

TREE EMERGENCY MANUAL

for

Public Officials



Developed by
Community Forestry Education Project
Cornell Cooperative Extension of Monroe County
Rochester, NY

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Amherst, MA

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INTRODUCTION

This *Emergency Tree Manual* is designed to be a practical short **guide** to managing disastrous tree damage, accompanied by a set of critical documents and standards called the *Tree Emergency Compendium*. Its focus is upon urban forests in the public realm, where questions of safety and cost are critical, and its target audience is public tree managers. To facilitate access to and speed through the document, it has been written in outline form. For more detail or explanation, readers are referred to publications listed under Printed Resources.

The *Manual* and the *Compendium* will be stored at the USDA Forest Service's Northeast Center for Urban and Community Forestry in Amherst MA, at offices of participating state urban and community forestry coordinators, and at the FEMA Region 1 and Region 2 offices in Boston and New York. Both documents will also be posted on the web site of the Northeast Center for Urban and Community Forestry, where they will be updated periodically as needed.

Funding for this *Manual* was provided by the USDA Forest Service, Northeastern Area, with special monies appropriated by Congress after 1998 ice storm in northern New York and New England. Grant definition, award, and administration were carried out through the USDA Northeast Center for Urban and Community Forestry.

This document was produced by personnel of the Community Forestry Education Project, located at Cornell Cooperative Extension of Monroe County, 249 Highland Ave, Rochester NY 14620-3036. Primary responsibility lies with Jerry Bond, Community Forester, whose work was made much easier by the creative and unfailing support of Frances Tucker, Program Assistant.

PROJECT COOPERATORS

- USDA Forest Service, Northeastern Area
- USDA Forest Service, Northeast Center for Urban and Community Forestry
- Cornell University, Cornell Cooperative Extension
- State of Maine, Department of Conservation
- State of New Hampshire, Division of Forests and Lands, Urban Forestry Center
- State of Vermont, Agency of Natural Resources, Division of Forests
- State of New York, Department of Environmental Conservation

EXPLANATIONS OF SYMBOLS USED IN THIS TEXT



Indicates that a document referred to in the text is included in the companion volume, the *Tree Emergency Compendium*.



Indicates that a technical term underlined in the text is defined in the Glossary at the end of this document.

ACKNOWLEDGMENTS

Various hands contributed to this work. It began as a request from the state urban and community forestry coordinators of New York and New England after a disastrous 1998 ice storm to Dave Bloniarz of the USDA Northeast Center for Urban and Community Forestry in Amherst MA. That request was itself an attempt to respond to emergency needs in the field and at FEMA offices. Without the initial concept and ongoing support of the state coordinators, this document would never have appeared.

The basis and benchmark was laid by *Storms over the urban forest* (2nd ed., 1994) by John Andresen and Lisa Burban. That carefully written classic provided the inspiration for this *Manual*, even if our approach differs from theirs in having a more technical orientation, a somewhat different audience (public tree managers), and outline form. Resources have been updated from that book, with special attention paid to web-based materials and computer applications, since much has emerged in those realms since the earlier text was written.

Many readers have taken the time to read drafts of this manual along the way: Dave Bloniarz (Northeast Center for Urban and Community Forestry in Amherst MA), tish carr (urban and community forestry coordinator, Maine), J. B. Cullen (urban and community forestry coordinator, New Hampshire), Jim Donovan (FEMA, Region 1), Peter Frank (urban and community forestry coordinator, New York), Doug Long (DPW Superintendent, Albion NY), Chris J. Luley (Davey Resource Group), Andy Pleninger (former City Forester, Rochester NY), Steve Sinclair (urban and community forestry coordinator, Vermont), Sue Sisinni (USDA Forest Service Research Unit in Syracuse NY), and Warren Spinner (City Arborist, Burlington VT). We are grateful for their time and effort--their contribution has been invaluable.

ILLUSTRATIONS

Unless otherwise indicated, images of trees are taken from the collection of the Community Forestry Education Project. We are grateful to Dr. Alex Shigo (Shigo & Trees, Associates, Durham NH) for permission to include three slides--as indicated in the text--from the excellent sets he has produced. Also, we appreciate receiving permission from the Press-Republican (Plattsburgh NY) and the Democrat and Chronicle (Rochester NY) to reproduce some of the extraordinary photographs taken by their staff.



Source: Mike Dowd, The Press-Republican (Plattsburgh NY)

THE PROBLEM

View down a street in Plattsburgh NY after the ice storm of January 1998. The important questions after such a disaster are what to do, and how do it. Later come questions such as how to recover, and how to minimize damage in the future.

I. EMERGENCY RESPONSE

A. First steps

Basic Point: *Tree emergency response should proceed in an orderly and prepared manner for maximum safety and minimum cost.*

- **Locate and consult Emergency Plans, Debris Removal Plan, and Contact Lists.**
- **Identify live electric wires** in, on, or under trees. Block public access to them, and report them to appropriate utility officials.
 - Only trained arborists should work around live wires, and the work should conform to ANSI standards Z133.1 and A300.
 - OSHA 1910.269 and other safety standards may also be relevant.Resources: Contact offices of ANSI, OSHA, and FEMA.
- **Response Phase I, "Debris clearance"** (FEMA 1999)*
 - **Clear priority traffic lanes and culverts**, beginning with main routes, roads to hospitals, etc.
 - **Push debris simply to the side** in this first phase, without attempting at removal or disposal.
 - **Clear at least one lane** on each arterial, major highway, and secondary road as soon as possible.
 - **Open major walkways** to provide access to critical buildings, as well as other locations you think important under emergency conditions.



Source: Press-Republican (Plattsburgh NY) staff photo

Rig with a long-armed rotary saw clearing a country road during Phase I response after an ice storm in northern New York during early January 1998.

*References in parentheses and smaller font are listed in detail at the end of this document under "Resources"

■ **Response Phase II, "Debris removal and disposal"** (FEMA 1999)

- Use **established routes and methods** for clearing tree debris. Hopefully, these were already set up before the disaster; if not, try adopting routes used for trash pickup or snow removal.
- In larger communities, it is often easiest to set up temporary collection points (malls, playgrounds, etc.) around the community, then clear those after things calm down.
- Debris removal is usually reported as the most difficult tree disaster problem for communities and individuals.
- In general, removal of debris from public property is eligible for FEMA assistance (FEMA 1999) when a Federal Disaster has been declared and when it constitutes an immediate threat to life, public safety, or improved property. See II B, below.

B. Communication

Basic Point: Communication is critical to surviving disasters. If you do not actively manage information during tree emergencies, things have a way of quickly getting out of hand and complicating your work.

■ **Set up clear communication channels among emergency agencies and personnel.**

■ **Establish and publicize a phone number and staff person for public contact.**

■ **Work with the media early and often.**

- Take the time to get accurate information out--it will be well spent.
- Be frank about the extent of damage and the estimated time needed for recovery.
- Useful tree disaster media releases can be downloaded from the web at

<http://www.arboday.org/storm> Here is one example from that site:



Trees & Storms: Others Have Recovered

Trees are often like good friends--not fully appreciated until they are gone or hurt. So, to anyone who anguished when a favorite tree was severely damaged in the recent storm, here's encouragement from The National Arbor Day Foundation and foresters in other cities: Don't despair--given time, the community's trees can come back.

"Trees are amazingly resilient," says John Rosenow, president of The National Arbor Day Foundation. "It may take several years, but many of the trees damaged by a storm will recover as they grow."

Rosenow also notes that damaged trees may need human assistance in the recovery process. "They need our help and our patience, and they need our care. The experience of other communities has shown that with proper care of damaged trees and planting of new trees to replace those toppled or mortally wounded by a storm, once-devastated neighborhoods can come back."

In one Miami neighborhood, more than 1,600 homes were destroyed, and photos taken immediately after the storm show most trees down or severely damaged. But five years after Hurricane Andrew, the powers of recovery from both human and tree loss were amazingly evident in follow-up newspaper stories. The homes had been rebuilt, the surviving trees had regrown and were in full leaf, and life had returned to normal. Eliot Kleinberg, writing for the Palm Beach Post, summed up the recovery in his community in these words: "The birds have returned. The trees have grown back. The walls are back up. Unless you look closely, you might never know."

■ **Deliver important messages to the community:**

- Stay safe (watch for hangers, leaning trees, downed wires, chainsaw injury, etc.).
- Stay calm--it may not be as bad as it seems, and panic only makes it worse.
- Get help from arborists who are insured and, if possible, certified or registered.
- Take your time in deciding tree removals, as long as no hazard is present.

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■ **Indicate how the public can help:**

- Placing debris at the curbside
- Keeping debris away from fire hydrants and valves
- Segregating recyclable and flammable materials

Resource: FEMA 1999

■ **Emphasize the need for careful professional damage assessment.**

- People often tend to become radical about trees after a disaster, wanting either to “kill” or to “save” them all, and they need to hear voices of reason from officials.
- Trees can recover from substantial damage, and what looks awful at first to an amateur may be judged as much less serious by an experienced professional.

C. Records

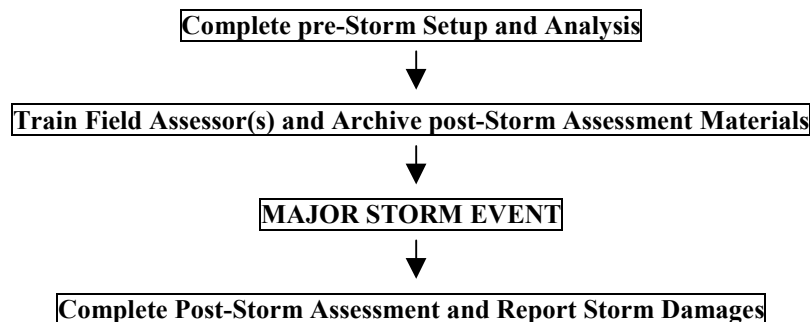
Basic Point: It will be infinitely easier later if you start your paperwork at the beginning, and keep it up as you go along. It is very hard to recreate records after an emergency.

■ **Complete an accurate damage assessment, and estimate associated costs**

- Use any method that will give you quick and reliable results. If your community is large, sample a random selection of streets that makes up at least 2% of street miles.
- Accurate damage assessment is vastly easier if you already have a pre-storm survey in place.
- You will need an accurate damage assessment for local officials, as well as for state and other emergency officials.
- Estimate hours of labor and equipment that will be required for:
 - standing tree removals
 - hazard pruning
 - debris removal
- Multiply hours by costs to obtain job cost, or determine a lump sum for the job if relevant.

Resource: FEMA 1999, Bloniarz et al *Initial*

Overview: Storm Damage Assessment Protocol



Source: Bloniarz et al *Initial*

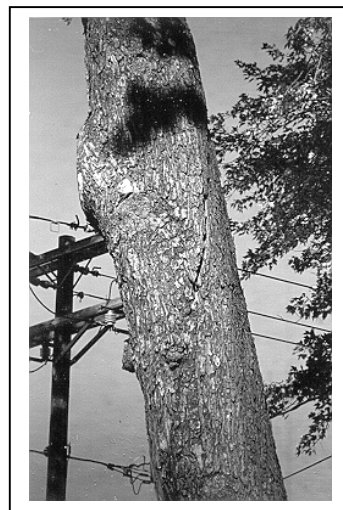
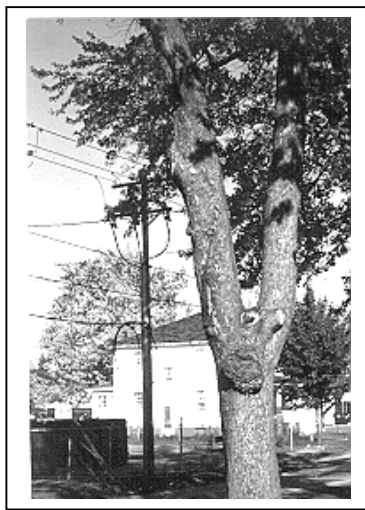
■ **Maintain good records from the beginning**

- Keep track of date, personnel, job, equipment, location, and hours.
- Basic FEMA forms can be found inside the back cover of this manual.
- Others forms available on the FEMA web site (<http://www.fema.gov>), or in the *Applicant Handbook* for public assistance available from your regional FEMA office.

D. Survey of immediate threats

Basic Point: *In addition to clearing trees and limbs on the ground, you need to examine and manage those that are still upright from the standpoint of public safety.*

- **Identify immediate threats**, and make Priority 1 (danger of immediate failure) decisions about removals and pruning.
- **Determine Priority 1 Removal**
 - Systematically search for public trees that are:
 - *uprooted*
 - *split in half*
 - *undermined*



This silver maple leader over a busy city street was split by rotational forces during a windstorm. It took binoculars to spot the crack. Once seen, it makes the tree an obvious Priority 1 Removal.

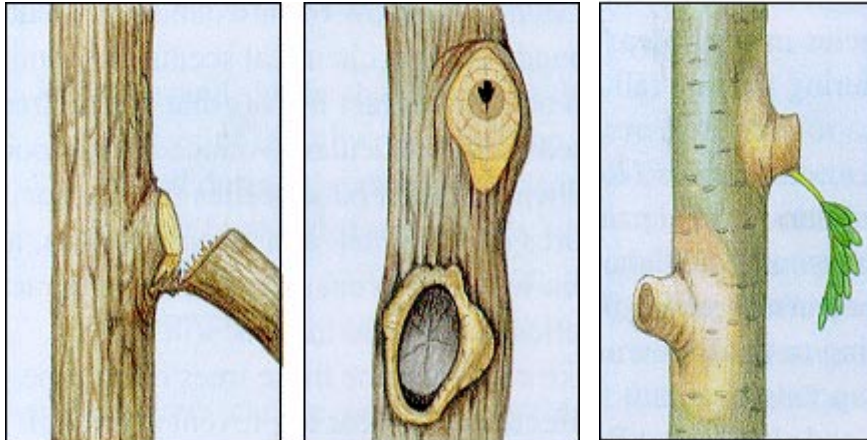
- Select such trees for immediate removal if they have a building, sidewalk, major electric wires, road, or other important structure as a likely target.
- Distribute work orders for the immediate removal of these hazardous trees.
- **Determine Priority 1 Pruning**
 - Systematically conduct high priority pruning street by street, taking out limbs over 2" in diameter that are *hanging, broken, or cracked*.
 - Select these trees for immediate pruning if they have a building, sidewalk, electric wire, road, or other important structure as a likely target.
 - Contracting out the work for these steps is often easy and cost-effective. This frees up staff for other emergency needs.
- **Hire professionals** whose work matches standards (ANSI A300) and whose costs are appropriate to the work. Include the phrase :*"all work to be carried out according to ANSI A300 standards."*
 - Let professionals know you are aware of the standards before they start.
 - Expect a reasonable markup for emergency work, but try to keep it under 20-25%.

■ **Inspect the work** before you sign off on payment.

○ Look for *errors*:

- rips, flush cuts, and stubs (see below)
- cuts through the branch collar or branch ridge
- cuts back to a lateral branch that is too small ($< 1/3$ main branch diameter)
- follow-through cuts into healthy wood

→ G



Source: USDA, 1995, *How to prune trees*

○ Look for *omissions*:

- dead branches $> 2"$, both attached and free
- cracked limbs
- trees with a new lean

○ Follow standard contract procedures when errors and omissions are found

■ **Estimate % crown loss**

○ Be sure not to confuse overall "% crown missing" (which includes earlier loss, pruning, etc.) from "% crown loss" caused by the event that led to your tree emergency

○ **There is a good correlation between the amount of crown a tree loses and its survivability**

- With 50% or less crown loss, a tree has a good chance of surviving
- With 50-75% crown loss, many trees will still survive, though with varying degrees of internal decay and growth suppression
- **Over 75% crown loss means trees generally have a low chance of survival**

○ The further outward the breaks occur, the less decay will occur

○ Weaker trees are less likely to survive than stronger trees

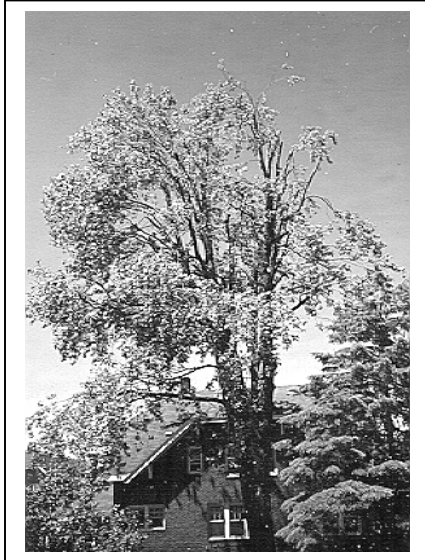
○ In declared Disaster Areas, FEMA usually covers removals of street trees above 50% crown loss where the tree's death is imminent and the dead trunk would become a threat to life, public safety, and/or improved property.

Resource: USDA FS 1998

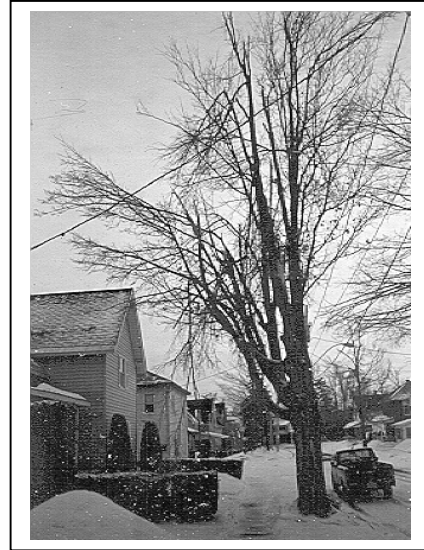
■ **Vigorous and healthy individuals may recover in spite of crown loss $> 75\%$**

- *If there is no hazard situation, and if you can wait from a budget standpoint*, postpone making removal decisions on vigorous healthy trees for a couple of years, to see how recovery progresses.
- For instance, individual green ash, Callery pear, and honey locust trees have been known to recover well from complete or nearly complete canopy loss in urban locations.

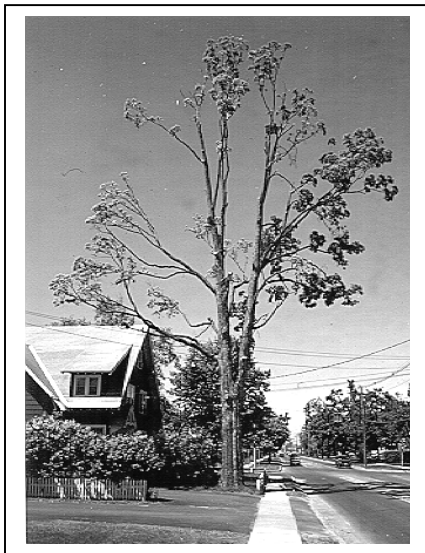
- These images will help you estimate % crown loss in deciduous trees.



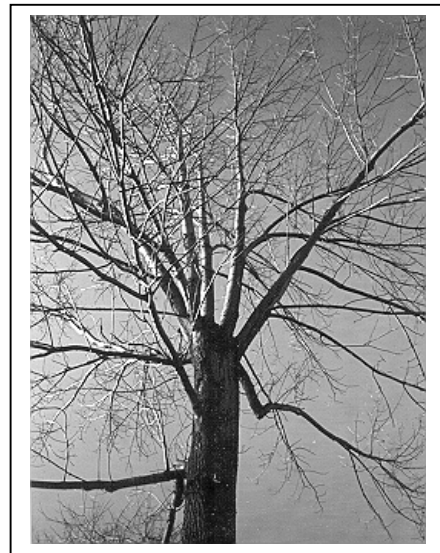
This silver maple lost only about 20% of its crown. Depending on other health factors, it should recover well.



It is harder to estimate % crown loss in the winter on deciduous trees. This sugar maple lost about 30% , below the critical level.



Here, the easiest way to estimate loss is to add up loss in each half of the crown. The total is probably near 65% (40 left + 25 right) on this sugar maple.



This young (11" DBH) green ash in a park resprouted a full crown in the 8 years after it lost 90% in an ice storm. Most trees can not tolerate such loss, and will die.

II. AFTER THE DUST SETTLES

A. Assessment and Planning

Basic Point: *Once the immediate tree emergency has been remedied, you will need to turn to long-term decisions and actions.*

■ Inventory/Survey

- Make a survey of the complete forest.
- If you already have a survey or inventory, you need to revise it now:
 - to update data
 - to establish damage, safety problems, work, and cost

■ Tree Inspection: systematically inspect each tree for *maintenance needs* and *site information*.

- For speed, you will probably want to conduct a windshield survey, but recognize that it takes a ground survey to see and evaluate more subtle problems such as decay.
- *Maintenance needs* include pruning, removal, cabling, mulching, etc.
- *Site information* includes presence of wires, width of planting area, soil texture, etc.
- Include potential *planting sites*, if not already noted in your inventory. Check local criteria for planting sites, including spacing from other trees and traffic objects.

■ Policies. This is a good time to get in place—or review—standard tree documents such as:

- up-to-date *specifications* for selecting, buying, planting, pruning, and removal
- a Tree Ordinance

Resource: Bernhardt and Swiecki 1991, on the web at <http://www2.champaign.isa-arbor.com/tree-ord/ordintro.htm>, and the "Sample Brief Tree Ordinance" at www.cce.cornell.edu/monroe/cfep

■ Education. Work again with the media, now that you have a plan.

- Publicize your next actions and decisions. People get most upset when they do not know what is going to happen, or when.
- Notify homeowners from now on before doing work on any public tree they might consider "theirs". Use letters, postcards, door hangers, or any other means that works.
- Get out good information on replanting and tree care. For example, excellent consumer brochures are available from the International Society of Arboriculture.

B. Working with FEMA and other reimbursement sources

Basic Point: *A little bit of care and attention on the front end can save a lot of pain on the back end!*

■ Records, records, records! Know what is needed, and keep track of it from the start.

■ To be eligible for FEMA reimbursement, work must be:

- overtime
- required as the result of a major disaster event
- located within a designated disaster area
- the legal responsibility of an eligible applicant

- **Understand the "disaster area" declaration process** (Resource: Andresen/Burban 1994, pp. 61-65)
 - Initial emergency response occurs at the local level.
 - Local officials can decide to contact their State Emergency Management Agency (SEMA) for assistance.
 - SEMA determines whether the affected area should be declared a disaster by the Governor.
 - The governor can request that the situation be declared a "major disaster" by the President.
 - If approved, the Federal Emergency Management Agency names a Federal Coordinating Officer who oversees the determination of what type of relief is needed.
 - Local, state, and federal representatives work together to develop the Damage Survey Report, which provides an estimated budget.
 - Tree removal and pruning in natural forest systems are excluded from FEMA reimbursement, unless the trees directly impact public safety of persons using a maintained public facility.
 - Hazard mitigation funding is also possible to reduce future damage, though it is much more limited.

- **Inform yourself about reimbursement requirements:**
 - Get a copy of your state's Emergency materials.
 - Understand FEMA and its role (current info on the web at www.fema.gov/about/)
 - **Get a copy of FEMA's *Applicant Handbook*** (FEMA 323).
 - Interactive application forms that can be filled out on the computer are available on the web at <http://www.fema.gov/r-n-r/pa/appfrm1.htm>
 - Directions for those forms can be found in the *Applicant Handbook*, and on the same web site as the forms.
 - Find out what will be reimbursed before you contract out work.
 - Public tree removal necessitated by a disaster in a declared area is usually reimbursed, stump grinding is not unless a clear threat to life and public safety can be identified.
 - Tree replacement is usually not covered by federal and state emergency management offices, unless it is a component of an otherwise eligible FEMA project.
 - **Only overtime emergency labor is eligible** for FEMA reimbursement.

- **Individual tree valuation may become necessary** in some instances for establishing the value of a specimen tree.
 - Tree valuation is difficult and often disputed, and for this reason is best carried out by a certified or registered consulting arborist trained and experienced in the technique.
 - There are two standard guidelines for doing this (ISA):
 - *Trunk formula method*: used for large trees
 - *Replacement cost method*: used for smaller, replaceable trees

Resource: ISA, *Guide for Plant Appraisal*

$$\text{Appraised Value} = \text{Basic Value} \times \text{Condition} \times \text{Location}$$

where

$$\text{Basic Value} = \text{Replacement Cost} + (\text{Basic Price} \times [\text{TA}_A - \text{TA}_R] \times \text{Species})$$

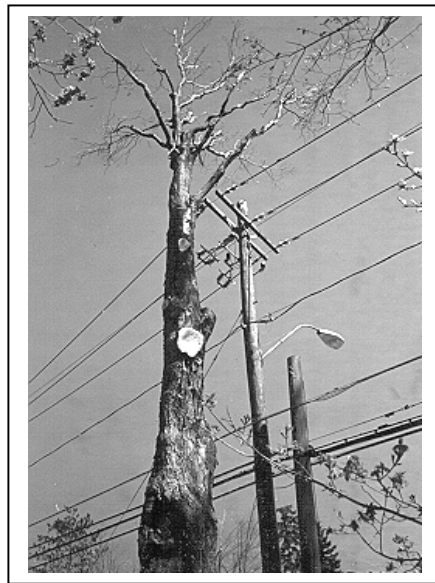
Source: ISA Guide

General formulas for deriving a guideline value for a specimen tree according to the "Trunk Formula Method"

C. Reducing delayed threats to public safety

Basic Point: *Disasters weaken surviving trees, leaving future safety and cost questions.*

- **Priority 2 Removal.** Priority 2 trees have no danger of immediate death and failure, but they are expected to decline and fail over the next 5-10 years. *Making decisions about Priority 2 Removals is probably the hardest and most controversial step in managing a storm-damaged forest.*
 - Decide which trees should come down now to remove a likely source of future hazards, and to be more cost-effective. Use your inventory/survey to set priorities.
 - Consider factors such as safety, looks, neighborhood effect, cost, age, vigor, crown loss, balance, heartwood damage, and species.
 - Good candidates for Priority 2 removal:
 - low-vigor trees with 50% or more of the crown destroyed or heavily damaged, → **G**
especially when the loss is mostly on one side
 - trees with leaders broken back into the trunk
 - split or tipped trees that were not removed as Priority 1
 - FEMA usually does not reimburse communities for non-hazardous tree removal.
 - Consider closely those trees that have a high hazard potential by virtue of species. In the Northeast, these typically include:
 - basswood (American linden)
 - black locust
 - willows
 - boxelder (ash-leaf maple)
 - silver maple
 - cottonwood, quaking aspen, and other poplars
 - tree-of-heaven



This old sugar maple lost about 75% of its crown in an ice storm, and has a restricted rooting volume between the street and a new sidewalk. Sugar maple is a species that is unable to resprout lost crown.

Finally, its failure would impact the busy street intersection, as well as significant utility fixtures.

For these reasons, this tree is a Priority 2 Removal candidate.

- Get help if possible, using knowledgeable tree professionals who have little or no monetary stake in the outcome. Check with your state forestry or Cooperative Extension office for suggestions.

■ Priority 2 Pruning.

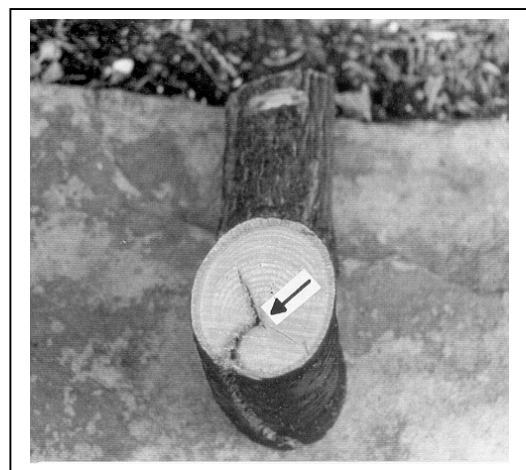
- Use your inventory to locate trees with a high hazard rating that need to be pruned.
- Prune off stubs or broken branches, and begin rotational maintenance pruning to reduce future hazards. FEMA usually does *not* pay for non-hazardous pruning. → **G**
- Identify vigorous trees that will need crown restoration.
 - Hold off any restoration work until the tree has resumed normal growth.
 - When many sprouts emerge after severe loss, it often helps to select a new scaffold limb structure by reducing competing limbs to the strongest.
- Many communities have found it often more cost-effective to clean and repair Priority 2 trees than to remove them and replant.

■ Delayed storm response

- After winter storms, be ready for new failures of split trunks and limbs when leaves come out in the spring. The leaf surfaces catch extra air and rain, increasing the load on the damaged tree parts.
- Trees flooded when they are actively growing (especially just after the first flush of growth) will often have their roots weakened or killed, rendering them susceptible to later incidents of insects, disease, and windthrow.
- All storm-damaged trees are weakened trees, and significant problems routinely emerge much later.

A radial shake in a linden that had gone through a severe ice storm, showing tri-part rupture through bark and wood on the outer surface. The radial shake weakens the limb, making it susceptible to later failure.

Source: Miller 1991

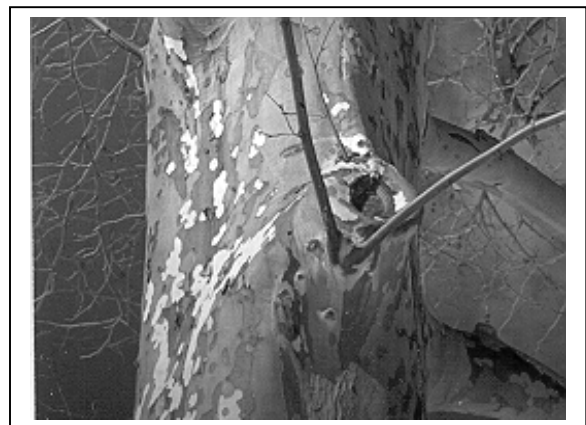


D. Recovery and reforestation

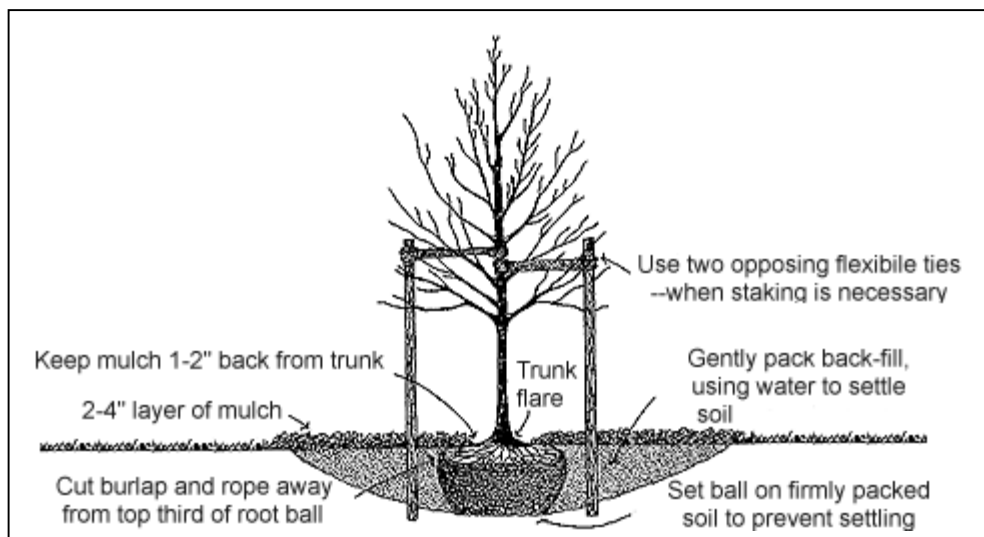
Basic Point: *Tree loss means the community itself has lost value because of factors such as reduced cooling, less air purification, and lower attractiveness. It is in the community's best long-term interests to promote recovery and reforestation.*

- **Trees have means to recover after disasters, because they have been dealing with natural disturbances (storms, fires, floods, insect plagues, etc.) since they first arose.**
- **All tree species have innate means to control the decay that comes with damage.**
 - Trees produce chemicals through photosynthesis that kill fungi. The healthier the tree is, the greater its capacity to produce these chemicals. → G
 - Trees also change the physical structure of cells surrounding the decay, making it harder for the fungus to digest and grow through them.
 - Combining these techniques, trees can build internal barriers to the expansion of decay in a process called "compartmentalization."
 - The larger and deeper the wound, the greater the extent of decay. Also, trees cannot compartmentalize decay associated with the loss of their main stem.
- **Deciduous trees have another means of recovery: the ability to resprout lost crown.**
 - Buds in older wood that had been suppressed while the crown was healthy are released for growth.
 - Younger, healthier trees on good growing sites will usually respond best.
 - Some species (e.g., green ash) are very good at resprouting lost crowns, others (e.g., sugar maple) are not.
 - The energy to resprout lost crown comes from starch that had been made and stored in previous growing seasons.
- The length of time required for recovery depends on many factors, but forests often return to normal appearance within 5-10 years.
- The loss of starch for containing decay and resprouting lost crown leaves the tree vulnerable, however, and long term decline may set in without many external symptoms at first.

On this London plane can be seen signs of a deciduous tree's responses to loss of crown, 8 years after a severe ice storm. The swollen ring of woundwood indicates compartmentalization of decay, and the shoots indicate attempts to sprout new foliage. There are great differences in trees' abilities to compartmentalize decay and to resprout lost crown.



- **Develop a restoration plan** that will become the reference document for the future.
- **Seek out replanting funds** from private and public funds while memories are fresh.
 - Possibilities include local businesses, charity organizations, individuals, nurseries, green professionals, etc.
 - Contact the office of your state (urban and community forestry coordinator for other sources.
 Resource : Tree City Bulletin #34, "How to Fund Urban Forestry."
- **Set up and use purchasing and planting specifications** for standard use.



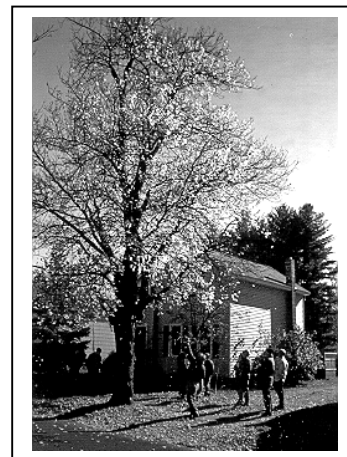
Source: ISA, "New Tree Planting"

- **Have good selection criteria** in place.
 - Check with your state urban and community forestry coordinator or Cooperative Extension office.
 Resources: Bassuk 1998, Reynolds and Boivin, 1994.

- **Establish a Tree Commission**
 - Include concerned citizens as well as tree management personnel.
 - Use them for help in areas such as:
 - basic tree inventory and assessment information
 - tree selection
 - keeping track of species diversity
 - matching tree species to site
 - relations with homeowners.

Resource: Lipkis and Lipkis, "The Simple Act of Planting a Tree"

Tree Commission members assessing a decayed horsechestnut in the village Right-Of-Way.



III. GETTING READY FOR THE NEXT ONE

A. *Emergency Plan*

Basic Point: You don't want to wait until disaster strikes again to figure out your best way of dealing with tree emergencies.

- **Establish tasks** and assign responsibilities: figure out exactly what will need to be done, and who will do it. Basic task list for a medium-sized community might include (adapted from Andresen and Burban, 1994):
 - Tree pruning and removal
 - Public alley clearance
 - Phone contact for public service calls
 - Communications with other local officials/offices
 - Location of equipment, fuel, generators, etc.
 - Search for additional equipment and assistance
 - Brush removal from private property
 - Debris disposal
 - Record keeping
 - Damage assessment
 - Emergency response evaluation.
- **Determine small management work units with priority routes**, and maintain
 - trees in the Right-Of-Way
 - relevant private trees (for example: any trees that would fall in the road)
- **Identify tree professionals** who are knowledgeable and reliable.
 - Get prices for labor and equipment now, so that later you can figure out how great the markup for emergency work is.
 - The larger the amount of debris, the more equipment you will need to remove it. Businesses like construction or timber companies will be a likely source.
- **Collect emergency documents** and place copies in central locations. Possible inclusions:
 - List of tasks and responsibilities
 - List of priority routes to clear
 - List of emergency officials
 - FEMA rules and regulations
 - Chain of command and organizational chart
 - List of other emergency telephone numbers (utilities, etc.)
 - List of reputable tree professionals
 - Tree care pruning standards (ANSI A300, Part 1)
 - Safety announcements
 - Public releases on safety and other topics.

B. Inventory

Basic Point: The better you manage and maintain trees, the less damage they will suffer.

- Inventories of public trees have multiple benefits:
 - Making and defending budgets is much easier with hard data.
 - Work orders, annual costs, and tree histories can be quickly produced.
 - Homeowners are happier when an inventory is in place. They seem glad that somebody actually knows about "their" tree.
 - By including potential planting sites in your inventory, you can figure out your stocking rate, plan your budget, and find locations for planting. → **G**
 - Funding requests to emergency agencies will usually be processed more quickly, and requests for reimbursement will be easier to justify.
- Computerized inventories are easiest to maintain and use.
 - Buy a professional program, or use an off-the-shelf spreadsheet such as Excel™

Resource: recent review of professional programs on the web at <http://willow.ncfes.umn.edu/pubs/urbanforestry/streettree/toc.htm>.

- Free basic inventory templates based on Excel™ and Access™ are downloadable from the web (<http://www.cce.cornell.edu/monroe/cfep>), or check with your state urban and community forestry coordinator's office.
- If an inventory is not possible, at least make sure that you:
 - have a system of annual inspection for needs and hazards
 - use a reliable method of evaluation
 - keep good records of complaints, decisions, and actions.

Example: Simple Inventory (using Excel™)

DBH = diameter at breast height; Cond = condition (5=excellent, 1=dead);
 HazEv = hazard evaluation rating (3=no hazard, 12 = highest hazard);
 Remv = remove; Remv/Trim codes: 0=None, 1=Required, 2=Optional

Trees Sorted by Address

Address	Species	DBH	Cond	HazEv	Remv	Trim	Comments
Bell St.							
21 Bigelow Side N	Sugar Maple	28	3	6	1		Clean
21 Bigelow Side S	Sugar Maple	28	4	3	2		Raise
3 Bell	Norway Maple	14	4	3	0		
5 Bell S	Green Ash	23	3	5	0		
5 Bell N	Sugar Maple	21	3	9	1		Decay btw leaders

Trees Sorted by Hazard Potential

Address	Species	DBH	Cond	HazEv	Remv	Trim	Comments
5 Bell N	Sugar Maple	21	3	9	2		Decay btw leaders
21 Bigelow Side N	Sugar Maple	28	3	6	0		Clean
5 Bell S	Green Ash	23	3	5	2		
21 Bigelow Side S	Sugar Maple	28	4	3	0		Raise
3 Bell	Norway Maple	14	4	3	0		

- A useful option is to determine **hazard potential** for your trees, using a consistent rating system. → **G**
Here is one well-tested simple formula for hazard potential developed by tree professionals in conjunction with the International Society of Arboriculture:

HAZARD POTENTIAL = failure possibility + part size + target rating

- Each category on the right side is assigned by field examiners a number between 1 and 4, the higher numbers being more serious. The tree's hazard potential is the sum of those numbers.



Resource: Matheny/Clark 1994.

- This hazard potential has little meaning all by itself, but gains value in comparison with other trees in the same area. It is a method to direct your resources toward the most dangerous trees.
- Action on trees with a hazard rating higher than 8 or 9 is often considered obligatory, and the trees are usually put on more frequent inspection as well.
- Good hazard evaluation depends on trained and experienced observers, and on consistency. For these reasons, it is best done by professionals.
- If you conduct the hazard survey yourself and are not a tree professional, be as consistent as you can in applying the rating system.
- Here is **an example** of a sugar maple on a country road with the top half dead:



Hazard Rating:

Failure possibility	4	(dead wood is non-negotiable)
Part size	3	(dead wood is about 24" in diameter)
Target rating	1	(occasional use road)
TOTAL	8	

C. Mitigation: How to Limit the Damage Potential

Basic Point: *what you do now--and the way you do it--will strongly impact how much damage you will have and how well your forest will survive in the next disaster.*

■ Tree Selection

- **Require site analysis** before selection, so limitations are known before a tree goes into the ground. Try to plant the "right tree for the right place."
Resource: site analysis form in Bassuk, 1998
- **Adjust the size of tree to the width of the tree lawn.** In the long run, the health of an urban tree will depend its having an appropriate rooting volume for its size.
- **Avoid planting large-growing trees under power lines.** You can train young trees around wires, but they will always have to be pruned, setting them up for weakness and failure.
- **Establish a list of acceptable species,** using materials from your state urban and community forestry coordinator or Cooperative Extension . Do not plant species known to fail.

→ G



In the Northeast, boxelder often fails during storms without any apparent damage or decay.
This one went down in a 1998 ice storm.

- **Aim for species diversity** to limit damage from any one kind of disaster. One common guideline states that any one species (e.g., sugar maple) should be limited to 10% of the forest, and any one genus (e.g., all maples) to 20%.
 - **Limit use of nuisance species (e.g., cottonwood) and species known to be invasive in your area (e.g., Norway maple).**
 - **Buy high quality stock:**
 - no defects or pests,
 - good crown and root structure
- Resource: "Buying High-Quality Trees", on the web at <http://www2.champaign.isa-arbor.com/consumer/buying.html>

→ G



■ Planting

- Dig shallow and wide holes. Make sure root ball sits on undisturbed soil, and that root flare is at soil grade, so roots don't suffocate or drown.
- Check for girdling roots, and prune them to promote outward growth.
- Don't stake unless necessary, and then only with wide, soft ties.
- Place organic mulch 2-6" deep out to the dripline (but not against trunk), and renew it when it decomposes.

→ G

→ G

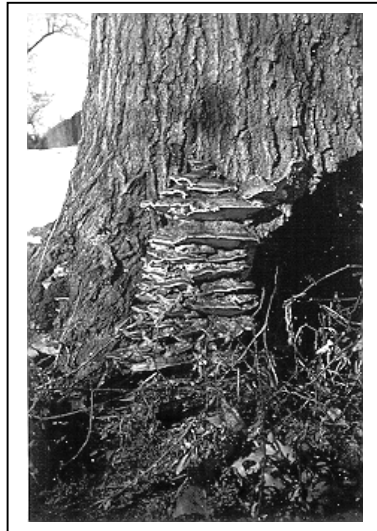
→ G

- Guard the young trunk with a recommended method (such as mulch and hardware cloth) to prevent damage to young tree from string trimmers, lawn mowers, etc.

Resource: Reynolds and Ossenbruggen 1993.

■ Pruning and Removals

- **Prune young trees for strength and form** (= "training"), starting a few years after planting. → **G**
 - Training is particularly important for species that tend to produce codominant stems.
- Resource "Pruning Young Trees" on the web at <http://www2.champaign.isaarbor.com/consumer/young.html>
- Carry out the pruning and removals indicated by hazard potential on your inventory.
 - Make annual inspections, and remove the riskiest trees as your budget permits.
 - Larger trees with indications of butt rot (hollow buttress roots, mushrooms on the base, etc.) must be evaluated carefully. → **G**



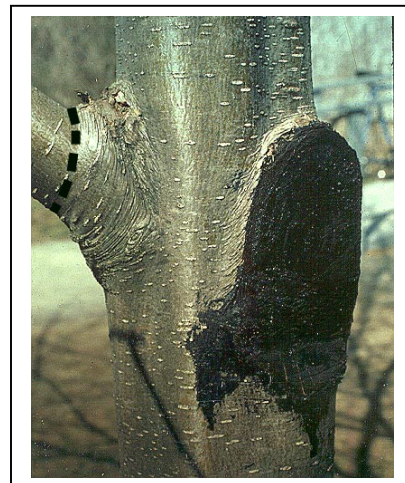
This red oak in a park was diagnosed to have extensive butt decay but, because it had no reasonable target, was left standing. Six months later, it toppled over in a severe windstorm, revealing the extent of dead and rotted roots.

- Make sure proper pruning cuts are made at proper times. Remember that decay routinely follows cutting, and that it will be less serious with:
 - *better cuts, smaller exposed surfaces*
 - *faster wound sealing, younger trees*

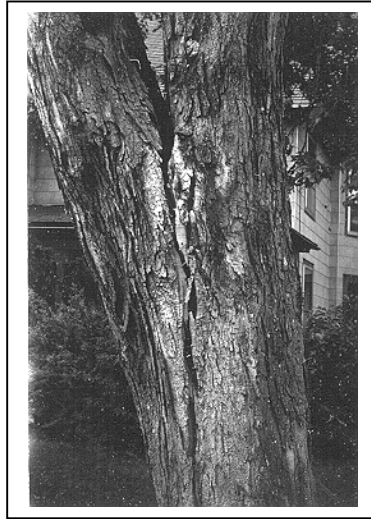
Resource "How to Prune Trees" (USDA, 1995).

On the right side of this tree is a flush cut painted with a creosote-based material. This technique is now known to be harmful to the tree. A proper cut is indicated on the left side with a dotted line; nothing should be applied to the cut surface afterwards in most cases.

Source: adapted from a slide by Alex Shigo in the set "TLC for City Trees"



- **Pay attention to codominant stems** on larger trees: they commonly fail in windstorms.
 - The time to remove codominant stems is when the trees are young, because they can recover very well at that time.
 - Removing a codominant stem on a large tree can cause as many problems as it solves, and should only be done when no other solution is possible and the target is serious.

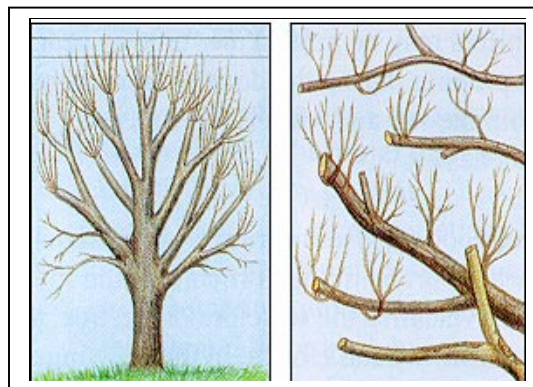


The codominant stems on this red maple failed in a windstorm, leaving this crack on both sides of the trunk. **Such a tree is already in failure, and requires immediate action.** The best mitigation strategy would have been to remove one of the stems as early in the life of the tree as possible, cutting at an angle and avoiding wounding the branch ridge through the middle of the union.

- **Avoid (if you can) cutting live wood in the spring** between bud break and full leaf expansion, **and in the early fall** when decay fungi are dispersing their spores. → **G**
- **Establish maintenance pruning** on a rotational basis. Maintained forests suffer less damage and cause less harm in disasters than those that are not maintained. → **G**
 Resource: "Community Maintenance Pruning" on the web at www.cce.cornell.edu/monroe/cfep. 
- **Do not top or tip trees.** This only causes more problems, and creates weaker trees. → **G**
 Resource: "Why Topping Hurts Trees" on the web at <http://www2.champaign.isa-arbor.com/consumer/topping.html>

Topping (left) and tipping

Source: USDA, 1995, *How to prune trees*



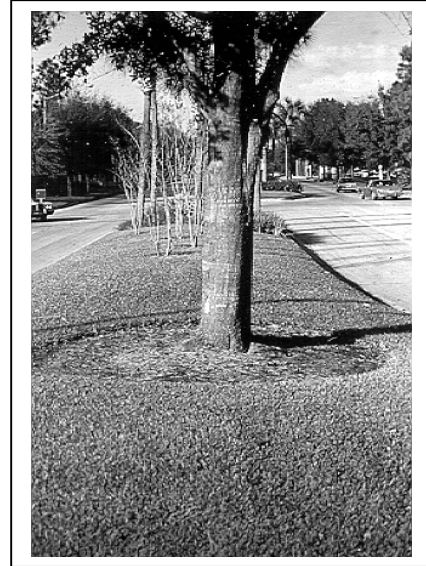
■ Roots

- **Promote the health of the root zone as much as possible.** This may include keeping a 2-6" layer of organic mulch underneath the crown, installing fencing, or planting other woody and herbaceous plants with the tree.
- Protecting the roots and their soil environment is the best long-term investment in the health of the tree.

Resource: Shigo, "Troubles."

A large mulched zone around a tree set into turf. Such a separation of grass and trees leads in the long run to healthier, safer, and less costly trees.

Source: the slide set "Tree Anatomy Below Ground" by Alex Shigo

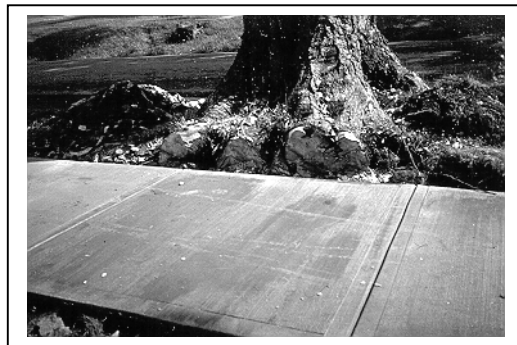


- **Keep grass away from the root system, especially around young trees.** Grass competes well against trees, and limits growth above and below ground.
- Provide slow-release fertilizer to young trees in the early fall or early spring. Young trees have been shown to benefit especially from a small amount of additional nitrogen—check for details on amounts and methods with your local Cooperative Extension office. → G

Resource: ANSI A300 fertilization standards.

- Consider tunneling instead of trenching when installing underground utilities.
- **Avoid grade changes over mature tree roots**, since the additional soil will suffocate them.
- **Avoid cutting the large buttress roots** that flare out from tree bases. One common example occurs during sidewalk repair, and alternatives should be considered where possible.

Resource: "Trees and Sidewalks" on the web at www.cce.cornell.edu/monroe/cfep



Large sugar maple with buttress roots cut for new sidewalk. When buttress roots are cut on a tree of this age and species on such a site, it will often die in 3-5 years or suffer from windthrow.

IV. RESOURCES

A. Printed resources

General

- Albers, Mike, et al. 1993. *How to detect, assess and correct hazard trees in recreational areas*. St. Paul MN: Minnesota DNR.
- Andresen, John, and Lisa Burban. 1994. *Storms over the urban forest. Planning, responding, and regreening -- a community guide to natural disaster relief*. 2nd ed. Illinois: Division of Forest Resources. On the web at <http://willow.ncfes.umn.edu/sotuf/sotuf.htm>.
- ANSI. 1995. *A300 American National Standard for Tree Care Operations. Tree, shrub, and other woody plant maintenance --standard practices*. New York: ANSI.
- ANSI. 1998. *A300 (Part 2) American National Standard for Tree Care Operations. Tree, shrub, and other woody plant maintenance --standard practices fertilization*. New York: ANSI.
- ANSI. 1994. *Z133.1 American National Standard for Tree Care Operations. Pruning, trimming, repairing, maintaining, and removing trees and cutting brush safely*. New York: ANSI.
- Bloniarz, David, Ryan, H. Dennis, Luley, Christopher, and David Hawkins. [In Press] *An Initial storm damage procedure for urban and community forests*. Naples NY: Davey Resource Group.
- Capon, Brian. 1990. *Botany for gardeners*. Portland OR: Timber Press.
- Chaney, William. 1996. "How trees grow." *Tree Care Industry*. April, pp. 28-36.
- Elmendorff, William F., and Henry D. Gerhold. 1996. *A Guide for municipal tree commissions*. Mechanicsburg PA: Pennsylvania Forestry Association.
- Hanson, Trish, and E. Bradford Walker. 1996. *Field guide to common insect pests of urban trees in the northeast*. Waterbury VT: Department of Forests, Parks and Recreation. Order off the web at <http://www.state.vt.us/anr/fpr/forestry/pubs/pest.html>
- Hauer, Richard J., et al. 1994. *Trees and ice storms: the development of ice storm-resistant populations*. Special Publication 94-1. Champaign IL: Illinois Dept. of Forestry. On the web: <http://www.ag.uiuc.edu/~vista/abstracts/aicestorm.html>
- Hayes, Ed. 1998. *Risk assessment guidelines for hazard trees, "An Easy to Use Field Guide."* St. Paul MN: Minnesota DNR.
- ISA. 1995. *Guidelines to tree pruning*. Savoy IL: ISA.
- Kozlowski, T. T. 1985. "Soil aeration, flooding, and tree growth." *Journal of Arboriculture*. 11 (3), pp. 85-96.
- Matheny, Nelda, and James Clark. 1994. *A Photographic guide to the evaluation of hazard trees in urban areas*. 2nd ed. Champaign, IL: ISA.
- -----. 1993. *A handbook of hazard tree evaluation for utility arborists*. Champaign IL: ISA.
- Nowak, D. J.; Rowntree, R. A.; McPherson, E. G.; Sisinni, S. M.; Kerkmann, E. R.; Stevens, J. C. 1996. "Measuring and analyzing urban tree cover." *Landscape and Urban Planning* 36: 49-57.
- Shigo, Alex. [N.d.] *Tree Basics*. Durham, NH: Shigo and Trees, Associates.
- USDA Forest Service. 1995. *How to prune trees*. NA-FR-01-95. On the web at http://willow.ncfes.umn.edu/ht_prune/prun001.htm
- Watson, Gary, and E. B. Himelick. 1997. *Principles and practice of planting trees and shrubs*. Champaign IL: ISA.

Emergency response

- Council of Tree & Landscape Appraisers. 2000. *Guide for plant appraisal*. 9th ed. Champaign IL: ISA.
- Fazio, J. R., ed. [N.d.]. *When a storm strikes*. Tree City Bulletin No. 2. Nebraska City NE: National Arbor Day Foundation.
- FEMA. 1999. *Public assistance: debris removal guide*. On the web at <http://www.fema.gov/r-n-r/pa/dmgtoc.htm>
- Semrau, A. 1993. "Helping Trees Weather Nature." *Urban Forests*, Vol. 13, No. 1, pages 12-17. On the web at http://willow.ncfes.umn.edu/sotuf/chapter_4/appendix_d/appendixd.htm
- USDA. 1998. *How to determine percent live crown loss in hardwoods before leaf-out*. Ice Storm Information Sheet #1. Durham NH: Forest Service. On the web at <http://www.fs.fed.us/na/icestorm/Infoshts.html>

After the dust settles

- Bassuk, Nina. 1998. *Urban trees: site assessment selection for stress tolerance planting*. Ithaca NY: Urban Horticulture Institute, Cornell.
- Bernhardt, E., and T. J. Swiecki. 1991. *Guidelines for developing and evaluating tree ordinances*. Sacramento, CA: Urban Forestry Program, California Department of Forestry and Fire Protection. On the web at <http://www2.champaign.isa-arbor.com/tree-ord/ordintro.htm>
- Lipkis, Andy and Katie. 1990. "The Simple Act of Planting a Tree." Los Angeles CA: Tarcher. On the web at <http://treelink.org/>.
- Mattheck, Klaus. 1994. *Body language of trees*. Research for Amenity Trees No. 4. London: The Stationary Office.
- Miller, Kenneth. 1991. *Investigation of internal stress damage from ice storm*. Kent OH: ACRT. On the web at http://www.acrtinc.com/Ice_storm/index.html.
- Reynolds, Mary K., and Raymond Boivin. 1994. *Selecting trees for urban landscape ecosystems*. Concord NH: State of New Hampshire, Department of Resources and Economic Development.
- Reynolds, Mary K., and H. Sharon Ossenbruggen. 1993. *Planting trees for communities. Checklist for success*. Concord NH: Department of Resources and Economic Development, Division of Forests and Lands.
- Shigo, Alex. "How Trees Survive." *Tree Care Industry*. Volume VII, Number 2-February. On the web at <http://www.chesco.com/~treeman/SHIGO/SURVIVE.html>
- Smith, Kevin, and Walter Shortle. 1998. *A first look at tree decay*. NA-PR-02-98. Durham NH: USDA NE.
- USDA Forest Service. [N.d.]. *Flooding and its effects on trees*. On the web at <http://willow.ncfes.umn.edu/flood/table.htm>

Getting ready for the next one

- Fazio, J. R., ed. [N.d.]. *How to conduct a street tree inventory*. Tree City Bulletin No. 23. Nebraska City NE: National Arbor Day Foundation.
- Shigo, Alex. 1996. "Troubles in the Rhizosphere." *Tree Care Industry*. Volume VII, Number 10 - October. On the web at <http://www.chesco.com/~treeman/SHIGO/RHIZO.html>
- Miller, Robert W. 1998. *Urban forestry: planning and managing urban greenspaces*. 2nd ed. Upper Saddle River, NJ: Prentice Hall.
- Shigo, Alex. 1986. *A new tree biology*. Durham, NH: Shigo and Trees, Associates.

B. Videos

- Clemson University, Department of Forest Resources. *Managing trees for public safety*. 3 tapes: "The Administrator's Responsibility," "The Role of Landscape Maintenance Personnel," "An Arborist's Guide." 65 mins total. Available from the International Society of Arboriculture.
- Illinois Arborist Association, et al. [N.d.] *Root injury and tree health*. 91/2 mins. Available from the International Society of Arboriculture.
- USDA Forest Service. [N.d.] *Evaluating trees for hazards*. 39 mins. Available from the American Forestry Association, or the International Society of Arboriculture.
- National Arborist Association, and the International Society of Arboriculture. [N.d.] *Pruning standards and techniques for the 21st century*.

C. Emergency and Urban/Community Forestry Web Sites

- <http://www.isa-arbor.com/> The International Society of Arboriculture
- <http://www.asca-consultants.org/> The American Society of Consulting Arborists
- <http://www.treelink.org/> The National Urban and Community Forestry Advisory Committee
- <http://www.willow.ncfes.umn.edu/> The USDA Forest Service in Minnesota, includes a "Hazard Tree Page"
- <http://www.natlarb.com/> The National Arborist Association
- <http://www.arborday.org/> The National Arborday Foundation's home page
- <http://www.amfor.org/> The American Forests home page
- <http://www.aces.uiuc.edu/~eden/resources.html> The Extension Disaster Education Network
- <http://www.fema.gov> The home page for the Federal Emergency Management Agency. Regional offices (Boston, New York, etc.) are linked to the site.
- <http://www.umass.edu/urbantree/> Northeast Center for Urban and Community Forestry Amherst MA.
- See "Emergency Contacts" (cover insert) for your state urban and community forestry web site.

D. Useful Addresses for Additional Resources

In addition to local FEMA, state urban and community forestry coordinator, and Cooperative Extension offices listed on the cover insert, here are some further places where you can obtain useful resources:

American National Standards Institute (ANSI)
11 West 42nd Street
New York, NY 10036

International Society of Arboriculture
PO Box 3129
Champaign IL 61826-3129

Northeast Center for Urban and Community Forestry
Department of Forestry & Wildlife
Holdsworth Center
University of Massachusetts
Amherst, MA 01003-4210

E. The Tree Emergency Compendium

The Tree Emergency Compendium can be obtained from your state urban and community forestry coordinator (see front cover insert). It is also available on the web at the web site of the USDA Forest Service, Northeast Center for Urban & Community Forestry (<http://www.umass.edu/urbantree/>). It contains the following resource documents for tree emergency use:

I. Emergency Response

- "A300 Tree Care Standards"
- "How to Determine Percent Live Crown loss in Hardwoods Before Leaf-Out"
- "How to Prune Trees"
- "In the Storm's Wake"
- "Safety Tips for Preventing Injury"
- "Watch Out for Scam Artists Posing as Arborists"

II. After the Dust Settles

- "A First Look at Tree Decay"
- "Buying High-Quality Trees"
- "Can these trees be saved?"
- "Flooding and its Effects on Trees"
- "Helping Trees Recover From Ice Storms"
- "Mulching Trees"
- "Native Tree Species"
- "Planting Trees for Communities"
- "Rating System for Tree Hazard Potential"
- "Risk Assessment Guidelines for Hazard Trees"
- "Setback Planting"
- "Site Assessment Checklist"
- "Staking Trees"
- "Underwire Trees"

III. Getting Ready for the Next One

- "Agency Planning Worksheet"
- "Community Maintenance Pruning"
- "Evaluation of Trunk Cavities"
- "Helping Trees Recover From Ice Storms"
- "How to Recognize Hazardous Defects in Trees"
- "Predicting Limb Breakage"
- "Pruning Young Trees"
- "Sample Brief Tree Ordinance"
- "Trees and Sidewalks"
- "Why Topping Hurts Trees"

IV. Other resources and useful information

V. GLOSSARY

Borer

A borer is any sort of insect that bores into wood, including moths, beetles, sawflies, horntails, and flies. Most of the damage is done when they are in the larval ("grub") stage. A common example is the bronze birch borer that can kill a susceptible tree within a few years.

Branch collar

At a branch's point of attachment, there is usually a swollen area where branch tissue and main stem tissue overlap. This collar contains the tree's primary defense mechanism against decay when the branch loses vigor or dies. In pruning, it is important that this collar be left intact.

Bud break

Bud break is the moment in the spring that the scales of a bud first open and shoot elongation begins. The exact time of bud break varies by species, plant health, and weather.

Butt rot

When decay fungi (see below) attack the part of a tree where the trunk meets the roots, it is commonly termed butt rot. It is a very dangerous form of tree decay, since it leads to failure of the whole tree but is often difficult to detect without special means.

Buttress root

This term applies to the large thickened roots that flare out from the trunk to the ground and form the upper part of the root crown. They provide much of the stability of a tree, and are the major path for water nutrients to the upper tree.

Certified arborist

The term "certified arborist" usually refers to someone who has fulfilled the requirements of the International Society of Arboriculture, which include a rigorous and long examination. Continuing education on an annual basis is required to retain certification. Some states have their own certification program as well.

Consulting arborist, registered

A registered consulting arborist has satisfied the requirements for technical education and experience set by the American Society of Consulting Arborists. They can bring a comprehensive and objective viewpoint to the diagnosis, appraisal, and evaluation of tree issues.

Codominant stems

Double or twin leaders of similar diameter that meet in a "V" union at their base. Such narrow unions commonly develop on opposite budded trees (such as maples) and some other species or cultivars (such as Bradford pear). They tend to fail during storms, especially when associated with decay, and dealing with them before serious storm events is good practice.

Crown

The crown is used here as a synonym of "canopy," and includes all the smaller branches, leaves, and fruiting structures that form the upper and outer part of the tree. It is one of the main parts of the tree, along with the roots, trunk, and scaffold branches. The crown's condition—leaf color or size, twig vigor, etc.—is a good indication of the overall health of the tree, although it says little about its stability (its ability to remain standing).

Crown cleaning

This term refers to the removal of dead wood above a certain minimum diameter (often 2"). One of the standard pruning types.

Crown raising

You raise the crown when you remove limbs that reach down below a certain minimum such as 8' (over sidewalks) or 14' (over roads). One of the standard pruning types.

Crown restoration

After crown loss in a disaster or in radical pruning, trees often release many new shoots from one location. With crown restoration, these new shoots are reduced to a few in order to produce a stronger crown and more natural shape. One of the standard pruning types.

Decay fungi

Most fungi are able to break down dead wood, but a few are actually parasitic and can attack living wood. They digest the wood of the tree, leading to strength loss and eventual failure of the tree part. They attack branches, roots, and any wounded part, and range from visible decay of the growth layer ("canker") to hidden decay of the roots. When decay has advanced, mushrooms appear as the fruiting body of the fungus. Decayed wood typically appears brown and crumbly or white and stringy.

Defect

Any tree factor that affects its health or stability negatively is a defect. Examples include chlorotic leaves, cut roots, wounded trunk, decayed branch wounds, codominant stems (see above), etc. Tree evaluation depends upon the careful detection and analysis of defects.

Dripline

A tree's dripline is the imaginary line around the edge of the crown projected on the ground. The outline of the canopy shadow when the sun is exactly overhead is a good approximation. It is used as an estimate of the extent of a tree's root system for things like tree protection or root fertilization, although in many situations the actual roots extend much further away from the trunk.

Flush cut

A way of pruning off branches that takes off the branch and its branch collar (see above) so that the cut is flush to the trunk. It used to be done for looks and health, and was once much recommended and practiced. It is now known to be detrimental to the tree's ability to limit the resulting decay.

Girdling root

When a root curls around the trunk base instead of growing outward away from the tree, it is called a girdling root. As it becomes larger over the years, it can cut off the flow of sugars down from the leaves to the roots. The roots will die, and the tree then lacks both water and support from that direction.

Hanger

Any dead piece of wood that is broken and hanging up in the crown, whether still attached or not. This obvious yet common defect poses a hazard to traffic or objects below.

Hazard potential/hazard rating

The hazard potential of a tree is a measure of its threat to an urban population. Methods to evaluate it usually examine the tree's potential to failure, the size of the part that might fail, and the relative significance of potential targets below.

Hazard tree

A hazard tree is one that in the judgment of an evaluator poses a significant threat to a significant target. Examples include a tree with a large dead branch over a street

Leader

A leader is a large, dominant, and more or less upright limb attached to the trunk. In some species, there is only a single or central leader, in others, there may be several.

Low-vigor trees

Vigor refers here to the average rate of growth of a tree, which can vary by species, age, site, and weather. When a tree has reduced growth, it often has a reduced ability to make sugar and to resist pests. Vigor can be measured directly with an increment borer, which takes a small core of wood directly out of the tree. A good non-invasive field estimate can often be made by looking at the annual growth increments of terminal twigs; anything consistently under 2" usually indicates low vigor.

Maintenance pruning

Maintenance pruning refers to the practice of maintaining tree structure, form, and appearance by periodic pruning visits. It is safer and more cost-effective to conduct maintenance pruning for an urban forest than to manage it by simply responding to reported problems.

Pest

A pest is any insect or disease that adversely affects the health or appearance of a plant. It is important to separate serious pests, such as borers, from cosmetic pests, such as galls.

Photosynthesis

Any plant that has chlorophyll can produce sugar and other chemicals from water and carbon dioxide in the presence of light. The reverse of photosynthesis is respiration (see below). The plant's photosynthetic rate is closely connected to its growth and health.

Pruning types

Six categories of pruning are defined in the ANSI A300 standards for hazard or maintenance pruning. These "pruning types" include crown raising, crown cleaning, crown thinning, crown reduction, vista pruning, and crown restoration. Using such standard terms brings clarity and responsibility to tree care.

Respiration

Sugars are consumed by plants as by animals: oxygen is taken in, and carbon dioxide is released. Trees need a certain level of respiration to maintain their health, and even more to be able to grow. If oxygen is cut off from respiring plant parts, such as when soil is heaped over small roots, they suffocate and die.

Root flare

When tree roots experience stress, they are strengthened. Trees undergo great stress from wind and gravity where the trunk meets the roots, and the result is a root thickening that produces a flare. The lack of a flare on an open-grown tree often indicates serious root problems, and should be evaluated carefully.

Rotational pruning

It is a common practice to conduct maintenance pruning (see above) in larger urban forests by dividing the forest into management units, and rotating the pruning to a different unit or group of units each year. This has been shown to be a very cost-effective way to manage public trees.

Scaffold branch

Scaffold branches are the large limbs that define the overall structure of the crown. They include leaders and large lateral limbs on many hardwoods, the central leader alone on many softwoods.

Site analysis

Many factors influence whether a tree will be able to grow successfully on a given site, and it is important to analyze them if the future forest is to be healthy and strong. These factors include: soil pH and soil texture (ratio of sand, silt, and clay), rooting volume, presence of utilities, heat load, soil moisture, etc.

Slow-release fertilizer

A slow-release fertilizer uses a method to make a small amount of its nutrients available to the plant over a long period of time. It has been shown that young trees particularly benefit from such a technique, because extra nitrogen is available whenever they need it.

Species diversity

The best defense against pests and disasters lies in having species diversity, or a mix of species, in the urban forest. Forests that contain predominantly one species (such as American elm), or one genus (such as maples) are much more susceptible to harm than those have a variety.

Stocking rate

This number is found by dividing the number of existing trees by the number of possible trees (= # of planting sites, whether filled or not). Expressed as a percentage, it can be used to estimate the degree of historic commitment to public trees, as well as to indicate the potential for growth.

Target pruning/Lateral pruning/Directional pruning

A tree's growth can be directed away from a target such as a building or wire by pruning to a sufficiently large lateral branch pointing away from the target. Fewer cuts have to be made, and pruning visits are reduced. If the trunk or limb is simply headed back without attention to where the cuts are made, resprouting will be encouraged on hardwoods and even more work will be produced.

Topping

When many branches are simply pruned back indiscriminately to reduce the height of a tree, it is called topping. Topping produces many new sprouts and introduces multiples wounds for decay fungi, and is therefore harmful to the tree. It also produces disfigured trees.

Training

Training is the pruning of young hardwood trees for strength and beauty. Well-spaced limbs with strong unions result from proper training. It is also the best method of taking care of codominant stems (see above), since one of the stems can be removed while the tree is young and can recover quickly.