Tree Risk Assessment Methods: A Comparison of Three Common Evaluation Forms[1]

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Introduction

All trees pose some level of risk to nearby people, structures, and utilities. Typically, this risk is minimal and is far outweighed by the environmental, social, and economic benefits offered by the tree in question. As trees age or become weakened by pests, disease, and/or other stresses, this balance may shift, requiring a tree owner or manager to decide what risk level he or she is willing to accept and what modifications, if any, are needed. Experienced arborists can aid in this decision process by conducting a professional risk assessment that specifies the likelihood of whole or partial tree failure, the consequences of such a failure, and the potential targets affected.

A variety of risk assessment methods have been developed to guide professionals through the tree inspection process. In North America, three risk assessment methods have gained the greatest acceptance among tree care professionals, municipal urban forestry programs, and government agencies. These methods are:

- **International Society of Arboriculture (ISA) Tree Hazard Evaluation Method** (Matheny and Clark 1994)
- **United States Department of Agriculture (USDA) Forest Service Community Tree Risk Evaluation Method** (Pokorny 2003)
- **ISA Tree Risk Assessment Best Management Practice (BMP) Method** (Dunster et al. 2013; Smiley et al. 2011)

Sidebar 1.

Quantitative vs. Qualitative Risk Assessment

Although the ISA Tree Hazard Evaluation Form and the USDA Forest Service Community Tree Risk Evaluation Form both generate a numerical rating as a final product of the assessment process, they are not quantitative assessment methods. The numeric inputs used to generate a final score are qualitative or subjective ratings of defect severity, size of defective part, and target. To help eliminate this confusion and the false sense of accuracy that was often experienced with these qualitative, mathematical formulas, the updated International Society of Arboriculture Best Management Practice method has replaced numerical rankings with descriptive categories, such as "improbable," "possible," "probable," and "imminent" for likelihood of failure. Users are guided through a series of decision matrices to determine the overall risk rating.

If using one of the risk assessment forms that generates a final, numerical rating, note that this value is intended for assessing populations of trees. No concrete risk threshold can be applied to categorize a single tree as either "safe" or "hazardous" (everything rated greater than seven must be removed). Instead, numerical ratings allow users to prioritize risk reduction efforts by addressing the trees that pose the greatest potential threat to people and property first and, as resources and time permit, working down the list to lower-rated trees.

Each risk assessment method is paired with its own data collection form. These forms serve many functions and in particular, they:

1. Pull out and summarize key concepts within each assessment methodology

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2. Guide the user through a systematic assessment of root, trunk, and crown conditions

3. Ensure the collection of standardized data

4. Provide a written record of the assessment and any prescribed risk abatement measures

Throughout this article, we use risk assessment *method* and *form* interchangeably because both are closely and deliberately linked by their associated developers. This does not suggest, however, that a potential user can gain all the background he or she needs from the form alone. Each risk assessment method included in this review is thoroughly documented with its own user manual. These manuals should be repeatedly referenced until the user becomes sufficiently experienced in the method used. Face-to-face training may also be available for the USDA Forest Service Community Tree Risk Evaluation method and the ISA Tree Risk Assessment BMP method.

For this article, we field tested the ISA Hazard Evaluation, the USDA Forest Service Community Tree Risk Evaluation, and the ISA Tree Risk Assessment Best Management Practice (BMP) risk assessment processes on three different trees in a botanical garden (Figure 1). In comparing the three methods and their data collection forms, we assessed the:

- similarities and differences,
- perceived advantages and disadvantages,
- time required for completion of a basic visual assessment, and
- potential application in commercial arboriculture and municipal forestry settings.

Figure 1. The three risk assessment processes reviewed all included data entry forms to facilitate the systematic collection of standardized information.
Credits: Gitta Hasing, UF/IFAS

These evaluations offer practical insights for arborists and urban foresters wanting to adopt a tree risk assessment method to aid in their professional responsibilities.

General Comparison of Data Collected

Sidebar 2.

Risk vs. Hazard
Something is considered a hazard if it simply has the potential (no matter how small) to cause harm. In contrast, risk is the *likelihood* that a potential hazard will cause harm, and risk is situation dependent. For example, even very hazardous waste materials can pose minimal risk to health and safety, if handled and contained appropriately. Similarly, large trees with compromised structures near targets are more likely to cause harm than small trees with the same probability of failure in remote areas.

Risk Assessment Background, Perceived Advantages/ Disadvantages, Time Requirements, and Applicability in Arboriculture and Urban Forestry

ISA Tree Hazard Evaluation Form (from A Photographic Guide to the Evaluation of Hazard Trees in Urban Areas)

Background: The ISA Tree Hazard Evaluation Form, which was developed by Nelda Matheny and James Clark and last updated in the second edition of *A Photographic Guide to the Evaluation of in Urban Areas* (1994), has been widely used and modified by municipalities and commercial arborists. Though the ISA (working with Matheny) has since published the ISA Tree Risk Assessment BMP, a new risk assessment approach, the original form is still used by many in the industry.

Advantages: The ISA Tree Hazard Evaluation Form summarizes an industry-accepted method for documenting risk and prioritizing hazard abatement efforts. The level of detail is suitable for a basic visual assessment of an individual or small group of trees. When used correctly, the hazard rating can prioritize pruning, removals, and other mitigation options.

Disadvantages: The time required to complete this form makes it difficult to assess large populations of trees in a municipal setting. However, the final numerical rating used for comparing the relative risk of trees plays a prominent role in the process and is a key focal point in the form. As such, the final hazard rating runs the risk of being misused by commercial or consulting arborists who inspect individual trees in a residential setting (see *Quantitative vs. Qualitative Risk Assessment* sidebar).

Time Required to Complete: Approximately 20 minutes for a basic, 360-degree visual assessment, using a diameter tape and a digital hypsometer (Figure 2). Time required should decrease as the user gains greater familiarity with the process and form.

Figure 2. Urban trees can often impact multiple targets.
Credits: Gitta Hasing, UF/IFAS

Use in Arboriculture and Urban Forestry: The ISA Tree Hazard Evaluation Form is best suited for a commercial arborist or urban forester working with smaller tree populations (e.g., the trees present on a residential lot or a high-use municipal property). Given the time requirements and labor costs, its usefulness in assessing large populations of urban trees will be limited for most cities.

Form: To view the form, see the appendix or visit http://www.isa-arbor.com/education/resources/educ_TreeHazard-Form.pdf.

USDA Forest Service Community Tree Risk Evaluation Process and Form

Background: The USDA Community Tree Risk Evaluation Form was developed by Jill Pokorny et al. (2003) as part of the USDA Forest Service guide, *Urban Tree Risk Management: A Community Guide to Program Design and Implementation.* The form summarizes and leads the user through a seven-step process, which includes identifying defective trees in target areas and determining the defects' severity, the consequences of failure, and the remedial action recommendations intended to reduce tree risk. Numeric tree risk ratings that are generated as part of this process can aid communities by prioritizing the application of corrective actions.

Advantages: The USDA Forest Service Community Tree Risk Evaluation Form is fairly simple to use, concise (10 trees per printed page), and relatively fast to complete compared with the other methods assessed. The risk rating and tree defect codes standardized data collection and made paper data entry faster. Similarly, using standard corrective action codes can prescribe remedial measures for evaluated trees at the time of assessment. While this nomenclature can be an initial hurdle, with time its use should further reduce the time needed to assess each tree.

In our assessment, the time required to complete the USDA Forest Service Community Tree Risk Evaluation Form took about 10 minutes or about half the time required for the other forms. This factor alone makes this form a compelling choice for urban foresters and others charged with managing large populations of trees.

Disadvantages: With the increased efficiency of the USDA Forest Service Community Tree Risk Evaluation Form comes some sacrificed detail, especially with regard to site history and condition (factors that are provided as background information, but are largely excluded from the actual ratings produced by either of the ISA forms). Site history can be crucial because certain parts of Florida are more prone to hurricanes and thunderstorms. Similarly, site development is important because rising water tables can injure tree roots and predispose them to catastrophic failure.

Additionally, while the standard codes facilitate the rapid recording of defects, the user has limited flexibility in describing unique problems encountered in the urban environments (e.g., utility conflicts, invasive species prone to specific modes of failure, or poor spacing). While including notes in the optional "Other Risks Factor Ratings" column alleviates some of this, data consistency may become an issue. Alternatively, one could add the list of defect codes to match typical conditions in a given region.

As with many tools developed in the northern United States, there are species-specific issues that can arise when using this form in the South. For example, in Florida, live oaks (*Quercus virginiana*) are commonly used in the urban environment. This species typically has branches with sharp bends or twists that, given the examples outlined in the guide, should be described as Poor Tree Architecture (PTA) in the list of available defect codes. However, history and research show live oaks are one of the more resilient species in high-wind events. Conversely, in cases where a known defect leads to a greater species failure rate, the "Other Risk Factor Rating" (0 to 2 points) can be used to increase the risk rating. This also applies to cases of a tree's location site that may increase its susceptibility; for example, a laurel oak (*Quercus laurifolia*) that is established in areas where water tables are rising.

While it's not considered a disadvantage, the USDA Forest Service Form does not include a section for tree height measurements, and the stem diameter is the sole size measurement. Tree height data combined with DBH can yield important information on a tree's vulnerability to the elements (i.e. for calculating wind loading). Also, the form's layout does not include sufficient space to list all defect codes for trees with multiple issues; thus, increasing this area would improve the form's functionality.

Time Required to Complete: Approximately 10 minutes for a basic, 360-degree visual assessment, using a diameter tape. Time required should decrease as the user gains greater familiarity with the process and form.

Use in Arboriculture and Urban Forestry: The USDA Forest Service Community Tree Risk Evaluation Form is well suited for commercial arborists or urban foresters working with key urban tree populations (e.g., downtown street trees or trees along evacuation routes).

Form: To view the form, see the appendix or visit http://www.na.fs.fed.us/spfo/pubs/uf/utrmm/chptr3_sec8.pdf.

ISA Tree Risk Assessment Best Management Practice Form

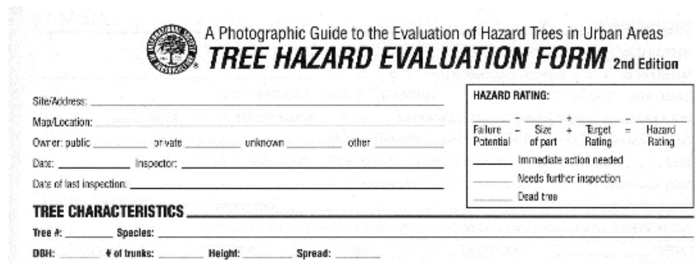
Background: The International Society of Arboriculture (ISA) Basic Tree Risk Assessment Method was developed in conjunction with the ISA's Tree Risk Assessment Best Management Practice (BMP) Manual. The assessment form and the BMP manual, which represent the work of E. Thomas Smiley, Nelda Matheny, and Sharon Lilly, draw on insights gained from risk analysis theory. The ISA Tree Risk Assessment Form is intended for trees receiving a basic (level 2) risk assessment is not designed to collect information from the advanced (level 3) or limited visual (level 1) tree risk assessments. The form serves as a replacement for the older ISA Tree Hazard Evaluation Form and is often called the "TRAQ form," given its use as part of ISA's Tree Risk Assessment Qualification.

Sidebar 3.

Levels of Risk Assessment (as defined by the ANSI A300 Standards for Tree Care Operations)

- Level 1—Limited Visual: A limited visual risk assessment is sometimes referred to as a *walk by* or a *drive by* assessment. It is most common in urban forest scenarios where trees are abundant and resources for inspection are relatively scarce. A limited visual is not necessarily a complete 360-degree inspection and may be employed in situations where access is limited. Professionals conducting a limited visual assessment identify high-risk trees that are mitigation priorities.
- Level 2—Basic Visual: A basic visual assessment is a 360-degree inspection from the ground that is more thorough and typically includes height and diameter measurements. An assessor may use binoculars for crown inspections, a mallet for sounding hollows, a probe for inspecting cavities, and other common tools to conduct the inspection.
- Level 3—Advance Assessment: An advanced assessment can be an aerial assessment or an assessment that includes quantitative decay detection, health evaluation, wind load assessment, and static load assessment. Given the more advanced tools and methodologies employed, this service is often offered at a premium to the customer and typically reserved for heritage or high-value trees.

Advantages: A major innovation in risk assessment methodology is this form's listing of multiple targets for a single tree. The earlier ISA Tree Hazard Evaluation Form and the USDA Forest Service Community Tree Form allow the user to identify multiple defects, but they are both lumped together with respect to one target rating. Even though the urban environment can make risk assessment a complex endeavor (Figure 3), this form provides a flexible, yet standardized means of coping with multi-faceted assessment scenarios.


A Photographic Guide to the Evaluation of Hazard Trees in Urban Areas
TREE HAZARD EVALUATION FORM 2nd Edition

Site/Address: ______
Map/Location: ______
Owner: public ______ private ______ unknown ______ other ______
Date: ______ Inspector: ______
Date of last inspection: ______

HAZARD RATING:
______ + ______ + ______ = ______
Failure Potential + Size of part + Target Rating = Hazard Rating
______ Immediate action needed
______ Needs further inspection
______ Dead tree

TREE CHARACTERISTICS
Tree #: ______ Species: ______
DBH: ______ # of trunks: ______ Height: ______ Spread: ______

Figure 3. The final numeric hazard rating plays a prominent role in the older ISA Tree Hazard Evaluation Form.
Credits: Gitta Hasing, UF/IFAS

Like the older ISA Tree Hazard Evaluation Form, this form is two pages and is designed to guide the user through a thorough, basic visual assessment. It also includes gridded spaces for the user to map targets and draw major trunk defects.

Finally, this new assessment method discards numerical ratings that were useful for urban foresters assessing tree populations but were often misunderstood and misused by tree care practitioners. Instead, the overall risk ratings are derived from a sequence of decision matrices, which factor in target, likelihood of failure, and consequence of failure with regard to target.

Disadvantages: The level of detail required to complete this form significantly increases the time required to complete an assessment. While replacing numerical ratings makes sense methodologically, reducing the final, cumulative rating to four possible outcomes (low, moderate, high, and extreme) could potentially limit one's ability to prioritize tree mitigation efforts when dealing with tree populations. As such, this form's use may be limited in assessing sizeable tree populations that urban forestry managers administer, unless individual trees of local or historical significance are being evaluated.

Time Required to Complete: Approximately 20–25 minutes for a basic, 360-degree visual assessment, using a diameter tape and a digital hypsometer. Time required should decrease as the user gains greater familiarity with the process and form.

Use in Arboriculture and Urban Forestry: The ISA Tree Hazard Evaluation Form is best suited for a commercial arborist or urban forester working with individual trees or smaller tree populations.

Form: To view the form, see the appendix or visit http://www.isa-arbor.com/education/resources/BasicTreeRiskAssessmentForm_FirstEdition.pdf.

To view more detailed, step-by-step instructions for this form, see the ISA *Tree Risk Assessment Manual* or visit http://1-www2.champaign.isa-arbor.com/education/resources/ISABasicTreeRiskAssessmentForm_Instructions.pdf.

Conclusions

All of the methodologies above draw on the same core risk principal, and assess potential targets, the likelihood of failure, and the consequences of partial or whole tree failure. These key similarities serve as an indication that any method could suit arborists and urban foresters in the field. The additional site data collected, coding, or refinements to the final rating derivation process may make a particular method stand out to a certain user group, depending on the group's needs and resources.

The need for collecting risk assessment data efficiently is critical to both private arborists and urban forestry programs. Care must be taken, however, to ensure the speed of data collection does not lead to a loss of accuracy and consistency, which are integral for an effective risk rating. It must also be kept in mind that these three risk assessment methods do not substitute for a more thorough level three assessment or an advanced assessment, where and when warranted. It is the arborist's or urban forester's responsibility to ensure that no unwarranted mitigation, including tree removal, occurs because of his or her assessments. All trees are unique, and no set of procedures can be standardized to successfully meet all clients' specific needs and their tree resources. The client, whether it's a private landowner or municipal government, relies on the arborist's or urban forester's training and experience to use the most appropriate risk assessment tools.

Finally, as technology advances and becomes less expensive, all or key parts of the forms can be programed with off-the-shelf data collection programs. This allows the user to use mobile devices, such as an iPad or Android/Windows-based tablet, to decrease data entry errors, to minimize the time required for data entry, and to increase organization and updating when the user returns to his or her office. Regardless of data collected through paper or electronic means, accurately assessed and collected tree risk information is critical to minimize injury and property damage when trees fail.

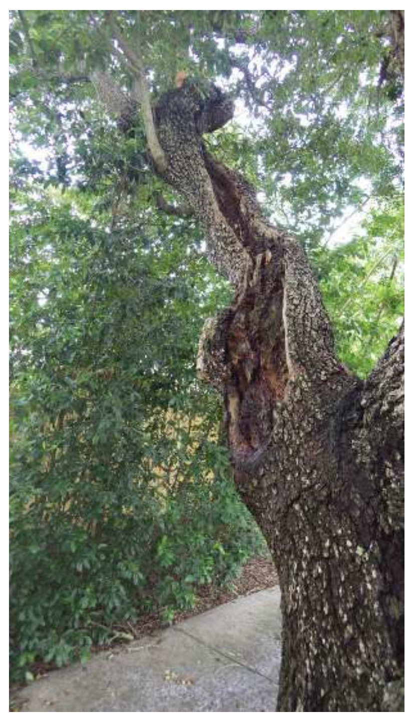


Figure 4. All three forms include qualitative ratings for size of affected part and probability of failure (given defect type).
Credits: Gitta Hasing, UF/IFAS

References

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Smiley, E.T., N. Matheny, and S. Lilly. 2011. *Best Management Practices: Tree Risk Assessment*. International Society of Arboriculture, Champaign, IL.

TCIA. 2011. A300 (Part 9)-2011 *Tree Risk Assessment a. Tree Structure Assessment*. Tree Care Industry Association, Inc., Londonderry, NH.

Table 1. Comparison of inspection meta-data (inspector, client, date, etc.), location, and site information collected from the ISA Tree Hazard Evaluation, the USDA Forest Service Community Tree Risk Evaluation, and the ISA Tree Risk Assessment BMP forms.

	ISA Tree Hazard Evaluation Form	USDA Forest Service Community Tree Risk Form	ISA Tree Risk Assessment BMP Form
Inspection Data			
• Client Information	X	X	X
• Inspector/Assessor	X	X	X
• Date/Time	X	X	X
• Address/Location	X	X	X
• Last Inspection Date	X		
• Time Frame[z]			X
• Assessment Tools Used			X
Site Condition/ History			
• Site Type/Zoning	X		
• Past Construction Activity	X		X
• Root Conflicts/Restrictions	X		X
• Soil Conditions/ Drainage	X		X
• Wind Conditions/Exposure	X		X
• Sign obstruction	X	X	

[z] Time frame in which assessments of likelihood of failure are made (e.g., the tree has an imminent likelihood of failure in the next five years).

Table 2. Comparison of tree health and defect data collected from the ISA Tree Hazard Evaluation, the USDA Forest Service Community Tree Risk Evaluation, and the ISA Tree Risk Assessment BMP forms.

	ISA Tree Hazard Evaluation Form	USDA Forest Service Community Tree Risk Form	ISA Tree Risk Assessment BMP Form
Tree Health			
• Vigor Rating	X		X
• Foliar Condition	X		X
• Woundwood Development	X		X
• Pest/Disease	X		X
• Species Failure Profile[z]		X[y]	X
Tree Structure			
• Height	X		X
• DBH	X	X	X
• Root/Root Crown Defect List	X	X	X
• Trunk Defect List	X	X	X
• Scaffold Branches/ Limbs Defect List	X	X	X
• Crown/Branches Defect List	X	X	X

[z] Observed weaknesses in a given species, variety, or cultivar, given typical and severe weather events
[y] Can be incorporated in the optional Other Risk Factors column (1–2 pts)

Table 3. Comparison of initial ratings, which include Target Assessment, Likelihood of Failure, and Consequences of Failure, with Final Ratings in the ISA Tree Hazard Evaluation, USDA Forest Service Community Tree Risk Evaluation, and ISA Tree Risk Assessment BMP forms.

	ISA Tree Hazard Evaluation Form	**USDA Forest Service Community Tree Risk Form**	**ISA Tree Risk Assessment BMP Form**
Target Assessment			
• Form Section Title	*Target Rating*	*Probability of Target Impact*	*Likelihood of Impacting Target*
• Rating Type	Numeric (1–4 Points)	Numeric (1–3 Points)	Descriptive (4 Categories)
• Levels	(1) Occasional Use (2) Intermittent Use (3) Frequent Use (4) Constant Use	(1) Occasional Use (2) Intermediate Use (3) Frequent Use	Very Low Low Medium High
Likelihood of Failure			
• Form Section Title	*Failure Potential*	*Probability of Failure*	*Likelihood of Failure*
• Rating Type	Numeric (1–4 Points)	Numeric (1–4 Points)	Descriptive (4 Categories)
• Levels	(1) Low (2) Medium (3) High (4) Severe	(1) Low (2) Moderate (3) High (4) Extremely High	Improbable; Possible; Probable; Imminent
Consequences of Failure			
• Form Section Title	*Size of Part*	*Size of Defective Part(s)*	*Consequences of Failure*
• Rating Type	Numeric (1–4 Points)	Numeric (1–3 Points)	Descriptive (4 Categories)
• Levels (in inches)	(1) less than 6 (2) 6–18 (3) 18–30 (4) greater than 30	(1) less than 4 (2) 4–20 (3) greater than 20	Negligible Minor Significant Severe
Final Rating			
• Form Section	*Hazard Rating*	*Risk Rating*	*Risk Rating*
• Rating Type	Numeric (3–12 Points)	Numeric (3–10 points + 2 optional points)	Descriptive (4 categories)
• Derived from	Sum of "Failure Potential Rating," "Size of Part," and "Target Rating"	Sum of "Probability of Failure," Size of Defective Part," and "Probability of Target"	Series of guided decision matrices
• Levels	Number from 3–12	Number from 3–10 (12)	Low; Moderate; High; Extreme