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TREE HEALTH MANAGEMENT: EVALUATING TREES FOR HAZARD^{1,2}

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Abstract. Many trees in our cities and urban areas are getting older. Planted at the turn of the century as civic improvements, they are potential hazards today. We are living in an era of increasing lawsuits. Currently one private lawsuit (for any reason) is filed for every fifteen Americans. City and urban foresters need knowledge on how to properly evaluate trees for hazard. A unique Tree Health Management (THM_s) program teaches the art of hazard tree evaluation. Concordant focusing, questioning and visualization guided by common sense are the basics of tree hazard evaluation.

Résumé. Plusieurs arbres dans nos villes et en milieu urbain sont âgés. Plantés au début du siècle comme améliorations civiques, ils sont devenus des dangers potentiels. Nous vivons dans une ère de procès de plus en plus nombreux. Actuellement, un procès privé (pour diverses raisons) est enregistré par quinze américains. Les forestiers municipaux et urbains ont besoin d'information pour bien évaluer les dangers présentés par les arbres. Un programme unique de gestion de la santé des arbres (THM) enseigne l'art de l'évaluation des arbres dangereux. L'observation, le questionnement et la visualisation, guidés par le bon sens, sont les fondements de l'évaluation des arbres dangereux.

The most recent population census in the United States tells us our population is getting older. By the year 2000 one-third of the population will be age 65 or older. That is not all that is aging. The trees in our cities and urban areas are getting older too. Many trees planted at the turn of the century as civic improvements are potential hazards today.

In a recent article by Gary Moll (3) entitled *State of Our City Forests*, Gary concluded after surveying managers of 20 major city forests, "The condition of the urban forest is declining at an alarming rate" ...and.. "tree removals occupy too big a por-

tion of most city programs." Arborists do not have to look far to find hazard trees.

In spite of their potential hazard, trees continue to be a desired amenity of most developed areas. They provide experiences of shade, smells, sounds and the watching of birds and small animals. People of all ages enjoy climbing, running, walking and sitting among trees. Trees add to the value of real estate except when they break apart and fall on cars, buildings and people. A positive experience becomes a negative experience; an amenity becomes a liability. When a failed tree or its parts damage property and injure people, we all pay. You may never be a defendant in a lawsuit but you are a purchaser of liability insurance.

A recent article in *The Pesticide Pipeline* (2) states "Last year there was one private civil lawsuit filed for every 15 Americans". It did not say how many had to do with tree failures, but can you imagine one lawsuit for every 15 Americans. Suing is becoming the American national lottery to be played whenever anyone can.

After extensively researching the literature on lawsuits, I have concluded there are three facts and only three facts anyone can state about lawsuits and liability: 1) anyone can file a lawsuit; all you need is the filing fee; 2) lawyers will argue any case; all you need is their fee, and 3) suing people, businesses and governments has become one of the growth industries of the 1980's in the United States.

The protection of property and the safety of the

1. Presented at the annual conference of the International Society of Arboriculture in Keystone, Colorado in August, 1987
2. Reference to any product does not constitute an endorsement by the U.S. Government

public are major concerns to managers of public and private lands. However, many managers continue to rely on crisis management strategies when dealing with hazard trees. Citizen complaints form their detection network rather than adopting a systematic inspection system. Most tree hazard reduction is incorporated into the tree maintenance program. Too often it is limited to cutting out the deadwood or removing dead trees. As long as the dead material is removed the problem is believed to be solved. Often a greater problem is exposed (Fig. 1).

Need for a Developed Program

To reduce potential liability for tree accidents, city attorneys continually urge cities to adopt a program of *systematic inspection, documentation* and application of *urban forestry principles* to promote tree health.

Why do attorneys encourage city managers to adopt such a program? Most liability suits are argued under the *prudent person concept* and the *law of negligence* (1). The prudent person is defined as judiciously or wisely cautious, carefully providing for the future, provident in the management of resources and one who shows wisdom to look ahead. Whereas the presence or absence of *reasonableness* is the basis for negligence. Is your prudence reasonable or unreasonable?

Hazard tree evaluation training. Training people in the art of hazard tree evaluation is basic in support of the *prudent person concept* and the *negligence doctrine*. There is nothing mysterious about hazard tree evaluation. It requires an *inquisitive mind*, the *ability to focus*, the *ability to visualize* and 2.3 ounces of *common sense*.

You believe you have an inquisitive mind and can focus; but you are not quite sure about visualization. What can you do? You learn to visualize by reading the literature, attending one of the many excellent workshops offered throughout the country and working closely with your tree crews.

Evaluating trees for hazard. Evaluating trees for hazard (4) involves three elements: 1) establishing a potential hazard exist, 2) systematic inspection, and 3) discovery. In general, trees become hazardous because branches become weakened through decay and

fall, decayed trunks fail, or a tree falls over because its support roots decayed. Trees fail for other reasons also; but it is the structurally defective tree that tests our reasonableness.

Target. A tree hazard involves more than a tree with a structural defect. A target must be present that the tree can hit if the tree or part of it fails. It could be a structure, vehicle, human or other object, mobile or fixed. Without a target even the most degenerate tree would not be a hazard. However, an exception has been the *attractive nuisance* sometimes cited in case law. Once a target or potential target is identified, a systematic examination is made of the tree. An inspector must be knowledgeable in tree structure, indicators and signs to properly evaluate a potential hazard.



Figure 1. To improve tree health and reduce potential liability, dead parts of trees are removed. In the process structural defects may be revealed, sometimes too late.

Tree structure and defect. It is important to understand tree structure: 1) to estimate the level of risk associated with structural defects that occur in trees; 2) to enable you to understand and apply the concept of compartmentalization (7) to your estimate of risk, and 3) to establish credibility as a competent inspector if you are required to give deposition in a liability suit or you are called as a witness in court.

Trees are generating systems. They annually produce new cells from cambial and meristematic tissue. Like a sheath the generating tissue encompasses the entire plant; roots, bole, branches and twigs (Fig. 2). Trees often are long living plants. Consequently they require a strong structure to remain erect and withstand the tests of weather. When the generating tissue is killed or removed the process of compartmentalization is limited at the site of removal or death. The site often provides an entry for microorganisms that digest wood. A wound that allows microorganisms to enter the tree can be as small as an insect hole or a series of holes caused by sapsuckers, a crack in the bark, injuries caused by vandalism, broken branches or numerous other causal agents, such as people, animals and environmental elements. Not all injuries become infected but enough do to result in failure of trees or their parts. The failures cause us concern for property and public safety.

Compartmentalization. Focus and visualize the edge of a wound on the bole of a tree (Fig. 3). Keep in mind the tree is a series of trees (Fig. 2). Tomorrow's wood is yet to form. A wound initiates enzymatic and electrical responses in tree tissue extant at wounding (5). Behind the margin of the wound a tissue of callus begins to form (Fig. 3). The wood present at wounding is separated from the wood formed after wounding. The physical and chemical barrier tissue formed in response to a wound protects the new wood from decay organisms that may invade the old wood (6).

Why is it important to understand the concept of compartmentalization? Because all trees with structural defects do not have to be removed. Many other factors must be considered. You must activate the 2.3 ounces of common sense when assessing risk in potentially hazardous trees.

Systematic Inspection

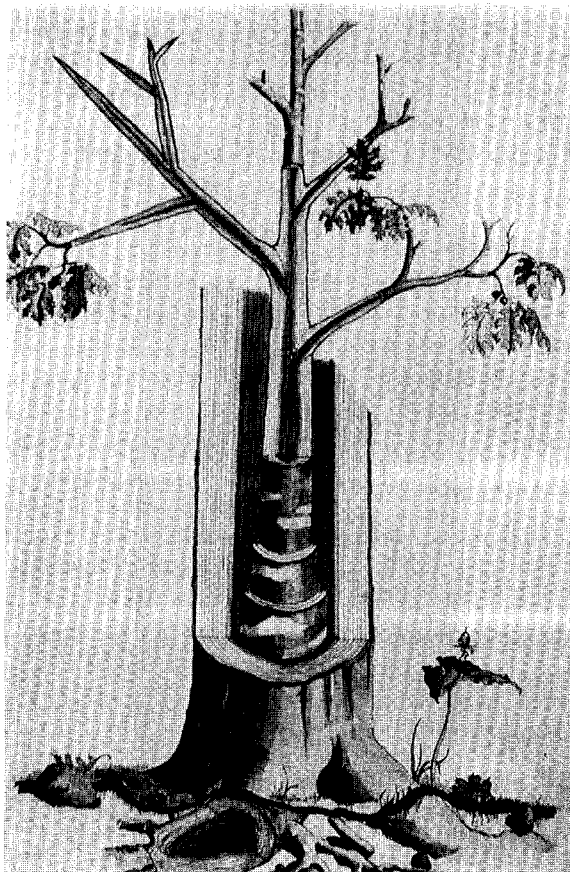


Figure 2. Trees grow by encompassing theirself (cambial generating tissue) and elongation (apical generating tissue). In essence a tree is a series of trees each a part of the whole and yet separate. This is the basis for the compartmentalization concept.

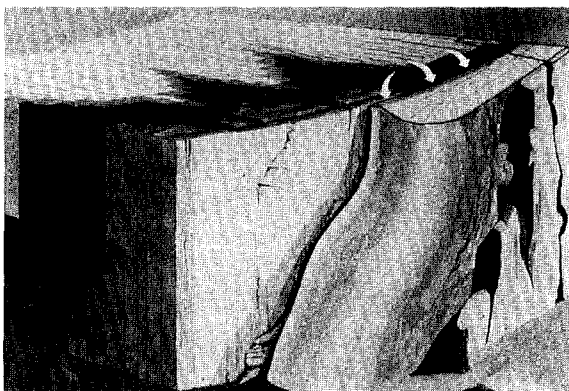


Figure 3. Callus tissue forms from the cambial tissue along a wound margin (arrows). Chemical and physical changes occur in the cambium and tissues extant at wounding. Tissues formed subsequently limit the effects of microorganisms, to tissues extant at wounding.

A tree hazard requires two potentials: a target and the potential for a tree to fail. You have established that a target exists. How do you determine that the potential for tree failure exists? You perform a systematic inspection of the tree by focusing, questioning and visualizing.

In my opinion, more failures occur in the crown of broadleaf trees than anywhere else on a tree. Consequently, I begin an inspection with the crown. When possible inspect when the leaves have fallen. However, combining inspection with maintenance work can be to your advantage, especially when you are dealing with crown problems. If you are unable to do the inspection from a mechanical lift, use binoculars to focus on suspected problems. Look for dead branches, branch stubs, especially with cavities (Fig. 4) and nesting holes. Focus on major branches that have failed or have lateral branches that have failed. A

broken branch that continues to support lateral branches becomes a potential hazard when its structure is eroded through decay (Fig. 5).

The progression of defect that may develop within a broken branch must be visualized for you to properly evaluate its potential for failure. In Figure 6 several minor lateral branches emerge from the affected limb. While the dead section persists, only wound associated discoloration forms within the main branch. The branch wound is prevented from sealing through callus formation. Decay develops with time and progresses through the main branch; the diameter of the column of defect is limited to the diameter of the branch segment that failed. The main branch continues to put on girth, so do the lateral branches emerging from it. An increasing load is put on the main branch. What happens if one of its laterals fail? The benefit of compartmentalization

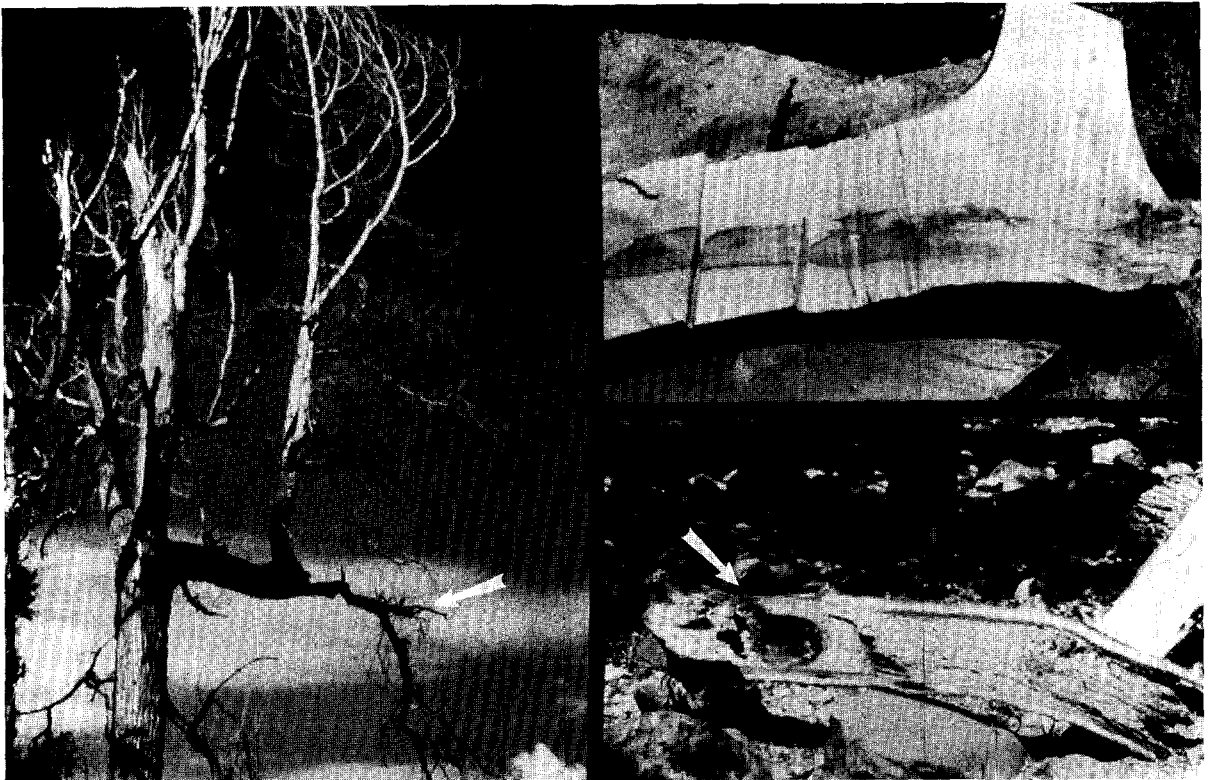


Figure 4. Defective branches that support other branches can be a hazard. When dead branches persist, branch wounds cannot seal by callusing. While the dead branch (arrow) persists, defect in the residual live branch is limited to discoloration. After the dead section fails, decay may progress within the live branch. Complicity occurs when other lateral branches die or birds make nesting sites (arrow) within decayed branches.

associated with the initial branch failure is negated. The main branch is weakened further and the load on it continues to increase as long as it supports growing lateral branches.

When inspecting for defects in the crown do not be deceived by the green foliage. This is not a concern in winter and early spring. Practice concordant focusing, questioning, visualizing and applying your knowledge of compartmentalization. You may be surprised how quickly you just naturally begin doing it.

Dead branches that do not break at the bole or are not pruned cannot be sealed by callus formation. Each open branch wound provides the opportunity for invasion by wood destroying organisms. At first, infections may be localized; with time the infections will coalesce. In the absence of sporophores (signs) which frequently form at branch wounds, you can detect structural deterioration by breaking off the suspicious branch. If decay is absent it will break clean at the bole. If the branch slips out from the bole check further for structural damage.

Nesting holes. Nesting holes are positive indicators of decay. Learn to focus for them; they are not always easily found. Woodpeckers select trees with decay for their nesting site. When evaluating the contribution of nesting holes to the risk potential, consider their location, number and complicity with other factors identified that contribute to the potential for failure.

Watching birds and small animals is a desired experience. Wildlife trees are necessary. Corrective action for a potentially hazardous wildlife tree may require only relocating the potential target. Apply your common sense.

Branch callus. As you scan through the crown examine previously pruned branches. How are they callusing? Callus tissue often seals small pruned branches whereas large pruned branches seldom seal. Large broken branches rarely seal. Pruned branches that expose apparently sound wood can be deceiving. During subsequent inspections the deception may be revealed by the presence of a nesting hole in the exposed branch wood.

The number, size and location of wounds in the crown and their relationship to tree form are extremely important in assessing risk and alternative

corrective measures.

Broken tops. The pattern of structural breakdown within a stem after a leader fails is similar to the broken branch supporting lateral branches. From the stem a lateral branch often will emerge as a new leader (Fig. 7). The residual stem will attempt to seal the wound by callus formation. While open the wound serves as a cistern. Water is collected and decay develops. Decay progresses downward within the stem while it attempts to support a new and growing terminal. The latter grows asymmetrically and is supported unevenly by a decaying base. In this case the application of compartmentalization to risk analysis must be tempered with common sense.

Bole wounds. In general, the initial defect associated with a single bole wound, other than a broken top, will depend on the width, length and depth of the wound and the tree species. Longitudinal spread of wound initiated discoloration and eventual decay is usually greater than lateral spread. Bole wounds that extend to the root collar or originate at or below ground should be examined closely. These trees are similar to a tree growing around an untreated pole stuck in the ground (Fig. 8). Above ground the exposed wood may be structurally sound. By digging into the soil, and chopping or coring into the wood close to the ground, decay can often be revealed.



Figure 5. Multiple stems and major branches that support the crown should be inspected carefully. The major branch on the left has been pruned; callus seals the branch wound. The adjacent major branch has a large branch wound cavity (arrow). Branch cavities delineated by thick callus are indicators of past dead branches. The branch is supporting other living branches. A potential hazard exists.

Exposed roots. Soil compaction around trees often results from people traffic. Tree roots close to the surface become exposed. Runoff from rain and poor drainage make the problem worse; more roots are exposed. Exposed roots are susceptible to wounding. Some become infected and decay. The process is similar to a branch wound except that the advancing column of defect moves upward into the base and bole of the tree. The pattern of defect, although similar to root rots, is not the same.

Root rots. Root rots can be the most difficult tree hazard to diagnose in city and urban trees. Patterns of symptoms, such as death of reproduction or clusters of trees, and signs of root rot mushrooms are masked by the city and urban environment. Sidewalks, driveways, parking lots, the greater distance between trees and the mowing of lawns around trees limits the detection of root

rot symptoms and signs. Even a thinning crown considered a symptom of root rot can be caused by many other factors.

Root disease organisms kill the apical and cambial root generating tissue. Most root diseases result in rotten roots. The appearance of wet spots or pitch at the base of the tree and the formation of mycelial fans under the bark indicate root rot. Mushrooms within the tree dripline may indicate root rot. Consult a mushroom field identification book.

Canker disease. Cankers are structural defects. Microorganisms cause most cankers. Cambial generating tissue is infected and killed. Successive years of killing disrupts the structural integrity of the affected area. A strong wind or other environmental force causes it to fail at the canker. Some microorganisms that cause cankers also decay the affected wood. Be aware of this

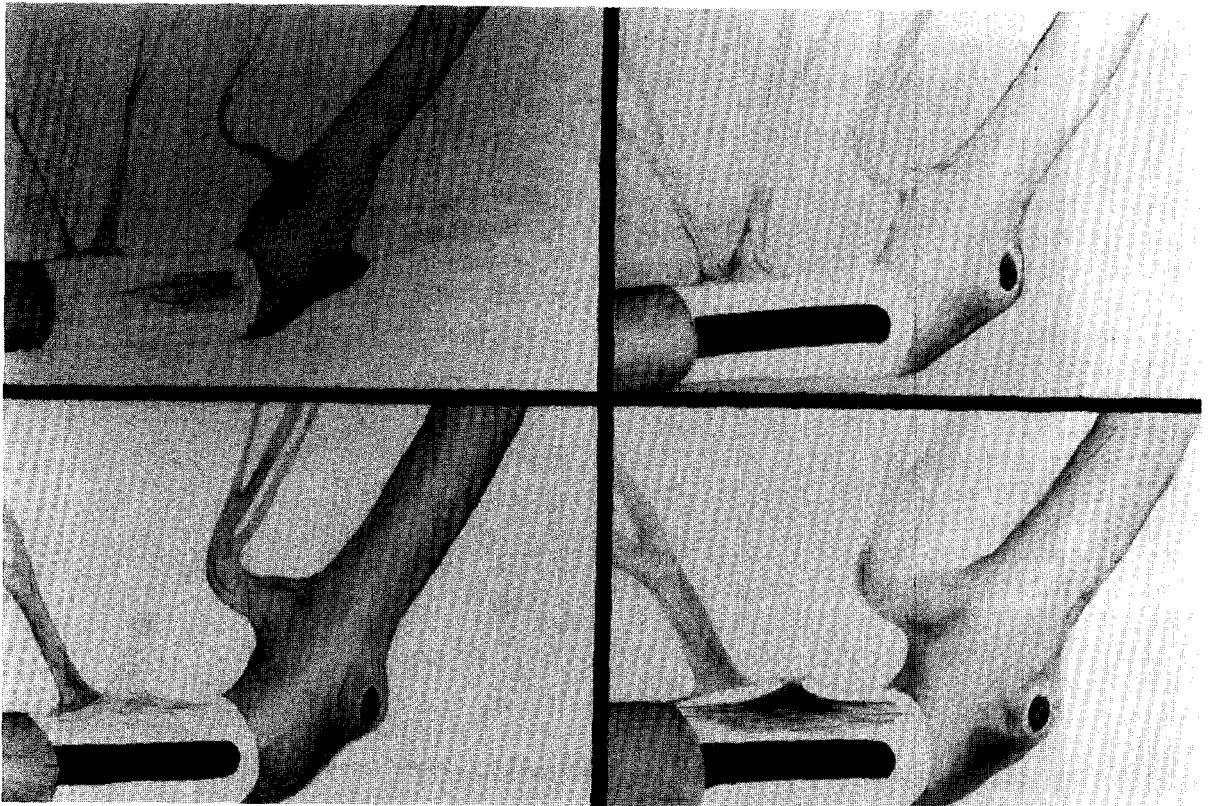


Figure 6. *Visualizing* can be helpful when evaluating trees for hazard. It is an ability that can be developed. By focusing, questioning and applying knowledge of compartmentalization you can visualize internal defects associated with external indicators. Schematics as shown above help to develop your visualization ability. (Artwork, C.A. Sharon)

complicity.

Forked trees. Forked trees can be problems depending on the location and type of fork. U-shaped forks seem to fail less frequently than v-shaped forks. Check for callus ridges at the fork crotch. Heavy callus, sap or pitch running from the crotch and open seams between callus ridges may indicate a pocket of decay. The crotch of v-forks can be like a wound that is never allowed to seal. Lopsided crowns and the force of the wind causes a crotch wound to open and close. The wound is like a cistern; water collects and decay microorganisms thrive in the wound.

Leaning trees. Unless there are mitigating circumstances, leaning trees seldom fail as a result of lean. Nature compensates for the lean. However, if a leaning tree has any of the structural defects I have mentioned, use common sense when evaluating its potential for failure. Dead leaners should be removed immediately if a poten-

tial target exists. Remember, a dead tree is nothing more than an untreated pole in the ground.

Discovery. Discovery is the process of uncovering mitigating circumstances that may predispose a tree for failure. In most cases the tree problem is a result of human activities that disturb the tree environment. It may involve widening a street, replacing a sewer or water line, installing sprinkler or utility lines, changing the landscape for urban beautification, water diversion, or recreational, residential, or commercial development. These activities result in tree roots being severed, wounded and suffocated. The consequences of these activities often are not visible until months or even years later. Knowledge of such activities requires good coordination between departments within city, county and state governments. To discover activities of private enterprise that may predispose trees to failure

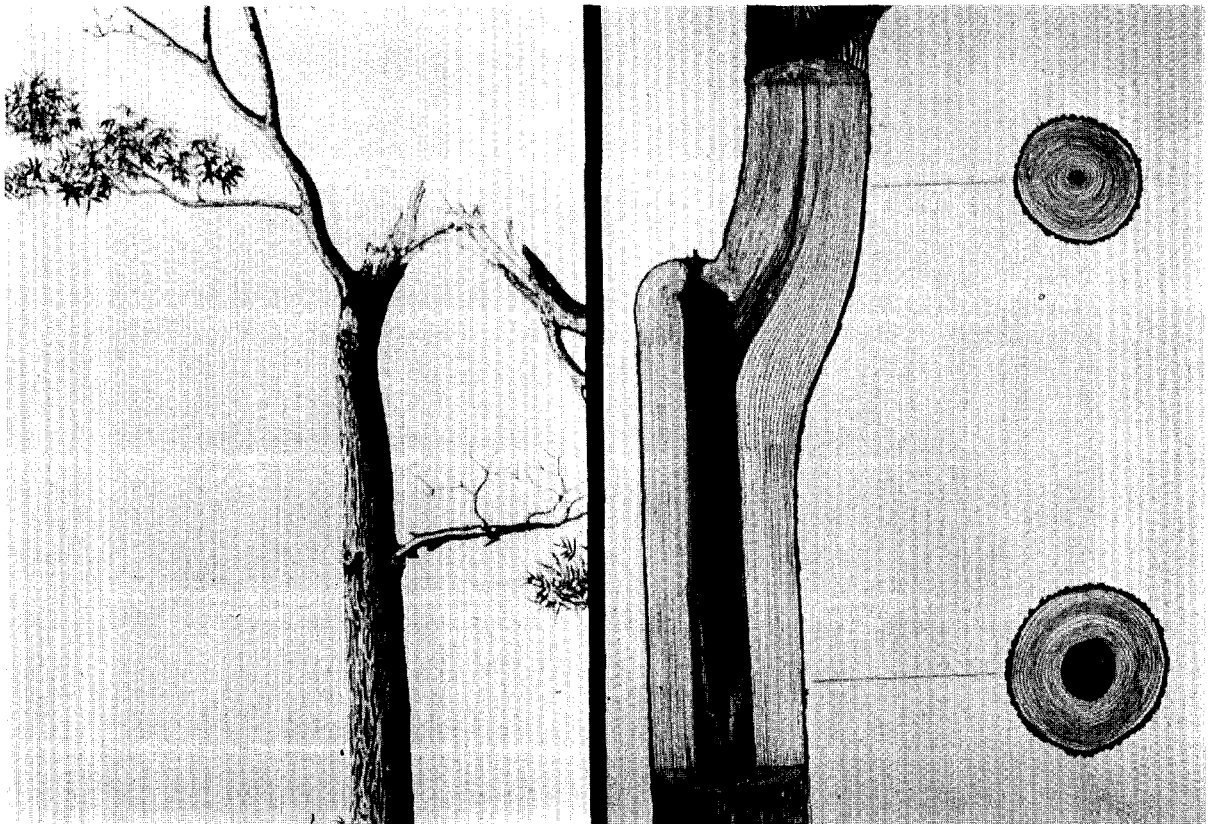


Figure 7. A dominant lateral branch forms a new leader when the previous leader fails. Broken tops seldom seal through callus formation. The new leader is supported by a decaying base.

you need a touch of Sherlock Holmes in you. Ask questions.

Coring. The amount of structural defect in a tree can be determined by sampling. Coring a tree is the common practice. Instruments that penetrate the bark and wood of a tree to detect structural soundness are apt to negate the benefit of compartmentalization. To prevent disturbing wall 4 formed by the compartmentalization process in a wounded tree (7) take a coring through the exposed wound face when possible. If the wound is sealed by callus, core through the callus seam; new callus will form quickly in this area. Avoid coring through sound wood. If you are unable to find the areas I have suggested and need to sample the tree or tree part, consider using an electric drill with a small diameter bit. It allows many holes to be made. This is necessary when trying to assess root rot. Defect associated

with root rots enters the base of the tree like extended fingers. You can easily core or drill between these fingers and miss the decay. You would believe the tree was sound. Using only a drill, it is difficult to determine the ratio of sound wood to defective wood. The Shigometer could be an excellent adjunct to drilling. It does require patience and experience with the instrument.

Conclusion

Evaluating trees for hazard can be a risky business. Risk activates some people; others are immobilized and look to someone else to act. Only you can decide how to play your cards. As Kenny Rogers sings in the ballad *The Gambler*...you got to know when to hold them, you got to know when to fold them, you got to know when to run. There is nothing mysterious about evaluating trees for hazard. All you need is an inquisitive mind, ability



Figure 8. Bole wounds that extend to the ground are similar to an untreated pole with a living tree growing around it. The non-living center (pole) frequently decays at or below the ground line. Farther up the bole above the wound, the wood may contain little or no decay.

to focus, visualize and 2.3 ounces of common sense. This paper recommends a reasonable sequence to follow until you just naturally begin doing it all concordantly.

Acknowledgements. The author thanks the numerous contributors and supporters of the Tree Health Management Series (THM_s) and the Hazard Tree Instructor Training (HTIT) project. These projects generated the impetus for this paper. A special thank you to Dave Steinke, Information Specialist, USDA Forest Service, Denver, CO and Ron Morrow, City Forester, Colorado Springs, CO.

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ABSTRACTS

GULBRANDSON, RUTH R. 1987. **Wearing protection.** Agrichemical Age 31(2): 12, 17-18.

Research has shown that pesticides are absorbed at different rates on various parts of the body. Special protection should be given to the scalp, ear canal, or forehead area, and also to the abdominal area and beltline or waistline, to prevent chemical access to the scrotum. The following clothing guidelines will help protect you from pesticides that can be absorbed through the skin or inhaled. Applicators and those mixing and loading pesticides should wear: coveralls or long-sleeved shirt and pants, gloves, boots, hat, lightweight raincoat or waterproof apron, goggles, face shield and respirator.

HEYDT, MICHAEL J. and RONALD A. MORROW. 1987. **Somboddy's gonna pay!** Am. Forest 93(1&2): 12-15.

The major issues that confront homeowners whenever a dispute involves the rights of their trees are worth exploring. 1) What are the most common forms of liability relating to ownership of trees for property owners to be concerned about? 2) What are a property owner's legal responsibilities with respect to hazardous trees on his property? 3) What are a property owner's responsibilities for a tree on his property whose limbs or roots intrude into adjacent property? 4) What about a tree that is on a property line? 5) What is the legal relationship between a property owner and the local government with respect to street trees or trees that are planted along the public right-of-way? 6) How are damages in a civil trial measured with respect to the destruction of trees?