



Tree Risk Assessment: A Foundation

By E. Thomas Smiley, Nelda Matheny, and Sharon Lilly

Tree failure that causes harm is a relatively rare occurrence, so the risk associated with living among trees is quite low. Nevertheless, it is impossible to maintain trees free of risk; some level of risk must be accepted to experience the benefits that trees provide. The National Tree Safety Group, which is a partnership of organizations in the United Kingdom, has drafted a guidance document that identifies five key principles for tree risk management. This provides a foundation for balancing tree risk and the benefits the trees provide.

Learning Objectives

- Describe how tree risk assessment fits into the larger context of tree risk management.
- Define basic terms used in tree risk assessment and explain the difference between *risk* and *hazard*.
- Discuss the various types of targets and explain how target mobility and occupancy rates affect their likelihood of being impacted by tree failure.
- Describe how targets play a role in both likelihood of impact and consequences of impact in tree risk assessment.
- Discuss the characteristics of a site that should be considered in tree risk assessment and the ways they affect the assessment.

CEUs for this article apply to Certified Arborist, Utility Specialist, Municipal Specialist, Tree Worker/Climber, Aerial Lift Specialist, and the BCMA management category.



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Tree risk is the likelihood of a tree failure occurring and affecting a target, and the severity of the associated consequences—personal injury, property damage, or disruption of activities.

To balance tree risk and tree benefits, it will help to know:

- Trees provide a wide variety of benefits to society.
- Trees are living organisms and naturally lose branches or fall.
- The risk to human safety is extremely low.
- Tree owners have a legal duty of care.

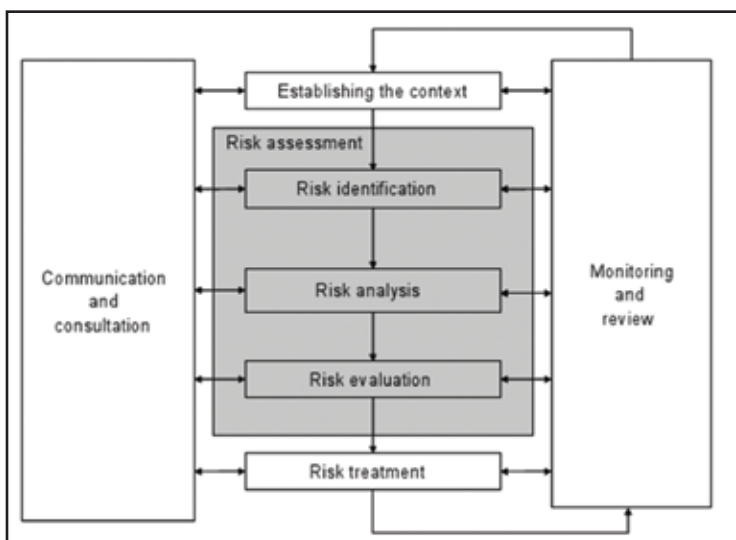
- Tree owners should take a balanced and proportionate approach to tree safety management.

It is helpful to look at tree risk assessment within the larger context of tree risk management. Tree risk management is the application of policies, procedures, and practices used to identify, evaluate, mitigate, monitor, and communicate tree risk. Various people share responsibilities for tree risk management—including the tree owner or manager, the tree risk assessor, and the arborist providing service work.

Risk Assessment Basics

The benefits trees provide to those living and working in the urban environment increase as the size of the trees increase. As a tree gets older and larger, however, it is also more likely to shed branches or develop decay or other conditions that predisposes the tree to failure. In assessing and managing trees, we should strive to strike a balance between the risk that a tree poses and the benefits that individuals and communities derive from trees.

Before a tree risk assessment takes place, it is important to determine if the possible degree of risk justifies the time and expense to perform tree inspection and assessment. Many trees are located where the consequences of failure are minor or negligible. In urban and developed



Contribution of risk assessment to the risk management process.

areas where people, property, and activities could be injured, damaged, or disrupted, the consequences of tree conflict or failure may be significant or severe. Decisions on whether a tree inspection is required or what level of assessment is appropriate should be made with consideration for what is reasonable and proportionate to the specific conditions and situations. These are tree risk management issues.

As previously stated, it is impossible to maintain trees free of risk. Some level of risk must be accepted to experience the benefits that trees provide. Fortunately, tree failure is an infrequent occurrence. Serious damage, injury, or death from tree failure is rare. Tree failures during normal weather conditions are sometimes predictable and preventable. However, any tree, whether it has visible weaknesses or not, will fail if the forces applied exceed the strength of the tree or its parts. For example, hurricane-force winds, heavy snow, or freezing rain can break solid, defect-free trees.

Tree risk assessors often must perform risk assessments with limited information about the structural condition of the tree and the environment that affects it. There is typically a considerable level of uncertainty associated with tree risk assessment due to our limited ability to predict natural processes (e.g., rate of progression of decay, response growth), weather events, traffic and occupancy rates, and potential consequences of tree failure. Tree risk assessors form opinions about what is likely to occur in the future based upon their experience and what is observed. These assessments are then provided to a tree owner or manager to make decisions about tree management. Sources of uncertainty should be understood and communicated to the risk manager/tree owner.

Definitions

There are a number of key definitions required for the understanding of tree risk assessment concepts. A partial list of these definitions is as follows:

Risk is the combination of the likelihood of an event and severity of the potential consequences.

In the context of trees, risk is the likelihood of a conflict or tree failure occurring and affecting a target, and the severity of the associated consequences—personal injury, property damage, or disruption of activities.

Tree risk assessment is the systematic process to identify, analyze, and evaluate tree risk.

Tree risk evaluation is the process of comparing the assessed risk against given risk criteria to determine the significance of the risk.

Risk is evaluated by categorizing or quantifying both the likelihood (probability) of occurrence and the severity of consequences. The magnitude of risk can be categorized or calculated and compared to the client's tolerances to determine if the risk is acceptable.

Targets (risk targets) are people, property, or activities that could be injured, damaged, or disrupted by a tree.

Failure (tree failure) is the breakage of stem, branches, roots, or loss of mechanical support in the root system.

Risk versus Hazard

Arborists and foresters have used the term *hazard assessment* to describe the process of inspecting and evaluating the structural condition of a tree and the harm that could occur if said tree fails. The more accurate and appropriate term *risk assessment* is now standard.

A tree is considered *hazardous* when it has been assessed and found to be likely to fail and cause an unacceptable degree of injury, damage, or disruption—that is, the tree poses a high or extreme risk.

Risk is the combination of the likelihood of an event and the severity of the potential consequences.

A *hazard* is a likely source of harm. In relation to trees, a *hazard* is the tree part or parts identified as a likely source of harm.

Harm is personal injury or death, property damage, and/or disruption of activities.

Tree risk management is the application of policies, procedures, and practices used to identify, evaluate, mitigate, monitor, and communicate tree risk.

Event is the occurrence of a particular set of circumstances. In tree risk assessment, an event is a tree affecting a target.

Likelihood is the chance of an event occurring. In the context of tree failures, likelihood refers to: 1) the chance of a tree failure occurring, 2) the chance of impact upon a specific target, and 3) the combination of the likelihood of a tree failing and the likelihood of impacting a specific target.

Consequences are the effects or outcome of an event. In tree risk assessment, consequences include personal injury, property damage, or disruption of activities due to the event.

Assessing and Evaluating Risk from Tree Failure

A primary goal of tree risk assessment is to provide information about the level of risk posed by a tree over a specific time period. This is accomplished in qualitative tree risk assessment by first determining the categories for likelihood and consequences of tree failure. These two factors are determined by:

1. Evaluating the structural conditions that may lead to failure; the potential loads on the tree; and the trees' adaptations to weaknesses—to determine the likelihood of failure.
2. Evaluating the likelihood that a tree or branch could strike people or property or disrupt activities.
3. Assessing the targets' values and potential damage—to estimate the consequences of failure.



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The tree risk assessor must assess the likelihood that a tree or tree part will fail, and evaluate the likelihood of the tree striking people or property, or disrupting activities.

With ratings for the likelihood and consequences, the level of risk then can be estimated or categorized.

Likelihood of Tree Impacting a Target

Likelihood of a tree failure impacting a target is the first of two key components of risk. While it is nearly impossible to precisely determine the likelihood of an event, tree risk assessors must evaluate and categorize the likelihood of failure and the likelihood of the tree impacting a target. Guidance for evaluating tree condition and assessing likelihood of failure are presented in other publications.

Target

In tree risk assessment, targets are people, property, or activities that could be injured, damaged, or disrupted by a tree failure. Targets include people, buildings, animals, infrastructure, vehicles, landscape structures, and other property that may be damaged or harmed by a tree failure.

The most important situations to assess are in locations where people are frequently present. The greatest risk for injury from tree failures is in places where many people are unprotected and within the target zone for long periods of time, especially during storms.

Target areas that are often evaluated include streets, parking areas, footpaths, and play areas. Although damage to structures is possible, the bigger concern is the people that use them, even if they are not present at the time of the evaluation. For example, when assessing the risk of a tree failing in a parking area, the assessor must consider possible damage to cars that may be parked nearby,

the frequency and intensity of use of the area, and injury to people who drive the cars and may be within the target zone.

Roadways are a commonly assessed target. Possible consequences of a tree falling across a road include: the tree striking a vehicle and possibly injuring people inside; a moving vehicle running into the tree that has just failed; crashes associated with rapid stopping or swerving to avoid the fallen tree; and disruption of access to points farther along the road. There are also costs and inconvenience factors associated with closing the road during the clean-up and remediation process.

Electric lines and facilities are targets of great importance to electrical utility risk managers and users of electric power. Electric lines that are brought down by a falling tree can be a threat to the people who may make contact with them, and there are costs, inconvenience, and possible losses associated with the disruption of service that will potentially impact many people.

Targets can be categorized by their ability to move or be moved. A static target is one that is fixed or not readily moved. Examples include buildings, utility facilities, or other structures. Movable targets are those that can be relocated, such as sculptures, picnic tables, parked cars, or swing sets. A mobile target is one that is in motion or intermittently moving. Examples include pedestrians, bikes, and vehicles on a sidewalk, footpath, or road.

Known targets are those visible to the arborist and those that the arborist has been told about by the client. It is preferable to evaluate the target zone in consultation with the client, so that targets that are not present at the time of the assessment may be considered.

Target Zone

The target zone is the area in which the tree or branch is likely to strike when it fails. The target zone for a whole-tree failure is a circle around the tree with a radius equal to about 1.0 to 1.5 times the height of the tree. Trees with asymmetric crowns or leans may have irregularly shaped target zones. For a branch failure, the target zone is the area in which the branch could strike.

The target zone for dead trees or trees with dead or brittle branches is larger than those with live, flexible branches, because dead and brittle branches are more likely to shatter upon hitting the ground and may spread debris some distance beyond the tree. The target zone also may be larger when one tree could cause the failure of others that it could fall into. On the other hand, the target zone may be reduced in size by adjacent larger trees, strong lower branches, or other factors that will not allow the tree or branch to fall in a given direction.

It should be noted that trees and branches sometimes fall in unusual ways, striking outside of what would normally be considered the target zone. The direction of tree failure is often more closely related to wind direction than to the location of the defect on the tree. The direction that wind will come from during a storm is unpredictable and should not be confused with the direction of the prevailing wind.



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Target zone. If a tree fails across this path, damages would be minor. But if it fails and strikes a person, which is unlikely, the consequences would be severe. The tree risk assessor must consider both the likelihood of failure and the likelihood of impacting identified targets.

Occupancy Rate

Targets can be categorized by the amount of time that they are within the target zone—their occupancy rate. Not all targets are present in the target zone at all times. For example, a field with large trees may be used as a parking lot (car park) during sporting events, but it might be unoccupied most of the time. Therefore, the tree risk assessor should consult with the client to determine targets and their occupancy rates. The client or tree manager may define whether the risk assessment is to consider low- or high-use times, or both. Continuing the example, if the risk assessor was not told about the high-use times, then the target rating would be much lower than if the high-use times were considered as well.

Occupancy rates can be classified as constant, frequent, occasional, or rare. Static targets are constant. Movable and mobile targets can be in any of the four classifications. Occupancy rate is a primary component in an assessment of the likelihood of impacting a target.



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Consequences of Tree Failure Impacting a Target

When assessing tree risk, the second key component is the consequence of failure. Consequences are a function of the value of the target and the amount of injury, damage, or disruption (harm) that could be caused by the impact of the failure. The amount of damage depends on the part size, fall characteristics, fall distance, and any factors that may protect the target from harm.

Consequences of a tree failure may be considered “minor” for targets of relatively low value or for easily repaired structures, such as outbuildings, fences, and bird baths. At the opposite end of the spectrum, a tree failure that could lead to severe injury or a fatality, or that disrupts a primary power line, poses potentially “severe” consequences.

It is often said that without a target, a tree poses no risk, but that may not mean that a tree failure does not have consequences. Trees have value. If a tree fails, the value and benefits associated with that tree are lost or diminished. Therefore, there are always some consequences associated with failure.

When evaluating consequences, consider the size of the tree or branch that could fail, and how it could impact a target. Generally, a small branch has less potential to cause damage than a large branch. Small branch failures do occur more frequently, and even a small branch could cause personal injury, a power outage, or a traffic accident. Branches less than one inch (2.5 cm) in diameter are not usually considered in most tree risk assessments. The minimum size branch that should be considered by

the tree risk assessor may be specified in the scope of work. In some low-use areas, the minimum branch diameter of concern may be as large as four inches (10 cm) in diameter.

For example, if a four-inch diameter branch falls on a house from a height of 10 feet (3 m) above the roof, the degree of damage would be low, and no injury to people inside would be expected. If the same size branch were to fall from near the top of a large tree with no branches in between to slow it down, more extensive damage could occur. If lower branches of the tree would slow or stop the fall of the falling branch, the anticipated damage would be less.

In estimating how much damage could occur from a tree failure, consider the relative amount of force with which it is likely to strike the target. A falling tree or branch will gain speed as it accelerates toward the ground. So, in general, the higher the distance from which a branch falls, or the greater the distance from the tree to the target, the greater the force that the tree or branch will have at the point of impact. If the distance from a tree trunk to a well-built, multi-story house is short, a tree that fails may simply lean against the house, causing minor damage. On the other hand, if the distance is such that the tree can accelerate significantly before the trunk strikes the house, damage may be much greater. If there are lower branches in the tree that are likely to slow or stop the fall of the trunk, damage may be lessened. In this example, the lower branches serve to protect the target. Large diameter, wide-growing branches that are low

on the trunk may also affect the fall pattern of a tree. If the branches contact the ground well before the trunk, the fall may be slowed or stopped, or the tree may roll.

Trees that stand between the tree being assessed and a target also may serve to increase the target zone of the tree being assessed. If a large tree falls against another tree, the force of the impact may cause one or more sequential failures (the domino effect). This is more likely with wet or saturated soil and species prone to root or soil failures. Progressive, whole-tree failure may also occur if newly exposed trees are not well-adapted to the lack of shelter they had before the adjacent tree failed.

Protection against falling trees or branches may be provided by structures that surround the people in the target zone. Building structures that are substantial provide protection against injury to people inside them. Pedestrians, children on playgrounds, and people in tents have no significant protection from falling tree parts, so they can be seriously injured by small- or medium-sized branches.

Vehicles provide some protection against small-diameter falling branches. However, vehicles struck by a larger branch or trunk account for a substantial number of tree-related fatalities. Trees also can cause accidents if they fall across a motorway in front of moving traffic. Because of this, when evaluating targets, careful consideration must be given to traffic flow, traffic speed, street configuration, and occupancy rates within the target zone near roads and parking lots.



This tree had codominant stems with included bark, which elevated the likelihood of failure. Fortunately, in this case, the consequences of failure were minor.

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Guidance on the intended roles of the tree risk manager, tree risk assessor, and the arborist. Additionally, legal counsel can provide advice with regards to duty of care, professional responsibilities, negligence, title and boundary matters, and other concerns. All recommendations should be made in accordance with industry standards.

Tree Risk Manager

(tree owner, property manager, controlling authority)

- Duty of care responsibility
- Define and communicate tree risk management policies
- Determine the need to inspect the trees in question
- Identify the geographical limits of the tree inspection
- Determine target zone use
- Determine target use and occupancy rates
- Specify the desired level of assessment
- Establish the budget
- Decide the level of acceptable risk
- Establish the inspection frequency
- Determine scope of work
- Prioritize work
- Choose among risk mitigation options

Tree Risk Assessor

(as defined in scope of work)

- Identify tree and site conditions to inspect
- Evaluate and classify the likelihood of a tree failure impacting a risk target
- Estimate the potential consequences of a tree failure
- Record and explain findings to the client
- Determine and recommend advanced assessments, if needed
- Determine tree risk
- Provide options for treatment to mitigate risk
- Estimate residual risks after treatment
- Define inspection frequency
- Develop report
- Provide specifications for selected treatments

Arborist/Tree Worker

(as defined in scope of work)

- Provide requested services:
 - Tree work safety review
 - Pruning
 - Removal
 - Support systems
 - Lightning protection
 - Tree health treatments
 - Transplanting
 - Tree replacement
 - Identify the need for follow-up treatments

Site Factors

Site factors have significant influence on both the likelihood and consequences of tree failure. When performing a tree risk assessment, the site is often first evaluated for targets and consequences of failure. Site factors that can be used to evaluate the likelihood of tree failure impacting the target include the history of previous failures (e.g., including branch, trunk, root, and soil failure), wind exposure (e.g., all other things being equal, a fully exposed lone tree may be more likely to fail than a tree within a stand protected from the wind), and changes that have occurred at the site (e.g., forest clearing, trenching, earth excavation or filling, groundwater lowering or raising, infrastructure repair, or other construction). Recently exposed forest-edge trees may be more susceptible to failure due to increased wind exposure, poor trunk taper, inadequate root systems, and/or changes in soil hydrology.

Site examinations can provide information on root damage and susceptibility to root failure. Soil factors that risk assessors should also consider: the frequency of saturation; compaction; erosion; textural gradients; restrictions to root growth from shallow, impermeable layers; and restrictions by roads, rock, or building foundations. Site topography, including slope and aspect, are also relevant factors. Trees are more susceptible to windthrow during storms when the soil is saturated.

Most tree failures occur during storms when strong wind, rain, snow, or ice loads exceed the capacity of trees to withstand the loading. Wind speeds are strongly affected by topography. In urban areas, wind speeds vary depending on placement in the landscape; trees that are located on the leeward side of taller buildings are exposed to slower wind speed than those along streets through which wind is funneled by surrounding structures. Knowledge of regional and local climate, wind, and precipitation patterns, and observation of specific site conditions, is important in assessing the likelihood of failure.

Tree failures under normal wind speeds are usually associated with serious, uncorrected, or unmitigated structural defects or other conditions, alone or in combination.

When wind speeds exceed a strong gale force, even defect-free trees can fail. When wind speed reaches a hurricane force, failure of defect-free trees can be widespread. Wind speed is variable. Winds can be sustained, but commonly occur in gusts that may exceed the reported wind speed. Microbursts that produce strong lateral winds can fell mature trees.

In some locations where strong winds are rare or infrequent, the wind speed at which failures of structurally sound trees occur may be lower. For example, in some tropical areas where gale force winds are rare, trees

may fail at wind speeds that would not damage most adapted temperate-zone trees. Trees adapt to their locations and to the wind speeds that commonly occur in an area. Most trees also have significant additional strength to resist occasionally higher wind speeds.

When evaluating wind loads during tree risk assessment, normal weather conditions (from one to many storms per year) for a region are assumed. In areas prone to extreme weather conditions, the arborist should consider the likelihood for failure during infrequent but recurring extreme storm events. The timing of abnormally severe storms, freezing rain, and heavy snow is

uncertain. Tree risk assessments are designed to assess trees under normal circumstances and weather.

About the Authors

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1. In deciding whether tree inspections are required, tree risk managers should
 - a. inspect all trees that could have a high likelihood of failure
 - b. consider what investment of resources is reasonable and proportionate for the specific situation
 - c. provide some level of inspection for all trees because no tree is risk-free
 - d. inspect all trees that would result in severe consequences if they were to fail
2. Categorization of the amount of time targets are within the target zone is known as the
 - a. target zone rate
 - b. impact likelihood
 - c. target likelihood
 - d. occupancy rate
3. Any tree, whether it has visible weaknesses or not, will fail if
 - a. exposed to hurricane-force winds
 - b. the forces applied exceed the strength of the tree or its parts
 - c. it has internal decay within the lower trunk
 - d. the roots have been infected with *Armillaria*
4. In comparison to locations where strong winds are common, in locations where strong winds are rare or infrequent
 - a. the most common failure mode is sudden branch drop
 - b. the wind speed at which failures of structurally sound trees occur may be lower
 - c. trees will fail only when defects or conditions severely limit stability
 - d. failure occurs only with extraordinary weather events
5. The systematic process to identify, analyze, and evaluate tree risk is
 - a. tree risk assessment
 - b. tree risk management
 - c. basic tree inspection
 - d. advanced assessment
6. Targets that can be easily relocated is known in tree risk assessment as
 - a. static
 - b. dynamic
 - c. transient
 - d. movable
7. When assessing streets, footpaths, play areas, and other public spaces, it is essential to consider not only the structures but
 - a. targets that are not present at the time of the evaluation, but that are likely to be present at the site
 - b. potential disruptions that would be caused if failure were to occur
 - c. the likelihood of people or other targets being present at the time of failure
 - d. all of the above
8. Because tree risk assessors perform risk assessments with limited information about the structural condition of trees
 - a. the assessment is mostly dependent on the target value
 - b. opinions must be founded on observations, experience, and training
 - c. high levels of uncertainty make the assessments invalid
 - d. the assessment is mostly dependent on the target occupancy rate

9. Lacking factors that would prohibit a failing tree from falling in some direction, the target zone for whole-tree failure is generally a circle with a radius
 - a. 0.5 to 1.0 times the tree's height
 - b. 1.0 to 1.5 times the tree's dripline
 - c. equal to the tree's dripline
 - d. 1.0 to 1.5 times the tree's height
10. Tree risk assessors must take care not to confuse tree health and tree stability because
 - a. an unstable tree is, by definition, an unhealthy tree
 - b. poor structure is generally correlated with poor health
 - c. high-risk trees can appear healthy with a dense, green canopy
 - d. an unhealthy tree is, by definition, an unstable tree
11. A tree risk assessor should consult with the client to determine targets and their occupancy rates because
 - a. the client may inform the assessor of targets that would not be foreseeable
 - b. generally, occupancy rates are always based on their highest values
 - c. the risk assessor should consider only those targets that are visible or those the client has mentioned
 - d. all of the above
12. A tree is considered hazardous when it
 - a. has been assessed and found to be likely to fail and cause an unacceptable degree of injury, damage, or disruption
 - b. could cause harm if it were to fail, regardless of the likelihood of it failing
 - c. has decay present in more than 67 percent of the trunk diameter
 - d. extends over an area where people frequently gather and could be struck
13. In addition a tree's likelihood of failure, and before combining likelihood with consequences of failure, the assessor must also consider the
 - a. value of the most likely target to be struck
 - b. likelihood of impacting a target if failure occurs
 - c. value of each potential target
 - d. all of the above
14. When assessing consequences of failure, the assessor must consider
 - a. how tree or branch failure could strike a target
 - b. the potential distance of fall
 - c. the size of the tree or branch that could fail
 - d. all of the above
15. One way that tree health and structure are linked is that
 - a. trees respond to poor health by producing reaction wood
 - b. healthy trees are strong, structurally stable trees
 - c. woundwood development accelerates following drought stress
 - d. healthy trees are more capable of compensating for weaknesses with adaptive growth
16. Because dead trees or branches could shatter and spread debris upon failure
 - a. they should be rated at a higher level of risk
 - b. their target zone is considered unpredictable
 - c. the target area should generally be considered larger than living trees
 - d. consequences of failure should be considered less severe
17. The force of impact of even a large tree or branch could be minor if
 - a. its fall is broken by other trees or branches
 - b. the failed tree or branch is very close to the target
 - c. the distance of fall is very low
 - d. all of the above
18. The application of policies, procedures, and practices used to identify, evaluate, mitigate, monitor, and communicate tree risk is
 - a. tree risk management
 - b. inspection protocol
 - c. tree risk assessment
 - d. tree evaluation protocol
19. A target that is in motion or intermittently moving is known in tree risk assessment as
 - a. mobile
 - b. dynamic
 - c. static
 - d. movable
20. It is impossible to maintain trees free of risk because
 - a. there aren't enough arborists to assess all risks
 - b. not all practices can be applied in the same way to all trees
 - c. trees are living organisms and naturally lose branches or fall
 - d. tree maintenance budgets are too limited for risk mitigation
21. Wind speeds can be variable depending on
 - a. structures that can create a tunnel effect
 - b. topography
 - c. height above the ground
 - d. all of the above
22. A target that is fixed in place or not readily moved is known in tree risk assessment as
 - a. dynamic
 - b. immobile
 - c. static
 - d. unmovable
23. Which of the following is *not* considered a part of the risk assessment process?
 - a. risk identification
 - b. risk evaluation
 - c. risk treatment
 - d. risk analysis
24. The likelihood of injury to people inside structures that would be struck by a falling tree or branch is a function of the
 - a. occupancy rate of the structure in the target zone
 - b. protection the structure provides and the size and force of the falling tree part
 - c. likelihood of the tree or part to fail and the likelihood of impact
 - d. all of the above
25. The individual primarily responsible for tree risk management decisions is the
 - a. tree risk assessor
 - b. consultant
 - c. tree owner or manager
 - d. arborist

26. All other things being equal, a lone tree may be more prone to failure than a tree in a stand because
 - a. a stand will provide some protection from wind exposure
 - b. a lone tree would have a more restricted root system
 - c. lone trees do not tend to have many branches for damping forces
 - d. all of the above
27. Tree assessors should look at a site for a history of previous failures because
 - a. failure history can help determine target occupancy rates
 - b. failure history will always indicate potential consequences of failure
 - c. conditions may be an indicator of increased likelihood of future failures
 - d. all of the above
28. Risk is defined as
 - a. the likelihood of tree failure multiplied by the likelihood of impacting a specified target
 - b. probability + consequences + target rating, using a 12-point scale
 - c. the product of target value, target occupancy rate, and probability of failure
 - d. the combination of the likelihood of an event and severity of the potential consequences
29. Target characteristics are evaluated as part of
 - a. the likelihood assessment
 - b. the consequences assessment
 - c. neither likelihood nor consequences
 - d. both likelihood and consequences
30. Consequences of failure are a function of the
 - a. likelihood of failure and impact, the occupancy rate, and the target's value
 - b. value of the target multiplied by its occupancy rate
 - c. value of the target and amount of injury, damage or disruption (harm) that could be caused
 - d. likelihood of impacting the target and the value of the target
31. Risk is evaluated by categorizing or quantifying the risk and then
 - a. multiplying the probability of failure times the consequences
 - b. quantifying the consequences of impacting a given target
 - c. comparing the risk to the owner's tolerances to determine the significance of the risk
 - d. comparing that to the target occupancy rate and value
32. In very strong winds
 - a. palms are most likely to fail
 - b. tree failures are associated only with decay
 - c. even strong, defect-free trees can fail
 - d. tree failures are only likely with codominant stems
33. In the context of tree risk assessment, targets are
 - a. people, property, or activities that could be injured, damaged, or disrupted by a tree
 - b. only those objects within the target zone at the time of the tree risk assessment
 - c. any person, structure, or object with a high probability of being impacted by a tree failure
 - d. the product of the occupancy rate and value of any person, structure, or object within 1.5 times the tree's height
34. In balancing tree risk and the benefits of trees, it is important to recognize that
 - a. only trees' monetary values can be considered in the measurement of benefits
 - b. the overall risk to human safety from trees is extremely low
 - c. large, mature trees generally provide fewer benefits than young trees
 - d. risk is not quantifiable but tree benefits are
35. In determining the likelihood of a tree to fail, the assessor must assess
 - a. the potential loads on the tree or tree parts
 - b. the trees' adaptations to weaknesses
 - c. structural conditions that may lead to failure
 - d. all of the above
36. If winds and weather conditions are mild
 - a. tree failures are not possible
 - b. the only failure mode is associated with sudden branch drop
 - c. uprooting is the most likely failure mode with most deciduous species
 - d. failures are usually associated with severe defects/conditions
37. Recently exposed forest-edge trees may be more susceptible to failure due to
 - a. inadequate root systems
 - b. changes in soil hydrology
 - c. increased wind exposure
 - d. all of the above
38. In the context of tree failures, the term likelihood is used to specify the
 - a. the combination of the likelihood of a tree failing and the likelihood of impacting a specific target
 - b. chance of a tree failure occurring
 - c. the chance of impacting a specific target
 - d. all of the above
39. The area in which a failed tree or branch is likely to strike is known as the
 - a. failure zone
 - b. consequence zone
 - c. target zone
 - d. likelihood zone
40. Rainfall and soil moisture conditions are important site factors to assess because
 - a. trees are more susceptible to windthrow during storms when the soil is saturated
 - b. soil saturation helps increase root spread and stability
 - c. dry, sandy soils are associated with increased root decay
 - d. drought conditions typically increase the spread of disease fungi