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URBAN FORESTRY TREE CARE SERIES

Tree Defect Identification

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Well-maintained, mature trees provide increased property value and curb appeal. Whether you've just moved into a new neighborhood or interested in the health and safety of your trees, it is recommended to contact your local ISA Certified Arborist to help protect your trees and those around your trees.

All trees present risk of some type. They are living organisms that are threatened by environmental impacts and pests. However, it is important to realize that the benefits of trees far outweigh the risks. We don't want to remove trees unnecessarily, but rather reduce risk and the potential for failure by identifying, analyzing and evaluating risk, and performing the appropriate mitigation.

When should trees be inspected?

Inspection timing can vary according to the tree owner or client's needs. It is especially important to inspect trees after major weather events such as high winds or ice. Inspection intervals are based on the level of risk presented at the time of an initial inspection. Typically, the range for inspection intervals is from one to five years. The developmental age of the tree, growing conditions, and other factors will affect frequency.

Inspection for defects should be performed prior to any tree care activity and with consideration for any nearby targets (Figure 1). Any tree care activity, including plant health care, support system installation, pruning, or removal, should be preceded by some level of inspection for any defect which could endanger the tree owner or manager or another target such as a vehicle. Something as simple as a broken branch could dislodge and fall causing damage or injury to someone working beneath the tree. Tree assessments require experience and education on the process. When inspections include assessing a tree for risk potential, contact an International Society of Arboriculture Tree Risk Assessment Qualified (TRAQ) arborist.

Figure 1. Tree inspections are an important part of overall tree care and maintenance strategies.

Every tree inspection should be recorded and kept safely filed for future reference. There are management considerations and legal implications for documenting the review of a tree or trees on a site. Records of past inspections can show how a tree has changed in its health and structure over the years. These past inspections can aid in determining management strategies and risk mitigation for the tree owner. Also, written evaluations can help to minimize liability if a failure occurs and a claim is filed against the tree owner or the company providing services.

A tree's risk level will be based on conditions of concern and any target that is nearby or at located within the target zone. Targets are people, property or activities that could be injured, damaged or disrupted by a tree failure (Figure 2). Review everything in the target zone which should include the area inside a circle around the tree. The radius of the circle should be at least as wide as the total tree height.

What is considered a defect on a tree?

A tree defect is an injury, growth pattern, decay or other condition which reduces the tree's physical strength. Every tree has some sort of defect; however, not all defects impact tree stability or indicate increase in failure potential. It's important to include that not all defects may be visually available to inspect or analyze. Unseen defects might be underground, such as root issues. Decay hiding within an apparently normal trunk also will be hard to detect with a visual inspection.

Figure 2. Defects which lead to increased likelihood of failure will have significant impact on nearby targets.

What are we looking for when inspecting the tree for defects?

There are many and varied types of tree defects and causes, which can make an inspection complex. Defect identification is necessary to determine the structural integrity of the tree. With practice, simple tools and techniques such as metal implements (for probing) or a soft mallet (for sounding) can aid in the process. Another important tool is binoculars which can help pinpoint potential weaknesses in the crown.

Consideration should be given to tree species and condition. Stress can result in notable defects, and some tree species are more prone to defects such as poor, weak branching or fungal diseases. Defects can be the result of storm damage, a tree's branch arrangement, or the damage from a disease pathogen. Any defect which is recognized as a factor in tree health and stability should be examined more carefully to identify the best and most appropriate mitigation strategies.

Due to the variability of types of defects, it may be helpful to group them to aid in the inspection process. This article categorizes types of defects by causal factors or disease-causing agents. The majority of defects are found to be the result of structural, mechanical or biological factors. These are visible indicators of a condition of concern creating a potential risk issue. Examples include:

- **Biological-** defects caused by a living agent. This includes decline and dieback of branches, decay and cavities in the trunk, disease causing sap rot on a limb, insect pests such as borers, or fluxing from bacterial wet wood.
- **Structural-** poor architecture, such as codominant stems or branches, branch arrangement such as crossing or vertical branches, excessive branch end weight, or asymmetrical crown shapes from severe utility pruning, can create defects leading to failure (Figure 3).
- **Mechanical-** physical injury, such as lawn equipment or vehicular impact, construction damage to the root system, a storm event which breaks a limb, pruning cuts leaving stubs or wounds that don't close, and even vandalism, can cause serious defects.

Figure 3. Crown shape that is unbalanced can lead to twisting, resulting in cracks and potential failure.

Where do we look for defects?

During the investigation for tree defects which impact safety, look at the tree systematically from top to bottom (Figure 4). Read the body language of the tree inspecting each section of the tree including the crown, branches, trunk, and root zone for indicators of past or potential failures. Identify the structural, mechanical and biological factors which create a condition of concern. These factors can occur alone or in combination, such as:

- Dead, diseased, dying or broken branches as a result of poor growing conditions, storms or pest activity (Figure 5)

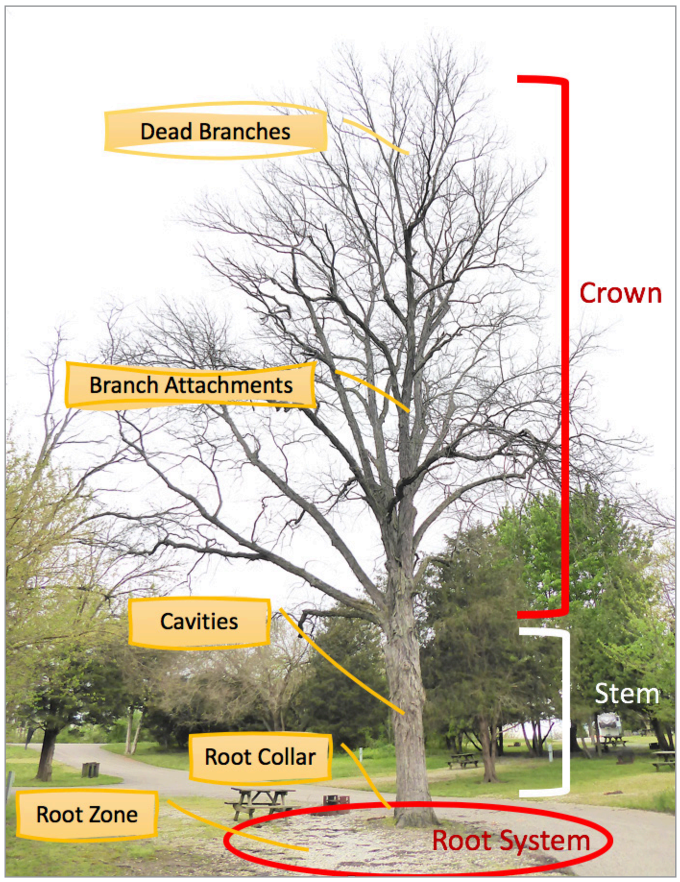

Figure 4. A systematic approach for identifying defects includes the crown, stem and root system of the tree.

Figure 5. Unhealthy, stressed trees can have defects with increased likelihood of failure.

Figure 6. Dieback in the top of a tree can indicate a defective root zone.

Figure 7. Tree with 2 or more main stems about the same diameter emerging from the same location on the main trunk are prone to splitting.

Figure 8. Internal decay causes pressure which can distort the trunk causing ripples.

Figure 9. Insect feeding damage can lead to injury and decay.

Figure 10. Seams and cracks from lightning damage can lead to extensive decay

Figure 11. Heavy equipment compacting soil and damaging roots can create high risk defects.

- Thinning or poor canopy health from environmental stressors or pests (Figure 6)
- An unstable branching pattern with overextended or weakly attached branches, such as some codominant branches and trunks (Figure 7)
- Ripples in the trunk or decayed areas with large cavities present, such as nesting holes (Figure 8)
- Insect populations which can destroy the cambium layer through boring and feeding, such as emerald ash borer (EAB) or pine bark beetles (Figure 9)
- Cracks or seams through the bark and into the wood of the tree from lightning or splitting due to wind forces (Figure 10)
- Root and root plate issues such as exposed or decayed roots, soil heaving, conks or mushrooms or cracks in the soil around the root plate (Figure 15)
- Cut roots or root compaction from construction, which can result in defects immediately or can be delayed for several years (Figure 11)

Some characteristics to consider when identifying tree defects are:

- Crown size, shape and weight distribution. This is especially true in situations where a tree is exposed to windy conditions, is leaning, or has been excessively pruned. Often utility clearance pruning can leave the tree with a misshapen crown.
- Crown architecture issues such as poor branching, which includes a codominant structure. Included bark in narrow branch angles can create high-risk situations with wind and ice or other dynamic loading
- Plant health and vigor. This determines how likely it is that a tree might overcome wounding or pest infestations. Trees that have adequate moisture, nutrition and soil conditions are less vulnerable to stress, reducing the impact of some defects
- Decay, cankers, missing wood fiber and other positive indicators of weakness in the roots, stems and branches

Biological Factors

Disease-causing agents present some of the most challenging conditions in determining their impact on likelihood of failure. Also, mitigation strategies are limited in these cases. Decay resulting in cavities, the presence of fruiting structures, and missing tree fiber are all critical defects to evaluate closely. The informed arborist should be capable of identifying some of the basic rot diseases and their modes of attack.

Decay or rot are general terms for degradation of wood fiber. Causes include fungi or other microscopic organisms which colonize wounded or weakened areas of the tree. Typically, most wood-rotting organisms are pathogens of opportunity and require some entry point such as a wound from a type of injury or damage. However, some diseases - such as *Armillaria* - can attack and colonize healthy tissue and are more invasive. These fungal organisms insert their hyphae into cells to take advantage of their nutrients and moisture. This results in cell death and decaying fiber. Often there is substantial wood strength loss before the decay is visibly evident.

Understanding the way these decay organisms work can help predict the impact of the defect. Before addressing this, it is important to understand basic wood anatomy. Trees are composed of primarily lignin, cellulose and hemi-cellulose. The key load-bearing components in xylem cells are cellulose and lignin. The lignin is the concrete; it holds the cellulose fibers in place and keeps them from buckling. Lignin alone, like concrete alone, would crumble under the weight of the tree. The cellulose takes the role of steel reinforcement bars. Cellulose on its own, like rebar, would buckle. Together, however, cellulose and lignin provide added strength—the whole being greater than the sum of the parts. Typically, rot leads to degradation of the woody materials, which leads to decay by attacking the cellulose, hemicellulose and/or lignin.

Locations of decaying wood and other defects are important in the inspection process.

Figure 12. Heart rot occurs in the center of a stem or branch reducing structural strength of the tree.

Figure 13. Loss of sapwood from disease is a defect that can contribute to tree failure.

Most decays start from the inside, working out and are called heart rot (Figure 12). This is a condition of concern in any tree, but the extent and location are of critical importance relative to likelihood of failure. This type of defect is common in many trees but isn't always a major defect. Hollow trees resulting from heart rot are not all dangerous. The extent and location of decay are major determinants of strength when rot is present. Heart rot, which decays the internal part of the tree is not always a serious risk consideration. Where is the living portion of the tree? It is in the cambial tissue where the xylem and phloem are developed in the outer rings of the tree. Also, secondary xylem vessels – containing cellulose and lignin - are essential for tree strength. Some guidelines recommend a minimum of 2-3″ of sound living shell for every 6″ of diameter. Regardless, the type of fungal organism and location of the decay are critical.

Sap rots (Figure 13) refer to any fungus that erodes woody tissue from the outside in and can present considerable risk for failure. It is critical that tree care workers are able to identify this type of decay as it can affect the strength and structural integrity of stems and branches. This is of particular importance to climbers and selecting tie-in points or rigging locations.

Researchers and practitioners typically categorize decay organisms into basic groups—white, brown and soft rots.

- **White rots** break down lignin, and to various extents cellulose, in cell walls. A wet and spongy wood, often white or yellowish in appearance, remains. The flexibility of the wood that remains may allow the tree to flex, thereby stimulating the production of response growth. Response growth is adaptive growth or wood fiber that adds strength to weakened areas of the tree. *Ganoderma applanatum*, or artist's conk, is a commonly found white rot.
- **Brown rots** primarily break down cellulose, but generally leave the lignin intact. This rot targets cellulose, which results in major loss of bending strength and are often considered to be more serious than white rots due to the greater loss of strength in the decayed wood. Because brown rots are more rigid and do not flex, response growth tends to be less than in trees with white rot. *Laetiporus sulphureus* is a common brown rot decay fungus.
- **Soft rots**, such as *Ustilina deusta*, typically decay cellulose first but may also affect lignin. These are generally localized and less aggressive in rate of spread than white or brown rots, which causes softening of living tree tissue. The decay is not necessarily softer than brown or white rots but softens the wood fiber.

Figure 14. Codominant stems with included bark in the union is a defect that increases the likelihood of failure significantly.

Structural Factors

One of the most common structural defects are codominant branches and stems (Figure 14). This is a condition where two or more stems about the same size arise from the same location. Branch attachments with similar aspect ratios are structurally weaker than those with a 2:1 branch aspect ratio. The union is even more weak when bark is included or trapped in the attachment. This defect is prone to failure and becomes a concern not only for the tree owner, but for climbers as well. These attachments are not reliable tie-in points and may split with dynamic loading.

It is critical to investigate the root system for defects as well. Inspect the ground below the dripline for roots exposed from wind throw or construction impacts. A helpful tool for detecting defects in the root system are fungal fruiting bodies (Figure 15).

Figure 15. Fungal fruiting bodies in the root zone indicate defects which include decaying roots.

Figure 16. Previous wounds are evidence of mechanical damage which may increase likelihood of failure, depending on the development of wound wood.

Mushrooms growing under the dripline of the tree are indicators of a potentially compromised root system. However, these fungal identifiers are not always present. Mushrooms are only present at certain times of the year, dependent on the decay organism.

Mechanical Factors

Mechanical defects are arguably the easiest of the three categories to detect. Typically, these are obvious injuries, wounds or damage from an external cause. Such defects include construction damage in the form of physical damage to the roots, trunk or branches (Figure 16). Trenching within the dripline of a tree or cutting roots to make room for new infrastructure, such as walks or curbs, can lead to serious defect issues for a tree. However, some root weaknesses may be hidden from a previous disturbance and not so easily identified without searching for clues in the crown. Sparse or undersized leaves, chlorosis, necrosis, or dieback can signal problems in the root zone.

Poorly executed tree care can cause defects as well, which may result in risk. Flush cuts, stubs, and other poor pruning cuts can result in disease and decay affecting tree health and strength. Topping trees creates an identifiable defect which leaves behind weak branch attachments and decay from the excessive pruning dose and disregard for appropriate cuts.

A professional tree service with qualified arborists can provide a tree health and tree risk assessment, helping to identify defects before they become major problems. Preventive tree care can save money and reduce potential injury, damage or the need for expensive removal services. Tree defect identification can be a complicated process requiring experience, training and expertise. However, early observation of some typical defects can determine if the services of a Certified Arborist are needed.

References:

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