



How to Make Trees Storm Resistant

TREE CITY USA®
BULLETIN

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There are some things in life you can't do anything about and the weather is one of them. When storms strike – and inevitably they do – trees suffer and can harm people and property. But much of the trouble can be avoided with some preemptive intervention.

Although we cannot prevent storms, there *are* ways to reduce the destruction they cause. In this bulletin, we look at some basic principles that can make trees more storm resistant. These guidelines can be applied to trees in the home landscape or to the entire urban forest. Importantly, they can save lives, reduce property damage, and increase services provided by healthy green canopies in our communities. Inaction is a poor option. Making our community trees more storm resistant should be a priority for all tree boards, community foresters, and residents with an interest in the future of our urban forests.

One of the more subtle results from storms is that trees are lost and not replaced. As once observed by Charlotte Glen, a horticulture agent for North Carolina Cooperative Extension, "Property owners who have experienced (storm) damage in the past are tempted not to replace fallen trees due to fear that the same thing will happen again in future storms. As a result, tree populations in our coastal communities are dwindling, and we are losing the significant economic and environmental benefits trees bring to these communities." This is undoubtedly true even beyond the coast and the trend needs to be reversed. If you are reading this bulletin, you can make the difference by planting trees and providing proper care.

Although storms cannot be prevented, steps can be taken in advance to reduce the chances of damage like this and to keep our community forests safe and productive.



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Trees and the Wind

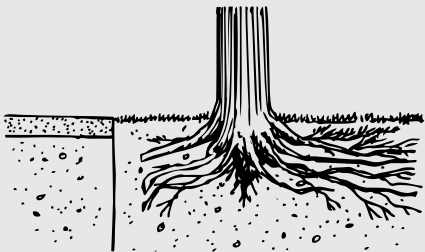
There is nothing to be done when catastrophic tornados come to town. But for lesser wind storms, including hurricanes, some preventative practices can pay huge dividends.

THE BASIC ELEMENTS OF GOOD TREE CARE

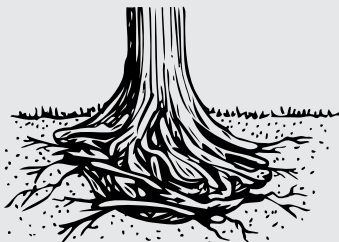
At the heart of storm-resistant trees in a community is simply the kind of tree care that should be provided regardless of storm potential. Post-storm inspection of trees by experts verify that many tree failures can be prevented with proper management and some planting design considerations.

HEALTHY ROOTS

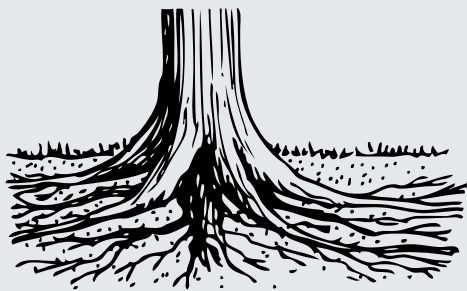
Roots with room to grow are an important key to tree stability. Just the opposite is an invitation to disaster — roots that are cut, smothered by change in soil level, or killed by chemicals or compaction. Minimum soil volume requirements and other factors affecting roots have been the topic of numerous Tree City USA Bulletins that are listed on the order form on page 8.



Avoid root cutting, especially within a distance 5 times the diameter of the trunk.



Plant properly. Avoid planting too deep, and straighten or cut circling roots in the planting ball or after removing from a pot.



Proper planting and roots with room to grow and receive proper aeration will result in greater support during storms.

If staking young trees, tie loosely enough to allow sway. This helps stimulate root growth and trunk taper, both important in tree stabilization.

- Use sidewalk design techniques to allow adequate space.
- Utilize structural soil or Silva Cells beneath pavements.
- Consider planting on the lawn side of a sidewalk.
- Soil volume requirements vary by city. For trees with soil depths of at least 3 feet, the University of Florida (Gilman and Partin) recommends:

TREE SIZE AT MATURITY	MINIMUM OPEN SOIL AREA AROUND TRUNK
Small (under 30 ft.)	10 ft. x 10 ft.
Medium (under 50 ft.)	20 ft. x 20 ft.
Large (over 50 ft.)	30 ft. x 30 ft.

SYSTEMATIC PRUNING

The Greater Milwaukee area is often cited as a model for urban forestry. Among its examples of systematic tree care is routine pruning of all street trees. Consultants that prepared a management plan for South Milwaukee wrote, “One of the most beneficial and noticeable activities performed in the urban forest is routine pruning. Routine pruning is the cycle of pruning all trees on a rotating basis.” Industry guidelines suggest that the cycle for trees over 6 inches in diameter should be once every 5 – 8 years.

Routine pruning reduces co-dominant stems that break easily and eliminates dead wood that is prone to be broken off and fall or become airborne during wind events. Correct pruning can also reduce wind resistance that is usually responsible for tree failure. In recent years, considerable attention has been given to what is termed ‘tree biomechanics.’ Links to some of this work are found at arborday.org/bulletins.

In one carefully controlled study by Gilman, Masters and Grabosky and published in *Arbiculture & Urban Forestry*, it was found that the effects of all pruning are not equal. In their study of young live oaks that were wired to measuring devices and subjected to generated wind speeds of up to 110 mph, thinning and reduction pruning resulted in less than half the crown movement than nonpruned trees. Raising the crown and “lion tailing” did not offer the same benefits and other studies have shown that these practices raise the mass of the tree and increase the likelihood of failure.

Pruning palm trees requires special care and most people tend to over-prune them. In fact, pruning species such as coconut palms may do more harm than good in preventing storm damage. For more information, follow the links as noted on page 8.



GROUPING

Trees that are isolated in the landscape are more likely to be lost to the brunt of storm winds than those that are in groups. A 'group' has been defined as five or more trees sharing the same soil space. This arrangement offers a degree of mutual protection, root stability and reduction of wind velocity. Replanting after storm destruction offers a good opportunity to evaluate design and consider group planting instead of lines of trees.

Streets that have a population of well-maintained trees of diverse species and ages are more resistant to storm devastation as well as to attacks by invasive insects and diseases.

SPECIES DIVERSITY

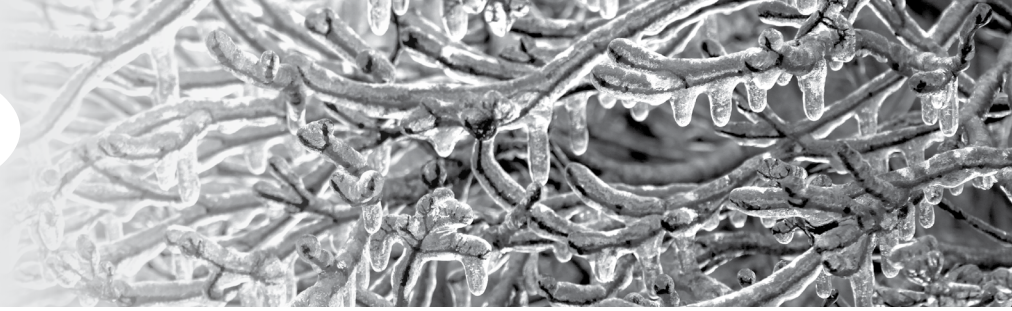
The uniform planting of elms in Midwestern cities more than a century ago resulted in a wakeup call that is still not taken seriously in some communities. When Dutch elm disease struck, entire blocks of beloved shade trees succumbed to the attack. By planting diverse species, the unexpected arrival of a new invasive insect or disease will have much less of an impact. This is also true for storm preparation. Since some trees are more susceptible to storm damage than others, species diversity is one more protection against the enormous loss of trees due to bad weather. Recommendations vary, but the National Arboretum's time-honored formula for species diversity in a community is that there should be no more than 10 percent of any one species, 20 percent in the same genus, and no more than 30 percent belonging to one family. Arborist John Ball suggests that five percent in any one genus is even better. When uniformity is considered a 'must,' scattering such blocks or strips of the same trees throughout the city (spacial diversity) is recommended.



Ice Storms

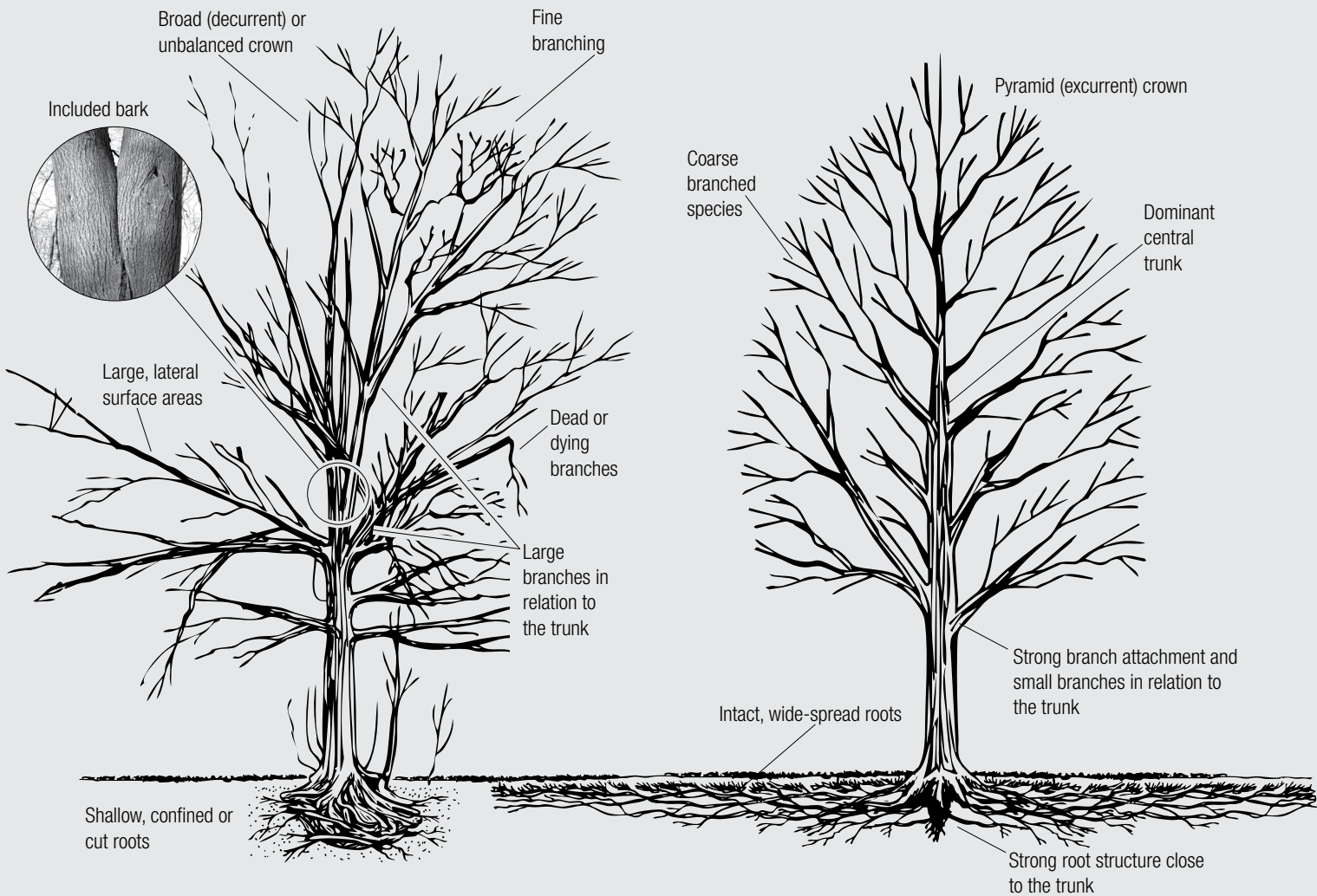
In America the ice storm is an event. And it is not an event which one is careless about.

– Mark Twain



Ice storms are defined by the U.S. National Weather Service as the accumulation of at least ¼ inch of ice on exposed surfaces. Unfortunately these weather events are a common problem over large areas of the country and can cause enormous damage to trees. Links as noted on page 8 will take you to some comprehensive treatments of this

subject, but the illustration below summarizes the problem and what makes some trees more ice-resistant. Careful species selection, pruning and root care are the keys to reducing vulnerability to ice storms. Illustrations are based on work at the University of Wisconsin – Stevens Point and the University of New Hampshire.



PRONE TO ICE DAMAGE

MORE RESISTANT TO ICE DAMAGE

Consider Storm-Resistant Trees When Planting

Prevention is the best cure for storm damage. Whether planting new areas of the community or planting for restoration following a storm event, here are some common species recommended by a variety of experts. In some cases, storm resistant cultivars may be available but native species that have developed with local weather conditions are almost invariably recommended as a first choice.

RECOMMENDED

WIND RESISTANT

- | | | |
|--------------------------------------|-------------------|--------------------|
| American Holly | Long Leaf Pine | Tulip Tree |
| Baldcypress | Southern Magnolia | Turkey Oak |
| Black Tupelo | Paradise Tree | Southern Magnolia |
| Buttonwood | Pigeon Plum | Swamp Chestnut |
| Carolina or Mountain | Pitch Apple | Sweetbay Magnolia |
| Silverbell | Pond Cypress | Sycamore |
| Chastetree | Redbud | Weeping Podocarpus |
| Coconut Palm | Red Oak | Winged Elm |
| Crepe Myrtle | River Birch | Yaupon Holly |
| Dahoon | Royal Palm | |
| Dogwood | Sabel Palm | |
| Fiddlewood | Sea Grape | |
| Florida Sugar Maple | Solitaire Palm | |
| Foxtail Palm | Sand Live Oak | |
| Geiger Tree | Saucer Magnolia | |
| Gumbo Limbo | Screw Pine | |
| Ironwood | Schumard Oak | |
| Live Oak (<i>not in wet soils</i>) | Slash Pine | |



NOT RECOMMENDED

NOT WIND RESISTANT

- | | | |
|-----------------------|-----------------------|-------------------|
| Avocado | Hong Kong Orchid Tree | Tabebuia |
| Banyan/Ficus | Laurel Oak | Washingtonia Palm |
| Black Olive | Mahogany | Water Oak |
| Camphor Tree | Norfolk Pine | |
| Carolina Laurelcherry | Queen Palm | |
| Carrotwood | Royal Poinciana | |
| Chinaberry | Sand Pine | |
| Chinese Elm | Schefflera | |
| Chinese Tallow Tree | Seaside Mahoe | |
| Clerodendron | Sea Hibiscus | |
| Ear Leaf Acacia | Silk Floss Tree | |
| Eucalyptus | Silk Oak | |
| Goldenrain tree | Sweetgum | |



NOTE: Not listed are species considered 'intermediate' in wind resistance. Always check locally for what survives storms best in your community. Also, many or most of these trees can be made more wind resistant through structural pruning.

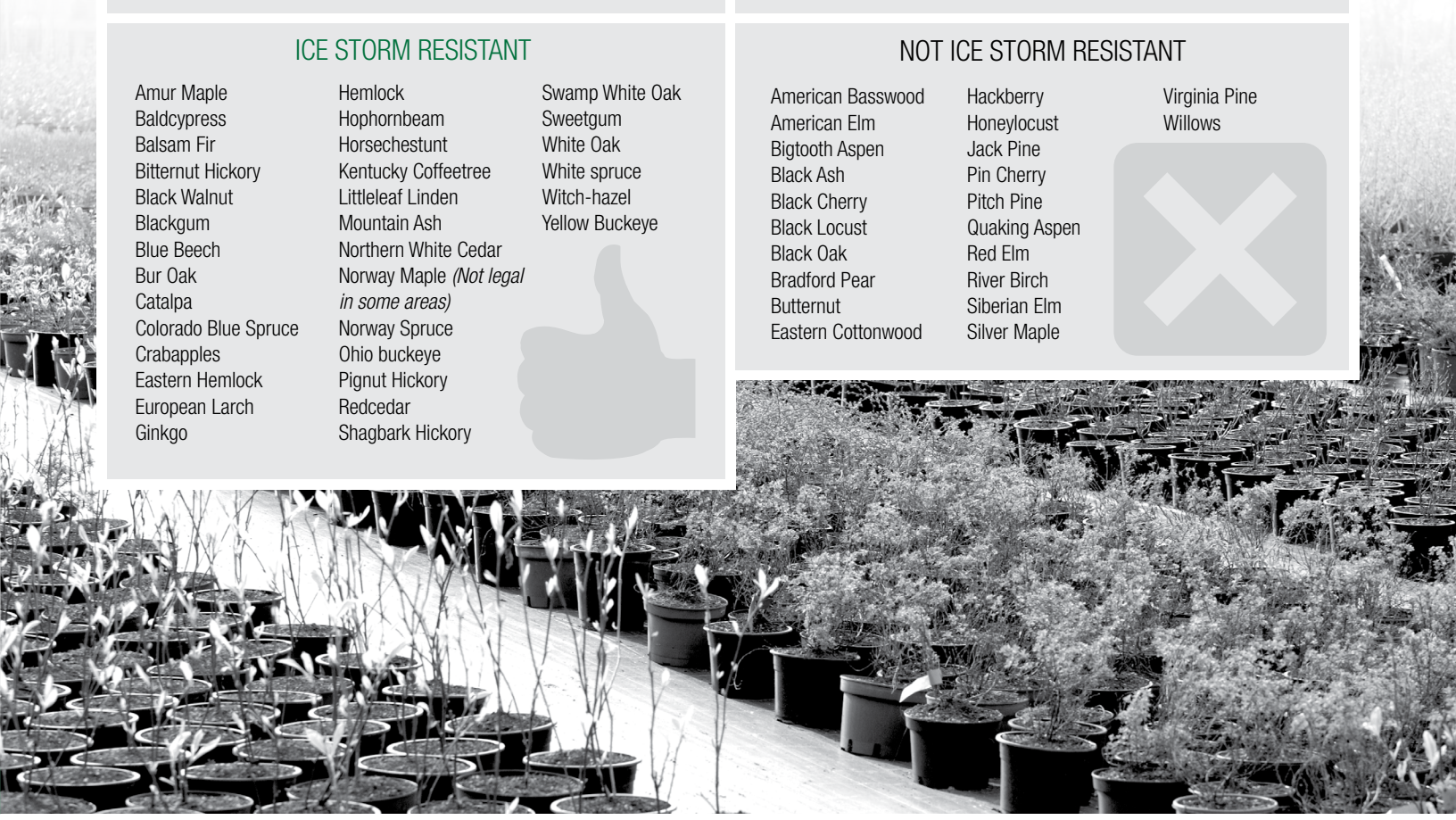
ICE STORM RESISTANT

- | | | |
|----------------------|---|-----------------|
| Amur Maple | Hemlock | Swamp White Oak |
| Baldcypress | Hophornbeam | Sweetgum |
| Balsam Fir | Horsechestnut | White Oak |
| Bitternut Hickory | Kentucky Coffeetree | White spruce |
| Black Walnut | Littleleaf Linden | Witch-hazel |
| Blackgum | Mountain Ash | Yellow Buckeye |
| Blue Beech | Northern White Cedar | |
| Bur Oak | Norway Maple (<i>Not legal in some areas</i>) | |
| Catalpa | Norway Spruce | |
| Colorado Blue Spruce | Ohio buckeye | |
| Crabapples | Pignut Hickory | |
| Eastern Hemlock | Redcedar | |
| European Larch | Shagbark Hickory | |
| Ginkgo | | |



NOT ICE STORM RESISTANT

- | | | |
|--------------------|---------------|---------------|
| American Basswood | Hackberry | Virginia Pine |
| American Elm | Honeylocust | Willows |
| Bigtooth Aspen | Jack Pine | |
| Black Ash | Pin Cherry | |
| Black Cherry | Pitch Pine | |
| Black Locust | Quaking Aspen | |
| Black Oak | Red Elm | |
| Bradford Pear | River Birch | |
| Butternut | Siberian Elm | |
| Eastern Cottonwood | Silver Maple | |



What About Salt?

In coastal areas, preventing wind damage is hard enough but salt spray and salt saturation of soil adds to the problems.

When Hurricane Ike struck the community of Galveston Island in 2011, hundreds of trees were destroyed by the wind. But after the storm, residents found that even most of the surviving trees were dying – up to 90 percent in some neighborhoods. The culprit was salt saturated soil left after the storm surge. In this case, a silver lining of the cloud was the formation of the Galveston Island Tree Conservancy and the replanting of some 25,000 trees in cooperation with the Texas A&M Forest Service. It also resulted in the creation of an urban forestry plan complete with planting standards, recommendations for species diversity and salt resistant trees, and a means for planting with the help of volunteers.



Salt basically robs a tree's ability to absorb life-sustaining water. Storms bring excessive salt spray as much as a quarter of a mile inland, and increasingly high sea surges can leave behind deadly amounts of salt water. Scientists at Virginia Tech offer these recommendations for countering salt problems:

- Plant on berms where salt water will not accumulate.
- After salt exposure, leach the soil through irrigation with fresh water. Flush salt by applying 2 inches of water over a 2 – 3 hour period or until runoff occurs. Repeat this treatment 3 days later.
- Plant salt resistant species, and plant salt sensitive species uphill or otherwise away from salt spray or soil saturation.



Storm-driven salt can damage trees with spray and inundation of the land by sea surges can result in saturation of soil with salt-laden water.

SOME SPECIES RESISTANT TO SALT SPRAY OR STORM-GENERATED SALT WATER SATURATION

Live Oak	Sweetgum	Red Maple
Palms	Water Oak	Dogwood
Slash Pine	Sycamore	
Longleaf Pine	Sweetbay	
Pondcypress	Southern Red Oak	
Loblolly Pine	Hickory	
Redcedar	Mimosa	
Tupelo	Pecan	
Baldcypress	Magnolia	



SOURCE: U.S. Forest Service and shown in descending order of resistance.

After the Storm

Although storms deprive communities of valuable trees each year, even more are lost because of how they are treated after the storm. With some precaution and good judgment, damaged trees can be saved. When this is not possible, prompt replanting will eventually erase the scars of storm damage.

“Experience 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,” observes Matt Harris, chief executive of Arbor Day Foundation. For information about the Foundation’s efforts to reforest devastated communities, please visit arborday.org and type ‘storms’ in the search box. Aside from replanting, here are some steps that will help save damaged trees:

- Don’t panic. Instead, take the view of ‘what can I do to save this tree?’
- If damage is not significant, prune off broken limbs and let the tree grow for 2 – 3 years; and then correct any structural defects.
- Resist any fly-by-night offers to remove a damaged tree. Check the credentials of any arborists who offer to help and make sure they are ISA certified. Talk to them about saving the tree instead of simply the cost of removal.
- Either yourself or with the help of an arborist, assess the damage and decide. Which of the categories shown to the right is it?

PALMS

Palms with broken trunks fall into the “farewell” category. However, if uprooted, the tree should be stood upright as soon as possible, replanted at the original depth, and braced and watered for at least 6 months. If the tree is otherwise okay but the fronds are broken or browned, leave them on the tree. The photosynthesis from any green portion will help the tree recover. In either case, use fresh water to leach salt from the soil if it has been brought in by the storm.



MINOR DAMAGE

Minor but prompt and proper pruning may be all that is needed. Retain as much of the foliage as possible, since this is how the tree manufactures the food it needs. Young conifers that are bent over can often be staked to eventually restore their original shape.



WAIT AND SEE

If less than 30 – 50% of the branches are broken and the tree is otherwise healthy and free of decay, there is a good chance it will survive. Prune broken branches and correct any other hazards, but then give the tree some time.



FAREWELL TO A FRIEND

If the damaged tree has a split trunk, unnatural lean, more than 50% of its crown missing, or was already in poor condition, then it is probably time to say goodbye. Have the tree removed by competent professionals – and be sure to replant with a storm-resistant species or cultivar and establish a young-tree pruning program to develop good branch architecture.

Storm Preparation Can Lead to Growth Award



Communities that meet the standards for a Tree City USA award are more likely to be prepared for storms than those that do not. Seeking the next step – a Tree City USA Growth Award – can help even more.

Here are examples of activities that can help you prepare for adverse weather events while at the same time earning points toward the ten needed to qualify for a Tree City USA for a Growth Award.

CATEGORY A: EDUCATION & PUBLIC RELATIONS

- A campaign to promote planting storm-resistant trees
- Publicity about tree care following a storm
- A workshop or mass media ads about proper pruning (including pruning for strong branch architecture and other storm-resistance techniques)

CATEGORY B: PARTNERSHIPS

- Creating a tree planting and/or stewardship group
- Establishing a formal working relationship with a utility or nonprofit tree organization
- Initiating or improving a cost-sharing program to encourage the planting of storm-resistant trees on private property

CATEGORY C: PLANNING & MANAGEMENT

- Completing a management plan or emergency plan
- Creating or updating a street tree inventory or conducting an ecosystem service analysis.
- Conducting the pre-storm stage for use in i-Tree Storm (a method of rapidly assessing the extent of damage and cleanup needs after a storm)

CATEGORY D: TREE PLANTING & MAINTENANCE

- Assessing tree risk and mitigating or removing hazard trees
- Street tree pruning
- Tree planting for restoration after a storm

FOR MORE INFORMATION...

For more information about the Tree City USA Growth Award, please visit arborday.org and enter Growth Awards in the search box. For quick links to more information about topics mentioned in this bulletin, go to arborday.org/bulletins and navigate to Bulletin No. 75.

Tree City USA Bulletin ORDER FORM

Name _____
 Organization _____
 Address _____
 City _____ State _____ Zip _____
 Phone _____

Here are some additional bulletins with information that can help your community make its trees more storm resistant or that can help with storm recovery and restoration. For a complete list of back issues, please visit arborday.org

	1 Issue \$3.00 ea.
2. When a Storm Strikes	2. \$
4. The Right Tree for the Right Place	4.
6. How to Hire an Arborist	6.
7. How to Save Trees During Construction	7.
8. Don't Top Trees!	8.
9. Writing a Municipal Tree Ordinance	9.
15. How to Recognize/Prevent Hazard Trees	15.
16. How to Recycle Shade Tree Materials	16.
18. Tree City USA Growth Award	18.
19. How to Select and Plant a Tree	19.
25. Tree Line USA	25.
26. Understanding Landscape Cultivars	26.
28. Placing a Value on Trees	28.
29. How to Plan for Management	29.
31. Tree Protection Ordinances	31.
32. Let's Stop Salt Damage	32.
35. Protect Trees During Underground Work	35.
36. How to Work with Volunteers Effectively	36.
40. Trees in the Riparian Zone	40.
41. Reduce Wildfire Risk	41.
43. Selling Tree Programs	43.
45. Trees for Better Streets	45.
48. Teamwork Strengthens Community Forestry	48.
51. Trees and Safety	51.
54. How to Grow a Great Tree Board	54.
55. How Trees Can Retain Stormwater Runoff	55.
56. Help Stop Insect & Disease Invasions	56.
58. Community Engagement	58.
63. Living on the Edge – Wildland/Urban Interface	63.
64. Saving Our Heritage Trees	64.
68. How Communities Recover From Disasters	68.
72. Working with Contracts & Contractors	72.
---- Tree City USA Annual Report	
TOTALS:	\$

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