CONTINUING EDUCATION UNIT

Managing Risk in the Urban Forest

Part 3: Risk in the Urban Forest

By Nelda Matheny and Jim Clark

This article is third in a series of four on the topic of risk management. The articles are adapted from ISA's upcoming Municipal Arborist Certification Study Guide.

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LEARNING OBJECTIVES

The arborist will be able to

- understand the context in which tree risk rating systems have been developed.
- explain the advantages and limitations of rating tree risk.
- develop a system of procedures that apply to a specific population of trees.
- understand the proper uses of a tree risk rating system.

This is the third of four articles on tree risk management. The first article in this series discussed the general principles of risk management; developing a risk management plan and policy; and communicating risk to clients, owners, and the public. The second article addressed tree risk assessment, which is assessing the potential for trees to fail and cause damage. The final installment (October 2007) will cover risk associated with tree litter and conflicts with pavement and other infrastructure.

A Summary of Tree Risk Assessment

The goal of tree risk assessment is to increase safety by abating structural defects before the tree fails and causes damage. This is done by identifying structural conditions that can lead to failure, then applying treatments such as pruning to reduce the risk of failure.

Trees cannot be maintained free of risk. This is because we cannot observe all conditions that lead to failure or control all factors that cause failure. For instance, we cannot see root decay if there are no symptoms above the ground. We cannot prevent tree exposure to abnormally strong winds or ice storms that create loads greater than the tree can bear.

In addition, the scientific study of tree failure is relatively young; we still have much to learn. We do not know, for instance, why branch failure occurs in some tree species

> "Safety costs trees as well as money."—Lee Paine, 1971

when summer temperatures are high and there is no wind. We do not know at what wind speed a specific tree will fail. We have tools that allow us to measure the amount of sound wood present at a point along the trunk, but we do not know how much sound wood that tree requires to remain stable. We do not know how many roots on a specific tree can be removed before it will fail.

Therefore, arborists perform risk assessments with limited information about the structural condition of the tree itself and the environment that affects it. We have a duty

The three components of tree risk assessment are (1) inspecting the tree and evaluating the potential for failure, (2) considering the contribution of site conditions and weather to failure, and (3) determining the likelihood that a person or object (the target) would be injured or damaged by the failure.

to inspect and manage trees in a reasonable manner. We use our experience, training, and education to process what we see and form opinions about what is likely to occur in the future; we do so with incomplete and imperfect information. That is the state of the art and science of tree risk assessment.

Communicating Risk to Tree Owners

People differ widely in what risks are acceptable. To some, living under a tree is too risky, and the fear of being crushed in a windstorm overwhelms them. Others enjoy the tree, not fear it. In addition, how the arborist feels about risk can influence what advice is given and how it is communicated, so it is important to guard against bias.

The arborist should provide as complete a picture as possible about what is likely to fail and under what conditions, what is certain and uncertain, costs and benefits, and relevant management issues. Ranking the risk into categories such as "low," "moderate," "high," and "severe" can help the owner understand the degree of risk. The arborist relies on experience and training to rank the risk for individual trees.

How the tree owner feels about trees and risk will affect decisions about how the tree should be managed. As an example, there may be two or three treatment options that could be applied to reduce the risk—for instance, weight-reduction pruning, pruning plus cabling, or tree removal. A risk-tolerant owner may opt for the pruning treatment, while a risk-averse owner may be satisfied only with tree removal to eliminate risk. Communicating the benefits of trees to risk-averse owners may increase their tolerance.

What is the difference between hazard and risk? A hazard is the presence of a condition that is likely to cause injury or damage. In this example, the hazard is the codominant stems that are cracked open at the attachment. The risk is the potential for damage or injury when the tree fails. Given the severity of the defect and the presence of high-value targets surrounding the street tree, the risk is high.

Rating Tree Risk

Risk management becomes more complex when many trees are involved. Municipal and utility arborists manage thousands of trees, with defined budgets. Tree risk rating systems allow municipal and utility arborists to numerically rank the relative risk posed by each tree within a population. Commercial or consulting arborists managing many trees on large residential, commercial, or institutional properties may also find a numerical rating system useful. Rating is a management tool that helps to

- identify the highest-risk trees so that they can be treated first.
- determine how many trees can be treated with the budget available and how much that would reduce risk within the population.
- assess the adequacy of the current budget to fund abatement treatments.
- determine whether additional funds are needed or, if educational efforts are needed, to moderate community risk tolerance.
- schedule tree care activities in a systematic way.
- demonstrate the agency is acting reasonably to protect public safety.

Some disciplines rely on statistical probabilities derived from historic data; the insurance industry is an example. We have yet to generate sufficient tree-failure data to do that in arboriculture. Although our assessments are informed by data from the International Tree Failure Database (http://svinetfc2.fs.fed.us/natfdb), to date there are not enough records for statistical analyses and development of probabilities. Eventually, we may be able to use that and other data to quantify risk. Currently, arboricultural risk ratings are based on professional judgment.

A number of philosophical approaches and methodologies have been applied to rating tree hazards or risk. In each, a qualitative rating using a numeric system is assigned to specific characteristics of the tree and its surroundings. Those ratings are either summed or multiplied for an overall rating. All require inspection of each tree, noting tree size and/or age, species, severity of defect, and likelihood to cause injury or damage. In some, monetary value of the loss that would occur is estimated and is used as the risk rating.

The first risk rating (then called

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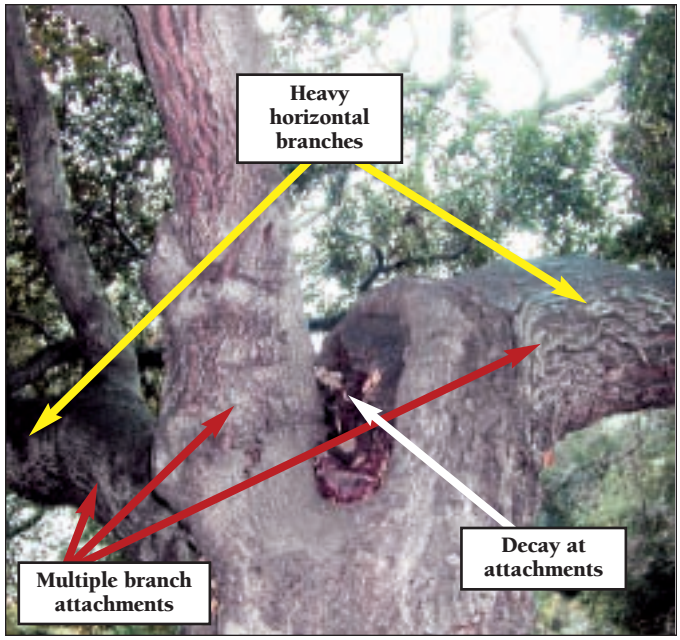
Tree risk ratings rank the relative risk for a tree to fail and cause damage within a population of trees. The rating is a management tool that helps to identify the highest-risk trees so that they can be treated first.

"hazard rating") systems in the United States and Canada were developed for federal and state/provincial forested recreational sites. The authors (Matheny and Clark 1994) adapted those systems to urban and community trees. First, the tree is visually inspected to identify the presence and severity of defects. Next, the part most likely to fail and strike a target within the inspection period (one to two years is recommended) is identified. Finally, the most likely failure is rated on three factors: (1) probability of failure, (2) size of the part, and (3) target use and occupancy. Each factor has four possible points, so the lowest possible rating is 3 and the highest is 12.



When evaluating the likelihood for failure, consider the interaction of defects. Three conditions that may contribute to failure are present in this tree: multiple branch attachments arising at one location, heavy horizontal branches, and decay at the attachment. Any one condition could be assigned a low to moderate failure potential. Combining all three, however, increases the failure potential to high. If the tree is exposed to strong winds, the failure potential may be severe.

The USDA Forest Service's *Urban Tree Risk Management: A Community Guide to Program Design and Implementation* (Pokorny 2003) includes two rating systems, one of which is the USDA Forest Service Community Tree Risk Rating system. This 10-point rating system includes the same three factors (although rated on different scales), plus two "optional subjective risk rating" points. ISA's Pacific Northwest Chapter has incorporated that system into a Tree Risk Assessor training course and certification (TRACE).

According to Norman Rasmussen (1990), estimating risk based on the probability of events "requires knowledge of both the probability (or, more precisely, the frequency) of possible accidents and the magnitude of the consequences." Using tree-failure information from federal and some state recreation areas throughout the United States, Paine (1971) based a tree hazard rating system on

- probability of tree failure.
- probability of a target being hit.
- expected damage to the target.
- monetary value of the target.

The first three, expressed as percentages, and the target value are multiplied together. If the product, expressed in U.S. dollars, exceeds the established hazard control level (determined by park administrators), corrective measures are to be taken. This system requires extensive records and many computations; it is no longer in use.

Michael Ellison (2005) applied Paine's probability analysis approach to tree risk assessment in the United Kingdom. The Quantified Tree Risk Assessment (QTRA) system is based on the same three components common to other risk rating systems—probability of failure, size of the part (called the "impact potential"), and target value—but multiplies these to produce the "risk of harm." Probabilities are expressed in ratios from published data, when available, or estimated. For example, the target occupancy for vehicles traveling on roads is determined from Great Britain's 1996 vehicle frequency statistics. Target values are estimated from the monetary value for repair or replacement. The value of "statistical life" (monetary value of an individual) in the United Kingdom is £750,000 to £1,000,000 (Health and Safety Executive 1995, as cited in Ellison). QTRA defines acceptable risks as those that have an annual risk of death below 1/10,000, a limit proposed by the British Medical Association's *Guide to Living with Risk* (Henderson 1987, as cited in Ellison). In the United States, however, there is no generally accepted level for risk tolerance, nor is there a defined value for human life.

Adapting Risk Rating Systems

The more the risk rating system is geared to reflect the unique character of the tree population, the more effective it will be as a management tool. When considering target ratings, for instance, the arborist should consider all the possible targets and group them into

categories of low to high occupancy and use. A road or building in a densely populated urban area might receive a rating much different from what it would receive in a rural area. Risk rating systems need not be consistent from one community to the next, but procedures and systems should be consistent within a jurisdiction.

Field Procedures

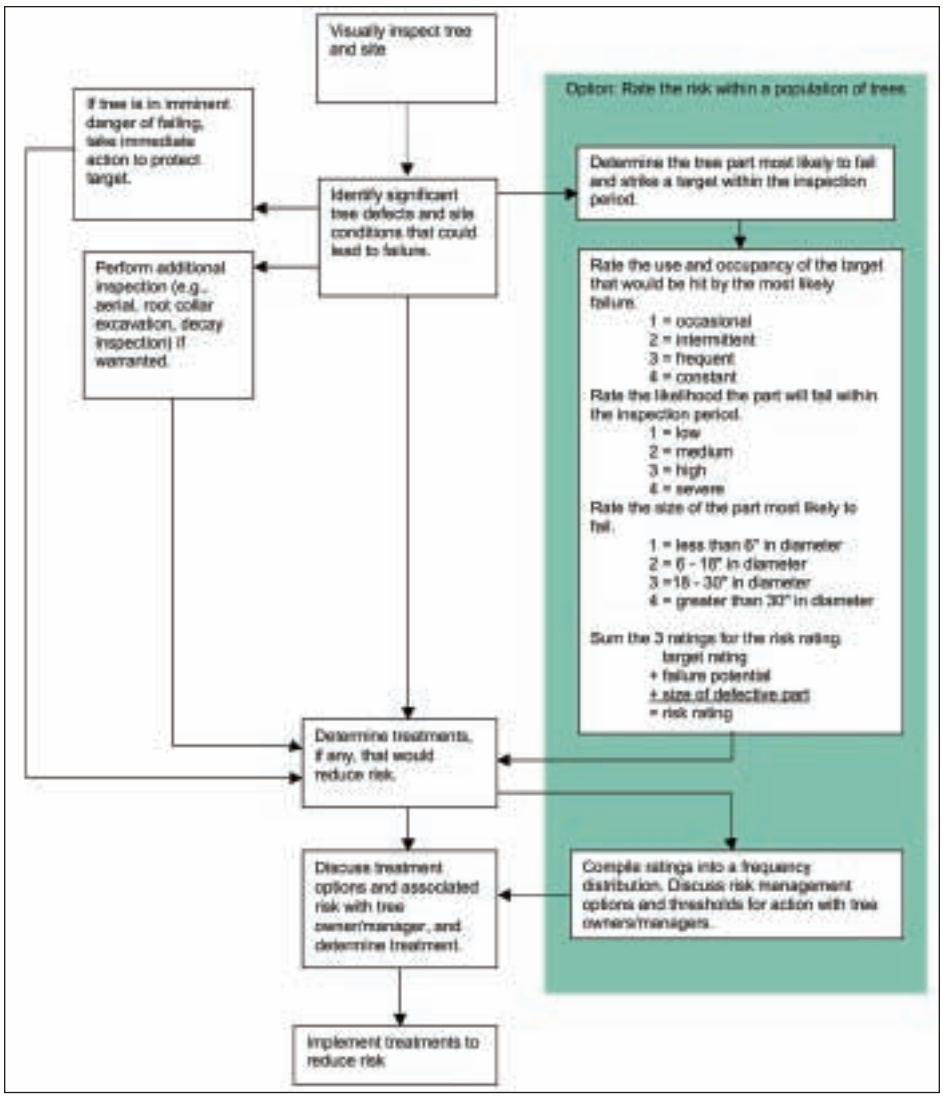
Risk is rated after a visual inspection and assessment of tree, site, and target. Ratings are assigned for each category and then summed. The process is outlined below and in the flow chart.

- Tag each tree with a numerically coded tag, and record its location by street address, building number, or GPS coordinates.
- Identify the species, with variety or cultivar if applicable.
- Measure tree size (for example, trunk diameter, height, canopy spread).
- Assess tree health and condition.
- Walking around the tree, describe all significant tree defects, beginning at the root collar and working upward.
- Determine the tree part most likely to fail and strike a target within the evaluation period.
- Identify the target(s) that would be struck.
- Rate the failure potential (1–4) associated with the part most likely to fail.
- Rate the size of the defective part (1–4) most likely to fail.
- Rate the target (1–4) for the part most likely to fail.
- Sum the risk rating of the most likely failure.
- Determine treatments, if any, to reduce likelihood of failure, including those requiring immediate action.
- Determine whether additional evaluation is needed, such as root collar examination, decay assessment, or aerial inspection by a climber or with a lift.
- Proceed to next tree.

If the inspector identifies a tree in imminent danger of failing, immediate action must be taken. This includes informing appropriate personnel, restricting access to the target area, and implementing abatement treatments (such as pruning, removal, moving the target, etc.) as soon as possible.

Maintaining Records

Observations, ratings, and actions taken should be documented, as well as dates and names of assessors. This not only creates a record that demonstrates performance of duty of care, but it creates a history that facilitates tree management and provides a tool for analyzing and preparing budgets. Training activities for every person involved in tree care also should be recorded.



Flow chart of tree risk assessment procedures.

Using Risk Ratings

Risk ratings help prioritize work by identifying the trees within the population likely to cause the greatest harm. Trees with high ratings should be treated before trees with low ratings. However, risk ratings cannot strictly define a numerical line for action between either removal and retention or treatment and no treatment. This must be an administrative decision, one made by owner and manager. For instance, an agency may determine that, given the resources available, only trees rated above a certain threshold will be treated. The treatment depends on the specific characteristics of the tree and its target and is not dictated by the rating.

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Over the years, we have used risk ratings in a variety of ways, depending on the needs of the client. We start by looking at data summaries and grouping trees into categories to develop action lists.

1. Create an assessment wide spreadsheet or database.
2. Rank trees by risk rating. A graphic presentation may help illustrate the range in risk ratings.
3. Divide the trees into "priority for action" categories. The arborist may want to consider species, age, health, and/or specific components of the risk rating (for example, trees rated "4" for failure potential or "4" for target). Also, consider how many trees can reasonably be treated with available resources and the owner's tolerance of risk. The ratings do not in and of themselves define the priority for action, nor do they define what action should occur.
4. Use summary tables and/or graphs to show the frequency distribution of risk ratings by species, defect, and/or location. Doing so will provide information about overall management needs.
5. Determine the time line for action, considering available resources and factors that could affect tree failure or intensity of use. For instance, timing may be affected by seasonal storms that cause the most number of failures or by heavy seasonal use.
6. Generate lists of trees and the treatment needed.

Tree Risk Reduction

Development of abatement options should be as systematic as evaluating the failure potential, considering the nature of the site, tree, and target. Mobile targets such as picnic tables may be moved outside the fall zone of the tree. Roads, walkways, and parking can be realigned or closed off. Fences may be needed to exclude use.

Treatments are applied to reduce the potential for failure. Treatments may include pruning, cabling, bracing, guying, propping, modifying site conditions such as drainage, or removing the tree (see previous article for further discussion).

After abatement treatments are applied, a follow-up evaluation should occur, because the potential for the tree to fail has changed. Effects on neighboring trees should be evaluated, as well. For instance, consider the change in exposure to wind if a protecting tree or branch is removed.

Dead and decaying trees may be retained for reasons such as wildlife habitat. Selection of suitable wildlife trees must consider the potential hazard, as well as the stability of the tree and its value for wildlife. Retaining high-risk trees or tree parts, even those with significant wildlife value, is not appropriate in public use areas where risk of damage or injury is unacceptable.

Key Ideas About Using Risk Ratings

- Risk rating systems are used to rank the relative risk among a population of trees. A risk rating is not a quantitative measurement of risk posed by an individual tree.
- The primary goal of examining trees is to increase safety. Although it is impossible to eliminate all risk associated with trees, we can reduce future injuries by inspecting trees and taking action to abate hazards in a reasonable manner. A risk rating is not needed to accomplish this goal.
- Trees cannot be separated into hazardous and non-hazardous groups. However, risk management policy can be developed that identifies a threshold above which trees are considered hazards, and at what ratings and when action will be taken.
- Risk ratings do not define action. There is not some threshold above which trees must be removed. Action is specified after considering the characteristics of the defect and target, as well as management goals.
- Risk rating systems may be customized to fit the specific conditions of a site, tree population, and management goals. Get to know the site and management well enough to address key issues and meet the specific needs. Then figure out what data to collect and how to use them most effectively.
- Consultants do not have carte blanche. Owners and managers must be involved in decisions about how to use risk ratings and develop action plans.
- It's not enough to inspect and rate trees. Reasonable action must be taken to abate the hazards and manage risk. The arborist should help the owner or manager use the information in a prudent way.

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Figures courtesy of the authors.

CEU TEST QUESTIONS

To receive continuing education unit (CEU) credit (1.0 CEU) for home study of this article, after you have read it, darken the appropriate circles on the answer form of the insert card in this issue of *Arborist News*. (A photocopy of the answer form is ***not*** acceptable.) A passing score for this test is 16 correct answers.

Next, complete the registration information, ***including your certification number***, on the answer form and send it to ISA, P.O. Box 3129, Champaign, IL 61826-3129. Answer forms for this test, **Managing Risk in the Urban Forest, Part 3: Risk in the Urban Forest**, may be sent for the next 12 months.

You will be notified only if you do not pass. If you do not pass, ISA gives you the option of re-taking the quiz until you do achieve a passing score.

1. The primary goal of assessing trees is to
   a. decrease spending
   b. decrease downtime
   c. increase air quality
   d. increase safety
2. To rank the risk for individual trees, the arborist relies on
   a. complete and perfect information
   b. experience and training
   c. actuarial tables
   d. a uniformed crew
3. Trees cannot be maintained entirely free of risk because
   a. we cannot observe all conditions that lead to failure
   b. we cannot control all factors that cause failure
   c. the scientific study of tree failure is relatively young
   d. all of the above
4. Rating systems are often customized to fit the
   a. site conditions, tree population, and management goals
   b. budget, resources, and staff expertise
   c. decay, imbalanced crowns, and included bark
   d. community values, budget, and staff
5. The USDA Tree Risk system includes two
   a. optional subjective risk rating points
   b. operational defect risk rating points
   c. forms that rate individual tree risk
   d. levels of hazard tree rating systems
6. Risk rating systems should be consistent
   a. within the global community
   b. within a jurisdiction
   c. in neighboring communities
   d. among commercial companies
7. Final decisions to remove or retain trees should
   a. be made by the owner or manager
   b. be made by the arborist
   c. be determined by the rating system
   d. err on the side of caution
8. Risk ratings apply to
   a. tree branches
   b. individual trees
   c. a population of trees
   d. a population of targets
9. Recording the dates, ratings, and actions
   a. demonstrates that the duty of care is being met
   b. creates a history that facilitates tree management
   c. provides a tool for analyzing and preparing budgets
   d. all of the above
10. Reasonable action must be taken to abate the
    a. standards
    b. hazards
    c. hooks
    d. ratings
11. The limit of acceptable risk referred to in Great Britain is
    a. 1/10,000
    b. 1/25,000
    c. 1/100,000
    d. 1/250,000
12. _____ has developed certification in tree risk assessment.
    a. ISA's Pacific Northwest Chapter
    b. The American National Standards Institute
    c. ISA's European Chapter
    d. The Office of Safety and Health Administration
13. Risk rating systems in North America were first developed for
    a. urban parks and streetscapes
    b. private companies with adequate budgets
    c. public agencies in urban areas
    d. public forested recreational sites
14. Arborists should know
    a. why limbs suddenly drop in summer when there is no wind
    b. at what wind speed a specific tree will fail
    c. when a tree needs closer inspection to assess risk
    d. the sporulation timing for each species of decay fungi
15. The essential steps in using risk rating systems are
    a. summarizing, charting, and treating
    b. organizing, prioritizing, and timing
    c. summarizing, prioritizing, and determining actions
    d. graphing, charting, and treating
16. The three components of most risk rating systems are
    a. species, size of the part, and target value
    b. probability of failure, species, and target value
    c. type of defect, size of the part, and target value
    d. probability of failure, size of the part, and target value
17. There is no specific threshold above which trees must be removed because
    a. risk ratings do not define action
    b. action is specified after considering the characteristics of the defect and the target
    c. management goals play a critical role in deciding on a course of action
    d. all of the above
18. Training activities should be recorded for
    a. landscape architects and supervisors
    b. every person involved in risk assessment
    c. landscape assessors and inspectors
    d. every person involved in tree care
19. Risk-rating field procedures begin with
    a. measuring dbh, identifying defects, and identifying targets
    b. numbering, recording location, and identifying species
    c. rating failure potential, measuring size of parts, and target location
    d. measuring dbh and assessing condition and health
20. An example of a risk abatement action is
    a. pruning a tree to remove a defective part
    b. moving a picnic table to reduce the target value
    c. limiting access to the area around a tree
    d. all of the above