Indicators of Decay in Urban Trees

By Chris Luley

Decay indicators are symptoms and signs associated with the fungal deterioration of wood in trees. *Symptoms* of decay are deviations in normal growth patterns, while *signs* are evidence of the decay's causal agent, including fungal conks and mushrooms. Decay indicators have been used for a long time to assess trees for decay. Some indicators are species specific, while others apply to a wider range of tree species. This article will provide information on the concept, importance, and use of decay indicators in tree evaluation.

The recently published Best Management Practices (BMP) for Tree Risk Assessment and the ANSI Standard for Tree Risk Assessment state that decay indicators should be used in both basic and limited visual assessments of trees. Decay indicators can help arborists evaluate trees for decay in several ways. They can help determine if decay is present, and if so, the severity of the decay. Indicators can also help determine arborist's application of assessment is needed. Finally, they can guide the arborist where to apply advanced assessment methods to quantify decay.

The decay indicator concept has been expanded to include potential and positive indicators of decay. Potential indicators suggest decay *may* be present in the tree while positive indicators mean the tree *has* decay. The BMP for Tree Risk Assessment uses a broader concept of positive indicators to include missing wood from causes other than decay fungi. This broader concept of decay indicators will be applied here, because it helps validate several indicators that are highly correlated with wood loss, but may on occasion occur without wood decay caused by fungi. For example, carpenter ants typically nest in decayed wood, but less frequently may form satellite colonies in wood without decay.

Positive Decay Indicators

Positive indicators of decay include:

- fungal conks (perennial or persistent annual fruiting structures that are tough or leathery) and mushrooms attached to trunks stems or roots (Figure 1)
- cavities or external openings caused by wood deterioration and loss

Figure 1. Conks or mushrooms are positive indicators of decay. Additional assessment is usually required to determine the severity of decay when conks are present.

- visual evidence of decayed wood without the formation of cavities (Figure 2),
- carpenter ant colonies or sawdust pilings on stems or at the base of a tree
- the presence of nesting holes of insects, birds, or mammals

Figure 2. Visual evidence of decayed wood on the surface of affected stems is a positive indicator.

Conks and mushrooms of wood decay fungi are positive indicators that mean a tree has internal decay, even if other outward symptoms of decay are not present. The presence of one or more conks means the tree has decay in its heartwood and/or sapwood. Identifying the species of a fungal conk can sometimes provide additional information on the severity of internal decay. Conks or mushrooms are not in and of themselves evidence that tree removal is necessary, anymore than the presence of other positive indicators, such as a cavity or carpenter ants, suggest removal is always necessary. When positive indicators are present, more rigorous visual evaluation or other evaluation methods may be required to ascertain the severity of the decay and to help determine an appropriate management recommendation.

Fruiting structures associated with sapwood decay are positive decay indicators that may be less familiar to the arborist (Figure 3). Most sapwood rot fungi produce numerous, small-sized fruiting structures on the face of infected and decayed wood. However, sapwood rot can be present without fruiting structures being present. Sapwood decay fungi typically become established in living trees on dead branches, or on large areas of bark or sapwood damaged by lightning strikes, ice, sunscald, or other injuries. In large wounds, sapwood decay fungi decay can subvert many of the defense mechanisms, normally present in living trees, and invade from the outside of the stem towards the center of the tree. This can result in a substantial loss of stem strength even when relatively small amounts of decay are present in the outer rings. Some sapwood rot fungi can also attack healthy bark and cambium once they become established in large wounds.

Figure 3. Sapwood rot fruiting structures are a positive indicator of decay. Sapwood decay typically develops when large areas of sapwood are exposed or large areas of bark and cambium are killed.

Potential Decay Indicators

The number of potential indicators is considerably larger than positive indicators because they are based on the biology of decay in living trees and decay impacts on structural health. Potential indicators are important in decay assessment because relatively few trees with decay have positive indicators. In my research on decay in street trees in New York State, U.S., 58 percent of trees were identified to have decay in the lower trunk (Luley et al. 2009), yet only six percent had positive decay indicators. Therefore, it becomes necessary to rely on potential indicators to help identify trees that might have decay but do not have positive indicators. Potential indicators typically require an additional assessment to confirm if decay is present in the tree.

Potential indicators can be placed into two broad categories. The first group is the presence of wounds or other damage that has exposed the sapwood or heartwood, such as pruning wounds, loose or missing bark, lightning strikes, or cankers. Wounds are common infection sites for decay fungi, and most wound infection occurs via airborne spores that are released from conks or mushrooms. Most small wounds can be sealed over by a tree before they become infected. Larger stem wounds, particularly those larger than 144 in^2 (929 cm^2), were reported to be twice as likely to become infected and decayed as smaller wounds. Oozing sap or liquid in deciduous trees or resin flow in conifers may also be a potential indicator of decay because they identify sites of old wounds.

The second group of potential indicators is symptoms associated with the loss of wood strength, such as partial wood failure and response growth patterns. Cracks in the bark or sapwood due to wood failure, and ribs that originate in decayed wood are common in trees weakened by decay. A more subtle indicator is response growth that results in bulges or swelling in branches or the stem. Response growth is a mechanical and physiological process where a tree reacts to the loss of wood strength and movement at the cambium. Response growth may result in an increased quantity and quality (strength) of wood being produced by the cambium. Another decay indicator is the exposure of the inner bark from increased secondary response growth (Figure 4), similar to that which occurs on young trees that are increasing faster radially than the outer bark is expanding.

Figure 4. Exposure of inner bark may be a potential indicator of decay because it suggests response growth due to increased stress in a particular location.

Indicators for Root Decay

Positive indicators for fungi that decay larger tree roots are primarily the same as those seen in stems, except the fungal fruiting bodies are attached to the roots. Cavities, conks, or mushrooms at the base of a tree often indicate root decay, because many of the fungi that cause butt rot also decay roots. A few decay fungi may fruit on woody roots at an extended distance from the tree trunk, but in all cases they are attached to a woody root (Figure 5). Arborists should be aware that many non-pathogenic fungi also fruit as mushrooms from the soil near the base of trees, including beneficial mycorrhizal fungi.

Potential indicators of decay or loss of woody roots are inherently different than the decay indicators in trunks and branches. Poor tree crown health can be an indicator of the presence of root decay. Symptoms include chlorotic, sparse, or undersized foliage, small and/or large branch dieback, and reduced growth rates. Because root decay fungi can spread from root-to-root contact and vegetative fungal growth through the soil, root decay centers may develop. These root decay

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centers may result in clusters of trees that have failed as a result of root and butt rot, and indicate that adjacent trees may also be affected.

Response growth patterns at the base of a tree, such as swellings, bulges, or absence of normal root flare development, are common in trees affected by butt and buttress root decay. These changes in normal trunk taper are more common in large diameter older trees (Figure 6).

Physical changes on the site that have wounded or damaged roots are another potential indicator of root decay. Evidence of fill or grading around trees, the lack of a normal basal root flare, or the wounding of exposed roots may suggest root loss or decay. Visually evaluating buttress and larger diameter roots is challenging, even if the tops of roots are exposed, because most root decay develops from the bottom of roots.

Figure 5. Some root and butt rot fungi may fruit on the ground from roots near the base of a tree. However, some mushrooms or fruiting on the soil near a tree may be from beneficial mycorrhizal or other non-pathogenic fungi.

Decay Indicators and Decay Severity

Severity of decay in roots, trunks, stems, and branches can be difficult to visually quantify using only decay indicators. In cases where decay has caused significant external cavities or where trees have partially failed, visual evaluation may be adequate to make an appropriate decision.

Figure 6. Bottle butt, or swelling at the base of the tree and loss of normal root flare, is a potential indicator of decay in the butt and buttress roots that is usually observed on older trees.

Sounding with a mallet is a common practice used by arborists to further assess indicators for decay severity, as is probing into cavities with a rod or other tool. In many cases, these additional basic assessment techniques can help with an initial evaluation for decay severity, and determining whether more advances assessment and testing tools might be required to quantify decay.

Conclusion

Decay indicators are useful in the basic assessment of trees for decay. The process of using decay indicators to initially evaluate decay in trees, followed by the use of advanced assessment techniques, can help establish a repeatable decay assessment process, and provide arborists with a framework for systematically assessing and evaluating trees for decay.

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All photos are courtesy of the author.

Literature Cited

Luley, C.J., D. Nowak, and E.J. Greenfield. 2009. Frequency and severity of trunk decay in street tree maples in four New York cities. *Arboriculture & Urban Forestry* 35(2):94–99.