Lake States Woodlands

# Oak wilt management— what are the options?

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Trees at risk

Thousands of oaks in woodland and urban settings die from oak wilt every year. Widespread in Wisconsin, Minnesota and Michigan, the disease is caused by the fungus *Ceratocystis fagacearum*. Figure 1 shows the extent of oak wilt in Michigan, Minnesota and Wisconsin.

Trees from the white and red oak groups, both found commonly in the Lake States, are susceptible to oak wilt. Because trees in the red oak group fall prey to the disease most often, this publication focuses on the red oak group.

Figure 1. This map shows the county distribution of oak wilt in Michigan, Minnesota and Wisconsin in 2010. Map produced by the USDA Forest Service, Northeastern Area–Forest Health Monitoring GIS Group.
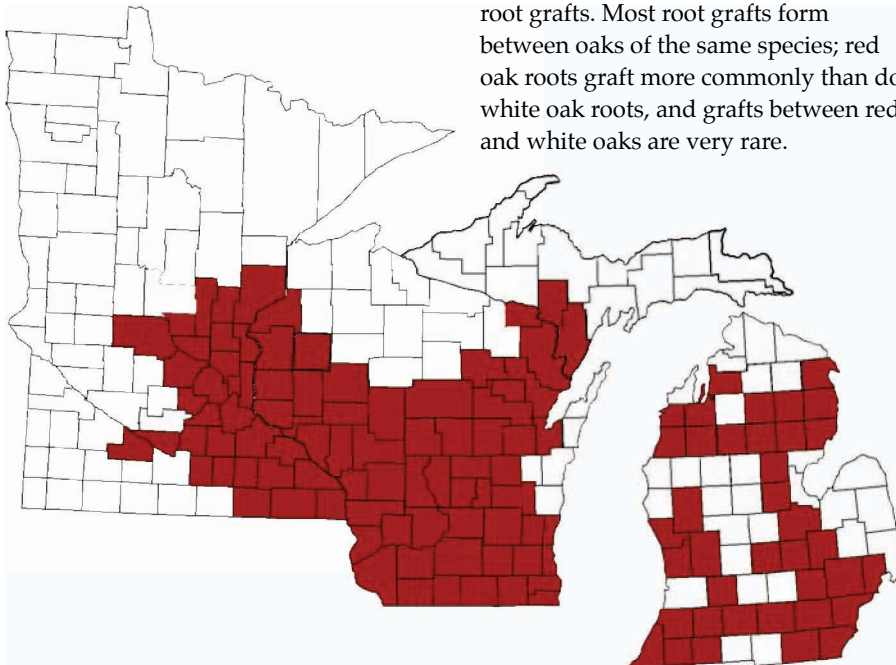
Biology and spread of oak wilt

Mats of fungus, known as "pressure pads," develop under the bark of trees that have died from oak wilt (example 1a). Mats form most often in spring, approximately 9-10 months after a tree dies from oak wilt. These mats force the bark to crack open. The fungus produces a sweet odor that attracts sap-feeding beetles such as Nitidulids (example 1b). The beetles pick up fungal spores by crawling on the mats. Then they fly to healthy oaks to feed on sap flowing from fresh wounds, thus infecting new trees.

As fungus invades a tree's water conducting system, the leaves turn dull green, bronze or tan, and wilt from the top of the tree downward (example 1c). Leaves fall rapidly after wilting. Infected trees are bare in 4-6 weeks.

Underground spread of oak wilt from infected to healthy trees occurs through root grafts. Most root grafts form between oaks of the same species; red oak roots graft more commonly than do white oak roots, and grafts between red and white oaks are very rare.

Example 1a. In April, May and June, fungal mats ("pressure pads") grow under the bark of trees that wilted the previous summer. Mats are sometimes present in late summer or fall.

Example 1b. Fungal mats force the bark to crack open. The mats' odor attracts sap-feeding beetles which spread the disease to healthy trees.

Example 1c. The fungus invades the tree's water-carrying system, causing leaves to wilt and fall. Wilting occurs most often in July and August, and occasionally in spring or fall.

Prevention, sampling and management

Prevention

You can take two precautions to lessen the chances of oak wilt invading your yards and woodlands.

1. **Do not harvest, prune or otherwise wound oak trees from bud swell up to two or three weeks past full leaf development.** During this time, fungal mats are most abundant and oak trees most vulnerable to oak wilt. In the urban setting, remember not to prune oak trees from April through July. If the spring comes early with unusually warm temperatures, pruning may need to stop before the beginning of April in some years. Infection is less common later in the summer but can occur after July. If you decide to take a very cautious approach—limit any cutting activities from April 1 to October 1. If wounding does occur,

apply a tree wound paint immediately. These products normally inhibit proper wound closure so limit your use of tree paint to these situations.

In the forest setting, the Wisconsin Department of Natural Resources developed new oak harvesting guidelines. The guidelines are site-specific, and based on factors that affect the risk level of introduction and spread of this disease. For more information about oak harvesting guidelines in the forest setting, please visit http://dnr.wi.gov/forestry/fh/oak Wilt/guidelines.asp

2. **Do not move infected trees with the bark still attached (as firewood or logs) into your woodlands.** Pressure pads may form on the transported wood, attracting insects that spread oak wilt.

> **Note:** The research on the transmission of oak wilt through tools is minimal. Transmission of the pathogen was observed via selected tools through artificial inoculation; however no evidence of natural spread through a variety of tools has been confirmed. At this time, it does not appear necessary to disinfect the tools.

Sampling

You may need a laboratory analysis to confirm the presence of oak wilt. To obtain an analysis, collect three twigs (about ½ in. diameter and 4 in. long) from three different branches with wilting leaves. You must send samples which still have live tissue. Scratch the sample branch with your fingernail. If the wood under the bark is a light color (white to green), the sample is fresh. If the wood is brown or dark, it is too old to be useful. Wrap the samples in wax paper and keep them cool until you mail them.

In Wisconsin, mail your samples to:
   Plant Disease Diagnostic Clinic
   Dept. of Plant Pathology
   University of Wisconsin-Madison
   1630 Linden Drive
   Madison, WI 53706
   (608) 262-2863
   www.plantpath.wisc.edu/PDDC

In Minnesota, send them to:
   Minnesota Dept. of Agriculture
   Plant Protection Laboratory
   90 West Plato
   St. Paul, MN 55108
   (651) 296-4749
   www.mda.state.mn.us

In Michigan, mail to:
   State Pathologist
   Michigan Dept. of Agriculture
   Laboratory Division
   1615 Harrison Rd.
   East Lansing, MI 48823
   (517) 337-5091

Example 2a. Don't confuse oak wilt with the two-lined chestnut borer. Galleries, or feeding tunnels of the two-lined chestnut borer are visible in this photo. The insect causes symptoms resembling that of oak wilt with one notable difference—trees infested with the chestnut borer usually keep their dead leaves, while trees with oak wilt lose them.

Example 2b. This aerial view shows the characteristic pocket of dead trees, a hallmark of oak wilt.

A fee may be charged for testing. Call the appropriate lab to determine charges.

If sampling results are negative

If your samples test negative for oak wilt, check for the presence of the two-lined chestnut borer which harms trees by tunneling between the bark and wood (example 2a). This insect causes leaves to wilt and turn brown in mid-summer when larvae feed between the bark and wood of infested trees. Dead leaves generally remain on the tree. A few branches or the whole crown may be affected. (Oak wilt always affects the entire crown in red oaks.)

If sampling results are positive

There are two management strategies from which you can choose.

Passive management. If you allow the disease to progress, it will spread to healthy oaks through the roots of diseased trees. In the Lake States, oak trees may grow in pure or relatively homogeneous stands. You may also find them mixed with species such as white pine, sugar maple, basswood and white birch (common in the northern hardwood forest type), or hickory, elm, ash, aspen, and black cherry (species common in the oak-hickory forest type).

In pure oak stands, the disease moves outward from the original infected trees through root grafts, killing more trees each year. This creates the pocket of dead trees that characterizes oak wilt. In mixed stands, where oaks are scattered among other species, root grafts may occur less often than in pure oak stands; thus, spread may be slower or less conspicuous. New pockets can appear in your woodlands from overland spread by Nitidulid beetles feeding on fresh wounds (example 2b).

If you allow the disease to progress, you should consider the impact on the health of neighboring trees. Even if root-graft spread to your neighbor's trees is unlikely, overland spread to a neighbor's yard or woodlot is a real possibility. Proper removal and utilization of infected trees reduces the hazard of overland spread. You can find guidelines for removing and using dead and infected trees in the section on active management.

As oaks die, the open spaces and dead trees can provide valuable feeding and nesting sites for wildlife. When overstory trees die, the site often becomes brushy for about ten years. Warblers, grosbeaks, cuckoos, cardinals, grouse, rabbits, deer and shrews will be attracted to the brushy area. Brown creepers may nest under the sloughing bark on dead trees. Dead trees will furnish insects for birds, and larger specimens may provide perches for raptors.

Example 3b. Oak wilt trenching.

Example 3c. Crown wilt indicates the presence of oak wilt.

Example 3a. The vibratory plow is a tracked or rubber-tired vehicle with a vibrating head attached at the rear. A knife-like plow blade with a slight hook at the bottom is attached to the vibrating head. The blade is pulled horizontally through the soil, slicing the root connections.

Active management. Since oak wilt spreads both underground and above ground, you must combat it with a two-pronged approach. To contain the disease:

1. **install a root graft barrier; and**

2. **remove and properly use trees inside the barrier.**

Installing a root graft barrier. Root graft barriers break the root connections between infected and healthy trees. A barrier should be at least four, and preferably five feet deep. Trenchers and vibratory plows are the tools most commonly used for this job (example 3a, 3b, 3d).

Locating the root graft barrier. Properly locating the root graft barrier is critical to stopping the underground spread of oak wilt. Incorrectly placing the barrier may cancel out your efforts to halt the disease (figure 2).

A forest pest specialist, forester or arborist trained in oak wilt management should work with you to plan the barrier location. Choose a location for the barrier in early August, after most of the year's infected trees have wilted. Barrier installation should take place before the soil freezes.

To determine where to place the barrier, measure the diameters at 4½ feet above the ground (or diameter at breast height, DBH) of an infected tree (example 3c) and a nearby apparently healthy tree; add these figures to calculate the combined diameter. A sprout clump is represented as the sum of the diameters of all its stems. Measure the distance between the same two trees. Consult table 1 to determine the minimum inter-tree distance listed for the combined diameters.

If the two trees are closer than the distance listed in the table, the barrier should be placed outside the apparently healthy tree. If the two trees are farther than the distance listed in the table, the barrier should be placed inside the apparently healthy tree.
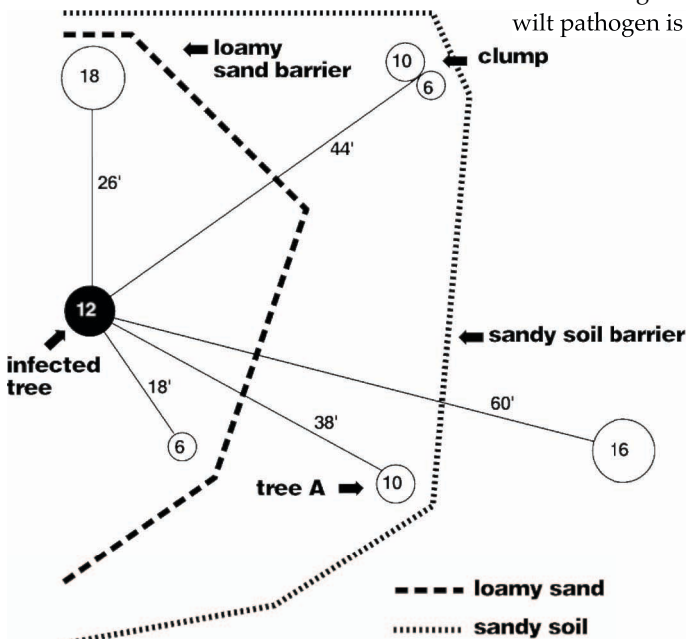
Research shows that three factors significantly determine the likelihood of two trees grafting:

1) diameter;

2) distance between the trees; and

3) soil and drainage characteristics.

In general, root grafts spread oak wilt farther in shallower than in deeper soils, and in sandier than in loamier soils. The exact underground location of the oak wilt pathogen is unknown.

Table 1. Distances for loamy sand and sandy soils were based on 95% confidence level model of Bruhn et al. (1992); Distances for sandy loam and loam soils were extrapolated from sandy loam model at 80% confidence level.

Combined DBH (inches)	Inter-tree distance		
	sandy	loamy sand	sandy loam/loam
2	3.9	3.1	2.2
4	7.8	6.2	4.5
6	11.6	9.3	6.7
8	15.5	12.4	8.9
10	19.4	15.4	11.2
12	23.3	18.5	13.4
14	27.2	21.6	15.6
16	31.0	24.7	17.9
18	34.9	27.8	20.1
20	38.8	30.9	22.3
22	42.7	34.0	24.6
24	46.6	37.1	26.8
26	50.4	40.2	29.1
28	54.3	43.2	31.3
30	58.2	46.3	33.5
32	62.1	49.4	35.8
34	66.0	52.5	38.0
36	69.8	55.6	40.2
38	73.7	58.7	42.5
40	77.6	61.8	44.7
42	81.5	64.9	46.9
44	85.4	68.0	49.2
46	89.3	71.1	51.4
48	93.1	74.1	53.6

Figure 2. Based on table 1, tree A must be at least 34 feet away from the infected tree on loamy sand, and 42.7 feet away on sandy soil, to assume that it has not been infected through root graft. Table 1 forecasts with 95% accuracy.

Since tree A is farther than the recommended guidelines for loamy sand, a barrier can be placed between the healthy and diseased tree. On sandy soil, tree A is less than the recommended safe distance, so you can conclude with 95% certainty that the tree has been infected and that a barrier must be placed outside it.

Model developed by Johann Bruhn from data colleted in Menominee County, MI. Bruhn, J.N., and Heyd, R.L., 1992, Biology and Control of Oak Wilt in Michigan Red Oak Stands, *Northern Journal of Applied Forestry* 9(2): 47-51.

The method shown in figure 2 attempts to include, inside the root graft barrier, all apparently healthy oaks with a 5% or greater chance of being infected in the first year after installation of the root graft barriers. Additional lines closer to diseased trees can be installed in an effort to save more trees, but such attempts often fail. This model was developed for sites with sand and loamy sand soils. Use of the model for root graft barrier placement on sites with sandy loam and heavier textured soil will predict longer root grafting distances than what actually occurs. Thus, if this model is used on sandy loam or loamy sites, the number of healthy trees removed to the line increases. The inter-tree distances to use for such sites were extrapolated accordingly based on a recent study in Minnesota (Arboriculture and Urban Forestry, in press), and are provided in table 1 when such sacrifices are unacceptable to the landowner.

Removing and using infected trees

You must install root barriers before trees in the pocket of wilting trees are removed. Water tension released when live wilting trees are felled permits fluids to move rapidly to grafted healthy trees beyond the intended barrier. **Remove all dead trees with the bark attached and all apparently healthy trees from inside the barrier** (all trees over 3 in. in diameter should be removed). Apply an herbicide registered for treating cut oak stumps to prevent sprouting and minimize the chance of roots regrafting across the barrier. If you do not use an herbicide, sprouts may continue to keep the disease active in the pocket, posing a risk to trees outside the barrier. Remove trees and treat stumps after placing the barrier and before the following April (when fungal mats may form). You do not need to remove trees with loose bark since they can no longer produce fungal mats.

Example 3d. A trencher is a rubber-tired vehicle with a digging chain attached to the back. The chain moves along a boom, digging a trench and breaking root grafts as it is pulled through the soil.

WHITE OAKS

🌰 **Types:** White oak, bur oak, swamp white oak

🌰 Oaks in the white oak group have greater resistance to oak wilt. They often remain healthy after surrounding black and red oaks succumb to the disease.

🌰 **Symptoms:** Wilted and bronzed leaves appear on scattered branches; leaf fall is usually light. More branches may die each year until the tree dies—or the tree may survive.

white oak

bur oak

RED OAKS

🌰 **Types:** northern red oak, northern pin oak, black oak

🌰 Oaks in the red oak group are most susceptible to oak wilt. Trees die rapidly after leaves wilt.

🌰 **Symptoms:** Leaves wilt from the top of the tree downward. Leaf fall is usually heavy and occurs during and shortly after leaves wilt. Wilting takes place most often in July and August.

red oak

black oak

Firewood. Dead trees with the bark attached should be debarked, chipped, or cut and split to hasten drying. Stack the cut pieces and place them in the sun; tarp the stack with 4 mil plastic. Placing the tarped pile in the sun will hasten bark deterioration and loosen the bark quicker. Seal the plastic around the base to be as airtight as possible to prevent insects from reaching the fungal mats. If the wood is not burned over the winter, leave the tarp on until the end of the following summer (approximately one year after cutting).

Moving infected firewood without careful attention to tarping can contribute to overland spread of oak wilt. Wood from dead trees with loose bark, and from apparently healthy trees with no wilting symptoms, does not pose a danger and does not require tarping.

Wisconsin has developed a number of requirements pertaining to the movement of firewood coming into the state and the movement of firewood within the state's borders. This is to limit the spread or introduction of invasive insects and diseases that are easily transported on firewood. For more information about firewood restrictions, please visit the Wisconsin Department of Agriculture, Trade and Consumer Protection website at http://datcp.state.wi.us/arm/environ ment/insects/firewood_restrictions/

Other wood products. Wood from infected trees may be sold to a sawmill or chipping facility—preferably one which is several miles away from the nearest red oak. Advise the purchaser that the infected trees with attached bark must be used over the coming winter.

Regenerating oak in the pocket. Though information on the likelihood of oak wilt transferring to regenerated growth is sparse, it is clear that thorough tree removal and stump treatment minimize the risk. Planting oak seedlings or encouraging natural oak seeding in the pocket can be tried after you remove the infected trees and treat the stumps. You may need to apply herbicides to sprouts for two to three years after cutting if sprouts continue to form inside the barrier.

Chemical treatment. Fungicides have recently been developed and may be added to the management toolbox. Currently available products contain the active ingredient propiconazol. This product may be effective in preventing oak wilt when injected into living oak trees without disease symptoms. If you are considering using chemical treatment, contact an arborist specializing in oak wilt management. The cost and intensity of this level of management is typically reserved for high-value urban oaks.

Herbicides as a tool to stop root graft transmission of oak wilt

Several studies have been conducted to test the effectiveness of various herbicides in stopping the transmission of oak wilt by root grafts in the Lake States. Three different combinations of herbicides were tested. Products tested included various formulations and combinations of Garlon 3A, Garlon 4, Arsenal AC, Stalker and Tordon RTU.

The results showed that some products were effective in killing the aboveground portions of the trees; some were not. None of the products killed roots completely in a timely manner. This lack of complete root death indicates herbicides may not be effective in stopping root graft transmission of oak wilt. There is a similar study in progress in Wisconsin and the test sites are being monitored.

Herbicides continue to be an important tool for killing or at least weakening trees and sprouts inside a trenched area. However, at this printing, herbicides should not be presented as a proven means of creating effective root graft barriers.

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