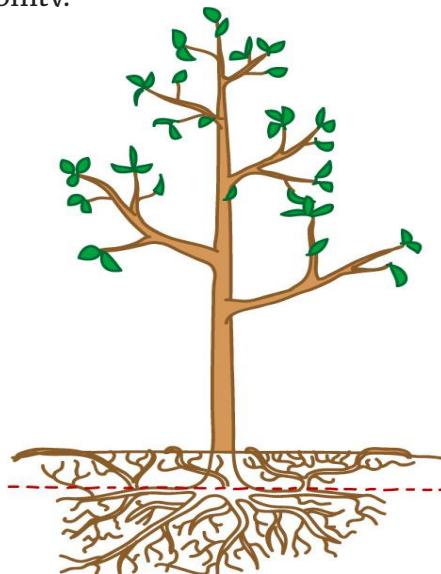
Unfortunately, planting too deep is all too common, even among professional landscapers. Many planting specifications fail to dictate the placement of the root crown in relation to finish grade. Some trees are deliberately planted too deep in a misguided belief that this will discourage surface roots. In fact, the opposite is true. The roots of a deeply planted tree are more likely to turn and grow upward in search of higher oxygen concentrations and surface moisture.

A tree that has been planted too deep resembles a telephone pole stuck in the ground, with a notable absence of trunk flare. When a tree is determined to have been planted too deep, replanting is not usually the best option. But the situation can still be greatly improved by removing soil and lowering the grade to the level of the root crown, creating a depression around the trunk. It is important to make sure that the depression is large enough that blowing sand and erosion won't quickly refill it.

In the past, it was common to dig the planting hole much deeper than the root ball, and then use the loose soil to build a mound for the tree to sit on before

backfilling. Sadly, trees that are planted this way often sink into the ground as the loosened soil mound compacts, settling the root crown below finish grade. Most experts now agree that a planting hole should be dug wider, but not deeper than the root ball. The tree should be situated so that the root crown is 1 inch or even slightly above the surrounding grade. This will ensure that water drains away from the trunk and root crown area. The root flare is easily visible when a tree has been planted at the correct level.

Taking a moment to place a tree as nature would, with the crown planted proudly above the surrounding grade, is a big step towards ensuring that after 6 years of care you'll have a happy shade tree instead of a liability.



Surface roots are more likely to become a problem with trees that are planted too deep.

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Visit www.treesaregood.com for additional information on planting and tree care

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Part IV: Over & Under Watering

If you own or manage a landscape in an arid environment, chances are good you also manage some type of irrigation system. Even native plants require supplemental irrigation to maintain optimal health, especially during the ongoing droughts we are experiencing in the west. Applying water to a plant can be as simple as turning on a hose or as complex as a state-of-the-art, multi-station, notify-you-on-your-cell-phone-when-there's-a-leak, mega-programmable controller with an attached weather station. Even with all of these options, over and under watering continue to play primary roles in the premature death of many urban trees.

This is not an article about the perfect irrigation system. Every type of system has its benefits and drawbacks, and there is more than one good system. Instead, this is an article about the needs of trees.

Under ideal conditions, irrigation is applied with the goal of maintaining a favorable environment in the root zone to support tree processes and to encourage colonization of beneficial organisms. What constitutes favorable varies somewhat from species to species,



A layer of organic mulch improves soil structure and reduces evaporation.

but there is a great deal of commonality. Water is critical to tree health, as a component of photosynthesis as well as for the distribution of carbohydrates (the product of photosynthesis) throughout the vascular system. Water dissipates from the soil through evapotranspiration (ET), a combination of evaporation from the soil and transpiration from the tree canopy. Ideally, irrigation replaces water lost through ET.

It is best to apply water to trees in large doses, wetting as much of the root zone as possible. If there is enough space the root zone may reach far beyond the canopy, but most experts suggest targeting irrigation at the drip line (or canopy edge). Roots generally grow to a depth of around 3 feet, and applying enough water to reach that depth is recommended. Trees perform best with deep watering followed by a period of time long enough to allow the soil to dry slightly. The drying period should be extended for low water use and drought tolerant species.

In addition to species, how often to irrigate depends on climate, rainfall, ET and soil type. Knowing your soil type is important for determining irrigation frequency. Sandy soils don't hold as much water as clay soils. One inch of water on sandy soil will wet the soil to a depth of about 1 foot. On clay soil, one inch of water will only penetrate about 4-5 inches. Clay soils hold more water and take longer to dry. Sandy soils hold less water and dry much more quickly. A soil probe, such as a long screw driver, can help determine how far water has penetrated in an unknown soil.

Deep irrigation followed by a drying period helps the soil to breathe, maintaining a healthy atmosphere in the root zone. When water penetrates the soil, bad air is

squeezed out of the soil pores. As the water drains from the soil pores and is used by the plant, clean air is drawn into the soil. This action helps avoid the development of anaerobic conditions that favor decay and disease causing organisms. Of course adequate drainage is critical to tree health, and issues of poor drainage must be resolved (e.g., drain tiles, planting mounds) regardless of irrigation practices.

It is not necessary to practice deep irrigation every time a tree is watered. In fact, watering too deep following the application of fertilizer may carry the fertilizer beyond the root zone. Conversely, salt buildup resulting from frequent, shallow irrigation can be flushed past the roots by occasionally watering deep.

A 3-4 inch layer of organic mulch spread over the root zone can reduce evaporation and preserve soil moisture, increasing the period of time between irrigation cycles. Additionally, organic mulch can improve soil structure, increasing water and nutrient holding capacity. And it helps to prevent weeds and turf from growing in the root zone and competing with the tree for available water. Remember to prevent the mulch from contacting the root crown.

When designing and installing an irrigation system, it is critical to separate plants of different watering needs by placing them on separate valves. Unfortunately, it is still quite common for trees to be combined with shrubs and groundcovers on the same irrigation line. In this situation, it is impossible to satisfy the needs of every plant. Scheduling irrigation for the health of the trees results in drought for the shrubs and groundcover. And programming for shrubs usually shallow irrigation to the trees. Trees that are irrigated too often suffer a variety of

dire consequences from over-fast growth and weak, brittle wood, to poor root development and root decline as a result of excessive moisture, anaerobic conditions and thriving colonies of moisture-loving, wood-destroying organisms.

Don't be fooled by late afternoon wilt in the hot days of summer. Some trees suffer afternoon wilt during high temperatures even when there is optimal moisture in the soil. This is a result of the inability of the roots to absorb water quickly enough to keep pace with transpiration, not a lack of available water. In some cases, this may be a sign of declining root health (perhaps due to over watering). Check for soil moisture before adjusting your irrigation system.

Over and under watering may be the hardest deadly sin to avoid. Many of us are burdened with poorly designed irrigation systems and financial constraints that preclude reconstruction. But understanding what's best for your trees will help you make the best out of a less than perfect situation. And when you are fortunate enough to be involved in the design and installation of a new landscape insist that plants be grouped properly according to their water needs. While it may cost a bit more to add additional valves, the investment is tiny when compared to the return. One additional irrigation valve - \$100, extra 300 feet of PVC pipe - \$175, extra wire to controller - \$15, extra valve box - \$10. A landscape graced with mature, healthy, life-giving shade trees ... Priceless!

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Part V: Poor or Neglected Staking

Each of the seven deadly sins is committed with the very best of intentions. Everyone who plants a tree anticipates that the tree will live a long and fruitful existence and be appreciated for many generations to come. Improper staking, the fifth deadly sin, conforms to this pattern of good intentions. Newly planted trees need to be properly and firmly staked so that they will grow up straight and strong, ... right? Not necessarily. Newly planted trees may or may not require support, and when they do, staking should be done with care and an understanding of how trees develop and what unnatural practices would cause a young tree to require artificial support in the first place.

Mother Nature never artificially supports a young tree. That's because every tree is provided with a natural support system developed and guided by its genetic code. Beginning with the emergence of cotyledons (seed leaves) and continuing throughout its life, every tree engineers its growth in response to the environmental stimuli that affect it. Just as humans must exercise to develop a healthy muscle structure, trees develop reaction wood through exposure to the forces generated by gravity, wind and the quest for sunshine. Bottom line is, left to their own devices, trees do just fine without our assistance and interference.



Do not forget to check ties and stakes!

Unfortunately, like so many corseted young maidens, trees are often strapped up tightly to nursery stakes. Sometimes this is done to facilitate a hyper-straight trunk, as if they were destined to be soldiers! More often, a nursery stake is a band-aid used to disguise and support a weak, skinny trunk caused by the premature and unrelenting removal of juvenile branches (more on this in Part 6). Whatever the reasoning, a tree that has been grown with a nursery stake will usually require a weaning period with support stakes before it will be able to stand up on its own trunk.

It is important to remove nursery stakes and ties at the time of planting. Supporting a developing trunk with a nursery stake is like leaving a cast on a leg that isn't broken. Muscles atrophy when they aren't being used and tree trunks won't develop reaction wood if they can't dance around and experience the forces of nature.

If the tree is unable to stand on its own once the nursery stake is removed, then it will require support while it builds up strength. The best way to provide support is with two sturdy stakes, driven into the ground on opposite sides and just outside of the root ball. The stakes should be oriented perpendicular to the prevailing wind and angled slightly away from the crown to prevent the branches from making contact as they blow around. Tie the tree to the stakes at the lowest, single point that provides the necessary support to hold the tree upright. The material that contacts the tree should be something soft and non-injurious to the tree. Commercial products such as ArborTie and Tree-Tie are available, but wide strips torn from an old t-shirt or an old tube sock work just as well in my backyard. Tie opposing loops one on top of the other and avoid interlocking the ties that come from opposite sides since

they can pinch the trunk as they are pulled apart. Wire covered with rubber hose should never be used to support a tree since it will bruise the young cambium and cause permanent scarring.

Although many architectural plans specify tying the tree at two points, and many landscape companies follow the practice, it is best to tie the tree at one point only. As the wind blows against the top of the tree, the bottom must be able to flex in response. Tying at two points restricts the bottom of the trunk and may cause the tree to snap off at the upper tie point.

Many trees don't require staking at all. Conversely, when large trees are transplanted, it is a good idea to provide some support even if the tree is standing fine on its own. In this case, the tree should be anchored or guyed to stakes from a few



Tie at the single, lowest point that supports the tree upright.

feet above grade to provide support and prevent the tree from blowing over while new roots are establishing.

Even properly staked trees are at risk of neglect. Once the support system is installed, it is critical to perform regular inspections to ensure damage is not occurring to the cambium and the tree is not growing into the ties. A tie that is restrictive will obstruct the flow of carbohydrates in the phloem, causing the stem to swell above the obstruction. Eventually, circulation of carbohydrates may be completely cut off, preventing the root zone from receiving vital nutrition from the canopy. Furthermore, when a stem grows around a wire or other tie, it causes a permanent wound. This type of wounding is similar to scoring a piece of glass and creates the potential for the trunk to snap off at some point in the future.

Support staking is a temporary treatment and stakes should be removed as soon as possible, usually between 6 and 12 months. Trees that are unable to support themselves after 12 months are most likely girdled and should be replaced. Trees that continually blow over in windstorms should be removed as soon as possible as they tend to become more hazardous as they grow larger.

Similar to raising young children, the goal of staking is to encourage independence and self-reliance by providing gentle support and guidance where needed. Of course you hope that the tree will stay around your house a whole lot longer!

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Part VI: Premature Removal of Juvenile Branches

You might imagine that a tree fortunate enough to be planted in the right place, possessing good structure, planted proud, staked properly, and irrigated optimally wouldn't have another care in the world. Unfortunately, it's a harsh world out there, and some do not let young trees be young trees. Young trees are often prematurely separated from their juvenile branches in a misguided attempt to encourage a more mature growth habit. By definition, any young branch is a juvenile branch, but those most often targeted for removal are the ones growing on the lower trunk beneath the establishing canopy line. It's important to note however that trees of any age can and do develop juvenile branches as needed throughout their lives.

As we know, trees develop according to a genetic plan that has evolved over many millions of years, long before the introduction of more advanced beings that can't even produce their own food! While we are only beginning to understand all of the possible benefits of juvenile branch placement, we do know that trees grow in a logical manner and it's a sure bet that they are there for very good reasons. Thanks to the tireless researchers out there, we understand at least some of these important functions.

Juvenile branches promote strong taper in a developing trunk. In order to withstand the environmental forces placed upon it, a tree must develop a strong trunk base that gradually tapers to the tips of the canopy. But if all of the food is being produced by leaves in the canopy, there might not be a lot left by the time the upper growing points take their share and the remaining photosynthates trickle down to the lower trunk. Young trees adjust for this by growing small branches along the trunk to

provide a local "fast food" source to fuel the expanding trunk. Premature removal of these branches transfers energy towards increased canopy growth at the expense of trunk girth. Trees that are prematurely stripped of their juvenile branches often develop spindly, weak trunks that require chronic staking to provide necessary support.

Juvenile branches aid in wind resistance and reduce the likelihood of damage to the tree. In addition to promoting healthy trunk taper, which aids in flexibility, young branches on the lower trunk help by spreading the forces of wind load over a greater vertical surface. The premature removal of juvenile branches causes the canopy to act like a sail, concentrating the force of the wind in the upper canopy. This action concentrates the wind load at a more specific point on the developing tree trunk and increases the likelihood of trunk failure through stress fractures.

Juvenile branches protect young trees from sunburn. Young bark, like the skin on a baby, is much more sensitive and susceptible to sunburn than mature bark. A fingernail can easily scratch through young bark and into the cambium layer. Try that with mature bark and you'll need a quick trip to the manicurist! Juvenile branches protect the tender trunk tissues by diffusing the intensity of the sun's harsh rays. The premature removal of juvenile branches often results in sunscald and peeling bark on the southwest side of the tree. As with all injuries to trees, the damage is permanent and results in a reduction of vascular flow and an inviting entry point for insects and pathogens.

Juvenile branches can be found throughout a tree and on trees of any age. They may

sprout to fuel the development of reaction wood for greater strength or in response to decay or disease. Preserving juvenile branches in the vicinity of larger pruning wounds can promote faster healing through greater wound wood development (compartmentalization). Wherever they occur, it is best to leave them on as long as practical so that they can perform their intended function.

Juvenile branches are often quite vigorous and may bravely grow out into parking lots, sidewalks, streets and other high volume traffic areas. This is unacceptable in an urban environment and they must be encouraged to conform to the constraints of the community while still performing their vital role. A juvenile branch that is growing in an undesirable direction can be tipped back to within 12 inches of the trunk. A reduction cut to a side shoot will direct the juvenile branch to grow in the direction of the selected side shoot. A heading or stub cut, while never recommended for a permanent branch, will promote an adventitious cluster of leaves. Either of these treatments will preserve the purpose of the branch while conforming to societal needs.

In a natural environment, trees shed juvenile branches when they are no longer needed. If you've ever crawled under a large canopy in the forest you may have noticed the dried up branch stubs still attached on the lower trunk. Trees naturally shed juvenile branches once their purpose has been fulfilled. Shade from the developing canopy eventually reduces sunlight to the small lower branches and renders them useless for photosynthesis. Once there is no longer a return on investment, the tree cuts off circulation and literally starves the non-productive member to death.

As mortals, we can't possibly be expected to exercise the patience and restraint necessary to wait for juvenile branches to dry up and fall off. When an undesirable branch reaches a diameter bigger than your "thumb", it's okay to remove it. Juvenile branches will continue to sprout as long as they are deemed necessary by the tree. Nature provides the answers if we are paying attention. A lot can be learned by touching and listening to trees... do you hear them whispering now?



Juvenile branches should be allowed to remain until they are at least as big (in diameter) as your "Thumb". Tip back branches that interfere with traffic or view.

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Part VII: Poor Pruning and Topping

Arguably, trees are the most successful organisms on earth. As a group, they hold bragging rights as the tallest (coastal redwoods), the most massive (giant sequoia), and the oldest (bristlecone pines) living beings on the planet. They produce their own energy and recycle available resources to molecular levels. As such phenomenal beings, they deserve our utmost respect and reverence. Unfortunately trees are often taken for granted, especially when it comes to our community forests.

Examples of improper pruning and topping abound in every community. While basic proper pruning is not terribly difficult to master, if the intent is to preserve the tree in a healthy manner, it does require some understanding of tree physiology and biological response. Many trees are killed and permanently disfigured by well intentioned ignorance and the misunderstanding that everyone who works in landscape maintenance knows how to trim a tree. Armed with a basic appreciation of pruning response and recognition of harmful practices, many common errors can be avoided.



Sealing is not complete until the branch collar grown completely over the wound.

Because a tree is a dynamic, living organism, every pruning cut results in a chain reaction within the tree, including response to the injury, changes in energy distribution and flow, and a reduced ability to produce food.

Trees do not heal in response to injury in the same way as animals. Instead of replacing bruised and damaged cells, trees compartmentalize, or seal their injuries by building barriers and diverting circulation around the damaged area. These compartments become permanent dead areas inside of the tree. Internal compartmentalization begins immediately in response to injury. Chemical walls form laterally, horizontally and radially to prevent the damage or disease from progressing and invading healthy tissue within the tree. Since tree bark serves as an outer layer of protection, much like our skin, compartmentalization is not complete until new tree rings grow over and completely cover the wound. Until this process is complete, the tree is vulnerable to invasion by insects and decay organisms. Painting the wound



Sealing takes longer in improperly pruned and large wounds.

does not facilitate this process, since these treatments are no substitute for new growth rings and in some cases actually retard the natural sealing process.

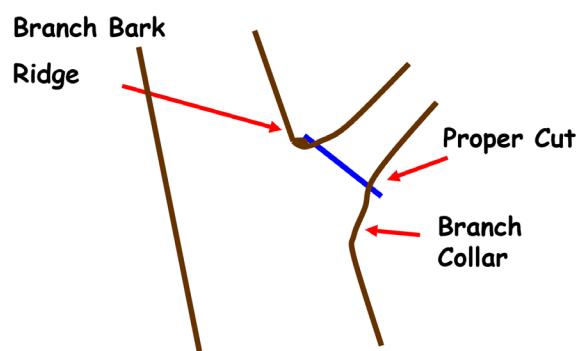
An important goal in proper pruning is to reduce the compartmentalization response. One way to minimize and speed up the sealing process is to minimize the size of wounds by removing undesirable branches when they are relatively small (preferably less than 4" diameter). This is why, with the exception of mitigating a hazardous situation, structural pruning should be performed when trees are young and actively growing.

Additionally, it is important to always prune to a branch union, being careful to cut just outside of the collar. The collar of a branch is actually the outer rings of the parent branch or trunk folded back around the base of the branch (like a towel draped around your neck). Once the branch is removed, the collar will grow over the wound, completing the sealing process. The branch union is also where natural intersections of the vascular system occur, and pruning to these intersections makes it easier for the tree to "detour" the vascular energy that once flowed into the missing limb. Failing to preserve the branch collar

by "flush cutting" or allowing branches to rip off the tree substantially increases the area of compartmentalization and severely inhibits sealing.

Every pruning cut alters the flow and distribution of energy within a tree, and understanding the basics is necessary for anticipating and controlling pruning response. In an un-pruned branch, the terminal bud (outermost tip) performs like a crew leader, using hormones to direct growth and keep the lateral branches in check. Removing the terminal bud releases growth energy to the remaining lateral branches and results in a leadership void. Pruning to the union of a lateral branch transfers the leadership role and redirects growth into the selected lateral. Removing an entire branch transfers growth energy into the remaining branches. The central leader (main stem) should not be cut or tipped back as this action will permanently alter the natural shape and structure of the tree.

Pruning removes leaves. Since leaves are responsible for producing energy, removing them has an impact on the tree's ability to grow, protect itself from disease and pests, and even to fuel the compartmentalization necessary to recover from the pruning event. The amount of leaf canopy that can be safely removed depends on many factors, including the age of a tree, species, general health, and season. A general rule of thumb is to avoid removing more than 25% of the living canopy. This is a maximum number, not a goal to be reached, and proper pruning practices seek to minimize canopy removal as much as possible while still correcting the structural issues.



Branch structure, the blue line represents an appropriate place to cut the branch.

Topping trees is never an acceptable practice. Topping results in many open wounds with no consideration to pruning at branch unions or collars. The cut stumps begin to compartmentalize, but they cannot completely seal since they are not at a branch union and are far removed from a collar. This leaves the stumps vulnerable to attack by insects and decay organisms. Unfortunately, topping a tree stimulates the growth of adventitious sprouts (multiple leafy shoots, especially on stumps), leading to the misconception that the tree responded favorably to the treatment. In fact, adventitious growth is an emergency response undoubtedly developed by nature to respond to catastrophic injuries caused by natural phenomena (e.g., hurricane, lightning strike, etc.). Stimulation of adventitious growth is a sign that the tree has suffered severe damage and is trying mightily to replace its food source. Adventitious branches grow quickly but are poorly attached just underneath the bark (of the dying stumps), leading to hazardous conditions as the branches become larger and heavier.



Topping kills trees!

The objective of proper pruning should be the removal of crossed and competing branches as well as dead and diseased wood and the correction of other major structural defects. Since urban trees are destined to be part of a community, they should be trained at a young age to conform to the standards set by the community. As with children, a properly trained tree is more likely to become a positive, contributing member. Trees must be guided to co-exist in harmony with other components and branches cannot be allowed to block stop signs or interfere with the normal flow of vehicular and pedestrian traffic.

Always keep in mind that pruning creates wounds, leaving the tree vulnerable to pathogen invasion. The power to shape growth and divert energy must be used wisely and sparingly to promote healthy structure while still preserving the natural grace and character of both the individual and the species. In order to preserve the value and dignity of a tree, most pruning should be performed by properly trained personnel, ideally, someone certified as an arborist or a tree worker.

REFERENCES

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