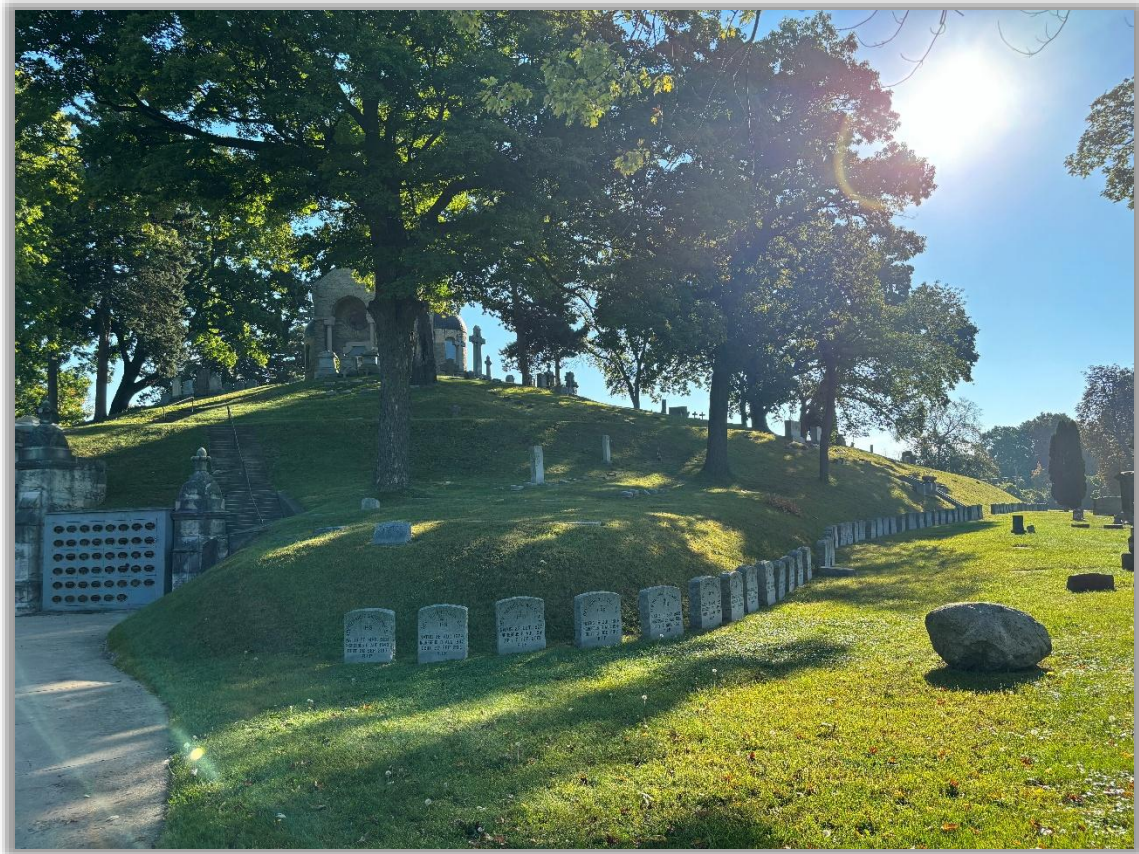


TREES OF SOUTHEASTERN WISCONSIN CEMETERIES



**Wisconsin Department of Natural Resources
Urban Forestry Program**



Preface

Cemeteries are expressions of cultural and natural history. Most cemetery visitors can extrapolate from a few letters and numbers carved into stone the lives of the lost and the heartbreak of those left behind. These same visitors can also interpret earth-shaking events clued into those same stones; evidence of war, waves of migration and medical advances. The botanically minded visitors can also explore an assemblage of plants unique amongst urban areas for their composition, size and condition.

This report documents the results of nearly 400 trees assessed within more than 100 “plots,” circular areas of a $\frac{1}{3}$ acre each randomly distributed across cemeteries in Milwaukee, Ozaukee, Racine, Washington and Waukesha counties. Following an introduction and description of our project’s methodology, we will place cemetery trees in the context of the wider urban forest by comparing our results with data from other local projects. We will then interrogate those results and provide suggestions for future maintenance and management of cemetery trees.

We are deeply grateful for the permissions granted to visit cemeteries for this project, and even more grateful for the work that you all do.

Thank you,
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Table of Contents

Title Page	1
Preface	2
Table of Contents	3
Introduction	4
Methodology	5
Results and Discussion	6
Number of trees and tree and shrub canopy cover	6
Genus and species diversity	7
Size and age	8
Health condition	10
Tree health and wildlife habitat	13
Pruning and tree health	14
Management and Maintenance Recommendations	15
Tree Planting and Tree Species Recommendations	15
Trees to Avoid	15
Trees to Consider	15
Tree Cultivars	16
Tree Pruning Observations and Recommendations	16
Funding and Training	21
Funding	21
Training	21
Additional Recommendations	22
Social strategies	22
Environmental strategies	23
Conclusion	25
Appendix A: Data Fields	26
Appendix B: Species Recommendations	28

Introduction

Cemeteries honor those who have died by giving them space in the earth, marking their presence, minimizing their eternal disturbance and maintaining respectful behavior. But how does that honor manifest itself in the landscape, particularly with trees? What current role do trees play in cemetery aesthetics and should they remain important features of the landscape moving forward?

There is a noteworthy gap in our understanding of trees in cemeteries. Despite occupying large and sometimes prominent parts of our communities, the urban forestry industry knows much less about these trees than, for example, trees within road rights-of-way or in parks. Most trees in those places are experienced more regularly by the broader population and are, because of that, likely more intensively managed.

We hypothesized that cemetery trees are less intensively managed than those in other maintained spaces of the urban forest due to the limited availability of funding or labor and/or a recognition that trees pose less of a risk in cemeteries than higher use areas. Cemeteries are incredibly important and have regular and consistent visitation, but with the exception of funerals, they do not tend to have significant numbers of people near any given tree at any given time. There is thus very limited time that people could be impacted by a tree that fails, in whole or in part.

It *could* be more acceptable for trees in cemeteries to have, for example, more decay in their trunks or dieback in their branches than in other parts of the urban forest. Though motivations around risk tolerance might be indistinguishable from, and intertwined with, aesthetic considerations and financial realities, the health difference between cemetery trees and the wider urban forest is explored in the results below.

Nevertheless, over the past few decades, many cemeteries have been forced into intensive management of their ash trees due to emerald ash borer and the widespread death and fracturing of large trees that has ensued. This in turn has forced managers to reevaluate the role trees will play on their properties moving forward.

We recognize that there is a range in tree management intensity across cemeteries, and that the diversity of ownership type (e.g., municipality, private business, non-profit) and limited scope of this project reduces the strength of one-size-fits-all observations. Despite these limitations, we feel that there are interesting and valuable insights and ideas for cemetery managers across the five-county area of this study, and perhaps beyond.

Methodology

Because we wanted to collect data from a broad swath of cemeteries, we pursued the study across a five-county area of southeast Wisconsin (Milwaukee, Ozaukee, Racine, Washington and Waukesha counties; Figure 1). Having no feasible way of visiting every tree in every cemetery, we conducted a sample tree inventory, meaning that we established circular plots (140 ft diameter, or about $\frac{1}{3}$ acre; Figure 2) across 108 randomly placed points in area cemeteries. Within each of those plots, we collected data on the trees which were then extrapolated to make estimates for all cemeteries. We only collected data in maintained parts of cemeteries (where mowing or landscaping occurred); we did not collect tree data in peripheral areas of regenerating forest. The underlying geographic data for cemetery locations were derived from land use maps from the Southeast Wisconsin Regional Planning Commission.

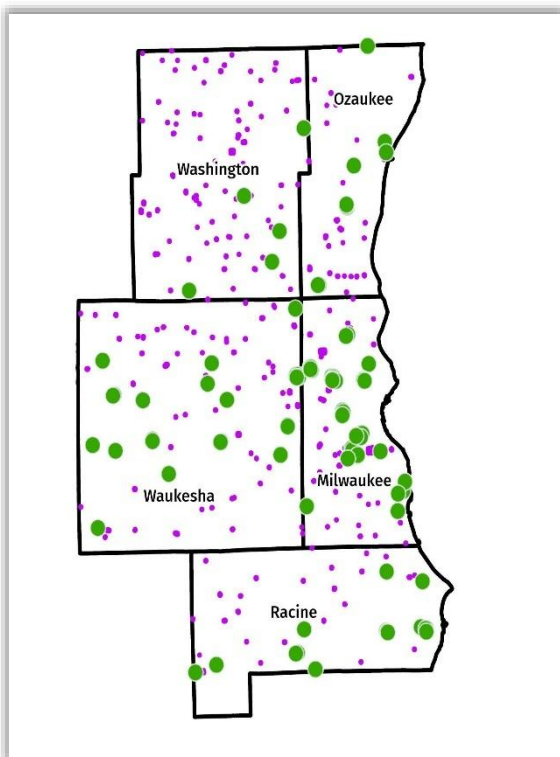


Figure 1 - Cemeteries in the five-county area of interest (Milwaukee, Ozaukee, Racine, Washington and Waukesha counties) are outlined in purple in the map on the left. Survey sites are the green circles.



Figure 2 - A sample survey site showing a circle with a diameter of 140 feet, totaling about $\frac{1}{3}$ acre in size.

The availability of preexisting urban forestry datasets allowed us to compare cemetery trees to the surrounding five-county area. These datasets, derived from the Urban Forestry Inventory and Analysis (UFIA) project as well as local street and park tree inventories, dictated many of

the tree characteristics that we collected in cemeteries. The UFIA project deploys a similar plot-based methodology to the one we used. Additional data were incorporated to better capture cemetery characteristics. See **Appendix A** for all the data fields collected. In this report, we often compared cemetery trees to trees in maintained areas (where mowing or landscaping occurred) in the UFIA dataset. These trees are grouped in figures and tables as “UFIA Maintained” or “UFIA-Maint,” while the entire UFIA dataset is “UFIA Total.”

Results and Discussion

Number of trees and tree and shrub canopy cover

There are an estimated 47,310 trees at least 1 inch diameter in cemeteries in the five-county area. All maintained spaces within the five-county area contain an estimated 8.4 million trees, meaning that cemeteries only account for 0.6% of these trees. However, it’s estimated that cemeteries have 6,707 trees at least 30 inches in diameter which would account for 6.3% of all such large trees in maintained spaces in the area. Cemeteries thus account for a much larger percentage of big trees than trees overall.

Based on our field observations, we estimated that tree cover - the area of land having trees overhead - across all the plots was 23.2% (Figure 3 shows a representative plot). This was almost the same amount that was estimated by UFIA for the urban areas of all five counties (23.6% canopy cover) indicating a surprising reflection of cemeteries to the surrounding region.

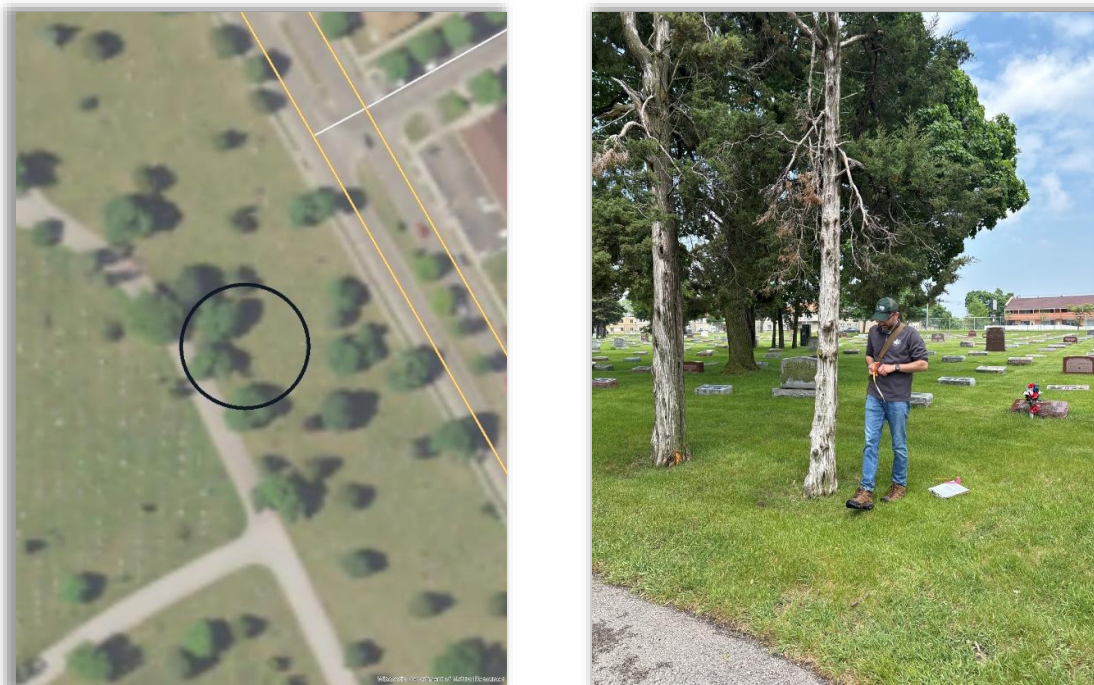


Figure 3 - An example of what 24% canopy cover looks like from an aerial (left) and field (right) perspective.

However, shrub cover in cemeteries (2.0%) was much lower than the surrounding urban areas (8.7%).

Genus and species diversity

Diversity in tree type is critically important in urban forests. Because of the massive, expensive, and traumatizing effect of losing local elm trees in the 1950s and 1960s due to Dutch elm disease, and more recently losing millions of ash trees due to emerald ash borer, urban tree managers are painfully aware of the impact of having an overabundance of a few types of trees. The more reliant a land manager is on one species or genus, the more vulnerable that area is to insects, diseases, or other disturbances.

A common benchmark for urban forests is the 30-20-10 rule - that is not to have more than 30% of the trees you manage be from the same family, no more than 20% from the same genus, and no more than 10% from the same species (Table 1). The Wisconsin DNR recommends an even more aggressive 20-10-5 rule¹.

Regardless of the rule applied, it is clear in the cemetery data that maple trees are overrepresented in cemeteries. Of the 395 trees assessed in this study, almost a third were maple trees (most common species in Table 2). Additionally, some cemeteries were almost exclusively composed of maple trees. This is understandable when design unity, fall foliage, and/or urban tolerance are priorities. However, this jeopardizes the long-term, decadal presence of trees on these properties. After all, what happens when an insect or disease appears that causes significant mortality in maple trees?

The current experience of ash trees dying and being removed from cemeteries and other parts of our communities has shone a light on this diversity problem (ash trees have been one of the most common trees in maintained and unmaintained areas alike). However, we advocate for different trees (see planting recommendations in Appendix B), not fewer trees.

As seen in Figure 4 on page 8, the five-county area is also overrepresented by maple trees, though not quite to the same degree as cemeteries. Diversity issues are certainly not unique to

Rank	Sample
Family	Soapberry
Genus	Maple
Species	Sugar maple

Table 1 - the lowest three levels of taxonomic ranking - family, genus, and species - are used to establish diversity guidelines.

Species	Percentage
Arborvitae	14.2%
Norway maple	13.7%
Silver maple	9.4%
Sugar maple	5.6%
White spruce	5.1%
Eastern redcedar	4.6%
Green ash	4.3%
Yew	3.3%
American basswood	3.3%
45 other species	36.7%

Table 2 - a total of 40 tree species were identified within project plots.

¹ https://dnr.wisconsin.gov/sites/default/files/topic/UrbanForests/EABToolbox_Diversity.pdf

cemeteries, but they nonetheless need to be addressed for long-term sustainability of these important places.

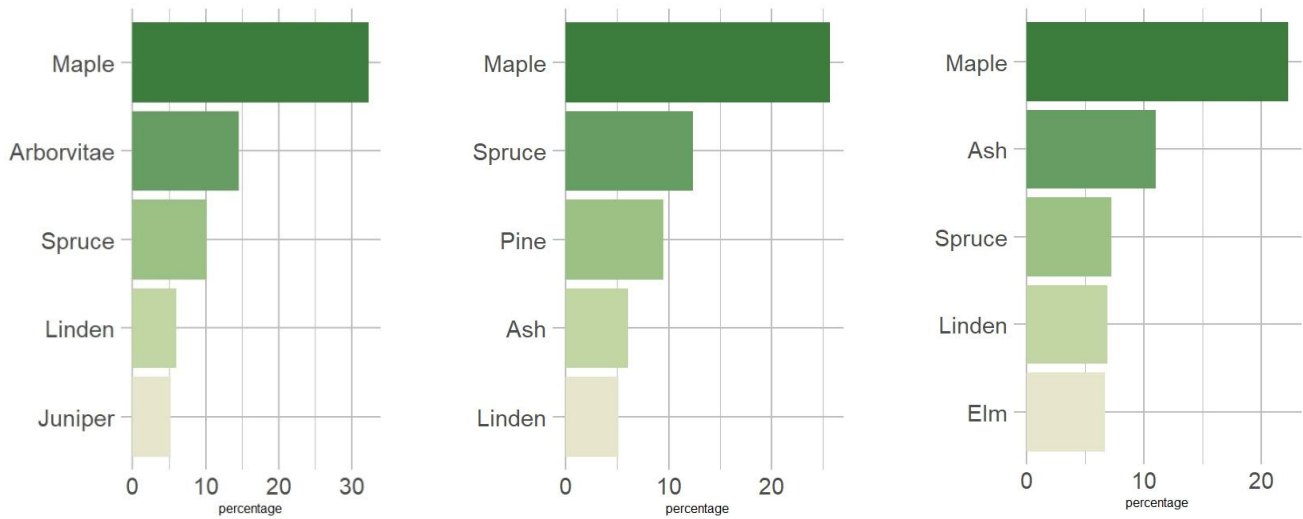


Figure 4 – Five most common tree genera in cemeteries (left), in maintained spaces of the five-county area (middle), and across the entire urban forest (right) of the five-county area.

Maple trees also account for a significant amount of the leaf area of cemeteries. It is estimated that maples, which represent 32% of cemetery trees, account for 47% of all trees’ leaf area because many of the maples are old and large (Table 3). Leaf area is an important characteristic which drives many of the benefits that trees provide, such as reducing heat and precipitation runoff.

Species Name	Percent Population	Percent Leaf Area
Silver maple	9.4	21.3
Norway maple	13.7	17.4
Sugar maple	5.6	8.0
Norway spruce	2.5	5.4
Green ash	4.3	5.0

Table 3 - Species comprising the most leaf area of cemeteries in the five-county area. Leaf area drives many ecosystem benefits, such as air pollution and stormwater reduction.

Size and age

Cemetery trees tend to be large, as measured by their trunk diameter. Their average size is an impressive 18 inches in diameter, more than 10 inches greater than the average size of trees in other maintained spaces in the five-county area.

The diameter distribution seen in Figure 5 below, with its increasing numbers in the 5-15 inch and 15+ inch size classes, is unique. Maintained and unmaintained areas alike have declining percentages of trees as size increases. Street trees, however, have their own unique assemblage, with similar percentages across the three size classes.

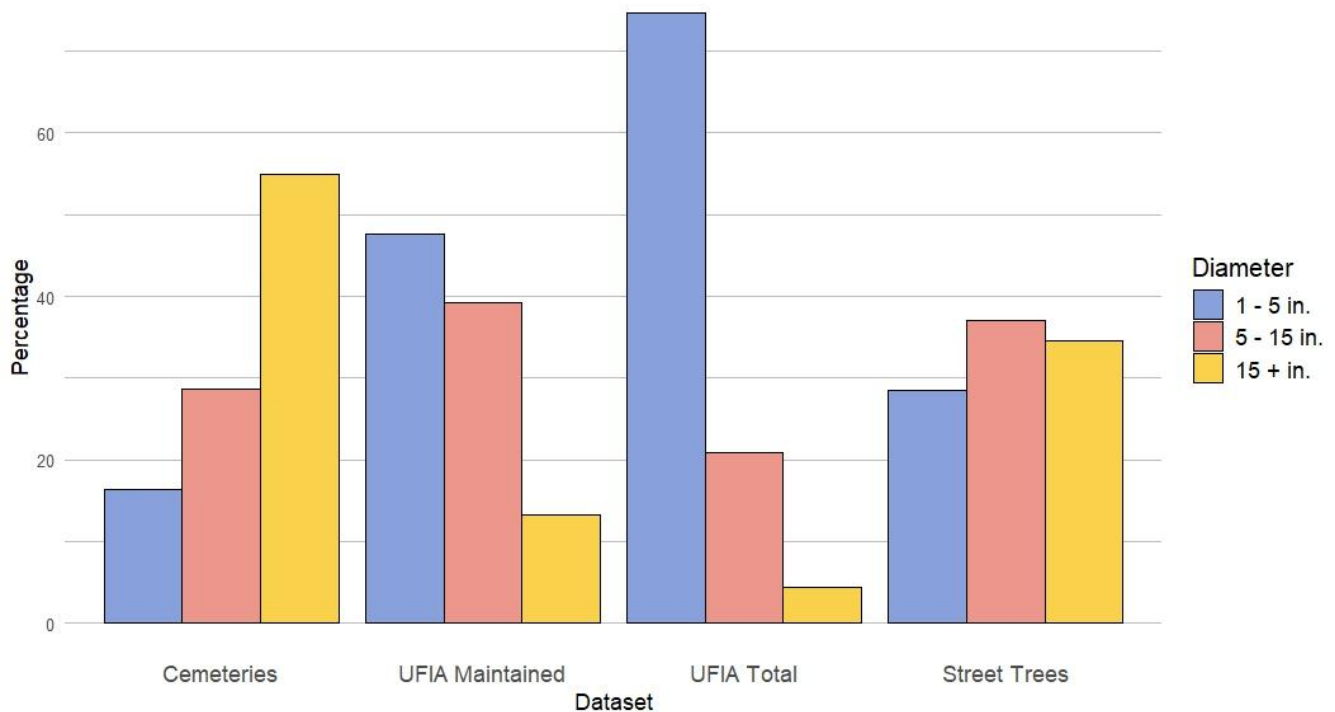


Figure 5 - Percentages of trees in three different diameter size classes across cemeteries, maintained spaces, all trees, and street trees in the five-county area.

Cemeteries thus have what would be considered an overmature tree population - an urban forest that does not have nearly enough young trees to fill space as the big trees age out. Indeed, there were very few young or small trees in our data. Of the 61 trees surveyed which were under 5 inches in diameter, over half of them were arborvitae, yew and other trees likely to remain small (Figure 6).

A troubling story emerges when looking at diameter sizes and most common species. Some of the most common trees are overwhelmingly represented in the large size classes (Figure 7). Silver maple, for example, is the third most common tree in cemeteries but we didn't come across one smaller than 18 inches in diameter!



Figure 6 - When large trees age out, cemeteries will increasingly be composed of smaller statured trees and shrubs, like this yew.

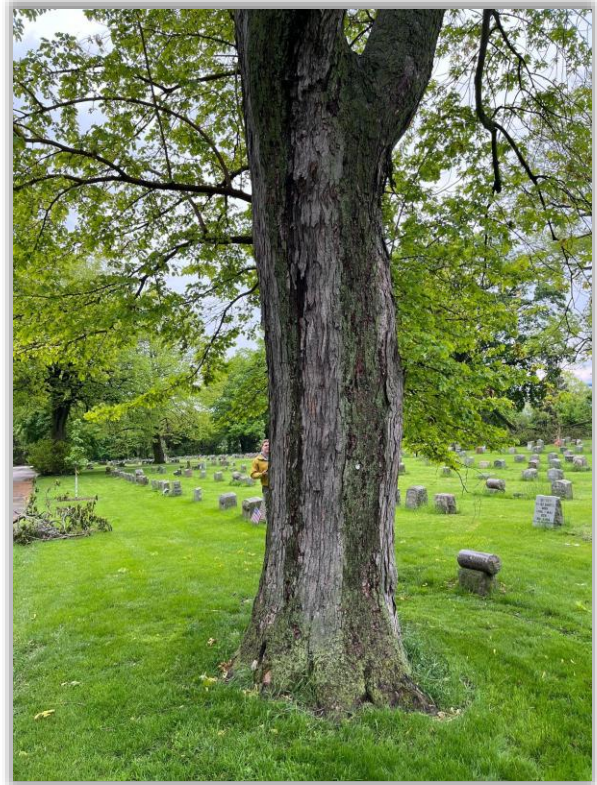


Figure 7 - Silver maples are the third most common tree in cemeteries, but we did not find one smaller than 18 inches in diameter.

Without additional trees planted, the character of cemeteries on the whole, and many in particular, are going to be radically different in future decades.

Health condition

One of the hypotheses of our study was that trees in cemeteries would generally have more rot in their trunks and more dieback in their canopy than other trees in maintained spaces. That panned out, as seen in Table 4 below. Note that for all categories, only living trees at least 5 inches in diameter were included. Figures 8 and 9 below help contextualize how dieback and rot appear in trees.

Dataset	Cemeteries	UFIA-Maint	UFIA-Total
Tree count	323	686	1,959
Average diameter	20.3	13.3	11
Percent trees with dieback	57.3	28.1	31.5
Average dieback	4.4	2.9	4.3
Percent trees with rot	42.4	29.0	26.9
Average rot	2.1	1.4	1.3

Table 4 - Indicators of tree health of cemetery trees compared to trees in maintained spaces, as well as all surveyed trees in the five-county area. Only includes living trees at least 5 inches in diameter.



Figure 8 - The canopy of this large silver maple contains about 15% dieback (note the thinning in the upper canopy and many empty branches in the lower canopy).



Figure 9 – While not a seemingly high amount, this is what 5% rotten or missing trunk looks like in the field.

However, some nuance is added when breaking the trees down by diameter sizes. Up to 15 inches in diameter, the rot and dieback in trees varies little between cemeteries and other maintained spaces. It is only in bigger trees, particularly at least 30 inches in diameter, that noticeable differences appear in the health of trees (Figures 10 and 11). Overall, large trees in cemeteries have greater rot and dieback than other maintained spaces. Presumably, this is due to a combination of funding challenges, the lack of specialist labor who can maintain large

trees, and a recognition that failing trees are unlikely to cause significant damage to people or buildings.

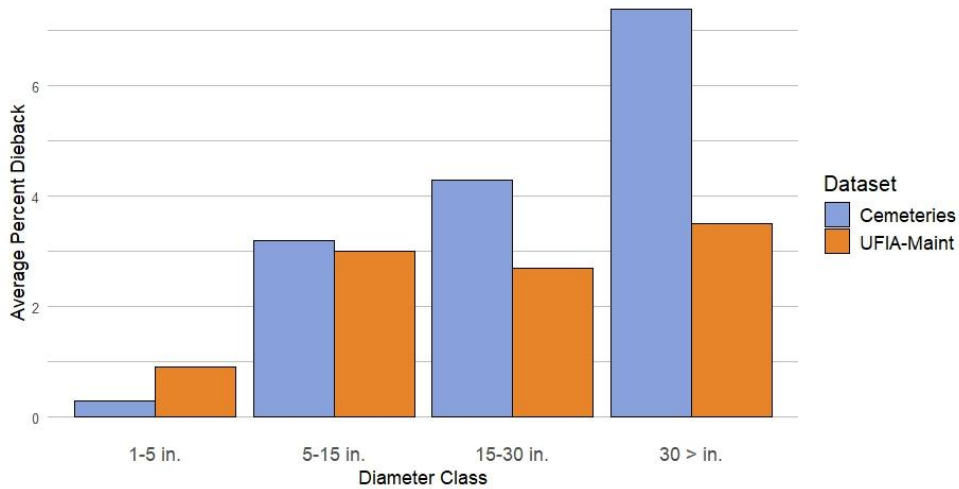


Figure 10 - Average percent dieback by diameter classes in cemeteries versus other maintained spaces.

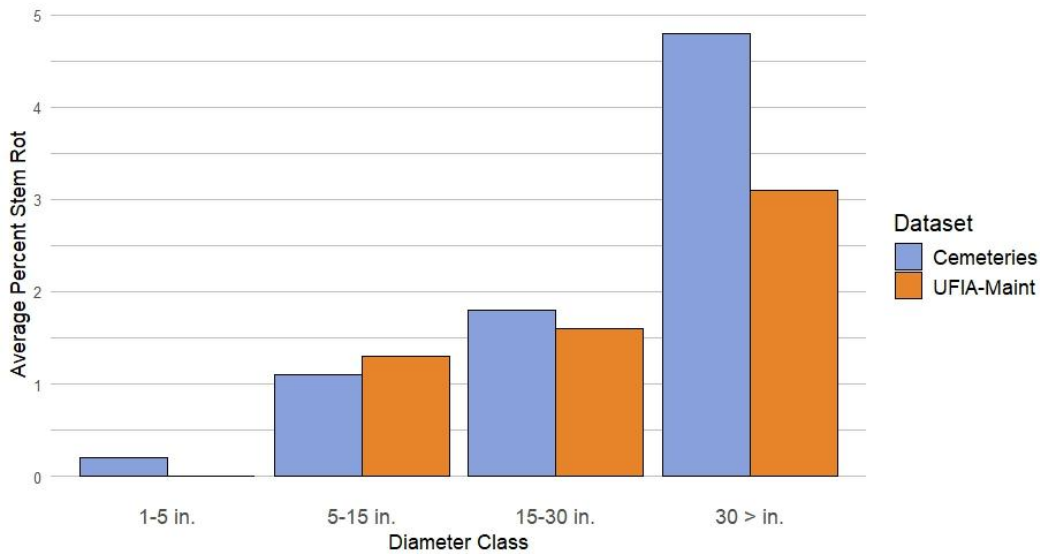


Figure 11 - Average percent missing or rotted trunk by diameter classes in cemeteries and other maintained spaces. Note that trunk rot was not recorded for trees less than 5 inches in diameter in the UFIA-Maint dataset.

Notably, cemetery trees had higher percentages of trees with dieback and rot in all eight genera with at least ten trees in both the cemetery and UFIA maintained databases (maple, ash, juniper, spruce, pine, oak, arborvitae and basswood). This could indicate that cemetery trees either were more predisposed to dieback and rot because of cultural or environmental

factors (e.g., poor pruning or disturbed soil), or were not as actively managed as in other maintained spaces (e.g., dieback in trees wasn't pruned out).

Likewise, the average dieback and rot for most genera was also higher in cemetery trees

Tree health and wildlife habitat

We don't think the above indicators of rot or dieback in big trees is necessarily a bad thing. On the contrary, we celebrate the presence of large trees that remain on the landscape. These trees often have excellent habitat value. Many animal species are attracted to trees with rot for food or housing (e.g., woodpeckers, squirrels). In fact, we modeled the suitability of cemetery habitat for eight bird species versus the City of Milwaukee on the whole (we only had this comparison data for Milwaukee). For five of the species (American robin, Baltimore oriole, black-capped chickadee, European starling and red-bellied woodpecker), the openly spaced, large trees with some rot in them that are common in cemeteries offer better habitat than in the wider urban environment.

Trunk cavities were also present in higher percentages (15% of all trees) than in street trees (2.6% of trees across 12 street tree inventories had cavities) or even Waukesha County Parks (8.4% of trees in park settings).

This is another indication of potentially excellent habitat for woodpeckers and other cavity-nesting birds (Figure 12).



Figure 12 - Cavities in tree trunks offer tremendous wildlife value.

Beyond bird habitat, we also surveyed the observations of wildlife in ten cemeteries through the iNaturalist website, which crowdsources data about living organisms. Dozens of species of insects, spiders, wasps, bees, butterflies, birds, amphibians, reptiles and mammals were observed in these spaces by visitors. These included coyotes, muskrats, painted turtles, great blue herons and great horned owls. While no observed wildlife was particularly rare, the assemblage indicated a variety of habitats within cemeteries. For example, at least eight bee species were observed, many of which require different nesting habitats. Digger bees generally nest underground and require some bare ground for nesting, while some of the

bumble bees nest in tussocky grasses or in abandoned rodent burrows. Seeing mixes of those indicates the presence of both foraging and nesting habitat.

Pruning and tree health

Pruned trees in cemeteries had, on average, better health condition ratings than those which weren't pruned (Figure 13). The better ratings with dieback and missing crown are unsurprising, but the lower percentages of trunk rot in pruned trees is surprising given that rot often starts in pruning wounds, especially if improper pruning cuts are present.

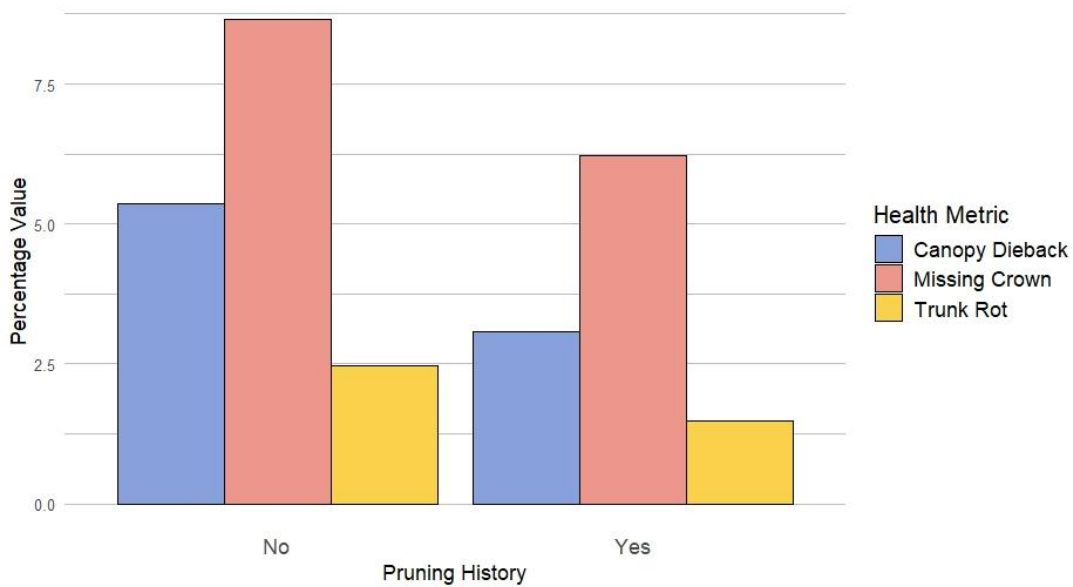


Figure 13 - Average dieback, missing crown, and missing/rotten trunk in cemetery trees between those trees not pruned, and those that were pruned.

Management and Maintenance Recommendations

Tree Planting and Tree Species Recommendations

Analysis shows an overmature and aging out populations of trees within cemeteries. Informal conversations with cemetery managers revealed a hesitancy and/or inability to plant new trees within cemeteries due to costs, maintenance responsibilities, future risk and limited space. However, additional conversations with cemetery managers highlighted the generally favorable opinion of trees within cemeteries by those who visit these spaces.

In the absence of any future tree plantings, cemeteries are at the risk of losing significant tree canopy over the next few decades. Cemeteries, along with most other land uses, have already sustained large amounts of tree loss due to emerald ash borer over the last two decades.

Cemetery managers must weigh the costs and benefits of planting new trees on their properties. Current best management practices used in combination with this new cemetery tree dataset can help to inform cemetery managers on tree selection, site selection and proper planting techniques. Timing is also a consideration; if trees are planned for removal, consider planting other trees nearby, allow them to establish and then remove the larger, older ones. This reduces the shock that the removal would otherwise make to visitors.

Trees to Avoid

As already mentioned, some cemetery properties should slow or limit planting trees within the maple genus. Likewise, if you are aware of other trees being overplanted on your property, you would want to avoid those as well. If you are unsure of your species makeup, you can reach out to the DNR Urban Forestry team for assistance. In addition, trees that are shown to be invasive should be avoided. You can consult the NR40 invasive species rule² as well as local ordinances to see if there are restrictions on species you can plant. Additionally, each cemetery manager may also have certain preferences or tolerances for certain types of trees in parts of their cemetery. For example, trees that produce high quantities of heavy fruit may not be appropriate for entrances and walkways, but they can be utilized in other areas of the property.

Trees to Consider

Some recommended tree species to be utilized on cemetery properties are identified in **Appendix B**. These are not exhaustive lists but were selected for several variables including their urban tolerance, appropriate climatic range and maintenance requirements.

² <https://dnr.wisconsin.gov/topic/invasives/classification>

Tree Cultivars

In addition to the species listed in **Appendix B**, there is an abundance of cultivated species that may warrant use in the cemeteries. Cultivated species are clones of certain specimens that have consistent attributes. For example, many tree and shrub species will have dwarf cultivars. When these cultivars are used in the landscape, they have a consistently smaller size than what is typically seen in the landscape. This can allow you to fit trees into tight areas while still diversifying your species palette. Additionally, cultivars can have unique leaf and flower characteristics, different fruiting habits, and even remove undesirable characteristics such as thorns.

Tree Pruning Observations and Recommendations

Of all the trees surveyed in the project, 69% had visible pruning cuts/wounds on the tree. The most common type of observable pruning cut was crown raising, which occurred on 65% of all surveyed trees.



Figure 14 - An example of crown raising, a pruning technique used to elevate the tree crown so that sight lines are improved and/or other infrastructure are unimpacted. Crown raising was commonly observed on cemetery trees.

Crown raising is a frequent arboriculture practice seen on trees in urban settings. Raising the crown allows for clearance of people, cars, signs, etc. In the case of cemeteries, the most logical reasons for raising the crown of the tree appear to be to provide clearance for people, lawn mowers, and the gravestones themselves (Figure 14).

Our team frequently observed incorrect pruning cuts on trees that had been raised. Incorrect pruning cuts can lead to poor sealing of the wounds, increased decay, poor future branch structure and an overall reduction in tree health and vigor. With just a little bit of training and the proper tools, correct pruning cuts can be made with little to no extra time spent at each tree. In the long run, performing proper pruning cuts can decrease the future risk of trees as they are less likely to gather decay and fail.

The two proper pruning cuts to deploy when raising the canopy of a tree are the reduction cut and the removal (or thinning) cut (Figure 15). Both of these methods can be utilized in combination to get the desired results.

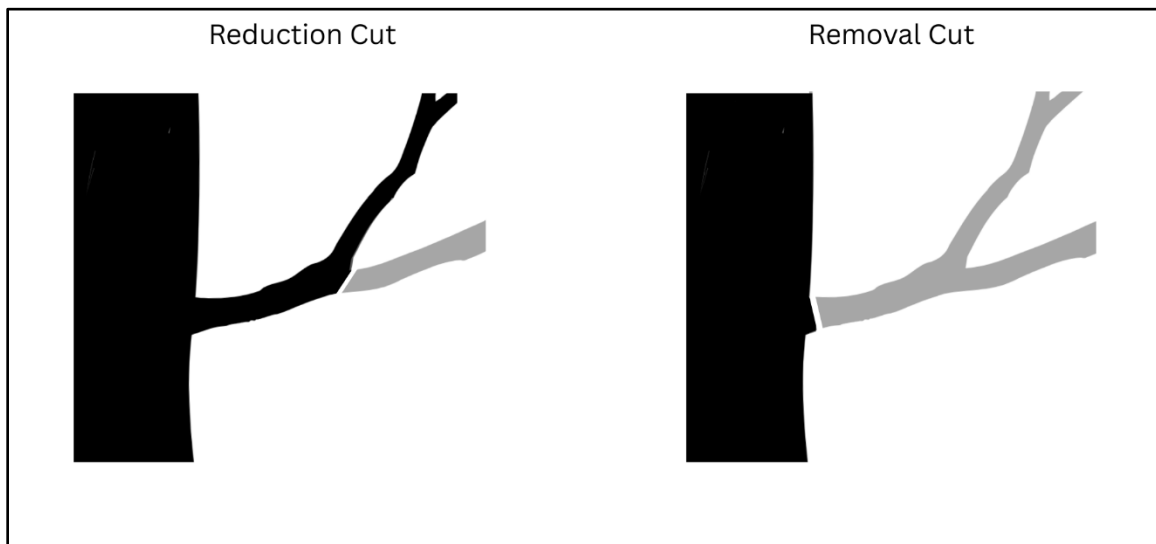


Figure 15 - Examples of removal and reduction cuts.

A reduction cut is made by taking the parent stem back to a branch. A reduction cut is most successfully used in a raising situation when you have a secondary branch that is growing upward. If there are no secondary branches suitable to reduce the parent stem back to, then a removal cut may be the best option.

A removal cut is performed by taking the branch back to the parent stem or trunk. It is important to make sure you are not cutting into the branch bark ridge or the branch collar when making a removal cut (Figure 16).

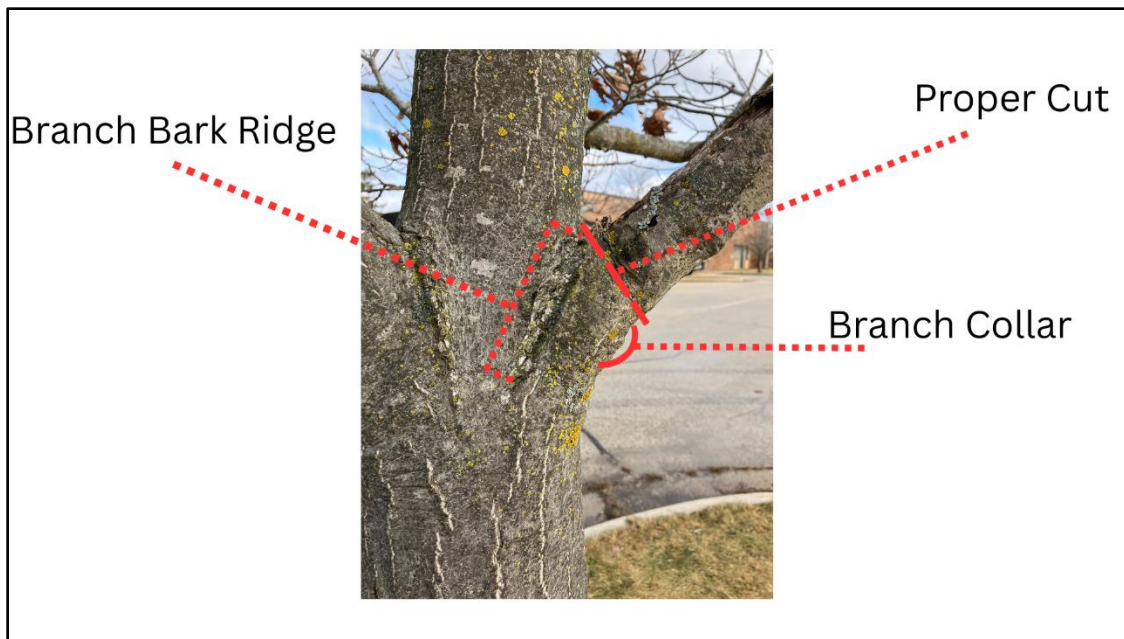


Figure 16 - A proper removal cut does not go into the branch bark ridge or the branch collar.

The more common poor cuts observed in the field on those trees that had been raised were flush cuts and stubs (Figures 17 and 18). These types of cuts should be avoided as they increase the risk of decay and reduce the ability of the tree to close the wound over time.

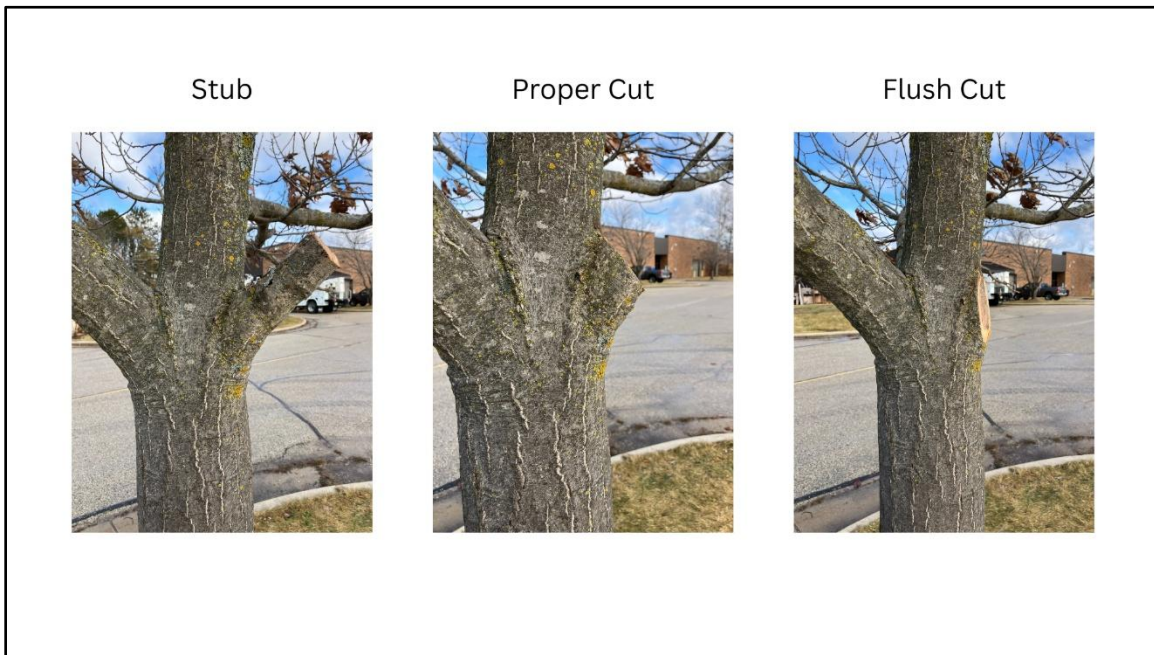


Figure 17 - Examples of poor pruning cuts, including a flush cut (right) and a stub (left). The middle cut shows the proper angle keeping both the branch bark ridge and the branch collar intact, without leaving a stub.



Figure 18 - A flush cut often leaves an excessive size wound while also removing the tissue of the tree designed for closing wounds. This image shows the result of a flush cut over time. The wound is only sealing on the sides and decay has moved into the main trunk of the tree from the pruning wound.

Less frequently observed pruning types on cemetery trees were cleaning cuts (15%), where dead, dying and diseased branches are removed from the canopy, and thinning cuts (7%) where live branches are removed from within the canopy to meet a variety of objectives. For many cemetery trees, crown cleaning and thinning cuts are probably not necessary. In some instances, these types of pruning cuts may be implemented for aesthetic purposes and/or to mitigate risk. On larger trees these types of pruning cuts often require specialized equipment such as bucket trucks, climbing gear and chainsaws.

Long-term pruning requirements can be mitigated through proper species and site selection, along with proper pruning when the tree is young. Cemetery managers can save immense future pruning and labor costs by performing what is known as **structural pruning** (Figure 19). By implementing a combination of proper raising, thinning, and cleaning cuts when the tree is young, cemetery managers can set up a tree for success in the years to come (Figure 20).

Additional information on proper tree pruning can be found on the University of Florida website³.

³ <https://hort.ifas.ufl.edu/woody/structural-pruning-flash.shtml>

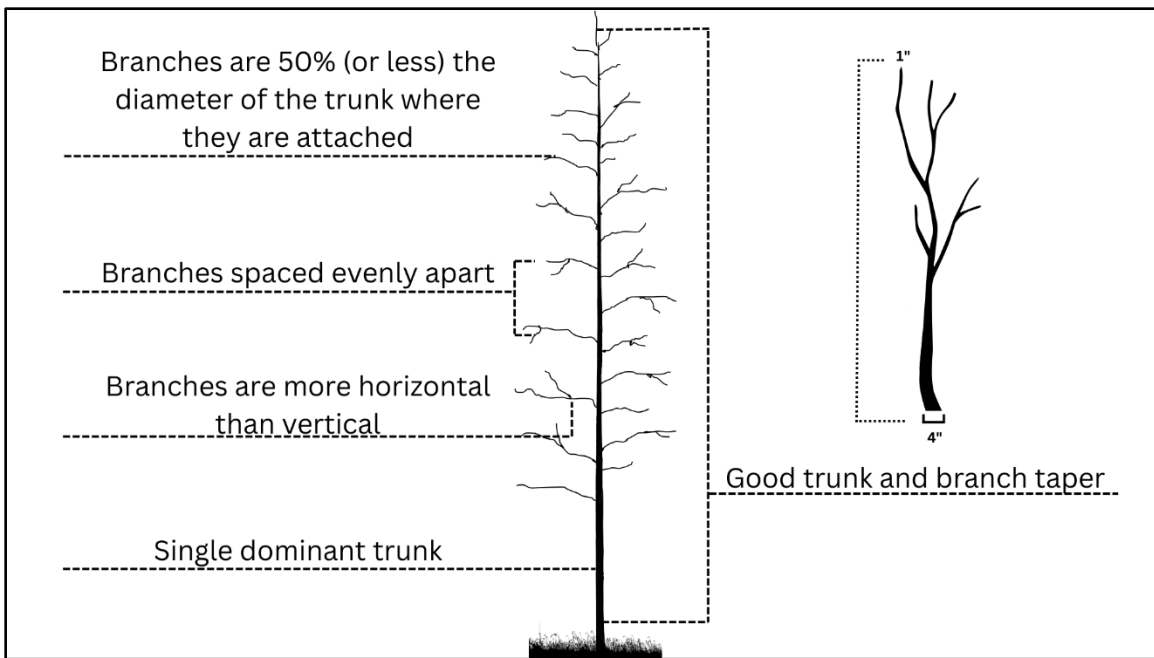


Figure 19 - Ideal tree structure for an urban tree. Note the image above is an extreme example to show the concepts of strong structure and you will seldom see or achieve such a uniform structure with most species of trees.

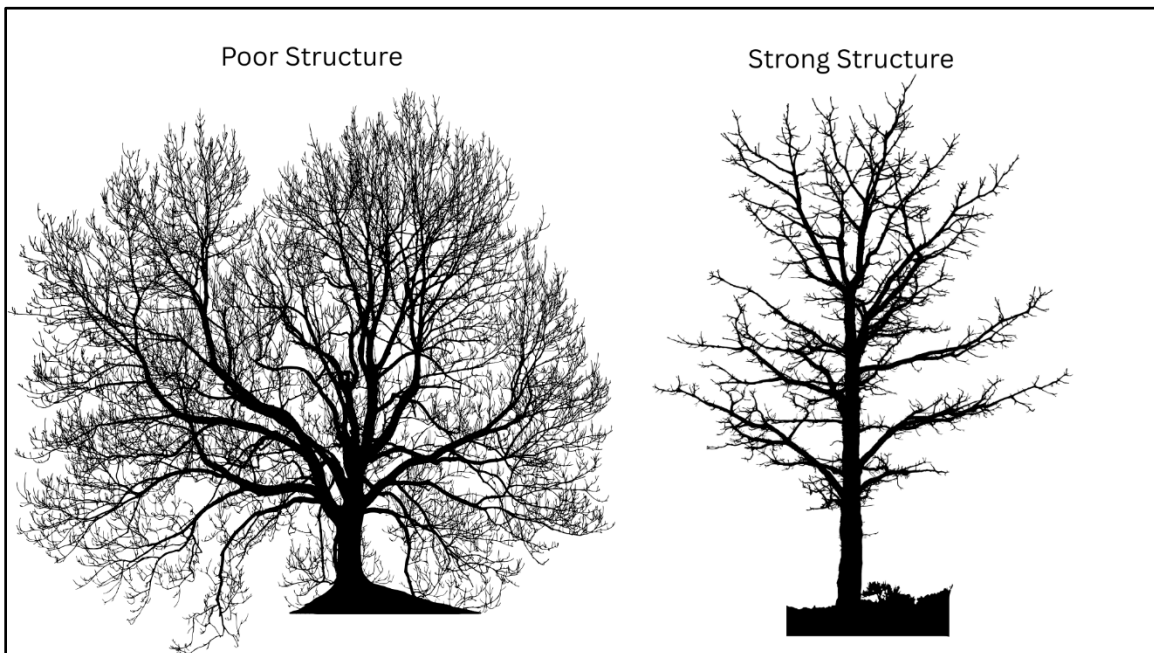


Figure 20 - Though there could be many exceptions to this, for medium-to-large shade trees, it is generally ideal to have a single dominant trunk. This improves structural strength by reducing weak connection points.

Funding and Training

Funding

Funding is a constant struggle for cemeteries. Those that are owned by local units of government or 501(c)3 non-profit organizations are eligible for Urban Forestry grants⁴ offered by the Wisconsin Department of Natural Resources. These are 50/50 competitive match grants up to \$25,000 for urban forestry projects.

Though often the highest-ranking grants support new, innovative projects that develop capacity, there are others that fund staff training, tree plantings, or removals. In addition to the regular grants, the DNR also offers start-up grants that are cost-share grants of up to \$5,000 aimed at new or emerging urban forestry programs. For those cemeteries that have many trees, we suggest a professional tree inventory and management plan. Many inventories also include locations of “vacant sites,” places where trees could be planted. This could be especially useful in light of this project’s results showing very low tree planting.

Another suggestion, particularly for organizations managing large or multiple properties, is to fund staff to be trained in arboriculture. Having at least one staff member with arboricultural skills could have positive cascading effects on other staff and properties.

The Milwaukee Metropolitan Sewerage District (MMSD) has an ambitious plan to plant 6 million trees and restore or enhance 4,000 acres of wetland. If a cemetery is in the MMSD footprint and is interested in partnering with them, trees or funding could be available.⁵

Training

The DNR’s Urban Forestry program hosts the Community Tree Management Institute (CTMI) every three years.⁶ This is a unique training experience designed for municipal or organizational staff with tree management responsibilities, but without a strong background in urban forestry. The program is ideal for staff who spend just part of their time dealing with trees.

CTMI consists of approximately 38 instruction hours and requires students to complete an out-of-classroom project (three two-day sessions). Additionally, a CTMI graduate workshop may be offered in the off years of the regular institute.

⁴ <https://dnr.wisconsin.gov/topic/urbanforests/grants>

⁵ <https://www.mmsd.com/what-we-do/flood-management/reforestation-wetland-restoration-program>

⁶ <https://dnr.wisconsin.gov/topic/urbanforests/treemanagement>

Another option is to attend in-person or virtual events or courses through the Wisconsin Arborist Association⁷ or the wider International Society of Arboriculture⁸.

Lastly, a simple suggestion is to sign-up for the DNR's Urban Forestry newsletter⁹, which includes useful information on urban forestry trends and advertises future training opportunities.

Additional Recommendations

Cemeteries are some of the most stable greenspaces in our urban areas. In many cases, as we often observed through our field work, cemeteries can even be a neighborhood or community's only accessible greenspace. As our urban areas continue to grow and develop, there are opportunities in cemeteries to foster not only a space for remembrance and memorial, but also for community building, local education and environmental stewardship.

Inspired in part by Milwaukee's Forest Home Cemetery & Arboretum, we became interested in potential strategies to encourage greater ecological health, as well as community use of urban cemeteries as shared greenspaces or parks.

Though we recognize that more ambitious strategies likely require continuous consideration and funding, and not every cemetery has the ability, resources or desire to implement these strategies, we nevertheless want to share some ideas for promoting cemeteries for greater community use or environmental stewardship.

Social strategies

Cemeteries are generally not locations for picnics, playgrounds or other recreational activities in the same way that public parks are, due to the sacred nature of these grounds and the need for privacy for those grieving. Nonetheless, encouraging occasional respectful visitation, beyond those in mourning, can be helpful for the long-term care of the property.

During our field visits, we sometimes noticed people using the space for recreational purposes such as running or walking their dog. In one case, a father and daughter mentioned that they ride their bikes through the cemetery because it was safer than using the roads, and in order to climb an extraordinary European beech tree. These types of activities can be encouraged by installing things like dog waste bags and disposal stands, trash and recycling cans, benches and picnic tables, little free libraries, etc.

⁷ <https://www.waa-isa.org/events-programs/>

⁸ <https://www.isa-arbor.com/Online-Learning/Online-Courses>

⁹ <https://dnr.wisconsin.gov/topic/urbanforests/events>

Cemeteries are truly time capsules of a community's local history and culture. There are great opportunities for cemeteries to engage in public outreach by hosting historical tours, cultural gatherings (e.g., Dia de los Muertos events) or educational programs. For example, the GRAVE initiative by the Florida Public Archeology Network encourages students and volunteers to research local cemeteries and gravestones as an introduction to archeology and historical inquiry¹⁰. Students are encouraged to write poems, design headstones, research family trees or write a biography of someone buried. Other events held in cemeteries that may be of interest could include tree identification walks, birding, runs, seed collection and foraging, and more. Integrating cemeteries into the wider community, in moderation, beyond those in mourning will make cemeteries more relevant to that community, and thus more sustainable. But that relevance requires people to be more familiar with the sites.

Environmental strategies

In addition to our recommendations on species selection for cemeteries, there are also several maintenance activities or services that could promote increased biodiversity and ecological health.

Green burials are likely the most well-known environmental adaptation that some cemeteries have recently offered. Increasing environmental considerations and popularity of green burials may increase public interest in more natural options. In fact, a 2024 study¹¹ on end-of-life services showed growing support for emerging disposition methods (green burial, natural organic reduction, water cremation) and diminishing interest in casket burial and cremation. Should these trends continue, investing time and consideration for incorporating diverse services may help satisfy future demand or concerns over land availability.

For traditional burials, steps could be taken to both enhance beautification of a loved one's burial plot while also promoting biodiversity of both flora and fauna. We recognize and understand restrictions for individual plot plantings due to maintenance concerns, costs and aesthetic considerations. Still, reconsidering rules to allow for certain shrub, tree or perennial flowering species, on or near a plot, could comfort a person's loved ones while also incorporating more diverse flora. There is a precedent in some communities to use curated lists of species from which homeowners can select street trees. Perhaps cemeteries can offer such a list to families, with a commitment to plant the species in the cemetery (though not necessarily right next to loved ones) if funds are provided for both planting and a few years of maintenance.

Other ecologically valuable items may also be incorporated on the landscape. For example, including the option of purchasing birdfeeders, birdhouses or bat boxes during the sale of a

¹⁰ https://www.fpan.us/wp-content/uploads/2022/05/GRAVE_Lessons.pdf

¹¹ <https://www.wakeforestlawreview.com/wp-content/uploads/2024/12/Pyatt.pdf>

burial plot could be a simple but effective strategy in encouraging wildlife activity and continuous visitation to cemeteries.

Changing mowing and pruning patterns, either in selective areas or for designated time periods, can benefit pollinator species, water conservation and soil health. For example, parts of a cemetery could participate in “no-mow May” and divert time and resources toward other landscaping efforts. Or, in designated cemetery areas, like those not actively adding burial plots or with older sites with low active visitation, avoiding mowing completely and lessening deadwood pruning. This can help establish “wildlife corners” or “pocket prairies” (Figure 21).



Figure 21 - Luther Parker Cemetery in Muskego is a settler cemetery that is also a remnant prairie.

There are also opportunities in cemeteries to develop microforests, small plots of land with densely planted shrubs and trees that can create pockets of forest relatively quickly. Partnering with local environmental or workforce groups could help with the installation or maintenance. For example, Groundwork Elizabeth recently installed a microforest on the periphery of Mary of the Assumption Cemetery in Elizabeth, New Jersey.

Conclusion

Trees can help reinforce cemeteries' sacred specialness. While we don't want to encourage overmanaging trees, there are relatively straightforward practices to implement to improve each cemetery's long-term tree canopy. That mainly comes down to planting a diverse array of new trees and changing pruning practices to minimize damages and long-term costs.

Having a more expansive, diverse and vibrant canopy will only increase the relationship between the site and the visitor, and the presence of the visitor will honor and memorialize those who rest there.

Appendix A: Data Fields

Plot Data

Percent Plot Measured (i-Tree/UFIA): Percent of 1/3-acre plot that was accessible and measurable, either directly or by estimation. For example, regenerating forested areas or areas past cemetery property (e.g. ROWs) were not included.

Percent Tree Cover (i-Tree/UFIA): Percent of 1/3-acre plot covered by tree canopy, estimated as if the sun were directly overhead, including canopy falling within the plot area even if the tree itself was not.

Percent Shrub Cover (i-Tree/UFIA): Percent of 1/3-acre plot covered by shrubs. Trees under 1-inch diameter and any present buckthorn was considered shrub cover.

Primary Ground Cover (custom): The predominant ground cover of the plot area.

Options included bare soil, building, rock, duff/mulch, maintained grass, unmaintained grass, herbaceous plants, impervious surfaces, and water.

Headstones (custom): Y/N if headstones were present in the plot area.

Headstone Years (custom): If headstones are present, the earliest and latest years within the plot area. This custom method was intended as a measure of disturbance, when the area was first and most recently added to.

Cemetery Information (custom): Cemetery name, year of cemetery establishment, and ownership type. Ownership type categories included government (local, state, or federal), private (business or individual), religious institution (e.g. church), and non-profit organization.

Tree Data

For any tree with at least a 1-inch diameter that fell within (or least 1/2 of its diameter within) the plot area, the following was collected:

Species (UFIA): Tree species categorization as definition by the list of species from UFIA. The list was modified for this study to exclude buckthorn as a tree species, which was instead counted as a shrub.

Number of Stems (i-Tree/UFIA): The number of stems on a multi-stemmed tree.

Diameter at Breast Height (i-Tree/UFIA): Diameter in inches at 4.5 feet from the ground on the upper sloped side of the tree. If the tree had any irregularities (e.g. burls), diameter was taken at an alternative height that was recorded. If the tree was multi-stemmed, each stem was measured (if many stems, the largest 6).

Codominance (Wachtel): Codominance is defined as stems of nearly equal diameter arising from a common junction with a nonnormal branch union on the central trunk, including bark inclusion.

Percent Rotten or Missing Trunk (UFIA): Estimated percent missing or rotten wood in the main stem of a tree.

Trunk Cavities (Tree Risk Assessment Qualification/custom): Measure of number of trunk cavities, cavity depth, and percent proportion of the cavity to the trunk circumference. If a tree had many cavities, the largest three were recorded.

Pruning History (Tree Risk Assessment Qualification/custom): Different pruning methods include crown cleaning (removal of dead/dying limbs), thinning (removal of live branches), raising (to provide clearance), reducing (to decrease tree height/spread), topping, and/or lion-tail. Pruning must be recent/distinguishable from self-pruning to be considered.

*Percent Uncompacted Crown** (UFIA): Percent of tree height supporting the obvious live crown.

*Percent Compacted Crown** (UFIA): Percent of tree height supporting obvious live crown, accounting for crown gaps, broken branches, and dieback. Estimations must account for species-specific typical branch spacing.

*Percent Dieback** (UFIA): Percent of crown dieback relative to the uncompacted live crown. Only included dieback that begins at the tips of the branch, has fine twigs, and begins in the top half of the crown.

Common Urban Tree Problems (UFIA/custom):
Stem girdling

Bark inclusion
Excessive mulch
Conflict with roots
Conflict with headstone
Conflict with crown
Improper Planting

* If a tree was dead, uncompacted/compacted/dieback were all 0%.

Appendix B: Species Recommendations

RECOMMENDED LARGE SHADE TREES

A short, non-exhaustive list of potential species to plant in cemeteries. Each of the listed species has the potential to grow 50-100 ft in height and 30-80 ft in width. Expected lifespan cannot be predicably forecast in an urban area. Cultivars or varieties may exhibit exceptions to below characteristics.

Common name	Scientific name	Cold hardiness zone	Showy fall color	Showy flowers	Large fruits or nuts	Soil moisture tolerance	Tolerance to construction stress	Notes
River birch	<i>Betula nigra</i>	3b	Yes	No	No	Wet to dry	Good	Prefers acidic soil; bark provides winter interest
Shagbark hickory	<i>Carya ovata</i>	4a	Yes	No	Yes	Moist to dry	Good	High wildlife value
Northern catalpa	<i>Catalpa speciosa</i>	4a	No	Yes	Yes	Wet to dry	Good	Tolerance for varied soil pH
Common hackberry	<i>Celtis occidentalis</i>	3b	Yes	No	No	Wet to dry	Good	Tolerance for varied soil pH and moisture
European beech	<i>Fagus sylvatica</i>	4a	Yes	No	No	Moist to occasionally dry	Low	Bark vulnerable to wounds; wildlife value; likes acidic soil
Kentucky coffeetree	<i>Gymnocladus dioica</i>	4a	Yes	No	Yes	Moist to dry	Good	Tolerance for varied soil pH; fruitless varieties available
Swamp white oak	<i>Quercus bicolor</i>	4a	Yes	No	Yes	Wet to dry	Good	Prefers acidic soil
Bur oak	<i>Quercus macrocarpa</i>	3a	No	No	Yes	Wet to dry	Good	Tolerance of varied soil pH and moisture; high wildlife value



Figure 1 - bur oak



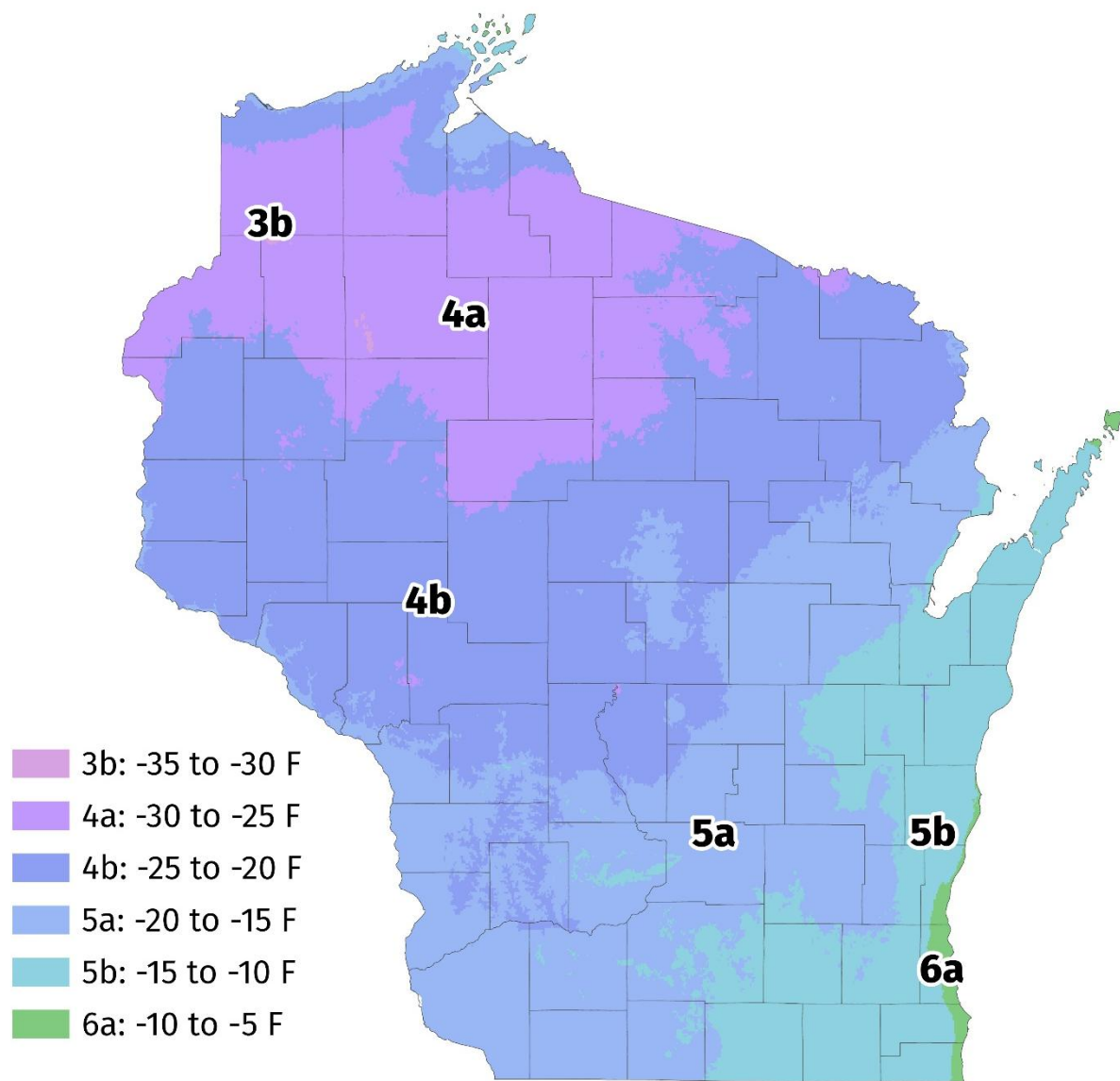
Figure 2 - Northern catalpa



Figure 3 - Kentucky coffeetree



Figure 4 - common hackberry



Zones in the United States based on their annual minimum temperatures. Plants grown in those areas must be able to tolerate temperatures down to those levels. Zone data from USDA and Oregon State University reflects updates published in 2023. Species zone data from Cornell University Woody Plants Database.

RECOMMENDED LARGE CONIFERS

A short, non-exhaustive list of potential species to plant in cemeteries. Each of the listed species has the potential to grow 50-100 ft in height and 30-50 ft in width. Expected lifespan cannot be predicably forecast in an urban area. Cultivars or varieties may exhibit exceptions to below characteristics.

Common name	Scientific name	Cold hardiness zone	Showy fall color	Showy flowers	Large fruits or nuts	Soil moisture tolerance	Tolerance to construction stress	Notes
White fir	<i>Abies concolor</i>	4a	N/A	No	No	Moist to occasionally dry	Fair	
Tamarack/larch	<i>Larix spp.</i>	2a*	Yes	No	Yes*	Wet to occasionally dry	Fair	Deciduous (loses foliage in the fall)
Dawn redwood	<i>Metasequoia glyptostroboides</i>	5b	Yes	No	Yes	Wet to dry	Fair	Deciduous (loses foliage in the fall); prefers slightly acidic to neutral pH soils
Norway spruce	<i>Picea abies</i>	2a	N/A	No	Yes	Moist to occasionally dry	Good	A stellar tree in cemeteries; many cultivars and varieties
Scots pine	<i>Pinus sylvestris</i>	3a	N/A	No	Yes	Moist to dry	Good	Vulnerable to many diseases and pests; many cultivars and varieties
Bald cypress	<i>Taxodium distichum</i>	5a	Yes	No	Yes	Wet to dry	Good	Deciduous (loses foliage in the fall); prefers slightly acidic to neutral pH soil

*Dependent on species



Figure 1 – Norway spruce



Figure 2 – Scots pine

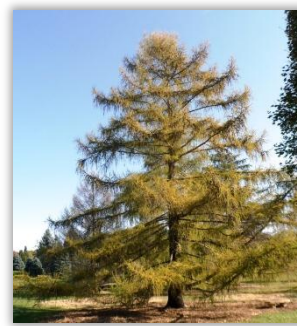


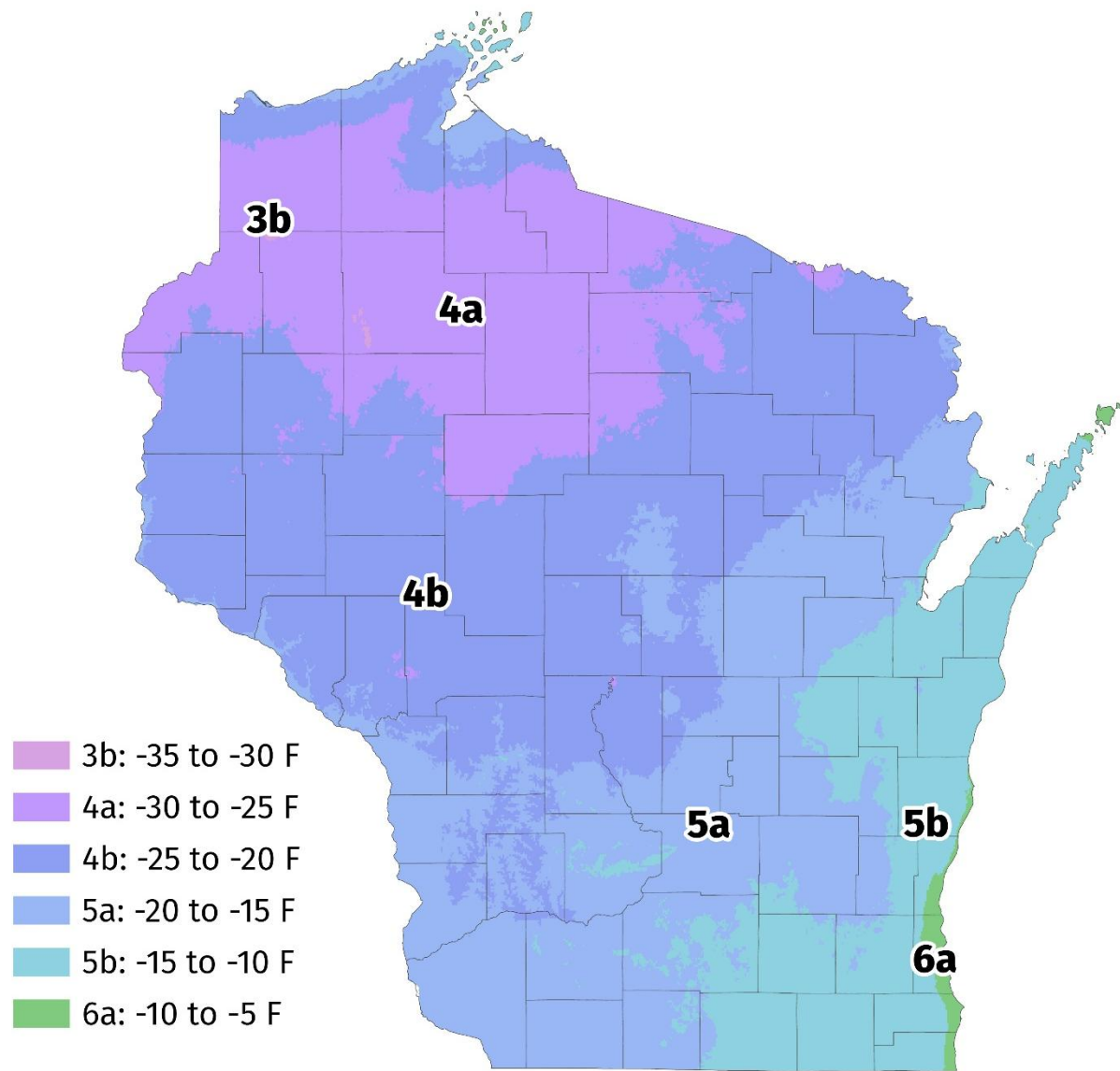
Figure 3 – European larch



Figure 4 – bald cypress



Figure 5 - white fir



Zones in the United States based on their annual minimum temperatures. Plants grown in those areas must be able to tolerate temperatures down to those levels. Zone data from USDA and Oregon State University reflects updates published in 2023. Species zone data from Cornell University Woody Plants Database.

RECOMMENDED SMALL ORNAMENTAL TREES

A short, non-exhaustive list of potential species to plant in cemeteries. Each of the listed species has the potential to grow 10-30 ft in height and 10-30 ft in width. Expected lifespan cannot be predicably forecast in an urban area.

Common name	Scientific name	Cold hardiness zone	Showy fall color	Showy flowers	Large fruits or nuts	Soil moisture tolerance	Tolerance to construction stress	Notes
Serviceberry	<i>Amelanchier spp.</i>	3b	Yes	Yes	No	Wet to occasionally dry	Good	Fruit is edible
Musclewood	<i>Carpinus caroliniana</i>	3b	Yes	No	No	Wet to occasionally dry	Fair	Smooth, rippled, unique bark
Redbud	<i>Cercis canadensis</i>	5b	No	Yes	No	Moist to occasionally dry	Fair	Unique, small-podded fruits
Cornelian cherry dogwood	<i>Cornus mas</i>	5a	No	Yes	No	Moist to occasionally dry		Fruit is edible
Hawthorn	<i>Crataegus spp.</i>	4a*	Yes	Yes	No	Moist to occasionally dry	Good	Susceptible to cedar-hawthorn rust; some have large thorns; fruit is edible
Juniper	<i>Juniperus spp.</i>	3b*	N/A	No	No	Moist to dry	Good	Evergreen; many cultivars and varieties
Ironwood	<i>Ostrya virginiana</i>	3b	No	No	No	Moist to occasionally dry	Fair	Pretty, unique hop-like fruits



Figure 1 - redbud



Figure 2 - hawthorn



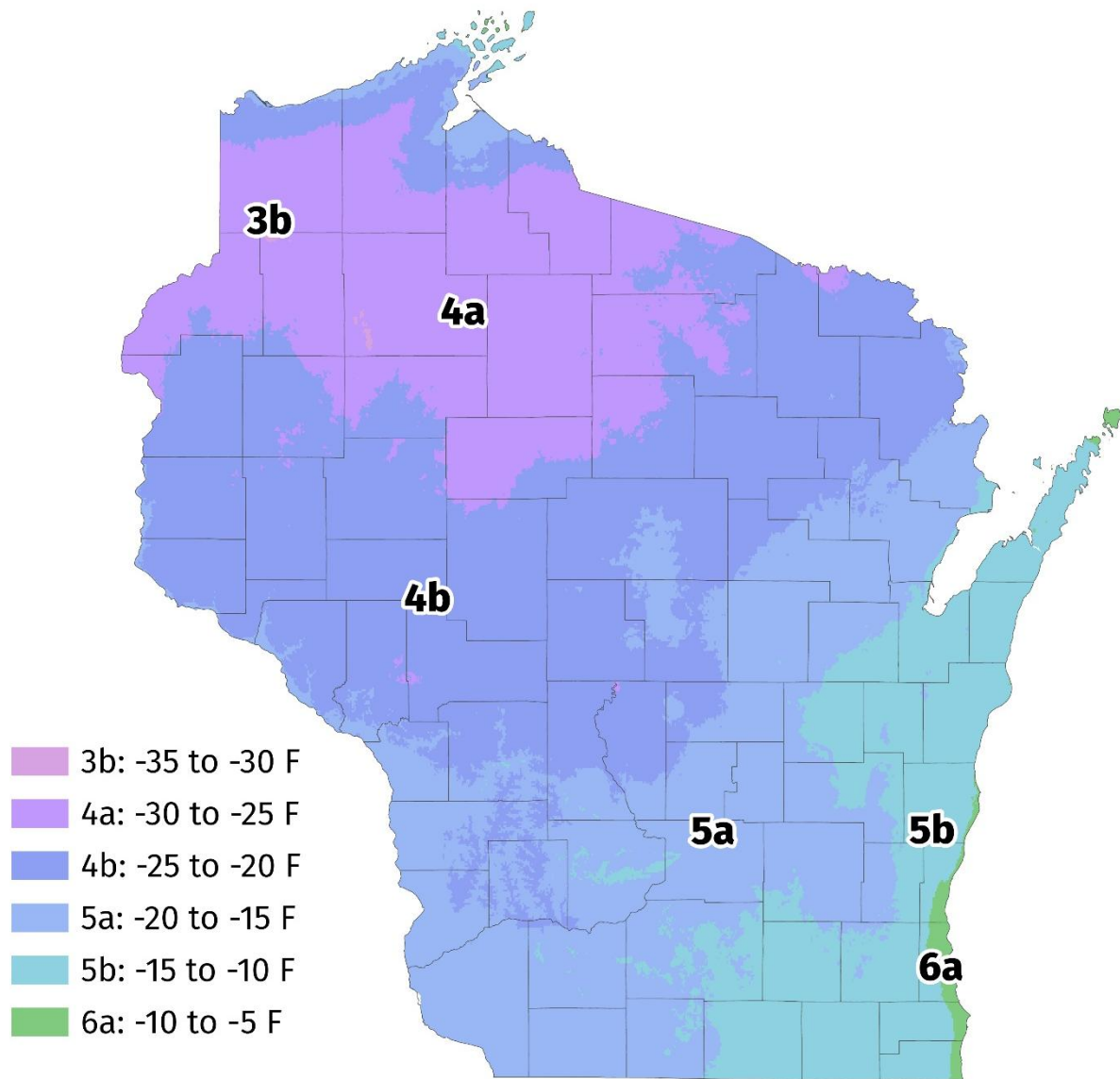
Figure 3 - serviceberry



Figure 4 - juniper



Figure 5 - ironwood



Zones in the United States based on their annual minimum temperatures. Plants grown in those areas must be able to tolerate temperatures down to those levels. Zone data from USDA and Oregon State University reflects updates published in 2023. Species zone data from Cornell University Woody Plants Database.

RECOMMENDED SHRUBS AND SMALL MULTI-STEMMED TREES

A short, non-exhaustive list of potential species to plant in cemeteries. Each of the listed species has a maximum height of less than 15ft and typically take a shrub form.

Common name	Scientific name	Cold hardiness zone	Showy fall color	Showy flowers	Large fruits or nuts	Soil moisture tolerance	Notes
Pagoda Dogwood	<i>Cornus alternifolia</i>	4a	No	Yes	No	Moist to occasionally dry	Distinctive horizontal, tiered branching
Witch Hazel	<i>Hamamelis virginiana</i>	4a	Yes	Yes	No	Moist to occasionally dry	Yellow flowers appear in the autumn
Seven-Son Flower	<i>Heptacodium miconioides</i>	5b	Yes	Yes	No	Moist to occasionally dry	Rose color in autumn comes from flower sepals, not leaves
Magnolia	<i>Magnolia spp.</i>	5a*	No	Yes	No	Moist to occasionally dry	Many cultivars and varieties
Ninebark	<i>Physocarpus opulifolius</i>	3a	No	Yes	No	Wet to occasionally dry	Unique sheathing, multicolored bark
Mugo Pine	<i>Pinus mugo</i>	3a	N/A	No	No	Moist to occasionally dry	Many cultivars and varieties; vulnerable to numerous diseases and pests
Lilac Spp.	<i>Syringa spp.</i>	3a*	No	Yes	No	Moist to dry	Many cultivars and varieties
Korean Spice Viburnum	<i>Viburnum carlesii</i>	4b	No	Yes	No	Moist to occasionally dry	Some cultivars and varieties have more vibrant fall color



Figure 1 – Mugo pine



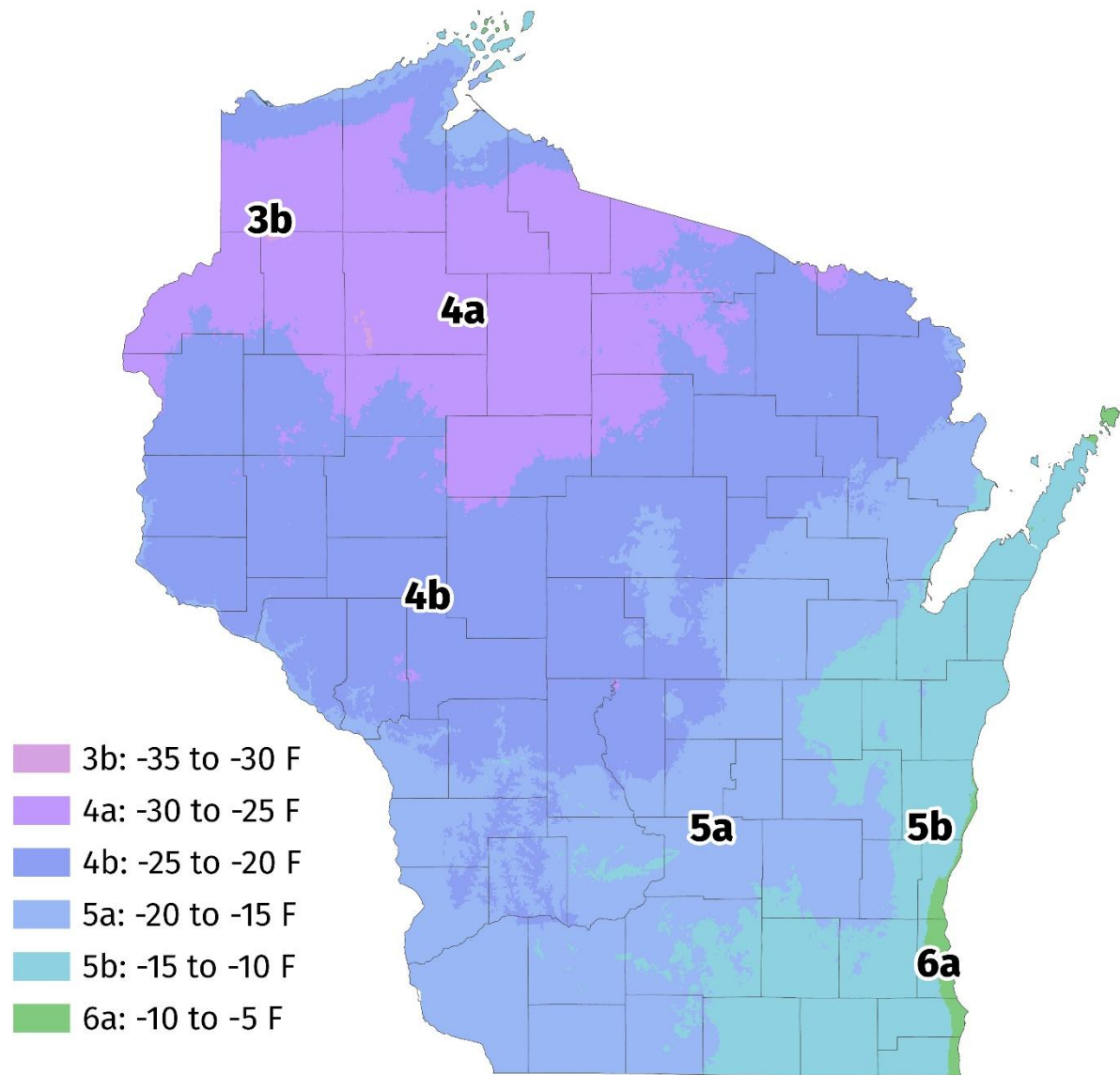
Figure 2 – pagoda dogwood



Figure 3 - magnolia



Figure 4 - lilac



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