

Oak Wilt and Michigan's Critical Dunes

What's the Best Management Option(s)?



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Dr. Roberts retired from Michigan State University in 2018 after committing over four decades to advancing MSU's Land Grant Mission, originally signed into law by President Abraham Lincoln during the midst of the American Civil War. He received his B.S. (1975) and M.S. (1977) from The Ohio State University and his Ph.D. from Michigan State University. Over the decades, Dr. Roberts has published hundreds of articles and has taught hundreds of lectures and workshops. He has re-searched many issues in Michigan's plant industry including Dutch Elm Disease, *Diplodia* Tip Blight of Pines, along with variety of cultural problems such as plant nutrition and herbicide toxicity. Dr. Roberts has worked on Oak Wilt for 40 years, inventing several new and innovative remediation techniques. During his career, he has discovered a variety of new diseases and pests such as *Phomopsis* Canker of Spruce and the first bacterial wilt disease of turfgrasses in North America. His discovery of a bacterial biological herbicide for weed grasses resulted in several patents with MSU. His research on greenhouse and nursery crops disclosed the first fungicide-resistant strains of the *Pythium*, a root rot fungus, altering management methods for crop preservation. In the early 2000s, his research on Ash Decline in Southeast Michigan led to the discovery of the invasive Emerald Ash Borer in North America. In his retirement, Dr. Roberts intends to remain active with the Arboriculture/Landscape/Nursery Industries while hoping to have more time for his hobbies. Dr. Roberts is President, CEO and CBW (Chief Bottle Washer) of The Plant Doctor, LLC... aka The Tree Doctor. Contact information:
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INTRODUCTION:

The shores of Lakes Michigan, Superior and Huron are home to the largest and tallest freshwater Dune Systems on Planet Earth (Photo 1). In 1989, approximately 74,000 acres along 265 miles of coastline were designated "Critical Dune Areas" (CDA) by Michigan's State Legislature to protect and preserve this unique ecosystem for future generations. The CDA are regulated by the Department of Environment, Great Lakes, and Energy (EGLE, Figure 1). The CDA ecosystem is unique and very fragile, representing a diversity of plant and animal life. Briefly, Critical Dunes were created over Millennia from constantly shifting (migrating) sand from water and wind erosion. Contributing to the dune environment is fire. Uncontrolled wildfires can result in significant loss of plant life which can lead to extreme erosion and destabilization of the Critical Dune Environment while low intensity fires can rejuvenate the Dune Ecosystem.

P1



The transition of plant life is vitally important for the fragile dune environment (Photo 2A). Invasive species, whether they are plants, pests, or diseases, pose some of the most serious threats to the health and viability of the Critical Dune System. Among the most common species of trees on Critical Dunes are oaks (*Quercus* sp.), especially red oaks, which seem to be particularly adapted to this low nutrient sandy soil. As we might expect, Oak Wilt is a major threat to the stability of Critical Dunes where many homes are also situated (Photo 2A). I have been addressing Oak Wilt along much of the Critical Dune System for decades. I think it is important to be “Critical” in our evaluation of options to contain and



P1 Michigan harbors the world’s tallest and largest freshwater dune systems in the world. Although a diversity of tree species can be found in the dune system, oaks and pines are among the predominate genera.

P2A & 2B The transition of the Critical Dune habitat is evident from this Lake Michigan shoreline - sandy beach transitioning to grasses (typically American Beachgrass, *Ammophila breviligulata*) to the “Tree Line”. With a significant population of red oaks in the Critical Dune Areas, we can expect the invasive disease Oak Wilt to represent a serious threat to the health of this ecosystem. Two factors contribute to the development of Oak Wilt on Critical Dunes: 1) Human Activity, and 2) Weather. In 2A, people crave lakefront property for the construction of homes; this and other human activities may attract Oak Wilt. In 2B, violent storms rolling across Lake Michigan can damage Oak trees, resulting in the development of “Oak Wilt Epicenters” (three dead trees), which contribute to Overland and Underground Spread of the deadly disease. Photo 2B Inset Left shows an injured tree from a lightning strike while Inset Right indicates physical damage from high winds; any tree damage during high-risk periods for Overland Spread can result in Oak Wilt infections and subsequent expanding “epicenters”.

eliminate Oak Wilt from CDA because, like other invasive species, Oak Wilt is caused by an introduced, invasive fungus (*Bretziella fagacearum*). As a reminder in our present discussion, Oak Wilt can move for several miles ‘Overland’ to fresh wounds on Oak trees by insects (especially sap beetles) and ‘Underground’ through root grafts between nearby trees. Two major factors contribute to the development of Oak Wilt on Critical Dunes: 1) Human Activity, and 2) Weather. The construction of homes and other related human activities may result in Oak Wilt outbreaks (Photo 2A).

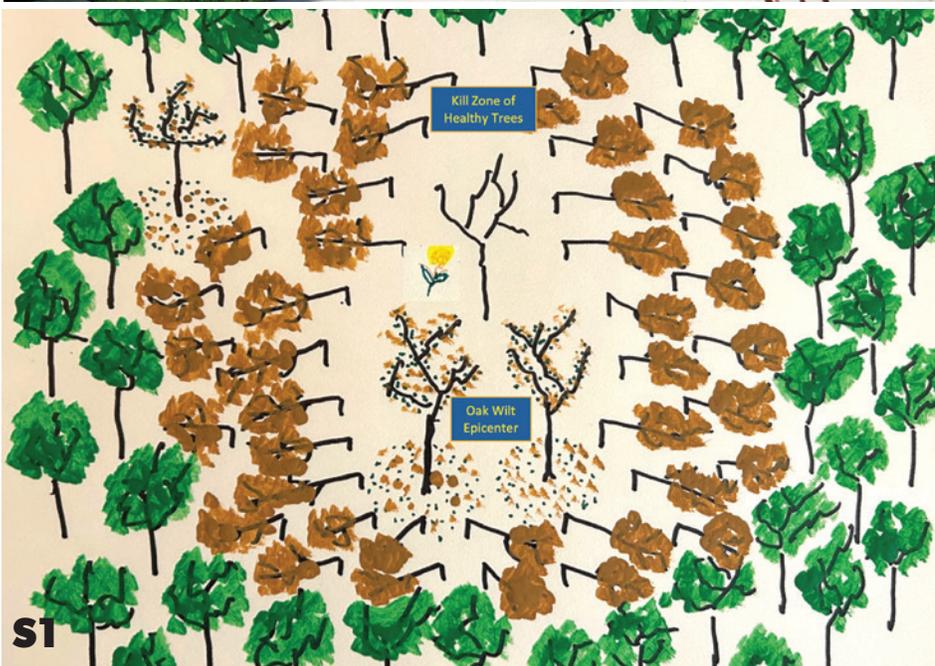
Weather also plays a major role; storms that roll across Lake Michigan first encounter the fragile Critical Dune System resulting in limb/tree breakage, lightning strikes, etc. (Photo 2B).

Options for Oak Wilt Management on Critical Dunes:

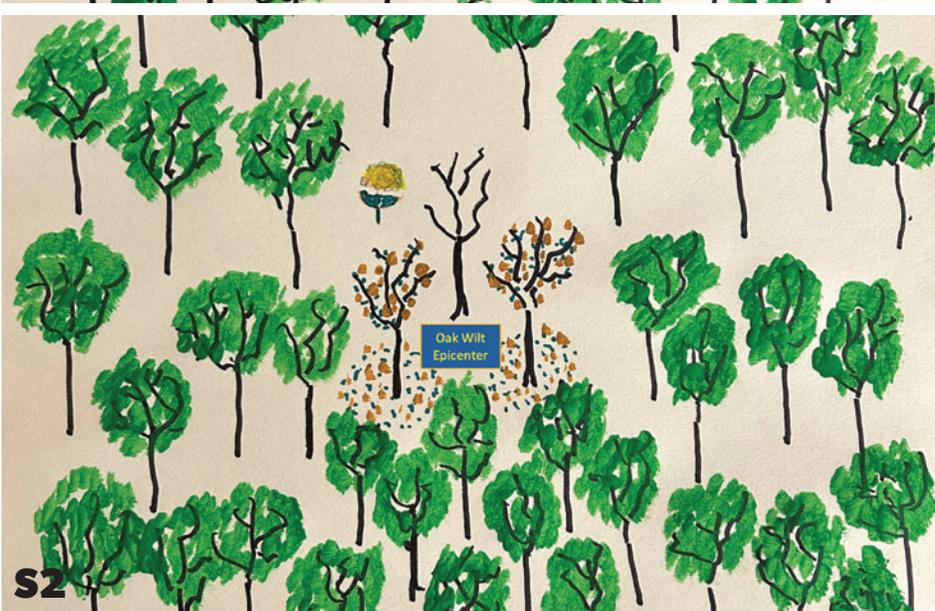
In Michigan, several options are usually considered for Containment and Eradication of Oak Wilt. It is important to understand that management of Oak Wilt on Critical Dunes may be more challenging than at other locations over Michigan’s vast natural forests,



P3



S1



S2

woodlands, and urban forest environments. However, there are some similarities as well.

Prevention: One of the most effective strategies is avoidance of Oak Wilt by not wounding (pruning, etc.) oak trees during the warm season when insects may transmit the Oak Wilt fungus to fresh wounds (Photo 2A). Because the stump of a freshly removed oak tree is a large wound on a still living below ground tree, it may attract Oak Wilt; we need to be sure stumps are treated accordingly (grinding, painting, etc.). Violent storms can cause injuries to trees on Critical Dunes (Photo 2B) and elsewhere throughout Michigan; “Prompt Storm Repair” by making fresh cuts within a couple of days of the injury followed by immediate wound painting is strongly advised to protect injuries from Overland Oak Wilt infections. Early detection of Oak Wilt can be difficult but is crucial for efficient Oak Wilt containment (Photo 3)

Root Graft Disruption

(RGD=Trenching): Trenching to sever root grafts between diseased and healthy trees has been a traditional method to control Oak Wilt for many decades. There are two major trenching models: 1) Tier Tree Model (Roberts, 1984), and 2) Bruhn Model (early 1990s). The Bruhn Model specifies destruction of many healthy trees surrounding an Oak Wilt epicenter while Roberts’ Tier Tree Model results in little to no sacrifice of healthy trees (depicted in Sketches 1 & 2 as herbicide remediation). Neither of these two trenching models are generally recommended on Critical Dunes for several reasons. First, the Dune environment is often so rugged that trenching is impractical (Photo 4). Second, the constantly shifting sand over centuries results in roots and root grafts much deeper than the 5-6 foot traditional trenching depth used in Michigan (Photo 4 Inset); it is doubtful that trenching would be effective in stopping Oak Wilt in the Critical Dune environment. Third, trenching can cause harm to tree roots, regardless of species, either serving as entry points for diseases such as *Armillaria* or *Phytophthora* Root Rots, etc. or possibly resulting in tree destabilization. Furthermore, EGLE generally does not

grant trenching permits for the Critical Dune Environments due to the fragile nature of the Dune Ecosystem. During a recent visit to an Oak Wilt site near Holland, I learned that EGLE had granted a trenching permit (rare, the first one I had encountered). But after discussing the above concerns, the HOA decided not to trench but elected to use herbicide remediation instead (discussed later in this article).

Tree Injections with Propiconazole: The fungicide Propiconazole has been shown to inhibit root graft transmission of the Oak Wilt fungus (Photo 5). However, tree injections are quite variable in their efficacy. I have encountered some sites where tree injections failed to stop root graft

infections 100% of the time; other sites benefited from injections nearly 100% of the time. This extreme variability seems to be associated with who is doing the procedure, which injection system is being used, and what rate of fungicide is injected, among other variables. I have witnessed failure with every injection system if the low label

rate of 10 mL of active ingredient of propiconazole per inch trunk dbh is used, while the success rate improves dramatically with the 20 mL rate.

Mycorrhizae and Chemicals: Many Michiganders and professional arborists alike probably do not consider the importance of Vesicular Arbuscular (VA) Mycorrhizae (fungus) in Critical

P3 At this Critical Dune residence near Lake Michigan, Oak Wilt was not detected for 1-2 years after tree death due to canopy cover (also see Inset). Early detection is crucial for effective remediation.

S1 **Garlon 4/Double Girdle:** In this AI-Generated 2nd Grader Sketch of the Garlon 4/Double Girdle procedure applied with the Bruhn design, note that the epicenter is comprised of three oak trees (center); one tree became infected one or two years ago by "Overland Spread" to a damaged limb, followed by "Underground Transmission" to two trees (leaf loss) this year. The large "Kill Zone" of sacrificed healthy trees according to the Bruhn design and the outer zone of healthy oak trees are depicted. According to Bronson et. al. (Table 1) and our observations, this method is only 55% effective on average (if that), resulting in breach of the "Kill Zone" by the Oak Wilt fungus (upper left corner), even after the sacrifice of so many healthy trees.

S2 **Glyphosate/Stump Cup:** In this AI-Generated 2nd Grader Sketch of the implementation of the Glyphosate/Stump Cup "Chaser" procedure as the Tier Tree Model, only the diseased trees are treated with Glyphosate; no sacrifice of healthy trees is needed because the herbicide prohibits the transfer of the Oak Wilt fungus through root grafts between diseased and healthy trees. "Chaser" has proven effective at numerous sites throughout Michigan (see Photo 9).

P4 Trenching to sever root grafts is often impractical due to the rugged terrain of the Critical Dune Landscape. In this photo taken in November, note the steep drop-off from this residence near Grand Haven, Michigan – no sleepwalking here! Furthermore, due to constantly shifting sand over millennia, roots and root grafts are often deeper than at other locations in Michigan. Inset shows a red oak root graft extracted from over 8 feet deep. Note Oak Wilt-infected tree in the distant rugged terrain (arrow).

P5 Tree injections with Propiconazole can be effective in preventing root graft transmission of the Oak Wilt fungus between diseased and healthy trees. The success of tree injections can be quite variable depending on rate of fungicide, what injection system is used, and who implements the procedure, etc.

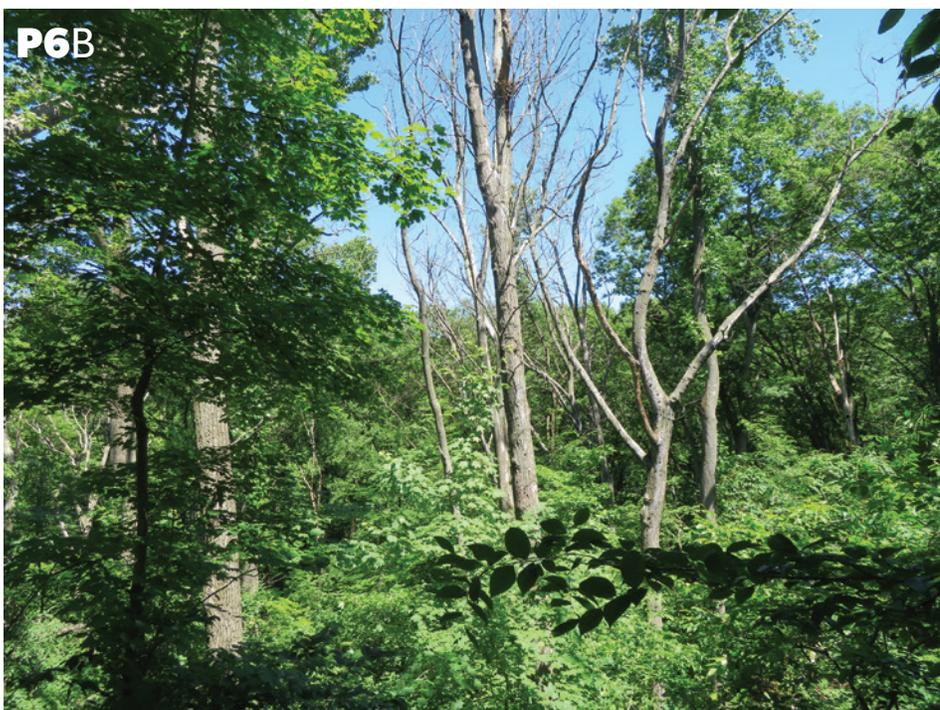


Dune Areas (and elsewhere). VA Mycorrhizae develop *symbiotic* relationships with oak trees (and other species) where the fungus serves as extensions of the trees' roots to absorb nutrients and moisture from soil in exchange for carbohydrates manufactured by the trees' photosynthetic processes. Mycorrhizae are particularly important for Critical Dunes where nutrient and water availability in almost pure sand soils are often deficient. As we might expect, *fungicides* (ex. Propiconazole)

can harm these beneficial fungal relationships. Research has also shown that other chemicals such as herbicides can harm these symbiotic relationships. The difference is that Propiconazole is applied to protect living trees from Oak Wilt infections while herbicides are typically applied to diseased trees or trees destined to be sacrificed (killed, Sketch 1), depending on the herbicide remediation method employed.

Girdle-Herbicide Methods: Girdling trees accompanied by herbicide

applications show potential for Oak Wilt remediation without more costly and invasive methods such as RGD (trenching). Because of this potential, Girdle-Herbicide (GH) research has been one of most intensely studied areas in recent years. Currently, there are two major herbicide models being utilized in Michigan: **1) Triclopyr (Garlon4)/ Double Girdle, and 2) Roberts' Glyphosate/Stump Cup.** The local impacts of these two methods are quite stark (Sketches 1 & 2). To better understand the differences between these two herbicide models, I thought it might be useful to briefly summarize them from a historical perspective. I designed the Glyphosate/Stump Cup method in 2008 and have been refining the technique with several variations and laudable successes ever since. Garlon 4/Double Girdle treatments were first implemented in 2015 in Warren Dunes State Park by a state department. The Garlon 4/Double Girdle method mirrors the Bruhn RGD model but without trenching; however, like Bruhn RGD, the Garlon 4/Double Girdle method specifies the destruction of many healthy trees (Sketch 1, Photo 6B). In 2020, a group of arborists and I visited Warren Dunes to examine the Garlon 4/Double Girdle treatments (Photos 6A & 6B). For transparency, an arborist who led our expedition in 2020 had been hired to implement treatments



P6A & 6B A group of arborists and I trudged through Warren Dunes State Park in 2020 to examine some Garlon 4/Double Girdle treatments that had been initiated in 2015. Some of the trees subjected to the Garlon 4 herbicide had recovered; 6A Inset shows callus tissue (arrow) supporting the canopy. In 6B, just a small portion of the healthy trees were sacrificed in a large "Kill Zone" in this Critical Dune environment (also see Sketch 1). Oak Wilt had also breached this large, sacrificial "Kill Zone" of healthy trees (exemplified in Sketch 1, upper left).

P7A & 7B In replicated field research comparing Glyphosate with Triclopyr (Garlon 4), I demonstrated that Garlon 4 failed to impact the health of oak trees when applied to half girdles; half girdles by themselves do not (initially) negatively impact the health of oak trees. In contrast, Glyphosate always killed oak trees even at a low label rate of one teaspoon per 12" tree trunk diameter. However, further replicated field research demonstrated that the one teaspoon rate of Glyphosate failed to inhibit root graft transmission of Oak Wilt, the reason I have used elevated rates quite successfully (See Photo 9).

at Warren Dunes. We found that some trees receiving the Garlon 4 herbicide treatment had recovered (Photo 6A) and that many healthy trees were sacrificed (Sketch 1-“Kill Zone”) in this Critical Dune environment (Photo 6B). We also discovered that Oak Wilt had breached these “Kill Zones”. These observations prompted me to test the impact that Triclopyr (Garlon 4) has on the health of oak trees. In replicated trials comparing Glyphosate with Garlon 4 using a Half-Girdle procedure, I found that Garlon 4 had no verifiable impact on oak tree health while Glyphosate readily killed oak trees even at a low (label) rate of one teaspoon per 12” tree trunk dbh (Photos 7A & 7B). My results with the Garlon 4/Double Girdle method largely reflect the inconsistent results observed at Warren Dunes and the results published by a group of Wisconsin Scientists in a peer-reviewed publication (Bronson et. al. 2023) as summarized in Table 1. My experience with Triclopyr (Garlon 4) over the past decade is that this herbicide does not even suppress sprouting of stumps let alone kill roots of oak trees quickly enough to suppress root graft transmission of the Oak Wilt fungus (Photos 8A & 8B). Conversely, my research with the Glyphosate/Stump Cup ‘Chaser’ procedure has demonstrated extraordinary results usually without the sacrifice of any healthy trees at numerous locations all over Michigan (Photo 9).

Conclusions:

Based on my more than 40 years of experience, observations, and research on Oak Wilt, there are several conclusions I have reached about Oak Wilt on Critical Dunes and elsewhere in Michigan. Usually, Root Graft Disruption (trenching) is not advised or permitted on Michigan’s Critical Dunes... and would not likely be effective anyway. In addition, because of the fragility of the Critical Dune Ecosystem, mass killing/sacrifice of healthy oak trees should never be recommended (Photo 6B, Sketch 1). When considering tree injections with fungicides, it is advisable to consider their efficacy; great in some situations and disappointing in others. It would also be prudent to consider fungicide impacts on Mycorrhizae symbiosis with trees;

mycorrhizal associations with trees are vitally important for the health of Critical Dune Areas. Regarding herbicide remediation of Oak Wilt, there is only one method that has shown consistent, reliable containment of Oak Wilt **and** without the sacrifice of healthy trees: The Glyphosate/Stump Cup ‘Chaser’ procedure. Because Glyphosate is administered systemically, the herbicide does not affect any other species of trees or plants. Furthermore, Glyphosate decomposes with the degradation of roots/plant tissues, resulting in no discernable impacts on the

associated ecosystem. I could make a strong argument that the Glyphosate/Stump Cup ‘Chaser’ is the most economical, the most environmentally friendly, the least invasive, and the most effective procedure in use in Michigan. “Chaser” exhibits the least impacts on Critical Dune Ecosystems. While the information contained herein is directed towards Critical Dunes, the same criteria can be applied to most other situations in Michigan and beyond... residential communities, parks, nature preserves, woodlands, recreational areas,





campgrounds, etc... where tree preservation and land stewardship is of the utmost importance. There's an adage advanced to me from a USDA Forest Service associate, "The trees you have in your landscape are the last trees you'll have in your landscape."



Table 1: Bronson et.al. (Wisconsin) Research Results with Garlon 4/Double Girdle & Bruhn Model* (April 1, 2023)

#Trees w/Oak Wilt	% Oak Wilt Control
≤4 Infected Trees	81%
>5 Infected Trees	29%
Average	55%

*42 Independent Sites • 2270 Treated Trees (248 Diseased, 2022 Healthy) Monitored 4 Years after Treatment



P8A & 8B At this location near Sutton's Bay, Michigan in 2016, trenching failed to stop Oak Wilt from advancing from the adjoining landscape onto this long, steep Critical Dune cliff leading down to West Grand Traverse Bay (8A). I recommended my Glyphosate/Stump Cup procedure, but my advice was overruled by others who recommended Garlon 4. Garlon 4 failed to even suppress sprouting (8B) and did not inhibit Oak Wilt advancement on this Critical Dune cliff.

P9 At this residence on the shore of an inland Northern Michigan lake, my Glyphosate/Stump Cup "Chaser" procedure was applied to the lone Oak Wilt-infected tree (Inset). No additional trees were destroyed in the remediation effort, and no further evidence of Oak Wilt has occurred in the past five summer seasons. Similar results have been achieved at numerous locations throughout Michigan.