

# Lightning-Struck Tree Assessment and Mitigation: Arborist Protocols based on Literature Review and Case Studies

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When lightning strikes a tree, its' owner or manager or insurance company faces a difficult decision. Information is needed before a reasonable response can be made, so an arborist or another professional is consulted. Depending on the appearance of the tree and the injury, the first reaction is often either "We don't know how bad the damage is, so we should remove it," or "It looks okay for now, let's wait and see." These responses often do not adequately address the needs of the owner or the tree. When the client is an insurance company, there is no time to wait and see because the economic loss to the property is calculated as part of a claim. After systematically assessing the damage, the experienced arborist can make a better prognosis of the tree's chance of recovery if mitigation treatments are applied. All reasonable arboricultural options should be presented, so an informed decision can be made.

A review of the following literature reminds us of the nature of lightning damage, and some of our arboricultural options:

In 1913's *Practical Tree Repair*, Elbert Peets of Harvard University noted that, "As the moister parts of the tree are the best conductors, the electricity almost invariably takes its course down the cambium and the wet sapwood just below it. The course is usually rather narrow, oftenest three or four inches wide, though sometimes there are two or more such courses down the trunk. The wood offers sufficient resistance to the electricity to produce a high degree of heat.

This heat instantly vaporizes the sap and it is the pressure of the steam thus produced which rips the long ribbons of bark and splinters of wood out of the trunk. The only thing to do with these long scars in the tree is to clean them of frayed and isolated bark and paint them. There is no certainty, after all, that this treatment will end the story, for lightning affects trees in strange ways."

In 1941's *Pruning Trees and Shrubs*, Ephraim Porter Felt of the Bartlett Tree Research Laboratory said that the effects were uncertain at first, so "...immediate extensive repairs are not advised... damaged branches should be cut away...advisable to tack the edges of the loosened bark firmly in place...Feeding or invigorating may be advisable...". After a year came tracing dead bark and covering exposed wood with a dressing.

In 1972's *The Pruning of Trees, Shrubs and Conifers*, George E. Brown of Kew Gardens said, "If only a few branches are affected, it is possible to retain a tree, provided that it is left in a safe condition...Such a wound should be cleaned up, the surface being left smooth and free of splinters. A dressing is also helpful."

In 1991's *Modern Arboriculture*, Alex Shigo said, "It is very difficult to assess the amount of injury when trees are struck and little mechanical disruption is evident. The only answer is to remove obviously injured branches and to wait and watch the tree. If a long strip of bark has been killed, remove the dead bark, but do not cut into the wood. Follow normal scribing techniques of shallow cuts and do not enlarge the wound."

In 2003's *Abiotic Disorders of Landscape Plants; A Diagnostic Guide*, Costello et al. noted that "Repairs to struck trees should be limited to safety pruning and cleanup. Further efforts depend on whether the tree survives and what condition it is in. Immediately after the strike, loose bark should be tacked back into place and kept moist to prevent drying. Improve vigor of lightning-injured plants by good culture, especially proper irrigation. Prune or remove dead branches to reduce potential hazards."

In 2003's June issue of *Arborist News*, Tom Smiley wrote that "appropriate treatments may consist of water management, bark repair, limiting bark desiccation, pruning, fertilizing, pest monitoring, and pest management...routine inspections for health and safety are recommended."

In 2004's *Arboriculture: Integrated Management of Trees, Shrubs, and Vines*, Harris, Matheny and Clark agree on limiting repairs until survival seems assured. They also recommend tacking and wrapping bark "with moist cloth or burlap and polyethylene film to slow drying," watering and fertilizing, and reassessing after a year to see if "more careful pruning and wound repair may be worthwhile."

In 2005's *Diseases of Trees* Sinclair and Lyon observed that "Formed by cambium at time of injury, lightning rings in resinous conifers have a lot of resin ducts...ridges develop on the trunks of angiosperms...adventitious roots grow from beneath the cover of dead bark."

Lightning often dislodges one vertical streak of bark, sometimes more, from the top of the tree to the bottom. Often this streak spirals along with the wood grain, but sometimes the grain is very straight and so is the streak. Lightning streaks may be continuous or discontinuous, wide or narrow. Streaks of dead and damaged bark can have other causes, such as girdling roots, the removal of large limbs, physical injury and damage to the branch collar such as flush cuts. By locating all of the injured tissue, the arborist can eliminate these other possibilities and more confidently diagnose lightning damage. Before taking a closer look at the bark, however, a look at the entire tree is needed. Here is one treatment protocol:

1. Evaluate the tree's overall structural condition, starting with preexisting defects such as basal decay, splitting forks, and dead or broken branches. Consider the tree's location relative to people and property—the Target Rating—and the risk to these targets. If these defects are severe, the arborist should exercise caution. Lightning can cause cracks in the wood, which may only be seen with binoculars. Deep cracks in a decay-prone



Lightning streak in Tulip tree (*Liriodendron tulipifera*). The raised area to the left of the streak—the bark is detached from the tree.

species can make it unstable, making it unable to safely sustain the loads of rigging during removal. Cracks can be assessed by probing with a handsaw, or a thinner instrument if needed. If the cracks are deep and many, consider removal.



Deep cracks in white oak (*Quercus alba*). Location was at a major fork thirty feet above the ground. Damage was not visible from the ground. Bark loss was extensive. The tree had to be removed.

2. Tap the bark with a mallet or hammer to see if the bark is dislodged from the wood. Some dead bark appears undamaged because it is still continuous, so an auditory inspection follows the visual inspection. A hollow sound indicates that air is resonating in the space created when the

bark is detached from the wood. As in other uncertain situations, the one-third rule can apply: wounds comprising more than 33% of the circumference are unlikely to close before there is substantial decay, and removal should be considered. As in other applications of “The one-third Rule,” this guideline and any decisions based on it must be tempered by other factors such as the vigor of the species, the vitality of the specimen, site factors and the owner’s tolerance and preferences.

3. Remove bark that is dry inside. Caution is needed to avoid pulling too hard and separating bark that is still moist inside from the wood. If the tool used for removal of thin bark has a hooked blade like a knife used to cut linoleum, the wood and the intact bark will be less likely to be accidentally damaged. On thicker-barked trees, a handsaw, hand pruners, and finally a chisel can be used to prune away the dead bark. Boundaries between dead and living bark should not be broken. In the rare case that the arborist gets to the tree while the tissue inside the bark (cambium) is still moist, the bark may be reattached to the wood. Consider closing that part of the wound by reattaching the bark, after assessing the rest of the tree.
4. Climb the tree, equipped with the same tools, plus a measuring tape and a camera to document observations. If there is uncertainty over structural safety, a pull test can determine whether the tree is safe to climb. If another assessor does the aerial work, make sure they are well trained. Starting at the highest structural branch, the lightning damage is located, measured and documented. Special attention should be paid to major forks, because of their structural significance. Lightning damage can be obscured by—and perhaps attracted to—debris that collects in these forks, and the streak of damaged tissue can follow the grain and take a turn around collars and branch protection zones. Data from the aerial inspection is combined with that gained from the ground, and a prognosis for recovery is made. Consider the tree’s location relative to people and property—Target Rating. Describe the present risk level to the owner or manager, and let them decide if the risk is acceptable to them. Next, outline all reasonable treatment options, including future needs and prognosis of future risk. With all the tools at your disposal, describe the likelihood and cost of increased safety.

If the owner decides to keep the tree, the following steps should be taken:

1. Reattach the bark that is moist inside. Thin bark may be held in place with moist cloth or burlap under polyethylene film. Thicker bark may be reattached with fasteners such as staples. Annual auditory assessment will show whether reattachment was successful. Prune any bark that dries and dies.
2. Treat the exposed wood, or treat the whole tree treated systemically to repel insects. Treatment should be reapplied as needed until the wound is closed.
3. Last but certainly not least, care for the roots. At a minimum, mulch the root system 2 to 4 inches with organic material and irrigate as needed. The soil around the roots, especially those that carried the current, should be aerated as needed and inoculated with beneficial microorganisms such as mycorrhizal fungi. Any mineral element that is lacking should also be applied. Lightning activity is considered to be a source of nitrogen that is fixed in the soil and available to plants, so

the need for nitrogenous fertilizer is unclear. Testing the soil where lightning entered the earth could reveal some interesting nitrogen levels.

4. Appraise the value of the tree, if the owner or manager considers that useful for insurance, tax or other purposes. If the damage is not considered terminal, this appraisal can take the form of Cost of Cure or Cost of Repair. If the tree is judged to be a total loss, Replacement Cost or Cost of Cure may be used. The Trunk Formula method may be used in cases where the owner will not be declaring a capital loss on the property for tax purposes.

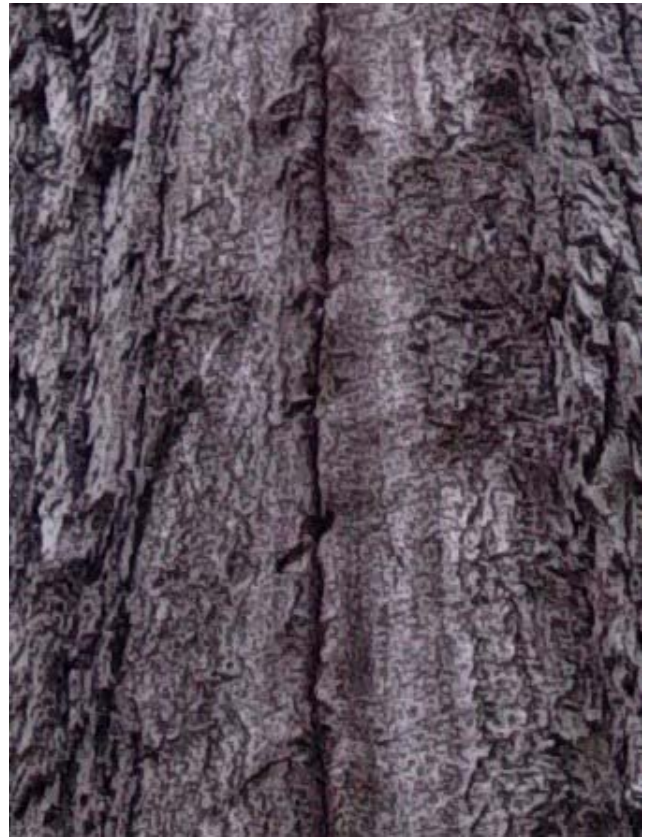
Following are some case studies of lightning-struck trees:

## A TALE OF TWO OAK TREES

Lightning struck twice in Wake County, NC one year, and two big oak trees bore the brunt. What happened next tells a tale of “Scrooge-like” assumptions, and how Great Expectations can go awry.

The first oak (*Quercus alba*), was undisturbed before the strike, except for a small driveway. The forester who looked at it said “Bah, humbug!” He assumed this tree was permanently destroyed. The wound was vertical, and no more than ten inches wide from the base to two damaged upper branches, which were removed. The bark was trimmed, the wood treated, and the roots invigorated. In four years the wound was completely closed.

The second oak (*Quercus falcata*) majestically defined the edge of the historic district in a small town. Two years before, it had received an historic tree award. Scant lawn in full sun covered half the root system, and little of the rest was mulched. The lightning damage seemed just slightly wider than the first, so the arborist started treating the wound as before. Halfway down, a portion of bark more than 4 feet square was detached below some old pruning wounds. Curiously, the detached bark was not near the lightning wound! Insects had entered wounds made by climbing spikes and eaten away the cambium. That climber must have dug in his spikes to keep his balance as he cut, with Great Expectations that those little holes couldn’t possibly hurt that great big tree. Aggravating this injury was the bare ground baking beneath. Oaks being ring-porous, the roots that were needed to help repair this damaged side of the tree had too many problems of their own to perform that function.



Wound closure on *Quercus alba*. Seals trees from insects and disease.

Added to the lightning wound, this human-made injury put the total dead bark area more than one-third of the circumference. Despite insect control, fertilization, and belatedly, mulch, the prognosis was poor.

Little scar tissue grew, the foliage turned pale, and the tree was removed. Its useful years were over, evidently due in part to the use of climbing spikes and root abuse.

Lightning may someday inflict a Twist-ed scar on your trees, but you can keep storms, disease and insects from picking your urban forest's pocket. A healthy root environment below organic groundcover costs less than a cup of gruel. The tree provides it for free when it sheds its leaves. That, and climbing with ropes instead of spurs, can keep your trees growing great. Lightning may scare the Dickens out of us, but it's nothing to lose all our trees over.

## LIGHTNING STRIKES TWICE

I was hired by an insurance company to look at two pine trees that had been struck by lightning. My assignment was to determine their condition and recommend whether the trees would be safe to leave on the property.

The tree closest to the house, near the southwest corner, has a narrow fork about thirty feet up. One side of the tree above that fork leans toward the house. The streak of bark damaged by the lightning charge appears to pass directly through this fork. This damage to this crucial area can lead to cracking and decay, which would likely result in tree failure and damage to the house. I recommend this tree be removed.

The second pine tree hit by lightning is further back in the yard, next to a magnolia tree. It has a single stem, and overall a stable form. It shows signs of a prior lightning strike, and the present strike has blown bark off in intermittent patches from top to bottom. Though no one damaged area comprises a significant defect to the tree, their cumulative effect needs to be considered.

The wounds from the prior strike have some callus "scar" tissue on their edges, indicating that the tree is starting to seal over these wounds. Inside the callus, the exposed wood is cracking, and some decay has begun. In a more vigorous pine tree, more sap would coat this exposed wood, preventing decay. Now the tree's resources must be applied toward sealing both the new wounds and the old wounds.

This was occurring during a period when the population of the pine tree's worst enemy, the southern pine beetle (*Dendroctonus* sp.) was on the rise. Summer droughts are also severe, which may be one factor for the tree's low vigor. Given the tree's size and location, failure at any one of the decayed sites on the trunk would likely cause significant damage to the house. For these reasons I recommend this tree's removal.

## A VETERAN FALLS

In 2002, lightning struck a post oak (*Quercus stellata*) tree located at the edge of the graveyard at Andersonville National Cemetery in Georgia, USA. In 2007 I agreed to inspect it, to inform decisions made by park staff regarding the management of these trees.

### OBSERVATIONS

I noted four separate streaks of wood down the stem, at approximately right angles to each other. The widest wound ran from the base up to the first primary fork on the northwest side and back down the other side. A small crack was starting at that fork, and there is active decay in a pocket above the crack,

just below the fork. A large fat skink (insectivore common to Georgia, U.S.A.) was living under the detached bark.

There is ongoing excavation for gravesites in the southern half of this tree's rootzone. The foliage is pale and yellowish. There is erosion and compacted soil to the north, and significant damage to buttress roots all around.

### TESTING & ANALYSIS

I used a hammer to test the trunk of Tree #263 for resonance at 4.5 feet above the ground. Fifty-two inches of bark circumference sounded hollow. Removal of this bark showed that it was dry inside and dead while 105 inches of the circumference sounded alive. Unidentified woodboring insects were active underneath the loose bark but not in the exposed areas, where the wood was dry. The wound above the primary fork was more than 20 inches wide. A probe went 6 inches through mushy tissue at the fork.

### CONCLUSION

With 1/3 of the bark blown off the trunk, and a 20-inch wound above the first fork, this lightning damage seems terminal. This fork seems at risk to fail in a moderate storm this summer, but it could be cabled to buy some years. However, it is a matter of time before cracking and decay render the lower trunk unstable. Poor root health and more excavation for graves mean this time may come fairly soon, despite this species' resistance to decay. Tree # 263 poses a high risk in the near to medium term and should be removed.

## A TALE OF TWO EVERGREENS

One Douglas-fir (*Pseudotsuga menziesii*), located between a trail and a slope at the magnificent Hoyt Arboretum in Portland, Oregon, USA was struck in 1982. Inches-thick callus tissue has slowly filled the void between the detached bark and the wood in the quarter-century since the hit. The foliage is sparse and pale and dead branches are visible, but the target rating is low so no action has been taken.

The second Douglas-fir was struck in late 1990s, is near the visitor's center. Callus growth is good and the crown is dark green and full. The staff is monitoring both trees. You can visit the Hoyt Arboretum while attending the ISA International Conference in 2012, and see if they are still there.

## BEYOND REPAIR: RECOVERING THE LOSS

### ASSIGNMENT

In 2006 I went to 123 Oak Street. I saw a post oak (*Quercus stellata*), in the front yard that had lost most of its bark due to an apparent lightning strike. I was asked to appraise the economic value of the tree, and recommend ways to replace the tree's contributions to the property. I understand the purpose and use of my report was to help the Smiths receive reasonable compensation from their insurance company for the loss of the tree.

### EXECUTIVE SUMMARY

A post oak was killed by lightning. Its economic value is appraised at \$x considering the loss of future benefits, or \$y to install and establish a smaller replacement tree, after removing the casualty tree.



Extensive bark damage and cracking forced removal of tree.

## OBSERVATIONS

The landscape is designed around this landmark tree, which dominates the front yard. The tree trunk has lost so much bark, the tree will soon die. Located in the southwest corner of the yard, the tree shades the home in the summer from midday through the evening.

## DISCUSSION

The tree's present contributions to the property include:

**Erosion Control.** By intercepting precipitation, and also through its network of feeder roots near the surface, this tree dominates the landscape. Through the activity of microorganisms attached to and among these roots, it builds the soil resource.

**Wind and Light Control.** By deflecting, obstructing and filtering the wind, it moderated the climate for this property. This effect also benefited the nearby community. By filtering sunlight, it provided the perfect environment for the understory plants, and moderated the environment around the home.

**Pollution and Noise Abatement.** Gaseous and particulate pollution was intercepted by the leaves and bark, and buffered by the rootzone. The sound of traffic and other urban activity was muffled.

**Ecosystem Values.** By attracting, sheltering and feeding wildlife, this mature tree was the keystone species in the local ecosystem. Its loss will have a ripple effect through the community of songbirds and small mammals, and many smaller species that often escape human notice.

**Shade.** The temperature under large trees is often more than ten degrees cooler than in the open. A nearby property which lost all its shade trees had a 67% increase in cooling costs.

**Transpirational Cooling.** A mature tree can transpire more than 200 gallons of water through its leaves per day. The evaporation of this water into vapor has a considerable cooling effect, and by recycling the water before it gets to the stream, the trees save on **stormwater control** costs.

**Aesthetic Value.** The tree's rounded outline softens the harsh edges of the built environment. The deep green color visually cools the homesite, and the sheer size of this specimen frames the view into and out of the home from many angles.

## APPRAISAL: COST OF CURE METHOD

“When extensive damage has occurred,” there is a Cost of Cure Method of appraisal, which “...determines the cost of replacement and/or repairing of plants and restoration of property to a reasonable approximation of its original condition...” This excerpt is taken from the ninth edition of the *The Guide for Plant Appraisal*, authored by the Council of Tree and Landscape Appraisers—a consortium of seven trade, educational, and scientific associations: the International Society of Arboriculture, the American Society of Consulting Arborists, the Tree Care Industry Association, the American Nursery and Landscape Association, the American Society of Landscape Architects, the Association of Consulting Foresters of America, and the Associated Landscape Contractors of America, and published by the International Society of Arboriculture in 2000.

This method has the advantage of addressing the loss to the property in its entirety. This Cost of Cure starts with the cost of obtaining and installing the largest commonly transplanted tree. I will use a 10 inch diameter tulip poplar (*Liriodendron tulipifera*), because it is a native, fast-growing hardwood. To consider the Smiths’ deprivation of the use and enjoyment of the tree’s contributions until it grows to replacement size, an interest rate of 5% is compounded and applied to the cost of the installed tree. The replacement tree will take 10 years to deliver the contributions of the casualty tree, so  $1.05 \times 1.05$ , multiplied 10 times = 1.65.

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The adjusted plant cost is \$a, x 1.65 =	\$b
Cost of installation = \$c, x 1.65 =	\$d
Maintenance cost will be \$q/year for fertilizing and pruning in late winter, for ten years =	\$e
Removal of casualty tree	\$f
<b>TOTAL APPRAISED VALUE, b + d + e + f =</b>	<b>\$g</b>

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Lightning strikes present arborists with a stimulating set of challenges. By actively employing all the arboricultural tools at their disposal, they can meet their mission of facilitating the coexistence of trees and people, whatever the forces of nature throw their way.