

Flooding and landscape trees

Damage to trees from prolonged submersion depends on water temperature, species, age of the tree and length of time under water.

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Floods washed over various parts of the United States this spring causing damage to thousands of acres of property.

The primary concern during floods, of course, is for the safety of residents. After flood waters recede, however, preservation of personal property, including valued landscape trees, becomes a priority.

Although floods are natural events, human activity has made them worse. Natural wetlands and flood plains serve as nature's controls. Development along stream banks and coast lines have altered or destroyed these natural habitats which are nature's way of mitigating storm water. This problem is worsened as more land in watersheds is developed. Land that is made impervious or less pervious by development results in more storm water run off directly

into receiving streams. This water bypasses natural filtration into ground water. All these conditions add up to increased flooding of landscapes in susceptible watershed areas.

Flooding's affects

It is important to understand how woody plants respond to flooding in order to manage existing situations, as well as to plan for landscape designs in flood prone areas.

Even though trees are amazingly resistant to environmental

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extremes, there are times when they succumb to prolonged flooding, ice/wind storms or other extremes. In the case of flooding, trees may be uprooted by water current, blown over after the soil is saturated, or be chronically weakened by the event and eventually be predisposed to secondary factors such as insects and disease. Additionally, trees can be injured mechanically by flood waters laden with debris, waste and logs that cause trunk wounding and limb breakage. The severity of the effects of

flooding on landscape trees varies depending on the season, the duration of the event, water level, whether the water is flowing or stagnant, and the degree to which siltation has occurred. Other factors that influence whether plants can survive flooding include: species (or genetic constitution), the age and size of the tree, and general vigor of the plant.

Season

Flooding is less detrimental to woody plants during the dormant season than during the growing season. Actively



growing trees and shrubs are more susceptible to the detrimental effects of flooding. Many species of trees may not be adversely affected at all by flooding during the dormant season. They may even be stimulated if the flood waters recede before the growing season beings.

Duration of flooding

The longer trees are exposed to flooding, the more likely they will be impacted or



killed. Most trees can withstand only one to four months of continuous inundation of the root crown by flood waters. Shorter periods of flooding (less than one month) during the growing season are not as detrimental to trees unless the flooding is recurrent and the soil remains saturated.

Water level, movement and temperature

Tree mortality is higher when exposed to standing water as compared to saturated soils. After water covers the soil, the depth may have little

significance until the lower foliage is covered. Flowing water is generally less detrimental than standing water because flowing water usually has higher oxygen content. Colder water is less injurious than warmer water because cold water has the capacity to hold more dissolved oxygen.

Sedimentation and scouring

As flood waters recede, sediment often remains. If silt and sand deposits of three inches or more cover the tree roots, the roots may experience oxygen deprivation and the tree may die. Species vary in tolerance to sedimentation but young trees and seedlings are especially susceptible to root injury. Trees that have evolved on flood plains such as cottonwood, bald cypress, tupelo and black willow can withstand moderate siltation.

The opposite extreme is scouring of the soil around the base of trees. Strong currents associated with flooding may cause soils around trees to be washed away, thus exposing tree roots. Exposed roots result in stress, and also make the trees more vulnerable to wind throw.

Species and age

Certain tree species seem to be genetically programmed to tolerate flood conditions, while others are quite intolerant. Very tolerant species are able to survive deep prolonged flooding for more than one year. Tolerant species are able to survive deep flooding for one growing season. Somewhat tolerant trees survive flooding or saturated soils for 30 consecutive days during the growing season, and intolerant species can not tolerate more than a

few days of flooding during the growing season without significant mortality.

Younger trees and older declining trees are the most susceptible to flooding. Seedlings and young trees may die because they are buried in mud or uprooted by the flood. Newly transplanted trees may show various degrees of distress from flooding because of insufficient root systems and poor recovery after transplanting. Older trees may be further weakened by flooding and succumb to secondary problems such as insect and fungal damage.

Physiological effects of flooding

Inundation, even if only short in duration, dramatically effects the ability of a tree to grow normally and defend itself against other stresses in the environment. Many of the negative effects of flooding are related to the changes that occur in the tree's root system environment.

Low oxygen levels in saturated soils cause most of the negative impacts of flooding. Flooded soils are rapidly depleted of oxygen that is required by tree roots to thrive. In this regard, flooded soils are similar to heavily compacted soils. Both flooded soils and compacted soils cannot exchange enough oxygen with the atmosphere to support normal root tissue metabolism and growth.

Along with the depletion of oxygen, toxic compounds begin to accumulate in the root zone of flooded trees. These toxins may be produced by tree roots themselves or by soil microorganisms. Eventually, roots and microbes quickly use all

the oxygen in the soil. This creates anaerobic (without oxygen) conditions in flooded soils. In flooded soils, many of the compounds that are toxic to trees are produced under these anaerobic conditions.

Trees react to flooding and the stressful environment surrounding their roots in a number of ways. First, tree growth slows. Reduced growth may occur only after a few weeks of flooding. Flooding may also slow the initiation and expansion of leaves if it occurs in the spring of the year. Other symptoms include yellowing or browning of leaves, premature leaf drop, sparsely foliated branches, branch dieback, and tree mortality.

Health impacts of flooding can vary greatly depending on tree species, tree age and prior health of the tree. Many flood tolerant trees produce adventitious roots in response to the flooding. These extra roots are an adaptation that helps them survive the saturated, low-oxygen conditions.

Effects on roots

Flooding also reduces root growth. But smaller root systems found on flooded trees are probably due to a number of factors in addition to slower growth. Small absorbing roots often die because of suffocation after a tree is flooded resulting in "wet feet disorder." Affected plant roots will be bluish black, have a pig pen odor, and bark that can be sloughed off. Foliage may display off color, mimicking nutrient deficiency disorder. Root decay from root rot fungi has also been found in the smaller root systems of trees after flooding. In addition, stud-

FLOOD TOLERANCE OF SELECTED TREE SPECIES

Very tolerant*/tolerant

bald cypress*
black willow*
boxelder
eastern cottonwood
green ash
hackberry
nutall oak*
overcup oak*
pin oak
red maple
shingle oak
silver maple
sugarberry
sweetgum
sycamore
water tupelo*

Somewhat tolerant

American elm
American holly
black gum
burr oak
downey hawthorn
honeylocust
red elm
river birch
southern red oak
swamp white oak
water oak
willow oak
winged elm

Intolerant

bitternut hickory
black cherry
blackjack oak
black oak
black walnut
flowering dogwood
Kentucky coffeetree
linden
loblolly pine
mockernut hickory
post oak
redbud
red mulberry
red oak
sassafras
shellbark hickory
shagbark hickory
shortleaf pine
shumard oak
white oak

PRIMARY SOURCE: WHITLOW, T., H. AND R.W. HARRIS, FLOOD TOLERANCE IN PLANTS: A STATE-OF-THE-ART REVIEW; NATIONAL TECHNICAL INFORMATION SERVICE, U.S. DEPT. OF COMMERCE, AUGUST 1979: 1-161.

ies have also shown that mycorrhizal fungi, or beneficial fungi that help trees take up water and certain nutrients, are reduced on flood-impacted trees.

Damaged root systems often means that flood-damaged trees are more susceptible to insect and disease attack in the years after flood waters recede. Low oxygen conditions in soils often persist after flood waters abate, particularly in finer textured soils. Other environmental stresses that follow a flood, such as drought, can be particularly hard on flood-weakened trees. Reducing any additional tree mortality is often the main challenge facing landscape managers after flood waters are gone.

Managing flood-affected trees

Most prescriptions for flood-affected trees are similar to those recommended for the

care of stressed trees in the landscape. Appropriate plant health care practices and timely management of insect and disease pests are essential.

Prompt sanitation or removal of dead or dying trees will help limit the spread of secondary pests that establish on flood-injured trees. Selective pruning of branches that have died or been damaged as a result of flooding is important. Proper pruning minimizes the size of the pruning wound. Flush cutting is not appropriate and it is not necessary to use wound treatments. Wound repair on lower stems may also be needed. Removing only loose bark and scribing or bark tracing wounds will help the

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compartmentalization process and wound closure.

Injured trees may also require care for problems that are unique to flooding. For example, removal of sediment, if greater than three inches deep, may improve soil aeration. Lesser amounts of sediments can usually be incorporated depending on the situation. In addition to the removal of sediment, vertical mulching or aeration may be beneficial (research and field trials are needed to verify this).

The impact of flooding may linger for years after flood waters recede. Monitor tree health annually and alter care levels in response to plant vitality, until conditions in the landscape stabilize.

In the long term, planting flood tolerant trees is the most reasonable landscape management tool for flood-prone areas. Vigorously growing, healthy trees will be more resistant and able to rebound from flooding with minimal impacts. It is wise to invest in a routine plant health care program

prior to flooding to ensure maximum survival of any landscape trees in susceptible areas.

Planning to mitigate flooding

Engineered solutions to flood problems have traditionally included dikes, levees and dams. Alternative ecological solutions should also be considered under certain situations. When possible, natural plant communities in undeveloped parts of the watershed and along riparian corridors should be preserved or restored to maintain a more natural hydrological regime. This biological approach should be considered along with engineering solutions when landscaping large grounds adjacent to wetlands, lakes, streams, or rivers.

Wide natural buffers, flood-tolerant tree species and natural understory plants can be aesthetically pleasing and ecologically sound. **LM**

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