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Effects of flooding on woody landscape plants

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The question often asked following a flood is, "How long will my plants survive with their roots under water?" The answer depends on a variety of factors including time of year, how long the roots remain submerged, soil type, plant species, and age and health of the plant. The effect of each factor is described at right.

Some plants can recover from flooding injury in as little as one growing season; others may never recover. Plants that survive a flood should be given special care to help them recover.

Symptoms of flood stress

Besides the obvious damage to submerged branches and foliage, few plants can tolerate having their roots submerged for long periods of time. (Refer to tables 1 and 2 for plants likely to be injured by flooding and those that can tolerate wet soils.)

Symptoms of plants experiencing flooding stress include yellowing or browning of leaves, leaves curling and pointing downward, leaf wilt and drop, reduced size of new leaves, early fall color, branch dieback, formation of sprouts along stems or trunk, and, in extreme cases, gradual plant decline and death.

Roots need oxygen for growth and respiration, so the longer they're submerged, the more difficult it is for the roots—and plant—to survive. Trees that have suffered a substantial amount of root injury are prone to "windthrow" (being uprooted in heavy wind) and should be monitored closely or removed. Trees that begin to lean severely should be removed as soon as possible.

Stressed trees are more susceptible to secondary organisms such as canker fungi and insects that bore into phloem and wood.

Will my plants survive?

The likelihood of woody landscape plants surviving a flood depends on a variety of factors:

- **Time of year.** Dormant plants are more tolerant of flooding than are actively growing plants.
- **How long roots remain submerged.** Most plants can tolerate a few days of flooding during the growing season. Some can survive a week or more of standing water (some species can survive months of standing water).
- **Sensitivity of the species to excess water.** For sensitive tree and shrub species (listed in table 1), anything more than a few days can start to cause severe injury and death.
- **Soil type.** Sandy soils drain much faster than predominantly clay-based soils, which hold water and remain wet for longer periods.
- **Age and health of plant.** Established, healthy trees and shrubs will be more tolerant of flooding than very old, stressed, or young plants of the same species.

Why do plants die in water-soaked soils?

Roots need oxygen for growth and respiration. Flooding reduces the amount of oxygen in the soil, impeding root respiration. As a result, carbon dioxide, methane, hydrogen and nitrogen gas levels around the roots increase sharply. The roots then suffocate and die. Toxic compounds, such as ethanol and hydrogen sulfide, can build up in saturated soils. As root function becomes impaired, photosynthesis in the leaves is inhibited and growth slows or even stops.

Excessively wet soils also favor soil-borne root and crown rot organisms including *Fusarium* spp., *Phytophthora* spp., *Pythium* spp., and *Rhizoctonia solani*. These organisms affect many species and prefer wet soil conditions.

Even when standing water is not present, poorly drained soils can reduce plant growth and long-term survival in the landscape due to low oxygen levels in the soil.

Caring for flood-stressed plants

Immediate plant care needs

Once floodwaters have receded, inspect the soil around your plants. Flooding may have deposited significant amounts of new soil and rocks over plant roots—or it may have eroded soil, leaving roots exposed. If more than 3 inches of debris has been deposited, remove it to allow oxygen movement from the atmosphere to tree and shrub roots. Conversely, carefully cover any exposed roots with soil back to the original depth to prevent drying or damage.

Long-term plant care strategy

Plant health care is an important component to improve plant vigor and further reduce plant decline.

- Remove any dead, damaged, or diseased branches.
- Water plants thoroughly (1 inch per week) during extended droughts.
- Aerate the soil around the tree's roots using vertical or radial mulching (should be performed by a professional arborist to protect roots).
- Properly mulch trees. Spread 2–4 inches of shredded bark (not wood chips) in a donut shape around the base of your plants, keeping mulch away from the trunk and off any low-growing branches.
- Do *not* fertilize trees and shrubs for at least a year following a flood due to root injury. Nutrient uptake is an energy-requiring process that will further stress the plant, especially during times of flooding (and drought).

Table 1. Plants likely to be injured by flooding

Scientific name	Common name(s)
Acer platanoides	Norway maple
Acer saccharum	sugar maple
Aesculus spp.	buckeyes, horsechestnuts
Betula papyrifera	paper birch, canoe birch
Betula populifolia 'Whitespire Senior'	Whitespire Senior gray birch
Carya spp.	hickories
Cercis canadensis	eastern redbud
Cladrastis kentukea	American yellowwood
Cotoneaster spp.	cotoneasters
Crataegus phaenopyrum	Washington hawthorn
Daphne spp.	daphnes
Euonymus spp.	euonymus
Fagus spp.	beeches
Juglans nigra	black walnut
Juniperus spp.	junipers
Ligustrum spp.	privets
Liriodendron tulipifera	tuliptree, tulip-poplar
Magnolia spp.	magnolias
Malus spp.	flowering crabapple
Microbiota decussata	Siberian cypress, Russian-arborvitae
Morus alba	white mulberry
Ostrya virginiana	American hophornbeam, ironwood
Picea abies	Norway spruce
Picea omorika	Serbian spruce
Picea pungens	Colorado spruce
Pinus spp.	pines
Prunus spp.	cherries, plums, peaches, apricots
Quercus alba	white oak
Quercus muehlenbergii	chinkapin oak
Quercus robur	English oak
Quercus rubra	northern red oak
Rhododendron spp.	rhododendrons
Robinia pseudoacacia	black locust
Sorbus spp.	mountainashes
Spiraea japonica	Japanese spirea
Syringa spp.	lilacs
Taxus spp.	yews
Tilia spp.	lindens
Tsuga canadensis	Canadian hemlock, eastern hemlock
Ulmus pumila	Siberian elm
Weigela spp.	weigelas
Yucca spp.	yuccas

Modifying the landscape

If water routinely stands in an area following heavy rains, you may wish to consider improving drainage and aeration, and replanting the area with plants that are able to tolerate wet conditions.

Before making any changes, evaluate the drainage situation. Is your area permanently wet, somewhat wet, or wet for only a few days at a time?

For areas that are permanently wet, you may be best off planting species that are tolerant of wet soils. Bottomland plants that naturally grow in lowland areas along riverbanks subject to fluctuating water tables are able to tolerate wet soils better than upland species that grow at higher elevations. Also, different plants tolerate different degrees of wetness. Woody species that can tolerate wet soils are listed in table 2.

In areas prone to staying wet for only a few days at a time, you can improve soil porosity before planting by adding loose organic material, such as composted leaves, pine bark, and peat moss.

Other options for improving drainage include planting on raised beds or berms, and installing swales, waterways, and drain tiles to divert excess water away from trees and shrubs.

Resources

Ball, J. and D.F. Graper. 1996. *What to do about flood-damaged trees?* South Dakota State University Extension Extra publication, Brookings, SD.

Coder, K.D. 1994. *Flood damage to trees.* University of Georgia Extension Publication FOR 94-61, Athens, GA.

(continued)

Table 2. Woody landscape plants able to tolerate wet conditions

Scientific name	Common name(s)	Zone	Notes
TREES—Deciduous			
w *Acer* x *freemanii*	Freeman maple	3b	native hybrid
Acer negundo	boxelder	2b	native, reseeds and sprouts readily
w *Acer rubrum*	red maple	3b/4b[a]	native, acid soils only
w *Acer saccharinum*	silver maple	3a	native, reseeds and sprouts readily
w *Alnus glutinosa*	European black alder	4a	invasive
w *Betula nigra*	river birch	4a	native, acid soils only
Carpinus caroliniana	musclewood, American hornbeam, ironwood	3b	native, periodic flooding only
Catalpa speciosa	northern catalpa	4a	
w *Celtis occidentalis*	common hackberry	3b	native
Fraxinus mandshurica	Manchurian ash	3	susceptible to EAB[b]
w *Fraxinus nigra*	black ash	3a	native, susceptible to EAB[b]
w *Fraxinus pennsylvanica*	green ash	2a	native, susceptible to EAB[b]
w *Gleditsia triacanthos* var. *inermis*	thornless honeylocust	4a	native
Gymnocladus dioica	Kentucky coffeetree	4a	native, periodic flooding only
w *Larix laricina*	tamarack, American larch	2	native, acid soils only
w *Liquidambar styraciflua*	sweet gum	5b	
Maclura pomifera	osage-orange, Bois-D'arc	4b	female trees have very large, messy fruit
Metasequoia glyptostroboides	dawn redwood	5b	
Nyssa sylvatica	black gum, sour gum, tupelo	4b	native, acid soils only
Platanus x *acerifolia*	London planetree	5b	
w *Platanus occidentalis*	American sycamore, American planetree	4b	native, disease prone
w *Populus deltoides*	eastern cottonwood	3a	native, reseeds readily, messy tree, disease prone
Quercus bicolor	swamp white oak	4a	native
Quercus macrocarpa	bur oak	3a	native
w *Quercus palustris*	pin oak	4b	acid soils only
Quercus x *schuettei*	swamp bur oak	4	native hybrid
w *Salix* 'Golden Curls'	Golden Curls willow	4b	
w *Salix lucida*	shining willow	2	native
w *Salix matsudana* 'Tortuosa'	corkscrew willow, curly willow	4b	
w *Salix nigra*	black willow	4a	native, messy tree
w *Salix* x *pendulina* 'Blanda'	Wisconsin weeping willow	4	messy tree
w *Salix pentandra*	laurel willow	2b	
w *Salix* 'Prairie Cascade'	Prairie Cascade willow	3b	messy tree
w *Salix* x *sepulcralis* var. *chrysocoma*	golden weeping willow	4a	messy tree
w *Taxodium distichum*	baldcypress	4b	
w *Ulmus americana*	American elm	3a	native, pest prone, plant only Dutch elm disease–resistant cultivars
TREES—Evergreen (narrow-leaved)			
Abies balsamea	balsam fir	3a	native, acid soils only
w *Chamaecyparis thyoides*	Atlantic white-cedar	4b	shrub forms available
w *Picea mariana*	black spruce	3a	native in bogs, hard to grow, shrub forms available, acid soils
Thuja occidentalis	arborvitae, eastern or northern white-cedar	3a	native, periodic flooding only
SHRUBS—Deciduous			
w *Alnus incana* subsp. *rugosa*	speckled alder, swamp alder	3b	native
Aronia arbutifolia	red chokeberry	4b	acid soils only
Aronia melanocarpa	black chokeberry	4b	native
Aronia x *prunifolia*	purple chokeberry	4a	
w *Betula pumila*	bog birch, swamp birch	3	native
w *Cephalanthus occidentalis*	buttonbush	4b	native
Clethra alnifolia	summersweet clethra	4b	acid soils only

(continued)

w = Able to tolerate extended periods (longer than a week) with roots submerged.

[a] Hardiness depends on cultivar.

[b] EAB = emerald ash borer

Table 2. Woody landscape plants able to tolerate wet conditions *(continued)*

Scientific name	Common name(s)	Zone	Notes
SHRUBS—Deciduous *(continued)*			
w *Cornus alba*	Tatarian dogwood	3a	
w *Cornus amomum*	silky dogwood	4	native
Cornus racemosa	gray dogwood	3b	native
w *Cornus sanguinea*	bloodtwig dogwood	4a	
w *Cornus stolonifera*	red-twig dogwood, red-osier dogwood	3a	native
Dirca palustris	leatherwood	4a	native
Hamamelis vernalis	vernal witchhazel	4b	acid soils only
w *Ilex verticillata*	winterberry, Michigan holly	3b	native, acid soils only
Itea virginica	Virginia sweetspire	5b	acid soils only
Lindera benzoin	spicebush	5b	acid soils only
w *Lonicera oblongifolia*	swamp fly honeysuckle	4	native
Morella (formerly *Myrica*) *pensylvanica*	northern bayberry	4a	periodic flooding only, acid soils only
Rhododendron arborescens	sweet azalea, smooth azalea	5b	acid soils only, periodic flooding only
Rhododendron vaseyi	pinkshell azalea	5b	acid soils only, periodic flooding only
Rhododendron viscosum	swamp azalea	5a	acid soils only
Rosa blanda	meadow rose	3b	native, periodic flooding only
Rosa carolina	Carolina rose, pasture rose	3b	native, periodic flooding only
w *Rosa palustris*	swamp rose	4a	native
w *Salix alba* 'Britzensis'	coral bark willow	2b	prune to keep it a shrub
w *Salix caprea*	goat willow	4a	
w *Salix chaenomeloides*	Japanese pussy willow	5b	
w *Salix discolor*	common pussy willow	3a	native
w *Salix elaeagnos*	rosemary or hoary willow	4	
w *Salix gracilistyla* var. *melanostachys*	black pussy willow	4b	
w *Salix integra* 'Hakuro Nishiki'	Japanese dappled willow	4b	
w *Salix purpurea* 'Gracilis'	blue arctic willow	3b	
w *Salix udensis* 'Sekka'	Japanese fantail willow	4	
Sambucus canadensis	American elderberry	3b	native
Sambucus nigra	European elderberry	4b	
Spiraea alba	meadowsweet	4	native
Spiraea tomentosa	hardhack, steeplebush	4	native
Staphylea trifolia	American bladdernut	4a	native
Vaccinium corymbosum	highbush blueberry	3b	native, acid soils only, periodic flooding only
Viburnum cassinoides	witherod viburnum	4a	native
Viburnum lentago	nannyberry viburnum	3a	native, pest prone, periodic flooding only
Viburnum opulus	European cranberrybush viburnum	3a	invasive, pest prone
Viburnum trilobum	American cranberrybush viburnum	3a	native, pest prone
SHRUBS—Evergreen (broad-leaved)			
Andromeda polifolia	bog rosemary	3	native in bogs, hard to grow, acid soils
Chamaedaphne calyculata	leatherleaf	3	native in bogs, hard to grow, acid soils
Kalmia polifolia	bog kalmia	2b	native in bogs, hard to grow, acid soils
Ledum groenlandicum	Labrador tea	2b	native in bogs, hard to grow, acid soils
w *Vaccinium macrocarpon*	American cranberry	2b	native in bogs, hard to grow, acid soils
VINES and GROUNDCOVERS			
Clematis virginiana	Virgin's bower	3b	native vine
Vitis riparia	riverbank grape, frost grape	4	native vine
Xanthorhiza simplicissima	yellowroot	3b	groundcover

w = Able to tolerate extended periods (longer than a week) with roots submerged.

Resources, *continued*

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Ranney, T.G., R.E. Bir, M.A. Powell, and T. Bilderback. 1994. *Qualifiers for quagmires: Landscape plants for wet sites.* N.C. State University Extension Publication HIL-8646, Raleigh, NC.

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