Storm-Damaged Tree Assessment

Best Management Practices

N.C. Forest Service Urban and Community Forestry

PROTECTION SERIES

BEST MANAGEMENT PRACTICES

Storms cause varying degrees of damage to trees. As a manager or professional, you are charged with assessing storm-damaged trees and taking action to mitigate the damage. This is a best management practices guide for municipal staff and professionals to assess storm-damaged trees and make management decisions.

This BMP is designed to be used in conjunction with the NC Trees & Storms Readiness, Response and Recovery series of documents. Those that use this BMP need to recognize the limitations of their knowledge and seek professional assistance when necessary. When professional assistance is needed or recommended in this document, professionals with International Society of Arboriculture Board Master Certification or Certified Arborist and a Tree Risk Assessment Qualification is a good minimum qualification.

Objectives

- Be prepared to assess a storm-damaged tree safely, efficiently and effectively in an emergency or non-emergency environment.
- Identify visually obvious storm damage that poses a threat to public safety and recommend action to mitigate the risk.
- Identify and assess the non-safety risk storm damage, crown loss and contributing factors, to facilitate making a tree removal versus preservation decision.
- Document tree assessment findings and integrate FEMA debris management guidelines to facilitate funding reimbursement if applicable.

Resources

- International Society of Arboriculture Website
  - ISA Certified Arborist and credentialed lists
  - Arboricultural standards & BMPs
  - www.isa-arbor.com
- N.C. Forest Service Urban & Community Forestry Website
  - Trees & Storms 3Rs BMPs
  - Contract tree work and urban forestry expertise specifications
  - Municipal data collection forms
  - www.ncforestservice.gov

Assessment Process

A storm-damaged tree assessment includes completing three assessments. Each has a specific objective and may be completed in one visit or severalcompleted in one or two site visits.

Assessment 1 – *Situational and Safety Awareness*

Objective: Assess the surrounding site to identify safety and operational issues.

Assessment 2 – *Hazard Remediation*

Objective: Identify tree-damage that poses a safety risk to people and property and make management decisions to eliminate or reduce the risk to an acceptable level as soon as possible.

Assessment 3 – *Crown Loss Assessment*

The tree has lost live crown directly due to the storm damage or pruning to remove hazardous branches.

Objective: Assess the non-safety risk storm damage, crown loss and contributing factors, to facilitate making a tree removal versus preservation decision.

Workload and Assessments

Ideally, all three of these assessments can be completed in one visit to the tree by a qualified tree assessment professional. However, in a severe event, hazard remediation and a large workload may warrant just completing assessments 1 and 2. Assessments 1 and 2 can be completed by a trained staff person and completion of assessment 3 can be completed by a qualified professorial left for a return visit if necessary when workload permits.

Inspection Process and Terminology

Assessing a tree is a series of inspections for each of the tree assessment objectives. Inspect each part of the tree in a consistent order, from the bottom of the tree to the top. Walk around the tree as you inspect each tree part to view the tree part from different viewpoints. If time permits, take photographs. This consistent tree inspection process will help you minimize overlooking a tree problem (See Figure 1 and Table 1.).

Tree Structure Terminology

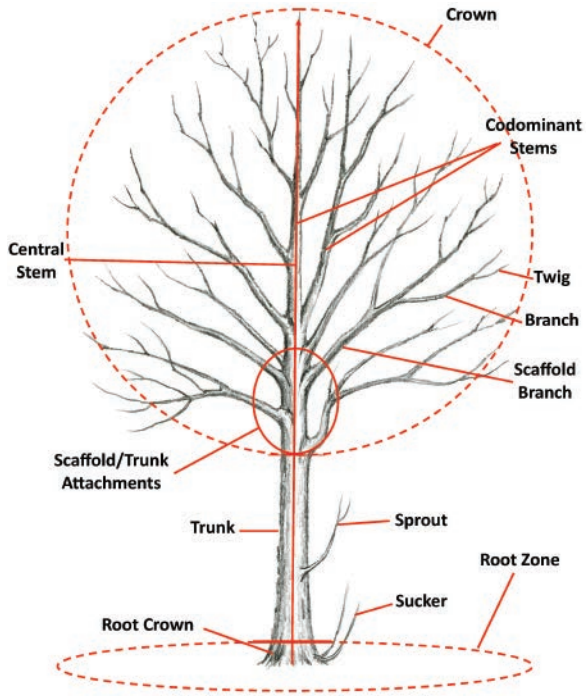


FIGURE 1

Documentation

Documenting an assessment facilitates work planning and memorializes your work for future reference. Where federal disaster assistance may be at play, FEMA will require documentation.

Develop a method to document a storm-damaged tree assessments as you complete the assessment. Paper forms are adequate (see Resources). Shorter data collection forms for just assessments 1 and 2 are appropriate and useful for managing the emergency response phase of an event. Digital data collection is also an option with applications such as ArcGIS Collector. The documentation should lead you through the inspection process as illustrated above. Noting the FEMA tree damage category will facilitate collecting FEMA funding reimbursements (see Table. 2).

Storm-Damaged Tree Assessment

For each of the three assessments, common types of storm-damaged trees are presented, and instructions and guidance for completing the assessments are provided. The suggested FEMA codes are noted with illustrations for documentation purposes if federal disaster assistance may be in play.

Gather your tools and documentation. Complete all 3 assessments during your visit if the workload permits and you are a qualified tree assessment professional. If public safety and workload dictates just addressing tree hazards, complete assessments 1 and 2. Assessment 3 can be scheduled for completion when workload dictates. Know the limitations of your expertise and seek guidance from a qualified profession when necessary.

Table 1. Tree Inspection Process

When assessing a tree, inspect each tree part in a consistent order; ground to top. This minimizes the risk of overlooking a problem.

1. Overview
2. Roots
3. Root Crown
4. Trunk
5. Scaffold Branch/ Trunk/ Central Stem attachments
6. Scaffold branches out to the
7. Smaller branches of the tree
8. Overview again

Table 2. Suggested FEMA Damage Coding

- **F1** – hazardous limbs > 2″ at break and hanging or lodged in tree
- **F2** – remove fallen or uprooted tree
- **F3** – remove tree with 30-degree or greater lean
- **F4** – remove tree with exposed heartwood
- **F5** – remove tree with 50% or more of tree crown damaged or destroyed

**These guidelines are subject to change.*

Storm-damaged Tree Assessment Data for Documentation

- Address
- Location of the Tree
- Tree Species
- Diameter
- Safety & Situational Awareness Assessment
- Hazard Remediation Assessment
- Crown Loss Assessment
- Management Recommendation
- Comments

Assessment 1 – Situational and Safety Awareness

Objectives: Assess the surrounding site to identify safety and operational issues.

Assess the site surrounding the damaged tree and situation. Avoid a common oversight of just focusing on the reported damage.

- Look at the site from various vantage points to identify safety and operational issues.
  – Electric lines, adjacent tree damage, equipment access
- View the subject tree from various vantage points.
  – Damage, safety risks to people and property
  – Worker safety
  – Equipment needs and access
- Document findings to share with event planning staff and work crews.

Situational and Safety Awareness – *Survey adjacent trees and surroundings for safety issues and conditions that may impact completing the tree work.*

Assessment 2 – Hazard Remediation

Objectives: Identify tree damage that poses a safety risk to people and property and make management decisions to eliminate or reduce the risk to an acceptable level as soon as possible.

Complete the assessment by completing all the steps below. The result will be a management decision to prune a hazardous tree part(s) from the tree or remove the tree to eliminate the hazard. If the tree will not be removed, assessment 3 can be completed now or at a future schedule assessment visit.

Step 1. Assess the Root System for Signs of Root Zone Failure

High winds or snow and ice loading may have caused root damage compromising root holding capacity and increasing the risk of windfall. A leaning tree or root plate lifting are signs of root damage.

- Is a leaning tree in the process of windthrow? Not all leaning trees are a safety risk.

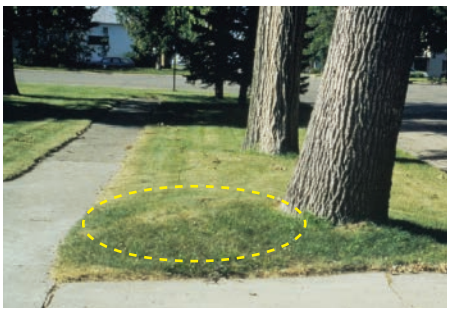
Leaning tree at approximately 30° angle or more should be inspected closely.

Self-correcting leaning tree. *The top of the tree has grown skyward indicating this tree has adapted to the lean. In the absence of soil cracking or lifting in the root zone, the failure risk of the tree is low. If the lean is not self correcting, closely inspect the root zone closely.*

Inspect the root zone.

- Mounding of soil around the base of the tree on the opposite side of lean.
  – Mound feels soft when stepped and jumped on.
  – Mound moves when the wind blows.
- Cracks in the soil on the opposite side of the lean, especially when combined with mounding.
- Exposed roots associated with the lean.

Photo credit: Peter Bedker, Bugwood.org



Soil mound on windward side of tree. Check the crown and determine if it is self-correcting. Inspect the mound. Soil cracking, softness and/or movement of the mound. Remove the tree. FEMA code F4.

Photo credit: John Pronos, USDA Forest Service, Bugwood.org

Root zone lifting and soil cracking. Remove tree. FEMA code F4.

Step 2. Assess the Trunk

High wind loads causes bending and twisting of the trunk. This can cause cracks and buckling of the trunk. Probe any cracks to see how deep they run into the trunk. Is there any decay or a cavity associated with the crack? A structurally compromised trunk could lead to a whole tree failure with little or no wind, rain or snow/ice loading in the future.

- Horizontal cracks or buckling cracks
- Vertical crack

Cracks. *Trees with cracks into the heartwood or associated with decay and/or a cavity should be removed. Have an ISA Certified Arborist inspect the tree. Potential FEMA code F4.*

Lightning damage. *Frayed bark associated with crack. Bark debris on the ground. Crack can run up to the top of the tree. If there is cracking into the heartwood consider removal. Have an ISA Certified Arborist inspect the tree. Potential FEMA code F4.*

Step 3. Assess the Trunk/Scaffold Branch Attachments

Inspect the unions between the trunk and main scaffold branches for damage. Structurally compromised trunk/scaffolds could lead to scaffold branch failure with little or no wind, rain or snow/ice loading in the future.

Codominant stem loss exposing heartwood. Trunk is structurally compromised. *Remove tree. FEMA code F4.*

Scaffold branch loss exposing heartwood. Damage has occurred at the unions of other branches structurally compromising the unions. *Remove tree. FEMA code F4.*

Codominant stems split into the trunk. Trunk is structurally compromised. *Remove tree. FEMA code F4.*

Codominant stems split into the trunk. Trunk and branch unions are structurally compromised. *Remove tree. FEMA code F4.*

Step 4. Assess the Scaffold Branches & Branches

Inspect each scaffold branch for breaks and cracks from the trunk to the termination of scaffold, beginning with the lowest and moving up the trunk to the top of the tree.

Scaffold branch split. *Remove the branch. FEMA code F1.*

Scaffold branch rip out exposing branch heartwood. *Remove the branch. FEMA code F1.*

Broken hanging branches (hangers). *Remove the hangers. FEMA code F1.*

If the tree will not be removed, assessment 3 can be completed now or during a future assessment visit.

Assessment 3 – Crown Loss

Objectives: Assess the non-safety risk storm damage, crown loss, and contributing factors, to facilitate making a tree removal versus preservation decision.

An ISA Certified Arborist or higher credentialed professional will need to complete this assessment. This assessment focuses on trees that have lost around 50% or more of their live crown directly due to storm damage, and/or hazard remediation pruning that was completed during the response phase.

Crown loss removes energy producing leaves and causes wounding which requires energy to close the wounds. The greater the crown loss, the greater the energy that will be required for a tree to recover. Significantly storm-damaged trees are also stressed trees, they attract disease and insect pests and will require more maintenance. Storm-damaged trees are also more susceptible to future storm damage.

A blanket recommendation is to remove a tree that has lost 50% or more of its live crown (FEMA code F5, 50% or more of tree crown destroyed). Pruning standards dictate no more than 25% of a tree's live crown should be removed in a year to maintain the tree energy production and use balance. There are other factors that can be considered in making decision to preserve or remove a tree that has suffered crown loss. These include tree health, age and size, species and distribution of the crown loss. Perform the assessments as detailed in steps 1 through 5. In step 6, you will make your management decision.

Step 1. Assess and Assign the Tree Health Class

A tree that was healthy prior to the storm has stored energy reserves (high energy sugars) available to replace crown loss and close wounds. Conversely, a tree in poor health is not producing enough energy to maintain health and fight disease. The loss of live crown will most likely accelerate the tree's decline. Assign the Tree Health Class.

Tree Health. *This mature oak is in poor health and is in a poor site. If it suffered any significant storm damage canopy loss. It would not be a good candidate for preservation.*

Assign the Tree Health Class

Inspect the tree and assign one of the three health classes.

- **Good** – exceptional or typical for the species; shoot (twig) growth, foliar color and density, woundwood development and absence of significant branch death or damaging pests
- **Fair** – minor deficiencies in one or several categories such as below normal shoot (twig) growth, foliar color and density, woundwood development or presence of dieback or damaging pests
- **Poor** – major deficiency in one or more categories such as shoot (twig) growth, foliar color and density, woundwood development or presence of major dieback or damaging pests

Tree age. *A younger and smaller a tree is, the higher the proportion of energy producing leaf area relative to its energy using live wood mass. As a result, more energy is available to overcome crown loss and close wounds.*

Assign the Tree Species Class

- **Good** – good decay resistance, good site
- **Fair** – Moderate resistance, good site
- **Poor** – Slightly/Non-Resistant, poor environmental conditions for species, invasive species

Step 2. Assess and Assign the Tree Age & Size Class

Young and semi-mature trees are producing more energy than they are using and thus they have stored energy reserves to overcome crown loss and close wounds. They have a higher ratio of energy producing leaf area to energy consuming live wood mass.

The larger the tree the more energy is required to maintain growth, therefore less energy will be available to overcome crown loss and close wounds. The ratio of energy producing leaf area to energy consuming live wood mass approaches 50/50 with maturity. Assign the tree age and size class.

Assign the Tree Age and Size Class

Based on the species of tree, assign the tree to one of three age classes.

- **Young or Semi-mature** – tree is growing vigorously and has not reached its size potential
- **Mature** – tree is growing and has reached its size potential
- **Over Mature** – tree growth is declining and has reached its size potential

Step 3. Assign and Assess the Tree Species Class

Some tree species compartmentalize wounds and decay better than others (see Table 3). Some species of tree respond better to crown loss than others. The tree may be in a site where environmental conditions do not favor the tree species, or the physical space is limited relative to the size potential of the tree species (see Tree Location/Site). Some tree species are less desirable such as an invasive species. Assign the tree species class.

Table 3. Tree Decay Resistance

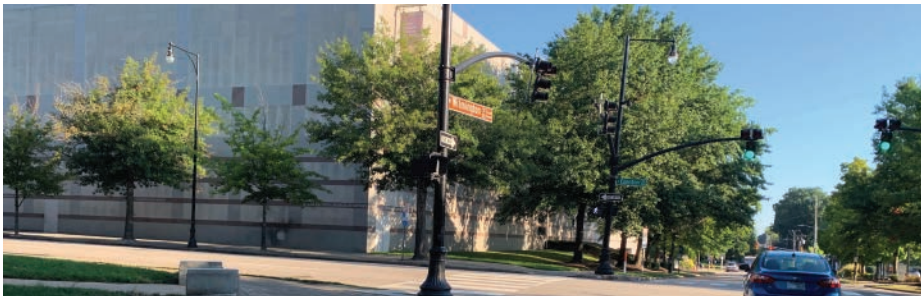
Resistant/Very Resistant	Moderately Resistant	Slightly/ Non-Resistant	
Baldcypress *(old growth)*	Baldcypress *(new growth)*	Alder sp.	Poplar sp.
Catalpa	Douglas-fir	Ash sp.	Spruce sp.
Cedar sp.	Honeylocust	Basswood	Sweetgum
Cherry, black	Larch	Beech sp.	Sycamore
Chestnut	Oak, scarlet	Birch sp.	Willow
Juniper sp.	Oak, shumard	Black tupelo	Yellow-poplar
Locust, Black	Oak, southern red	Cherry, yoshino	
Mulberry, red	Oak, swamp white	Cottonwood	
Oak, bur	Oak, water	Elm sp.	
Oak, chestnut	Pine, eastern white	Hackberry sp	
Oak, post	Pine, longleaf	Hickory sp.	
Oak, white	Pine, slash	Holly sp.	
Osage-orange	Tamarack	Magnolia sp.	
Sassafrass	Zelcova	Maple sp.	
Walnut, black		Oak, willow	
		Pine sp.	

Zabel, Robert. Natural Decay Resistance, 2020

Scheffer, T.C.. Natural Durability of Wood: A Worldwide Checklist of Species, 1998

Tree Location/Site

Right tree, right place. Some trees shouldn't have been planted where they are located. A tree located in a space that is too small for its size or too close to structures or facilities may already be or will become a problem in the future. The health of a tree located in a site with environmental conditions that do not favor the species of tree will be stressed, affecting survivability. If this is the case with a significantly storm-damaged tree, it may be best to remove the tree.



Tree Location – *These are all pin oaks on both sides of the building, and they were planted at the same time. The trees on the left are in tree pits and doing poorly. On the right, they are in a lawn area and healthy. Add storm damage to the trees in the tree pits, and preservation would not be a wise decision.*

Step 4. Assess and Assign the Crown Loss Class

The distribution and severity of the crown loss can impact the probability of recovery. The higher the percentage of crown loss the lower the survival probability. The following are three crown loss classes in order of recovery probability, better to lower. Assign the tree to one of three crown loss classes using the photographs and guidance below.

Assign the Crown Loss Class

- Broken Terminals/Even Distribution
- Large Scaffold Branch Loss/Even Distribution
- ~>= 75% Crown Loss or 50% Crown Loss on One-side of Tree

Broken Terminals/Even Distribution

- Terminals of scaffolds are lost or broken, however interior lateral branches and leaf area to support energy production of a scaffold remains.
- This type of damage allows for reduction cuts to lateral branches and heading cuts for restoration pruning on relatively fewer branches if necessary.

Large Scaffold Branch Loss/Even Distribution

This type of damage allows for the option of branch removal cuts or heading cuts for restoration pruning of the damaged scaffold branches.

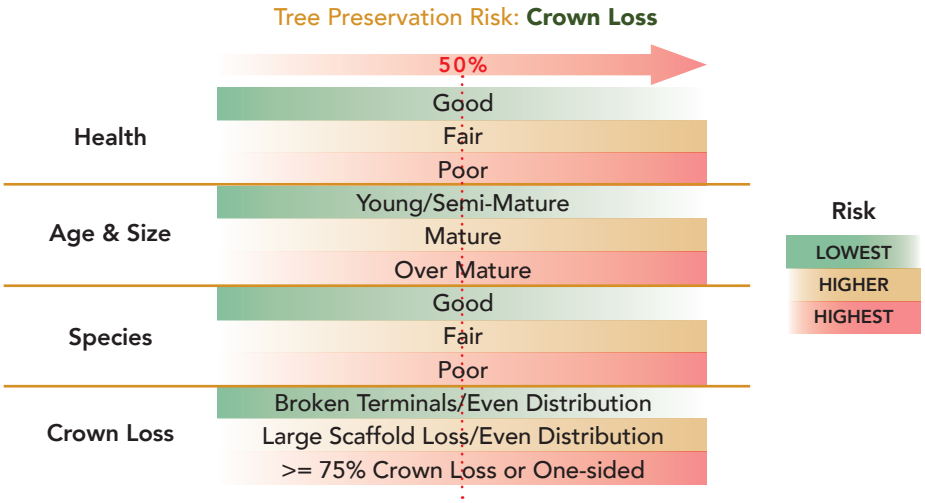
- Removal cuts will leave large wounds that will never close before decay sets in and will have to be monitored.
- Consider a heading cut for restoration pruning. This will delay decay entering the trunk and potential sprouting will add energy production potential.
- Heading cuts will require annual pruning visits to restore the branch.

~>= 75% Crown Loss or 50% Crown Loss on One-side of Tree

- ~75% or more crown loss will require annual restoration pruning to restore the crown and plant health care treatments.
- If crown loss has left a tree "one-sided" it may be more susceptible to windfall and restoration pruning will be required to restore the crown on the loss side of the tree.
- A tree in this category should rate good in the other assessment factors to consider preservation and will come with very high restoration costs.

Step 5. Assign a Preservation Risk Assessment

Assign the results of your health, age & size, species, and crown loss assessments in the chart below. The result is a general risk assessment of preserving the subject tree from a biological perspective.



Step 6. Management Decision

The decision to preserve a significantly storm-damaged tree is a decision that comes with risks. The decision to preserve or remove a tree is the tree owner's or manager's decision. What are those risks?

Biological Risks

- The tree will decline in health and/or die.
- The tree will attract insect pests and disease, posing a tree health risk to other trees.

Management Risks

- The tree(s) will become a safety risk.
- Tree(s) will be prone to more storm damage in the future.
- The tree(s) will require regular inspection, pruning and health care treatments.
- A large percentage of damaged trees will pose a tree health risk to the remaining larger population of trees.
- A large number of damaged trees will require significant resources to manage at the expense of the remaining trees.

Financial Risks

- The tree(s) will require significant expenses for regular inspection and health care treatments.
- Funding spent on severely damaged trees will not be available to spend on the remaining less damaged trees and tree planting.
- A large number of damaged trees will require significant financial resources to manage.

Preserve or Remove?

If the owner or manager has sufficient financial resources and is committed to providing the required health care treatments, the risks are low for an individual tree but will increase as the number of trees increases.

The biological, management and financial risks are high if the owner or manager has a significant population of trees, limited resources and capacity to provide required health care treatments.

Culling and replacing severely storm-damaged trees and pruning damaged trees are sound and sustainable tree management and urban forest health management practices. The decision to preserve a significantly damaged tree must be made within the context of the owner's/manager's capacity to allocate the resources and funding required to maintain a single tree or large population of damaged trees and accept the biological, management and financial risks of that decision.

Management Options and Recommendations

- Tree removal and replacement
- Preservation
  - *Annual inspection*
  - *Pruning*
  - *Plant health care treatments*

Other Considerations

- **Historic/Special Tree**
  Individual trees may represent a special significance to the owner or be a unique specimen of the tree species. This status may warrant accepting more risk and preserving the tree.
- **"Difficult" Sites**
  There may be value in preserving a relatively healthy tree located in sites that have proven historically difficult to successfully establish a tree.

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