

Flood Damage to Trees after Hurricane **Sandy: Lessons and Surprises**



Section of Long Island following Hurricane Sandy photographed by U.S. Coast Guard Petty Officer 2nd Class Rob Simpson. Photo in the public domain.

by Michelle Sutton

The 2016 Atlantic Ocean hurricane season officially began June 1, with meteorologists offering varying opinions about how much activity we in the eastern U.S. will see. Hurricane Sandy (October 2012) savaged tree populations with both high winds and flooding. Sandy brought one storm surge of salt water that retreated with the same day's tides. What were some of the impacts and lessons learned? We hear from a veteran arborist on Long Island and from a former NYC urban forester.

What are the major reasons flooding is so punishing for trees? Dr. Kamran Abdollahi, professor of forest ecophysiology in the urban forestry program at Southern University in Baton Rouge, Louisiana, explains that flooding fills soil pores, denying tree roots access to the oxygen they need for respiration and water and nutrient uptake. Dr. Abdollahi says, "In the urban environment where soils are already compacted by human activities, flooding exacerbates compaction and its negative effects. Flooding can also negatively affect root anchoring and tree stability."

Long Island

Arborist Joel Greifenberger is the owner of Valley Tree and Landscape in Long Beach, Long Island. Valley has planted more than 25,000 trees for NYC in over 25 years. Greifenberger says

that on Long Beach, Hurricane Sandy brought several feet of salt water on land, “bay to ocean,” for about 12 hours. That brief flooding event left dramatic damage to the region’s trees, with some surprising victims.



London plane trees, once thought to be salt tolerant, fared poorly on Long Island and in NYC after Hurricane Sandy. Photo Courtesy Cornell Urban Horticulture Institute

The biggest shock was how poorly Long Island’s many London plane trees fared. They were long thought to be flood and salt tolerant and had been widely advocated for seaside use. Greifenberger says the damage manifested in stages; the following spring, an average of a third of the canopy was affected. “It wasn’t typical dieback,” he says, “in that it didn’t affect the whole crown. A large section of the crown on one side would not break bud, while the rest leafed out normally.” However, over the 2013 growing season, the trees continued to show signs of decline, until by 2014 their bark started to peel off and the trees died.

In the summer of 2014, Long Beach took down more than 1400 dead trees. “My guess is that 85% or more of them were London planes,” Greifenberger says. “We used to have our streets lined with allées of them, like American elms back in the day. This was a huge blow to our city.” He says that the city will avoid planting monocultures in the future, no matter how flood-tolerant any one tree species is thought to be.

Arborvitaes in his area were instantly killed by the floods, as were blue atlas cedars. “I had a job where I’d planted 200 blue atlas cedars at 4-inch caliper,” Greifenberger says, “and they were at

7-inch caliper when the storm came; they were dead within weeks. That was heartbreaking.” Leland cypresses also were quick to die. Tulip trees never put leaf on again. Every single Japanese maple died. Pine trees and magnolias were a mixed bag. Across species, mortality was high for newly planted/younger trees.

In the “happy surprises” column, Greifenberger says, “Blue spruces, for one, never looked better; no one expected that! Junipers and red cedars did fine, as did holly trees. The Kwanzan cherry trees did ok if they’d been in the ground at least three years. Honey locusts and pears did ok, and Norway maples and zelkovas did well.”

New York City

New York City lost 10,926 trees to storm damage from Sandy and shared with Long Island the experience of significant die-off of London plane trees. NYC Parks and Recreation prepared a report after Sandy related to flooding. With regard to London planes, more than 1500 failed to leaf out at all the following season and more than 2500 leafed out 50% at best, with further decline anticipated.



Flooding can contribute to root instability Courtesy NYC Parks Recreation

Part of that report asks, “How will we change what we plant because of Hurricane Sandy?” Former NYC Parks and Recreation Director of Street Tree Planting Matthew Stephens said, “Sandy highlighted that we as urban forest managers must continue to be vigilant in our efforts to specify trees that will be resilient to not only a diverse array of urban factors, but also changing environmental factors. For example, going forward, trees we choose to plant within the advisory flood zone for a one percent storm must be tolerant of both coastal conditions as well as inundation.” To give you an idea of how important this consideration is, fourteen percent of NYC streets fall within the advisory flood zone.

Integrating what was learned from Sandy’s particular toll, Stephens and colleagues identified a list of 75 tree species and cultivars that the City considers worthy of use in the advisory flood

zone for a one percent storm (also known as a 100-year storm). “Every new tree planted within the flood zone will now be chosen from the refined palette to ensure our trees are long-lived and resilient,” Stephens said. See the first list below.

Choose the tree that will be “long-lived and resilient”

Private and public property owners will find the extensive compilation of “hurricane” survivor trees in **List #1** useful for selecting trees for side or back yards.

For trees close to the street, owners should consult **List #2 *Recommended Street Trees*** from the [Salem Tree Manual](#). This list is regularly updated by the Salem Tree Warden and Tree Commission. The species and cultivars that have a greater tolerance for saltwater inundation are marked “**FP**” for “**Flood Plain**.”

List 1: Tree Species and ‘Cultivars’ That Survived Hurricanes and Saltwater Inundations

Species and ‘Cultivars’	Common Name
<i>Acer campestre</i>	Hedge Maple
<i>Acer campestre</i> ‘Evelyn’	Evelyn Hedge Maple
<i>Acer campestre</i> ‘Metro Gold’	Metro Gold Hedge Maple
<i>Acer rubrum</i> ‘Red Sunset’	Red Sunset Maple
<i>Betula nigra</i> ‘Duraheat’	Duraheat River Birch
<i>Betula nigra</i> ‘Heritage’	Heritage River Birch
<i>Carpinus betulus</i> ‘Fastigiata’	Columnar European Hornbeam
<i>Celtis occidentalis</i>	Hackberry
<i>Celtis occidentalis</i> ‘Magnifica’	Magnifica Hackberry
<i>Cercis reniformis</i> ‘Oklahoma’	Oklahoma Redbud
<i>Crataegus</i> ‘Crimson Cloud’	Crimson Cloud Hawthorn
<i>Crataegus crusgalli</i> var. <i>inermis</i>	Thornless Cockspur Hawthorn
<i>Crataegus</i> ‘Lavellus’	Lavellus Hawthorn
<i>Crataegus phaenopyrum</i> ‘Washington’	Washington Hawthorn
<i>Crataegus viridis</i> ‘Winter King’	Winter King Hawthorn
<i>Eucommia ulmoides</i>	Hardy Rubber Tree
<i>Ginkgo biloba</i> ‘Autumn Gold’	Autumn Gold Ginkgo
<i>Ginkgo biloba</i> ‘Magyar’	Magyar Ginkgo
<i>Ginkgo biloba</i> ‘Princeton Sentry’	Princeton Sentry Ginkgo

<i>Gleditsia triacanthos</i> var <i>inermis</i> 'Shademaster'	Shademaster Honeylocust
<i>Gleditsia triacanthos</i> var. <i>inermis</i> 'Halka'	Halka Honeylocust
<i>Gleditsia triacanthos</i> var. <i>inermis</i> 'Imperial'	Imperial Honeylocust
<i>Gleditsia triacanthos</i> var. <i>inermis</i> 'Skyline'	Skyline Honeylocust
<i>Gymnocladus dioica</i>	Kentucky Coffeetree
<i>Gymnocladus dioica</i> 'Espresso'	Espresso Coffeetree
<i>Gymnocladus dioica</i> 'Prairie Titan'	Prairie Titan Coffeetree
<i>Juniperus chinensis</i> 'Hetzi'	Blue Hetzi Juniper
<i>Juniperus virginiana</i>	Eastern Red Cedar
<i>Koelreuteria paniculata</i>	Goldenraintree
<i>Koelreuteria paniculata</i> 'Fastigiata'	Columnar Goldenraintree
<i>Koelreuteria paniculata</i> 'Rose Lanterns'	Rose Lanterns Goldenraintree
<i>Lagerstroemia indica</i> 'Muskogee'	Muskogee Crape myrtle
<i>Maackia amurensis</i>	Amur Maackia
<i>Maackia amurensis</i> 'Starburst'	Starburst Maackia
<i>Malus</i> cultivars	Crabapple
<i>Metasequoia glyptostroboides</i>	Dawn Redwood
<i>Metasequoia glyptostroboides</i> 'Gold Rush'	Gold Rush Dawn Redwood
<i>Nyssa sylvatica</i>	Black Gum
<i>Nyssa sylvatica</i> 'Forum'	Forum Black Gum
<i>Nyssa sylvatica</i> 'Red Rage'	Red Rage Black Gum
<i>Quercus acutissima</i>	Sawtooth Oak
<i>Quercus bicolor</i>	Swamp White Oak
<i>Quercus macrocarpa</i>	Bur Oak
<i>Quercus muehlenbergii</i>	Chinkapin Oak
<i>Quercus phellos</i>	Willow Oak
<i>Quercus robur</i>	English Oak
<i>Styphnolobium japonicum</i> 'Princeton Upright'	Princeton Upright Sophora
<i>Styphnolobium japonicum</i> 'Regent'	Regent Sophora
<i>Syringa</i> 'China Snow'	China Snow Lilac

<i>Syringa reticulata</i>	Japanese Tree Lilac
<i>Syringa reticulata</i> 'Ivory Silk'	Ivory Silk Lilac
<i>Taxodium ascendens</i> 'Nutans'	Nutans Bald Cypress
<i>Taxodium distichum</i>	Bald Cypress
<i>Taxodium distichum</i> 'Shawnee Brave'	Shawnee Brave Bald Cypress
<i>Ulmus</i> 'Accolade'	Accolade Elm
<i>Ulmus americana</i> 'Princeton'	Princeton American Elm
<i>Ulmus americana</i> 'Valley Forge'	Valley Forge American Elm
<i>Ulmus</i> 'Frontier'	Frontier Elm
<i>Ulmus</i> 'Jefferson'	Jefferson Elm
<i>Ulmus</i> 'Morton Glossy'	Triumph Elm
<i>Ulmus</i> 'New Harmony'	New Harmony Elm
<i>Ulmus</i> 'New Horizon'	New Horizon Elm
<i>Ulmus parvifolia</i>	Chinese Elm (Lacebark)
<i>Ulmus parvifolia</i> 'Allee'	Allee Chinese Elm
<i>Ulmus parvifolia</i> 'Bosque'	Bosque Chinese Elm
<i>Ulmus parvifolia</i> 'Dynasty'	Dynasty Elm
<i>Ulmus</i> 'Patriot'	Patriot Elm
<i>Ulmus</i> 'Pioneer'	Pioneer Elm
<i>Zelkova serrata</i> 'Musashino'	Musashino Zelkova
<i>Zelkova serrata</i> 'Green Vase'	Green Vase Zelkova
<i>Zelkova serrata</i> 'Village Green'	Village Green Zelkova
<i>Zelkova serrata</i> 'Variegata'	Variegated Zelkova
<i>Zelkova serrata</i> 'Wireless'	Wireless Zelkova

See next page for List 2 Salem Recommended Street Trees

List 2: SALEM, MA RECOMMENDED STREET TREE SPECIES, [Salem Tree Manual](#)
LARGE (>45') & MEDIUM (35' - 45') SHADE TREES **No wires overhead.**

BOTANICAL NAME <i>Native Tree^N Flood Plain^{FP}</i>	COMMON NAME	These 'cultivars' have shown tolerance for Flood Plains	HEIGHT
<i>Acer rubrum^N</i>	Red Maple	'Red Sunset'	40-60'
<i>Acer x freemanii^N</i>	Freeman Maple		40-75'
<i>Betula nigra^N</i>	River Birch	'Duraheat'/'Heritage'	40-70'
<i>Carpinus betulus</i>	European Hornbeam	Columnar European Hornbeam	35-60'
<i>Carpinus caroliniana^N</i>	American Hornbeam		20-30'
<i>Carya ovata^N</i>	Shagbark Hickory		70-90'
<i>Celtis occidentalis^{N FP}</i>	Common Hackberry	'Magnifica'	40-60'
<i>Cercidiphyllum japonicum</i>	Katsura Tree		40-60'
<i>Cladrastis kentukea^N</i>	Yellowwood		30-50'
<i>Fagus grandifolia^N</i>	American Beech missing		50-80'
<i>Ginkgo biloba</i>	Ginkgo, Maidenhair Tree	'Autumn Gold'/'Magyar' 'Princeton Sentry'	50-80'
<i>Gleditsia triacanthos</i> var. <i>inermis^N</i>	Thornless Honeylocust	'Halka'/'Imperial' 'Shademaster'/'Skyline'	40-60'
<i>Gymnocladus dioica^{N FP}</i>	Kentucky Coffeetree	'Espresso'/'Prairie Titan'	50-75'
<i>Halesia carolina^N</i>	Carolina Silverbell		20-40'
<i>Koelreuteria paniculata^{FP}</i>	Goldenraintree		30-40'
<i>Liquidambar styraciflua^N</i>	American Sweetgum		40-65'
<i>Liriodendron tulipifera^N</i>	Tuliptree		70-90'
<i>Metasequoia glyptostroboides</i>	Dawn Redwood		70-100'
<i>Nyssa sylvatica^{N FP}</i>	Black Gum, Tupelo	'Forum'/'Red Rage'	30-60'
<i>Platanus x acerifolia</i>	London Planetree		65-80'
<i>Quercus alba^N</i>	White Oak		45-80'
<i>Quercus bicolor^{N FP}</i>	Swamp White Oak		45-70'
<i>Quercus imbricaria^N</i>	Shingle Oak		40-60'
<i>Quercus macrocarpa^{N FP}</i>	Bur Oak		60-80'
<i>Quercus palustris^N</i>	Pin Oak		50-70'
<i>Quercus phellos^{N FP}</i>	Willow Oak		40-60'
<i>Quercus robur^{FP}</i>	English Oak		40-60'
<i>Quercus rubra^N</i>	Northern Red Oak		60-75'
<i>Quercus velutina^N</i>	Black Oak		50-60'
<i>Styphnolobium japonica^{FP}</i>	Japanese Pagodatree (Sophora)	'Princeton Upright'/' Regent' Sophora	50-70'
<i>Tilia americana^N</i>	American Linden		60-80'
<i>Tilia cordata</i>	Littleleaf Linden		50-70'
<i>Tilia tomentosa</i>	Silver Linden		50-70'

<i>Ulmus americana</i> ^{NFP}	American Elm	‘Valley Forge’/ Princeton’	60-80’
<i>Ulmus parvifolia</i> ^{FP}	Lacebark Elm	‘Allee’/‘Bosque’/ ‘Dynasty’	40-75’
<i>Zelkova serrata</i>	Japanese Zelkova		50-80’

**SALEM, MA RECOMMENDED STREET TREE SPECIES
SMALL (<35’) & ORNAMENTAL TREES**

Wires may be overhead.

BOTANICAL NAME <i>Native Tree</i> ^N <i>Flood Plain</i> ^{FP}	COMMON NAME	These ‘cultivars’ have shown tolerance for Flood Plains	HEIGHT
<i>Acer campestre</i> ^{FP}	Hedge Maple	‘Evelyn’/’Metro Gold’	25-35’
<i>Amelanchier</i> spp. ^N	Serviceberry		15-25’
<i>Carpinus caroliniana</i> ^N	American Hornbeam, Ironwood		20-30’
<i>Cercis canadensis</i> ^N	Eastern Redbud		20-30’
<i>Cotinus obovatus</i> ^N	American Smoketree		20-30’
<i>Crataegus</i> spp. ^N	Hawthorn		25-35’
<i>Crataegus</i>	“	‘Crimson Cloud’	
<i>Crataegus crusgalli</i> var. <i>inermis</i> ^N	“	‘Thornless Cockspur’	20-30’
<i>Crataegus</i>	“	‘Lavellus’	
<i>Crataegus phaenopyrum</i>	“	‘Washington’	25-30’
<i>Crataegus virdis</i>	“	‘Winter King’	25’
<i>Maackia amurensis</i> ^{FP}	Amur Maackia		20-30’
<i>Malus</i> spp. ^{FP}	Flowering Crabapple		10-25’
<i>Ostrya virginiana</i> ^N	American Hophornbeam		25-40’
<i>Prunus</i> spp.	Cherry		20-30’
<i>Syringa reticulata</i>	Japanese Tree Lilac		20-30’