DAVEY Resource Group

February 2023

STANDARD INVENTORY ANALYSIS AND MANAGEMENT PLAN

City of Fayette, Missouri

Prepared for:

City of Fayette
City Hall
117 South Main Street
Fayette, Missouri 65248

Prepared by:

Davey Resource Group, Inc.
295 S. Water Street, Suite 300
Kent, Ohio 44240
800-828-8312

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

ACKNOWLEDGMENTS

This project supports the City of Fayette's vision to promote and enhance community well-being through public tree conservation and improved forestry management practices. This *Standard Inventory Analysis and Management Plan* offers expertise in preserving and expanding urban canopy so the environmental, economic, and social benefits it provides continue for generations.

Fayette is thankful for the grant funding it received from the Missouri Department of Conservation through its Community Forestry Cost Share program in cooperation with the Missouri Community Forestry Council and the U.S. Forest Service. This Grant Program is designed to encourage communities to create and support long-term and sustained urban and community forestry programs throughout Missouri.

Fayette also recognizes the support of its Mayor and City Council:

Mayor - Jeremy Dawson
Public Works Director - Danny Dougherty
Southwest Alderwoman - Bekki Galloway
Tree Board Chairman - Gene Gerlt
Certified Arborist - Dakota Wells
MDC Community Forester - Ann Koenig

Recommended Maintenance Types

STANDARD INVENTORY ANALYSIS AND MANAGEMENT PLAN EXECUTIVE SUMMARY

The City of Fayette's *Standard Inventory Analysis and Management Plan*, written by Davey Resource Group, Inc. "DRG", focuses on quantifying the benefits provided by the inventoried tree resource and addressing its maintenance needs. DRG completed a tree inventory for Fayette in January 2023 and analyzed the inventory data to understand the structure of the city's inventoried tree resource. DRG also estimated the economic values of the various environmental benefits provided by this public tree resource by analyzing inventory data with i-Tree Eco and recommended a prioritized management program for future tree care.

The inventory included 815 trees, and 84% of the inventoried trees were rated in Fair or better condition. The functions of Fayette's inventoried tree population provide benefits with an estimated total value of $92,154 annually. The city's annual tree maintenance budget is $10,000, making Fayette's return on investment over 900% annually. Supporting and funding proactive maintenance of the public tree resource is a sound long-term investment that will reduce tree management costs over time.

High priority tree removal and pruning is costly, accounting for the larger budget in the first years of the ten-year tree maintenance schedule, as shown in Figure 1. Tree maintenance costs typically decrease after high-priority work has been completed and management transitions from reactive to proactive maintenance. Proactive maintenance reduces the number of elevated risk trees over time by preventing trees with initial minor defects from deteriorating and becoming hazardous. Therefore, budgets for later years are projected to stabilize around $43,000 as work becomes more routine, making it possible to predict adequate staffing and funding from year to year.

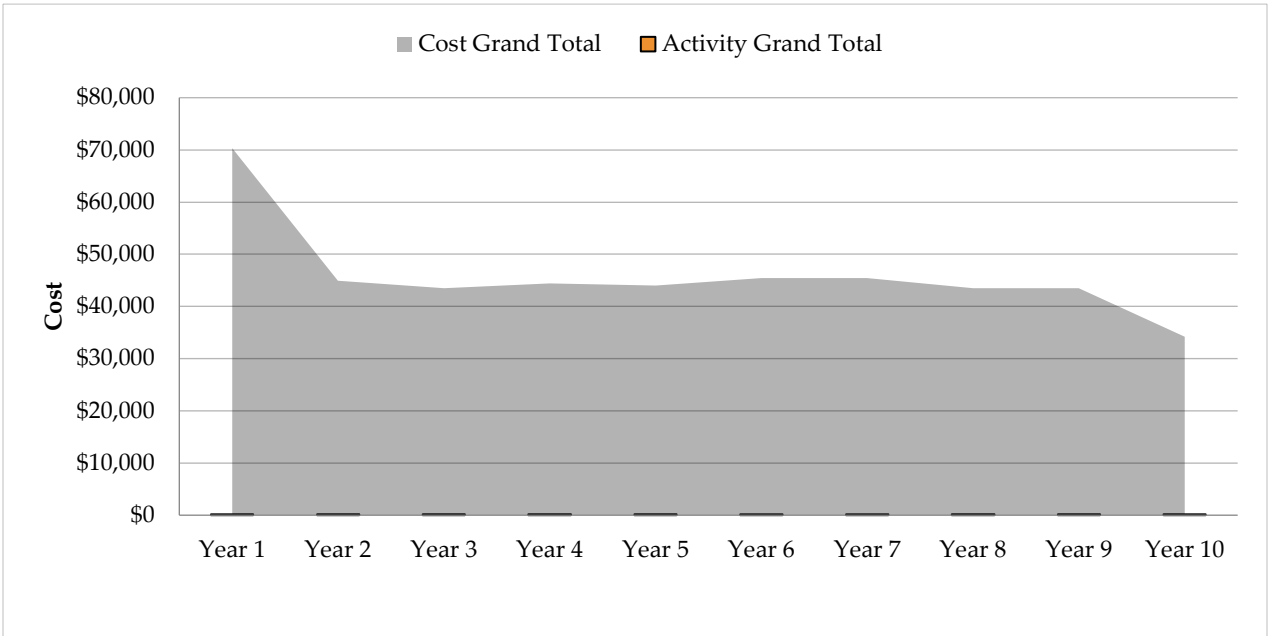


Figure 1. Ten-year management program budget vs. labor over time with projection into future.

Recommended Maintenance Types

Tree Removal

Trees designated for removal have defects that cannot be cost-effectively or practically corrected. Most of the trees in this category have a large percentage of dead crown.

Total = 77 trees
Extreme Risk = 0 trees
High Risk = 0 trees
Moderate Risk = 10 trees
Low Risk = 65 trees

Priority Pruning

Priority pruning removes defects such as dead and dying parts or broken and/or hanging branches. Pruning the defective limb(s) can lower risk associated with the tree while promoting healthy growth.

Total = 29 trees
Extreme Risk = 0 trees
High Risk = 3 trees
Moderate Risk = 26 trees

Routine Pruning Cycle

Over time, routine pruning of low and moderate risk trees can minimize reactive maintenance, limit instances of elevated risk, and provide the basis for a robust risk management program.

Total = 632 trees
Number of trees in cycle each year = approximately 63

New Tree Planting

Planting new trees in areas that have poor canopy continuity or sparse canopy is important to ensure that tree benefits are distributed evenly across the city.

Number of trees each year = at least 20

Young Tree Training Cycle

Younger trees may have branch structure that can lead to potential problems as the tree ages, requiring training to ensure healthy growth. Training is generally completed from the ground with a pole pruner or pruning shear.

Total = 77 trees
Number of trees in cycle each year = at least 26

Routine Tree Inspection

Routine inspections are essential to uncovering potential problems with trees and should be performed by a qualified arborist who is trained in the art and science of planting, caring for, and maintaining individual trees.

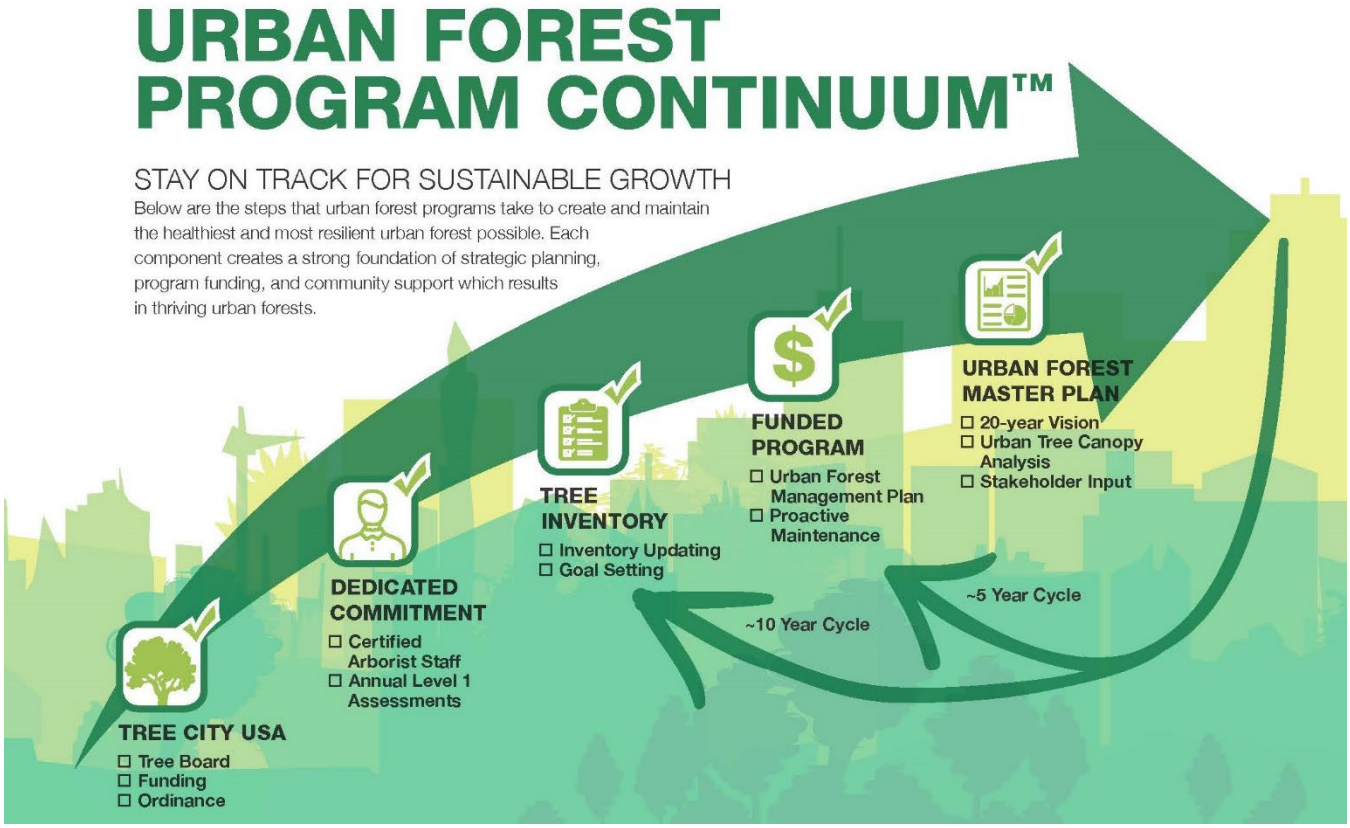
Total = 815 trees
Number of trees in cycle each year = at least 75

INTRODUCTION

The City of Fayette is home to 2,803 residents benefitting from public trees in their community. The city's urban forestry program manages all trees, stumps, and planting sites along the street rights-of-way (ROW) and throughout public parks. For 20 years, Fayette's staff in the Parks Department have shown continued commitment to developing a thriving public tree resource.

Urban forestry program budgets are funded by the city's General Fund. Fayette has a tree board, has a tree ordinance, spends more than $2 per capita on tree maintenance, and celebrates Arbor Day. Fayette has let their Tree City USA status lapse, but plans to reapply to be a Tree City USA community again.

Past urban forestry projects have demonstrated Fayette's dedicated commitment to sustaining the public tree resource with higher levels of tree care. Fayette currently has no ISA Certified Arborists on staff but will soon be able to set goals and perform proactive maintenance using this *Standard Inventory Analysis and Management Plan*. The city's urban forestry program is well on its way to creating a sustainable and resilient public tree resource, and it is important to stay on track by consistently renewing program funding and routinely updating the tree inventory.

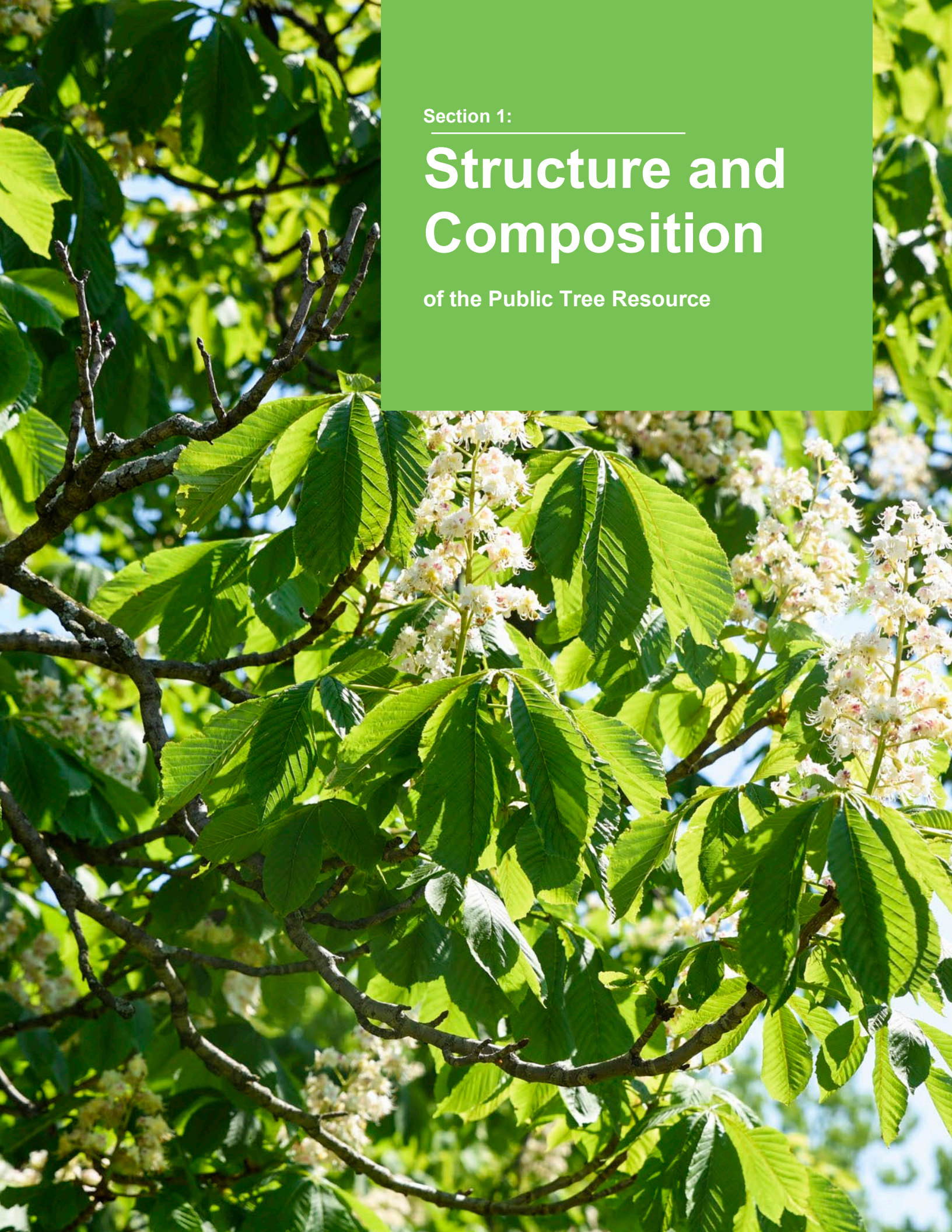


RECOMMENDED APPROACH TO TREE MANAGEMENT

An effective approach to tree resource management follows a proactive and systematic program that sets clear and realistic goals, prescribes future action, and periodically measures progress. A robust urban forestry program establishes tree maintenance priorities and utilizes modern tools, such as a tree inventory accompanied by TreeKeeper® or other asset management software.

In January 2023, Fayette worked with DRG to inventory its public trees and develop this management plan. Consisting of four sections, this plan considers the diversity, distribution, and condition of the inventoried tree population and provides a prioritized system for managing the city's public tree resource.

- *Section 1: Structure and Composition of the Public Tree Resource* summarizes the inventory data with trends representing the current state of the tree resource.
- *Section 2: Functions and Benefits of the Public Tree Resource* summarizes the estimated value of benefits provided to the community by public trees' various functions.
- *Section 3: Recommended Management of the Public Tree Resource* details a prioritized management program and provides an estimated budget for recommended maintenance activities over a ten-year period.
- *Section 4: Emerald Ash Borer* describes the destructive nature of this invasive pest, ways to mitigate its effects, and suggests an approach to managing the city's ash tree population.



Section 1:

Structure and Composition

of the Public Tree Resource

SECTION 1: STRUCTURE AND COMPOSITION OF THE PUBLIC TREE RESOURCE

In February 2023, DRG arborists collected site data on trees along the street ROW and on trees in public parks for a tree inventory contracted by the City of Fayette. Of the total 815 sites inventoried, 48% were collected along the street ROW, and the remaining 52% were collected in parks. Figure 2 breaks down the total sites inventoried by type for each location. See Appendix A for details about DRG's methodology for collecting site data.

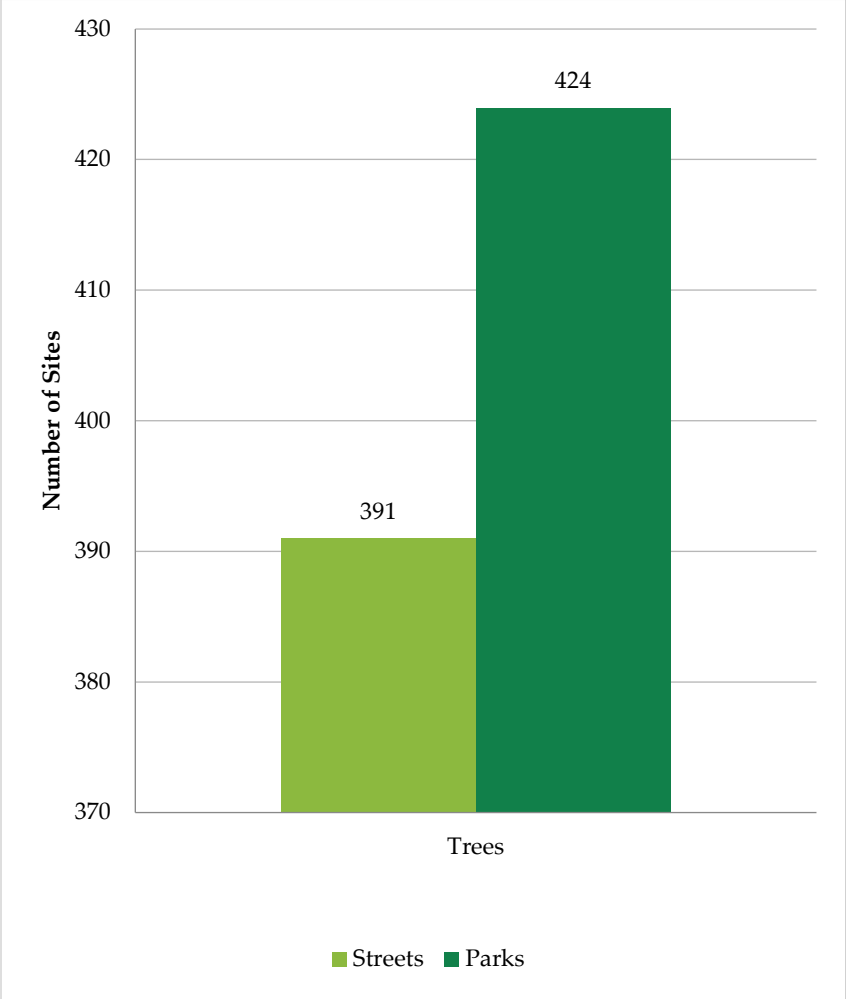


Figure 2. Number of inventoried sites by location and type.

The City of Fayette designated all of the Street ROW, and five public parks, for DRG to collect site data for the tree inventory. Inventoried parks include: City Park, DC Rodgers Lake, Paige-Liberty Park, Peters Lake, and Rickett's Lake Park. At DC Rodgers Lake, the Campground and Gun Range were also collected.

SPECIES, GENUS, AND FAMILY DISTRIBUTION

The 10-20-30 rule is a common standard for tree population distribution, in which a single species should compose no more than 10% of the tree population, a single genus no more than 20%, and a single family no more than 30% (Santamour 1990).

Figure 3 shows the Fayette street ROW distribution of the most abundant tree species inventoried compared to the 10% threshold. Red maple (*Acer rubrum)* is the most abundant species, and while 10% of the population is right at the threshold, it is not immediately concerning from this data alone.

Figure 4 shows the Fayette parks' distribution of the most abundant tree species inventoried compared to the 10% threshold. Black walnut (*Juglans nigra)* is the most abundant species with 23% of the inventoried park population.

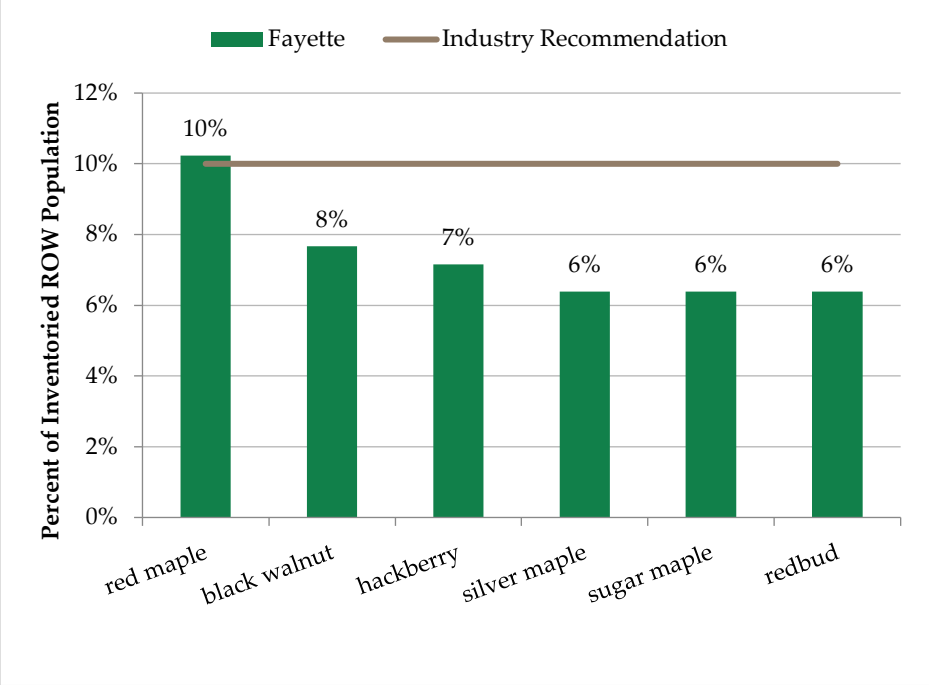


Figure 3. Species distribution of the inventoried ROW tree population.

RESILIENCE THROUGH DIVERSITY

The Dutch elm disease epidemic of the 1930s provides a key historical lesson on the importance of diversity (Karnosky 1979). The disease killed millions of American elm trees, leaving behind enormous gaps in the urban canopy of many Midwestern communities. In the aftermath, ash trees became popular replacements and were heavily planted along city streets. History repeated itself in 2002 with the introduction of the emerald ash borer into America. This invasive beetle devastated ash tree populations across the Midwest. Other invasive pests spreading across the country threaten urban forests, so it's vital that we learn from history and plant a wider variety of tree genera to develop a resilient public tree resource.

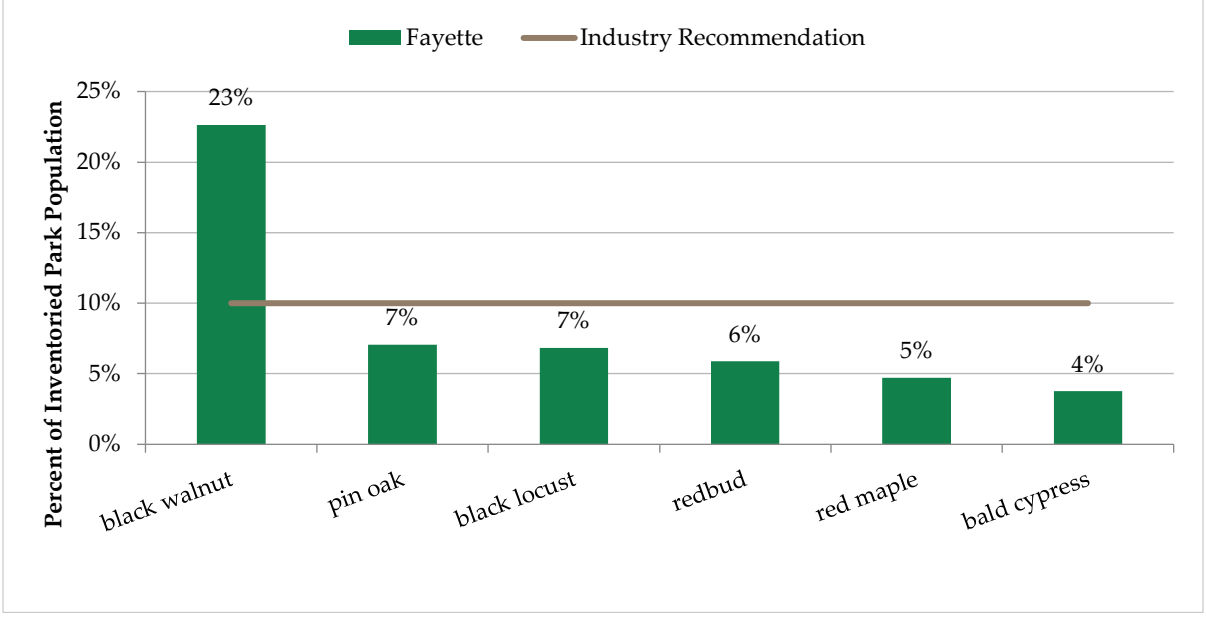


Figure 4. Species distribution of the inventoried park tree population.

However, Figure 5 shows the city ROW's distribution of the most abundant tree genera inventoried, and maple (*Acer*) is significantly higher than the 20% threshold. This means that red maple is concerning after all, because maple compose 29% of the inventoried population. For this reason, the City of Fayette should not plant red maple or any other maple species until this distribution becomes more ideal.

Figure 6 shows the parks' distribution of the most abundant tree genera inventoried, and walnut (*Juglans*) is slightly higher than the 20% threshold at 23%. Like maple in the ROW, walnut should not be planted in the parks until this distribution becomes more ideal.

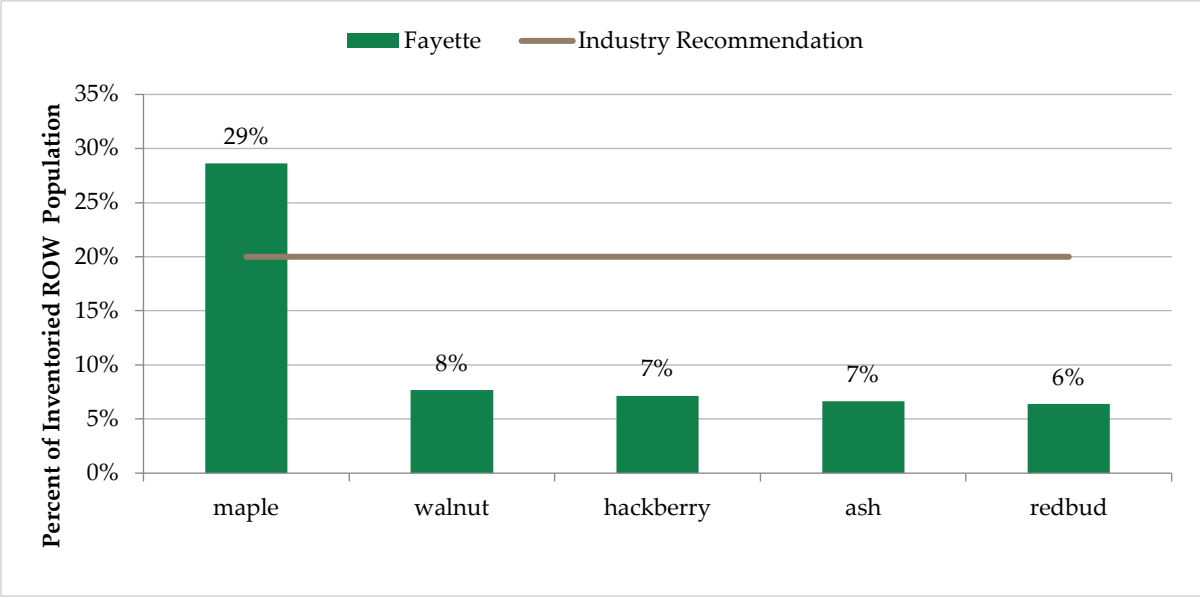


Figure 5. Genus distribution of the inventoried ROW tree population.

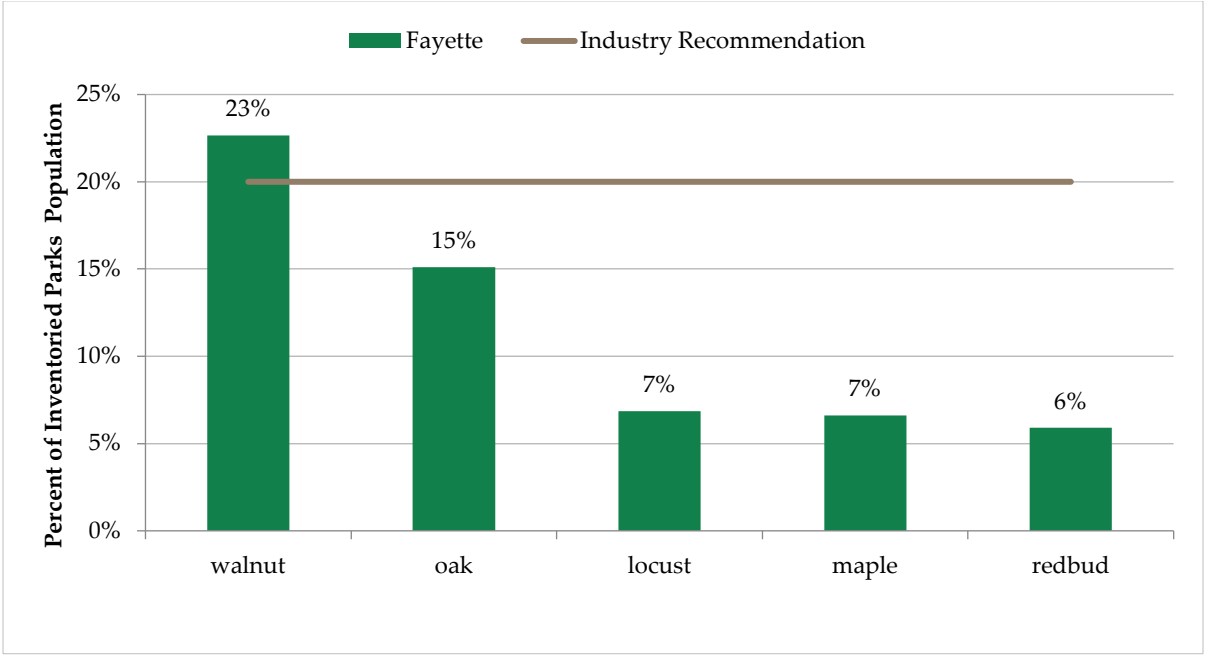


Figure 6. Genus distribution of the inventoried park tree population.

This illustrates how species distribution alone does not completely represent tree population diversity. Genus distribution is an important consideration because some pests, such as emerald ash borer (EAB, *Agrilus planipennis*), target a single genus as its host. Some pests also target a single family as its host, such as the bacterium *Erwinia amylovora*, commonly known as fireblight. Fireblight only affects plants in the rose family (*Rosaceae*), such as serviceberry, hawthorn, apple/crabapple, hawthorn, cherry/plum, and pear.

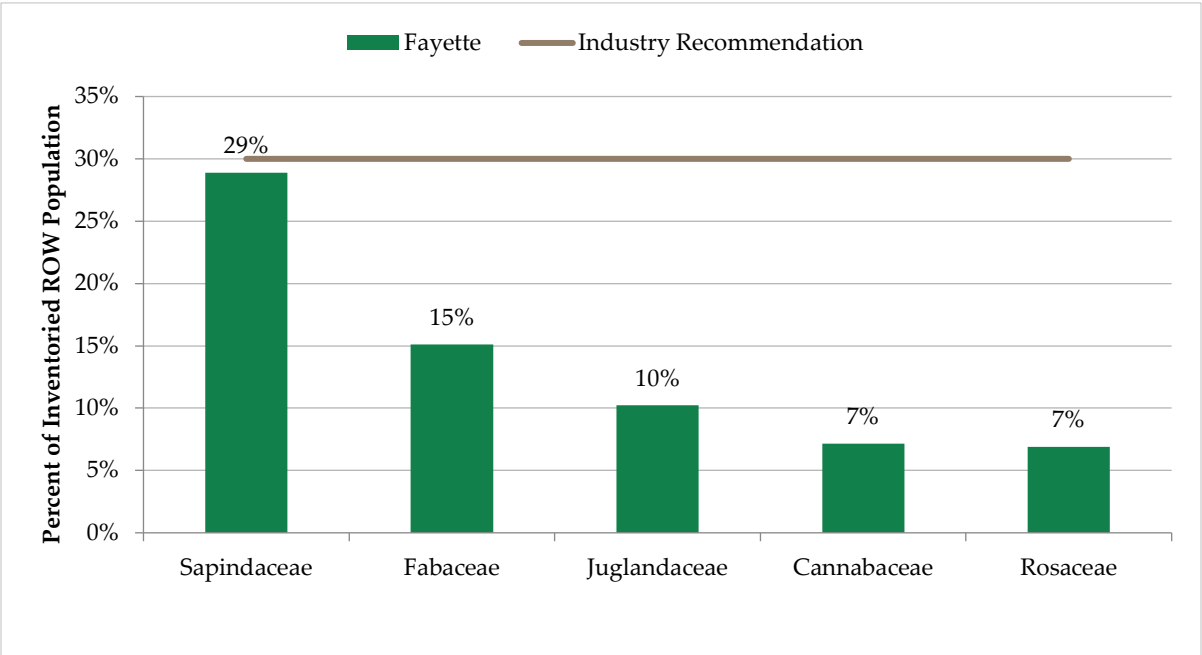


Figure 7. Family distribution of the inventoried ROW tree population.

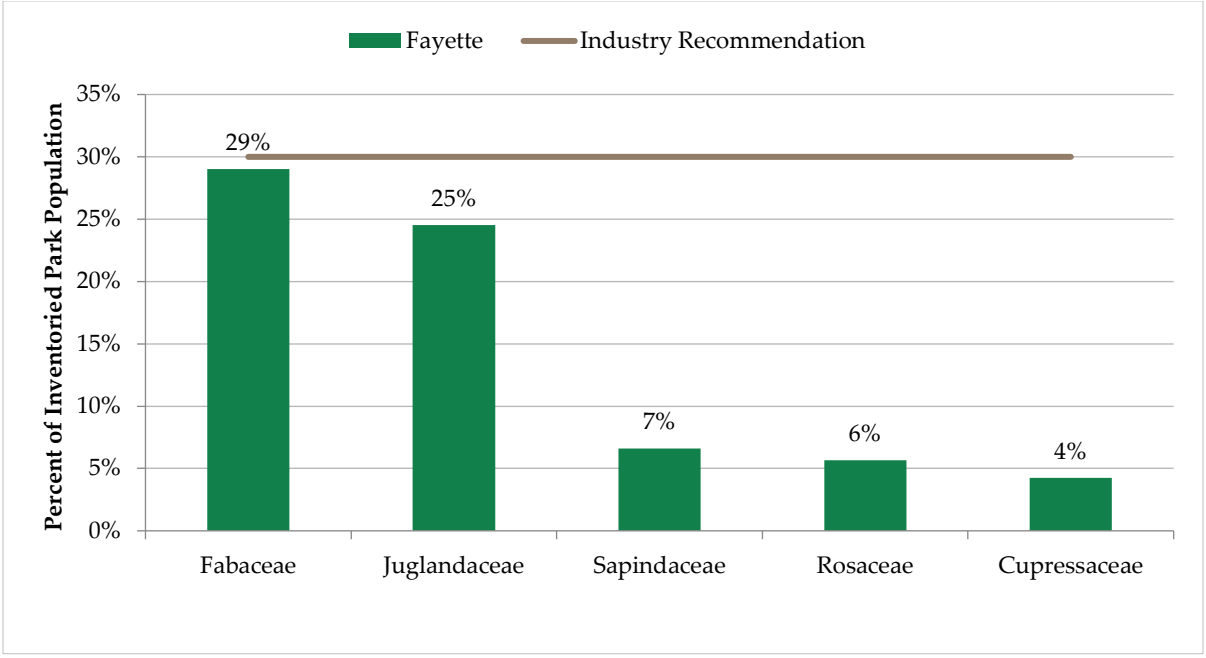


Figure 8. Family distribution of the inventoried Parks tree population.

Figure 7 shows the city ROW's distribution of the most abundant tree families inventoried compared to the 30% threshold. While Fabaceae (15%) is fairly far from the threshold, Sapindaceae (29%) is the only family composing a greater proportion of the inventoried population, which is almost exceeding the threshold. Figure 8 shows the city parks' distribution of the most abundant tree families inventoried compared to the 30% threshold. In the parks, Sapindaceae only comprise 7% of the inventoried population, and Fabaceae is near the threshold at 29%.

PEST SUSCEPTIBLITY

Early diagnosis of disease and infestation is essential to ensuring the health and continuity of Fayette's public tree resource. See Appendix B for some information about the pests listed below and websites where additional information can be found.

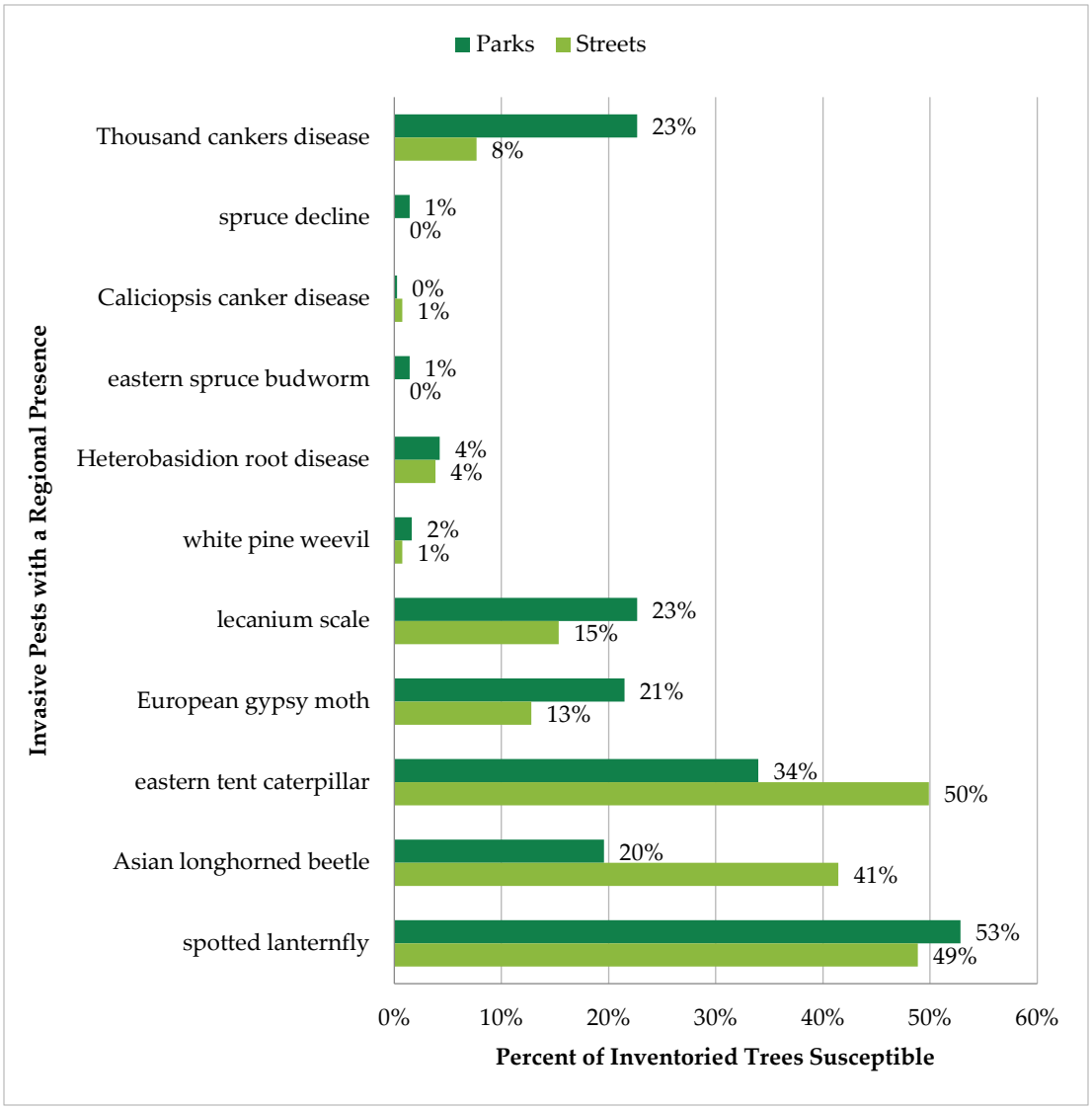


Figure 9. Tree resource susceptibility to invasive pests with a regional presence.

Figure 9 shows the percent of inventoried trees susceptible to some of the known pests in and around Missouri. It is important to remember that this figure only represents data collected during the inventory. Many more trees throughout Fayette, especially those on private property, may be susceptible to hosting these invasive pests. Spotted lantern fly (SLF, *Lycorma delicatula*) and Asian longhorned beetle (ALB, *Anoplophora glabripennis*) are known threats to a large percentage of the inventoried tree resource, 51% and 30%, respectively.

Pest Susceptibility Recommendations

The overabundance of maple in Fayette's tree resource is a management concern because it creates unnecessary risk in the event of an invasive pest outbreak. This abundance is not only more tree resource to lose but is also more habitat for the pests it is susceptible to, such as SLF or ALB, making it easier for them to spread. Another concern is the large population of black walnut in the parks should Thousand cankers disease (TCD, *Geosmithia morbida*) show up. Increasing species diversity is a critical goal that will help Fayette's tree resource be resilient in the event of future pest invasions.

While it might be prudent for the city to limit planting species in the Fabaceae and Sapindaceae families to prevent them from crossing the 30% threshold, efforts to improve diversity at the genus and species level are a better use of short-term resources until more research is done on family diversity as a mechanism for promoting system resilience. For this reason, Fayette should use its resources to inspect trees in the *Acer* genus for signs of infestation on a routine basis, so affected trees can be quarantined to contain the pest before an outbreak starts.

CONDITION

Several factors affecting condition were considered for each tree, including root characteristics, branch structure, trunk, canopy, foliage condition, and the presence of pests. The condition of each inventoried tree was rated by an arborist as Good, Fair, Poor, or Dead. The general health of the inventoried tree population was characterized by the most prevalent condition assigned during the inventory.

Figure 10 shows most of the inventoried trees for both the ROW and the parks were recorded in Good (29% and 49%, respectively) or Fair (51% and 38%, respectively) condition. Based on these data, the general health of the inventoried tree population is rated as Fair. Fayette has a low percentage of Dead trees and trees in Poor condition, so the general health of the city's tree resource is approaching Good.

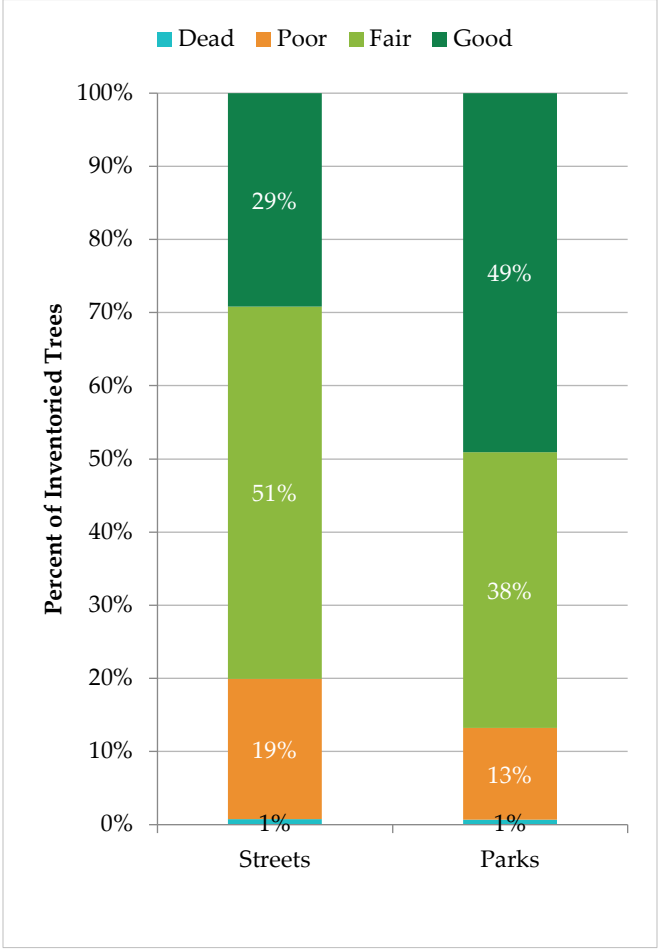


Figure 10. Condition of inventoried trees.

- Dead trees and trees in Poor condition should be removed as soon as possible, because the health of these trees is unlikely to recover even with increased care and present a risk.
- Younger trees rated in Fair or Poor condition may benefit from structural pruning to improve their health over time. Pruning should follow *ANSI A300 (Part 1)* guidelines.
- Poor condition ratings among mature trees were generally due to visible signs of decline and stress, including decay, dead limbs, sparse branching, or poor structure. These trees will likely require corrective pruning and intensive plant health care to improve their vigor and should be monitored for worsening conditions.

RELATIVE AGE DISTRIBUTION

Analysis of a tree population's relative age distribution is performed by assigning age classes to the size classes of inventoried trees, offering insight into the maintenance needs of Fayette's tree resource. The inventoried trees are grouped into the following relative age classes:

- Young trees (0–8 inches diameter at breast height [DBH])
- Established trees (9–17 inches DBH)
- Maturing trees (18–24 inches DBH)
- Mature trees (greater than 24 inches DBH)

These size classes were chosen so that the inventoried tree resource can be compared to the ideal relative age distribution, which holds that the largest proportion of the inventoried tree population (approximately 40%) should be young trees, while a smallest proportion (approximately 10%) should be mature trees (Richards 1983). Since tree species have different lifespans and mature at different diameters, actual tree age cannot be determined from diameter size class alone, yet size classifications can be extrapolated into relative age classes.

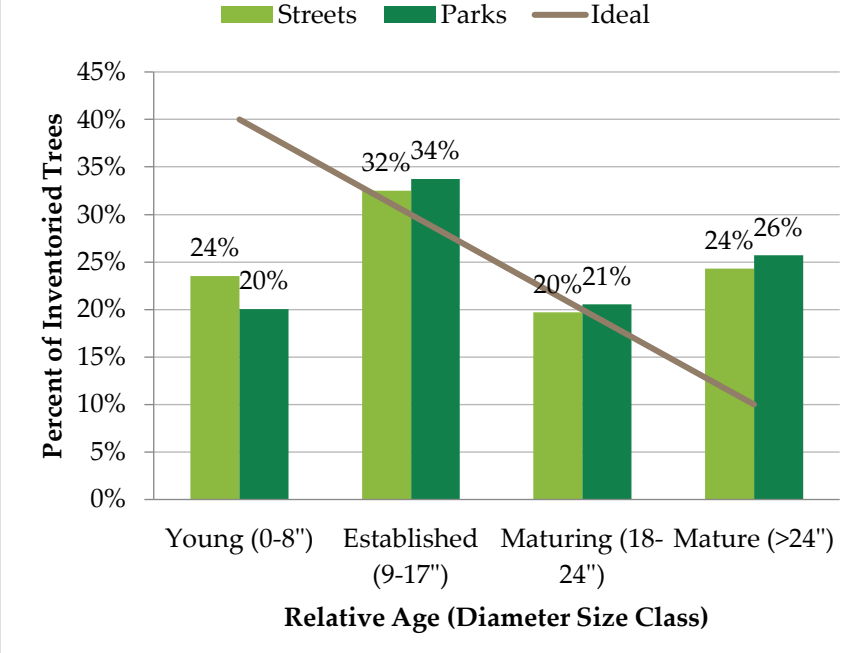


Figure 11. Relative age distribution of the inventoried trees.

Figure 11 compares Fayette's relative age distribution of the inventoried tree population to the ideal. The city's inventoried tree resource is starting to trend towards the ideal; however, mature trees exceed the ideal by 14% and 16%, while young trees fall short by 16% and 20%.

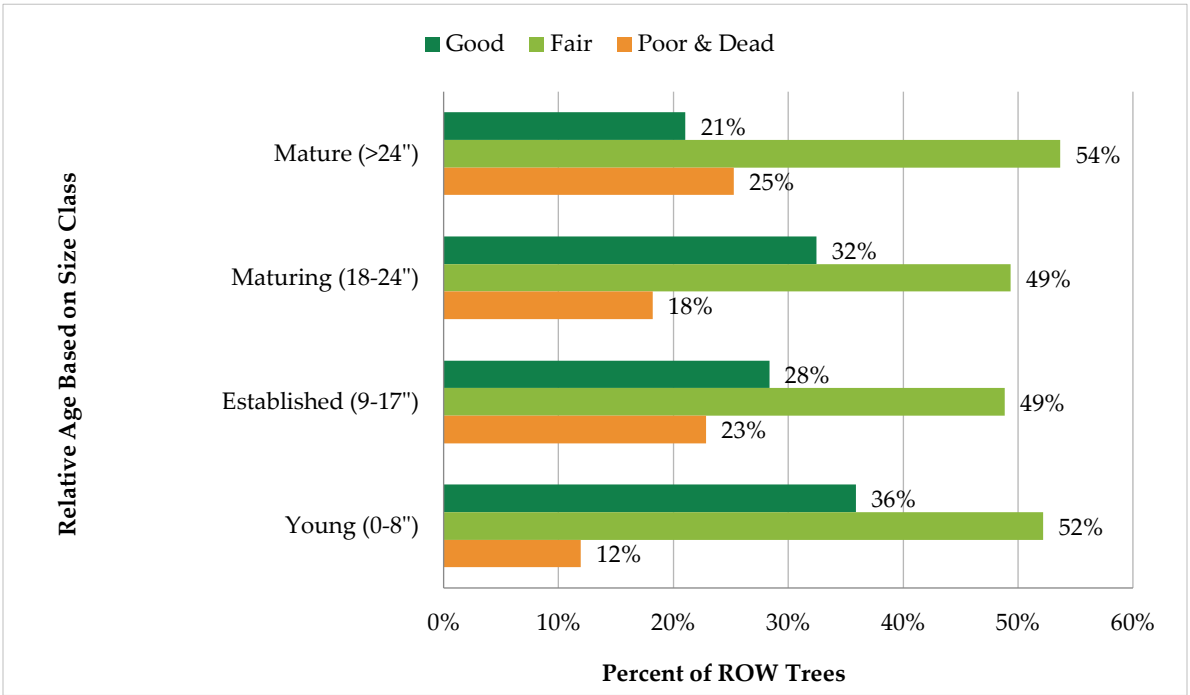


Figure 12. Condition of inventoried ROW trees by relative age (size class).

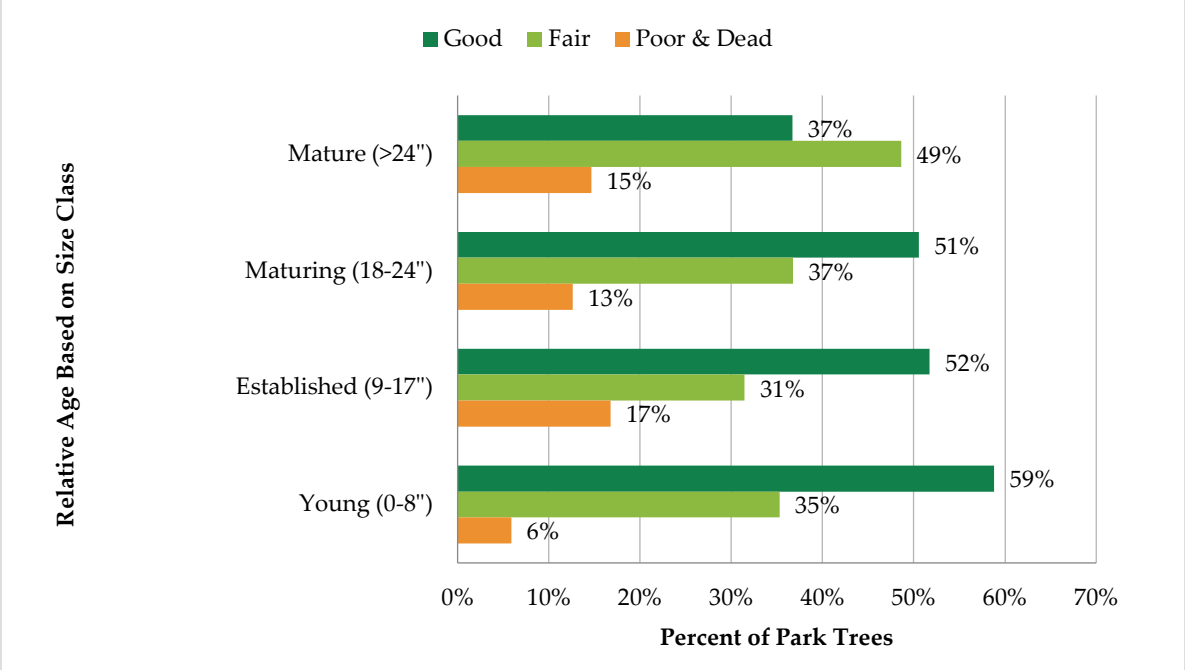


Figure 13. Condition of inventoried park trees by relative age (size class).

Figures 12 and 13 cross analyze the condition of the inventoried tree resource with their relative age distribution, providing insight into the inventoried population's stability. In the ROW, 75% of mature trees and 82% of maturing trees are rated in Fair condition or better, which matters because these larger trees would have a more damaging impact in the event of failure. The park trees fared slightly better with 85% of mature trees and 87% of maturing trees rated in Fair or better condition. In the ROW, 77% of established trees and 88% of young trees are rated in Fair condition or better, so it is important to provide the maintenance they need to remain healthy as they age and grow, to reduce the proportion of mature and maturing trees in Poor condition or worse. Once again, the park trees were rated slightly better, with 83% of established trees and 94% of young trees rated in Fair or better condition.

Relative Age Recommendations

While Fayette has an excess of mature trees and a shortage of young trees, the city has a low percentage of trees in Poor condition, indicating that the few young trees have the potential of reaching maturity if they are well maintained. DRG recommends that Fayette implement a robust maintenance and planting program to help the overall age distribution. This will also serve to conserve the condition of young trees as they age so they replace removed trees and fill canopy gaps in maturity. The city should also focus on tree preservation and proactive care, to protect mature and maturing trees from unnecessary removal and to prevent them from succumbing to treatable defects. Prioritizing proactive maintenance above tree planting will shift the relative age distribution towards the ideal over time.

DEFECT OBSERVATIONS

For each tree inventoried, DRG assessed conditions indicating the presence of structural defects and recorded the most significant condition. Defects were limited to the following categories:

- Dead and dying parts
- Broken and/or hanging branches
- Cracks
- Weakly attached branches and codominant stems
- Missing or decayed wood
- Tree architecture
- Root problems
- Other

Photograph 1. Tree with a basal defect consisting of missing or decayed wood.

Table 1. Defect observations recorded during the tree inventory

Defect	Street Trees	Percent of Street Trees	Park Trees	Percent of Park Trees
Broken and/or Hanging Branches	20	5%	29	7%
Cracks	1	0%	1	0%
Dead and Dying Parts	85	22%	96	23%
Missing or Decayed Wood	50	13%	61	14%
None	124	32%	184	43%
Other	2	1%	2	0%
Root Problems	1	0%	0	0%
Tree Architecture	44	11%	13	3%
Weakly Attached Branches and Codominant Stems	64	16%	38	9%
Total	**391**	**100%**	**424**	**100%**

The two most frequently recorded defect categories were Dead & Dying Parts and Weakly Attached Branches/Codominant Stems at 22% (ROW), 23% (Parks), and 16% (ROW), 9% (Parks) of inventoried trees, respectively (Table 1). Of the 181 trees with Dead & Dying Parts, 13 were recommended for removal.

Defect Observation Recommendations

When considering the defect recorded for each tree, there are two important qualifiers to keep in mind. First, the categories are broadly inclusive. For example, the "Dead and Dying Parts" category can include trees with just one or two smaller diameter dead limbs as well as trees found with large-diameter dead limbs or entire sections of dead canopy. Therefore, inferences on overall tree condition or risk rating cannot be derived solely from the presence or absence of a defect recorded during the inventory. Second, an inventoried tree may have multiple defects; the 2023 Fayette inventory recorded only the most significant defect observed for each tree. These two qualifiers are important to keep in mind when considering urban forest management planning and the prioritization of maintenance or monitoring activities.

Photograph 2. Example of a stem crack defect.

INFRASTRUCTURE CONFLICTS

In an urban setting, space is limited both above and below ground. Trees in this environment may conflict with infrastructure, such as buildings, sidewalks, utility wires, and pipes, which could pose risks to public safety. Existing or possible conflicts between trees and infrastructure recorded during the inventory include:

- *Overhead Utilities*—The presence of overhead utility lines above a tree or planting site was noted; it is important to consider these data when planning pruning activities and selecting tree species for planting.

Table 2. Inventoried trees noted to be conflicting with infrastructure

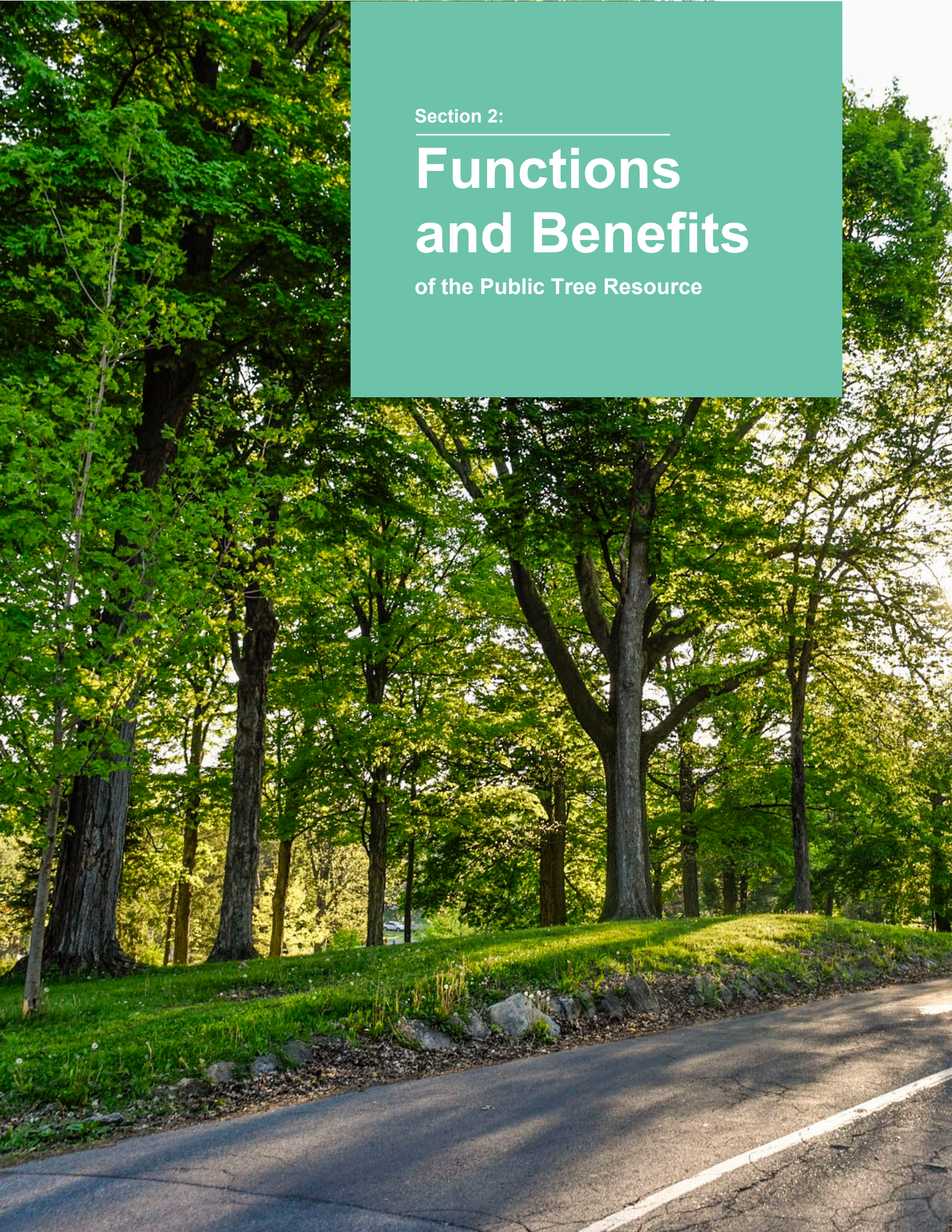
Overhead Utilities	Street Trees	Percent of Street Trees	Park Trees	Percent of Park Trees
Present and Conflicting	44	11%	9	2%
Present and Not Conflicting	26	7%	3	1%
Not Present	321	82%	412	97%
Total	**391**	**100%**	**424**	**100%**

Table 2 shows 70 ROW trees and 10 park trees recorded with an infrastructure conflict. There were 44 ROW trees and 9 park trees in direct conflict with utilities directly above, or passing through, the tree canopy.

Infrastructure Recommendations

Planting only small-growing trees within 20 feet of overhead utilities, medium-size trees within 20–40 feet, and large-growing trees outside 40 feet will help improve future tree conditions, minimize future utility line conflicts, and reduce the costs of maintaining trees under utility lines.

When planting around hardscape, it is important to give the tree enough growing room above ground. Guidelines for planting trees among hardscape features are as follows: give small-growing trees 4–5 feet, medium-growing trees 6–7 feet, and large-growing trees 8 feet or more between hardscape features. In most cases, this will allow for the spread of a tree's trunk taper, root collar, and immediate larger-diameter structural roots.



Section 2:

Functions and Benefits

of the Public Tree Resource

SECTION 2: FUNCTIONS AND BENEFITS OF THE PUBLIC TREE RESOURCE

Trees occupy a vital role in the urban environment by providing of a wide array of economic, environmental, and social benefits far exceeding the investments in planting, maintaining, and removing them. Trees reduce air pollution, improve public health outcomes, reduce stormwater runoff, sequester and store carbon, reduce energy use, and increase property value. Use of advanced analytics, such as i-Tree Eco and other models in the i-Tree software suite, continues to expand our understanding of the importance of trees to communities by providing tools to estimate monetary values of the various benefits provided by a public tree resource.

Environmental Benefits

- Trees decrease energy consumption and moderate local climates by providing shade and acting as windbreaks.
- Trees act as mini reservoirs, helping to slow and reduce the amount of stormwater runoff that reaches storm drains, rivers, and lakes. One hundred mature tree crowns intercept roughly 100,000 gallons of rainfall per year (U.S. Forest Service 2003a).
- Trees help reduce noise levels, cleanse atmospheric pollutants, produce oxygen, and absorb carbon dioxide.
- Trees can reduce street-level air pollution by up to 60% (Coder 1996). Lovasi (2008) suggested that children who live on tree-lined streets have lower rates of asthma.
- Trees stabilize soil and provide a habitat for wildlife.

Economic Benefits

- Trees in a yard or neighborhood increase residential property values by an average of 7%.
- Commercial property rental rates are 7% higher when trees are on the property (Wolf 2007).
- Trees moderate temperatures in the summer and winter, saving on heating and cooling expenses (North Carolina State University 2012, Heisler 1986).
- On average, consumers will pay about 11% more for goods in landscaped areas, with this figure being as high as 50% for convenience goods (Wolf 1998b, Wolf 1999, and Wolf 2003).
- Consumers also feel that the quality of products is better in business districts surrounded by trees than those considered barren (Wolf 1998b).
- The quality of landscaping along the routes leading to business districts had a positive influence on consumers' perceptions of the area (Wolf 2000).

Social Benefits

- Tree-lined streets are safer; traffic speeds and the amount of stress drivers feel are reduced, which likely reduces road rage/aggressive driving (Wolf 1998a, Kuo and Sullivan 2001a).
- Chicago apartment buildings with medium amounts of greenery had 42% fewer crimes than those without any trees (Kuo and Sullivan 2001b).
- Chicago apartment buildings with high levels of greenery had 52% fewer crimes than those without any trees (Kuo and Sullivan 2001a).
- Employees who see trees from their desks experience 23% less sick time and report greater job satisfaction than those who do not (Wolf 1998a).
- Hospital patients recovering from surgery who had a view of a grove of trees through their windows required fewer pain relievers, experienced fewer complications, and left the hospital sooner than similar patients who had a view of a brick wall (Ulrich 1984, 1986).

i-TREE ANALYSIS

i-Tree utilizes tree inventory data along with local air pollution and meteorological data to quantify the functional benefits of a community's tree resource. By framing trees and their benefits in a way that everyone can understand, dollars saved per year, i-Tree Eco helps a community to understand trees as both a natural resource and an economic investment. Knowledge of the composition, functions, and monetary value of trees helps to inform planning and management decisions, assists in understanding the impact of those decisions on human health and environmental quality, and aids communities in advocating for the necessary funding to manage their vested interest in the public tree resource appropriately.

ANNUAL RETURN ON INVESTMENT FROM THE PUBLIC TREE RESOURCE

The i-Tree analysis of the City of Fayette's inventoried trees quantified the functional benefits of three critical ecosystem services that they provide: air pollution removal, carbon sequestration, and avoided surface runoff. The city's annual tree maintenance budget is $10,000, making Fayette's return on investment over 900% annually.

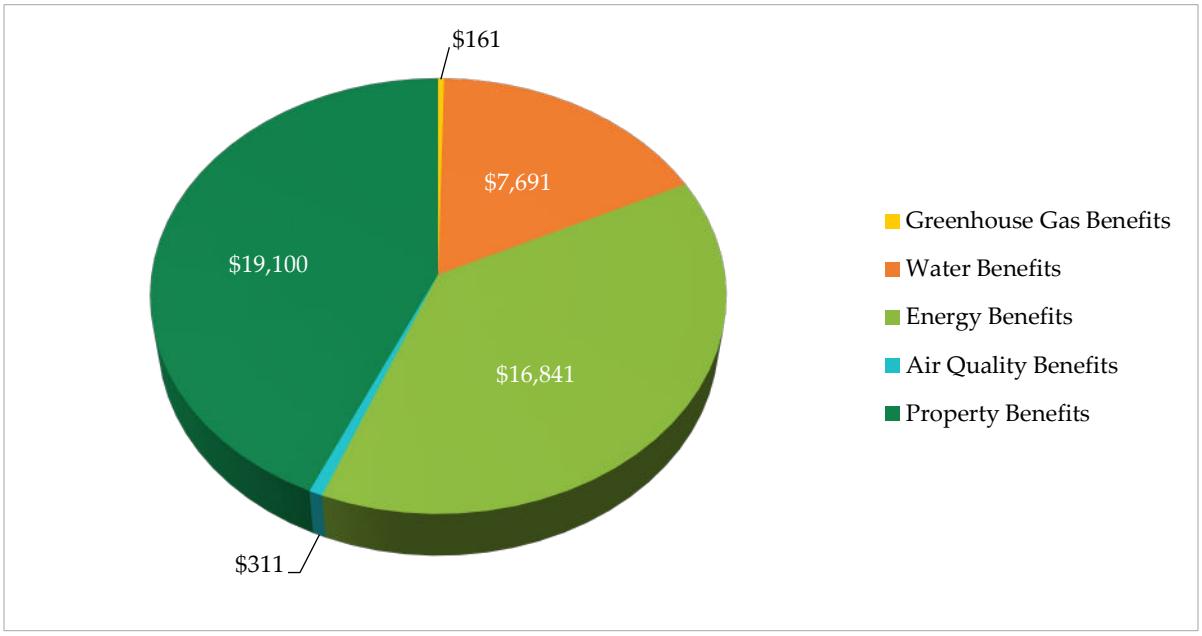


Figure 14. Estimated annual value of the inventoried ROW tree resource functional benefits.

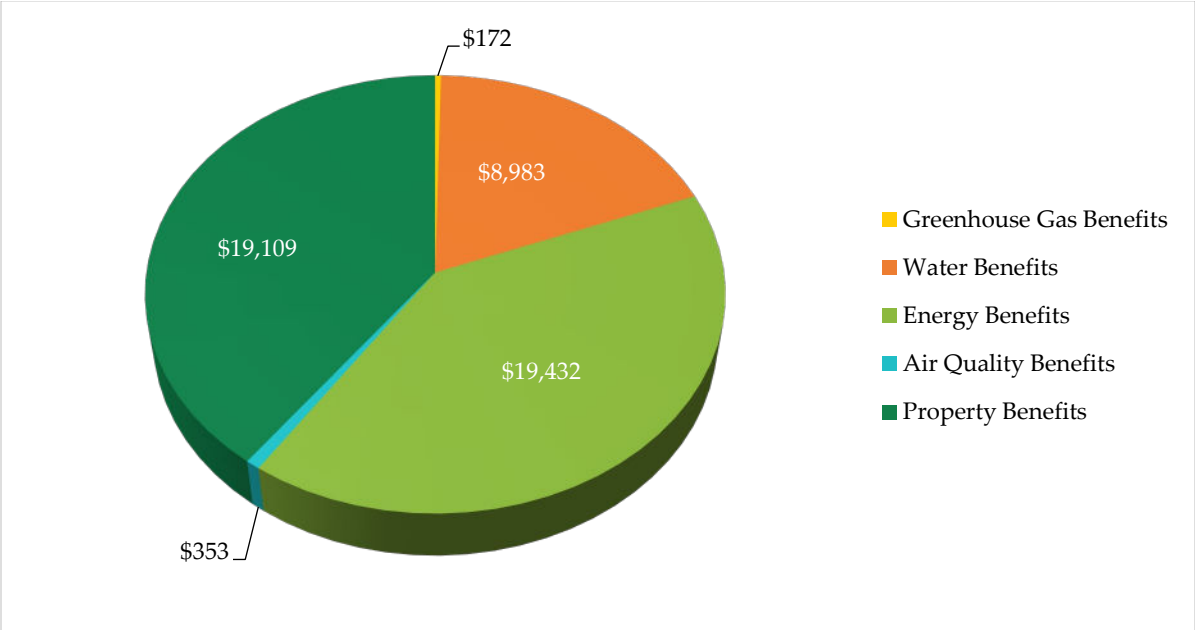


Figure 15. Estimated annual value of the inventoried park tree resource functional benefits.

Urban environments have unique challenges that make the estimated $92,154 of functional benefits provided by Fayette's combined ROW and parks inventoried tree population an essential asset to the city (Figures 14 and 15). Avoiding stormwater runoff reduces the risk of flooding and combined sewer overflow, both of which impact people, property, and the environment, valuing the 615,272 gals. of runoff avoided with Fayette's tree resource at an estimated $16,674. Carbon dioxide ($CO_2$) also impacts people, property, and the environment as the primary greenhouse gas driving climate change, valuing the 46,824 lbs. sequestered or avoided by Fayette's tree resource at an estimated $334.

In Fayette, only a few species account for almost half of the public tree resource and half of the functional benefits it provides. If any of these species were lost to invasive pests, disease, or other threats, its loss would have significant costs. It is critical to promote species diversity with future plantings to minimize susceptibility to potential threats, and to plant large-statured broadleaf tree species wherever possible to maximize potential environmental and economic benefits. See Appendix C for a tree species list recommended by DRG.

SEQUESTERING AND STORING CARBON

Trees are carbon sinks, which are the opposite of carbon sources. While carbon is emitted from cars and smokestacks, carbon is absorbed into trees during photosynthesis and stored in their tissue as they grow. The i-Tree model estimates both the carbon sequestered each year and carbon avoided. Fayette's inventoried trees have sequestered 26,470 lbs. of carbon and avoided 20,354 lbs. and is valued at $334.

CONTROLLING STORMWATER

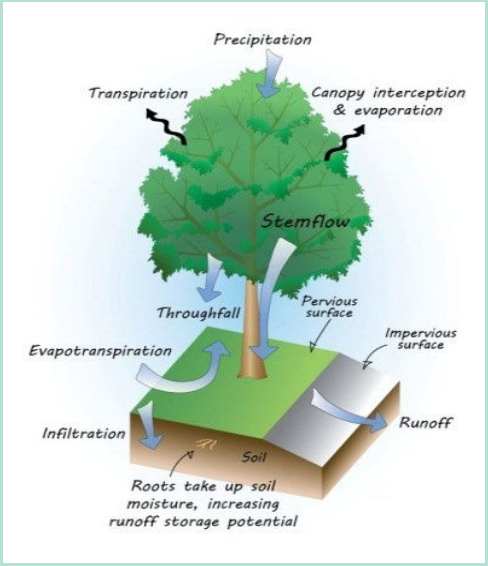
Trees intercept rainfall with their leaves and branches, helping lower stormwater management costs by avoiding runoff. The inventoried trees in the City of Fayette avoid 615,272 gals. of runoff annually. Avoided runoff accounts for 18% of the annual functional benefits provided by Fayette's public tree resource.

On a per-tree basis, large trees with leafy canopies provide the most functional benefits.

IMPROVING AIR QUALITY

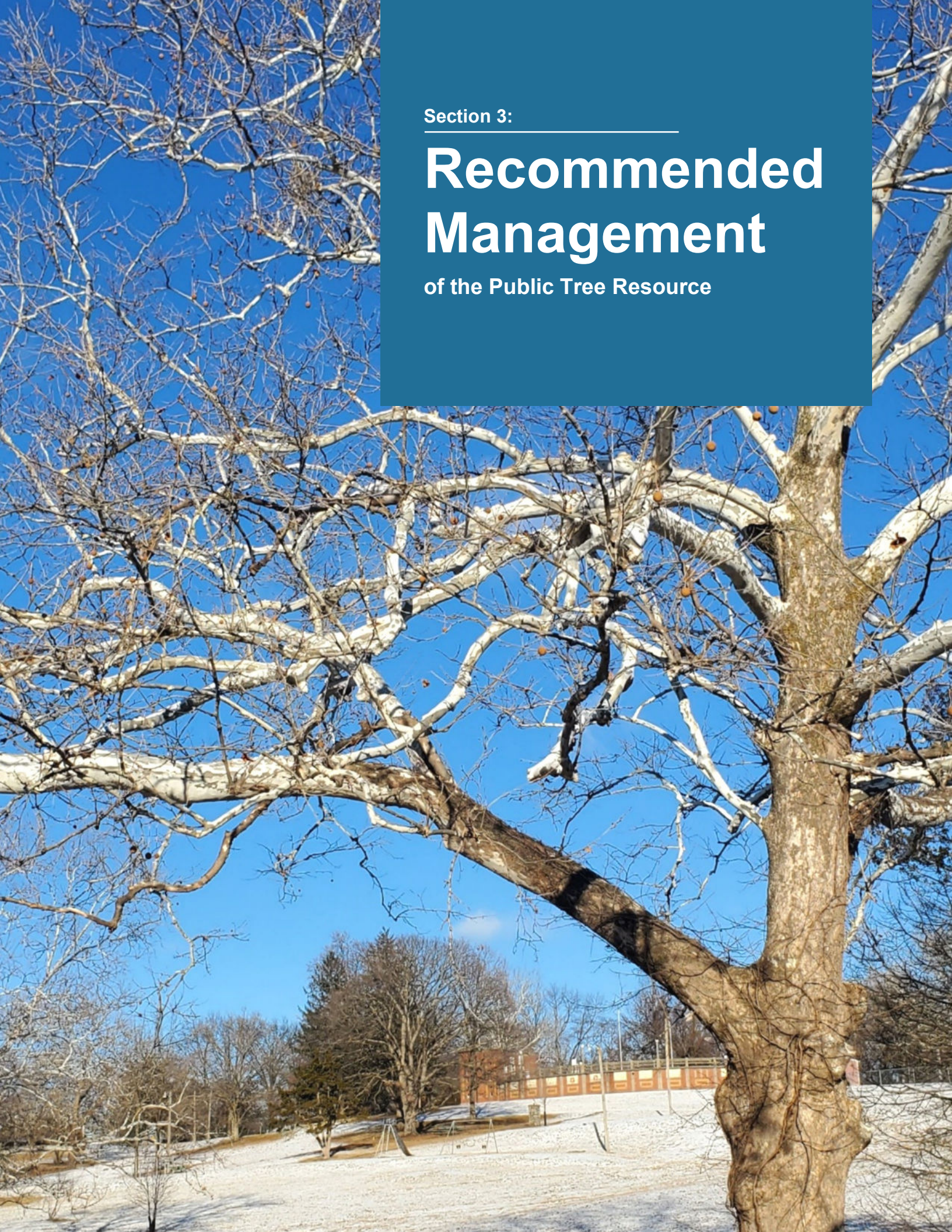
The inventoried tree population annually removes 214 lbs. of air pollutants, including sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), and particulate matter ($PM_{2.5}$). The i-Tree model estimated the value of this benefit at $664.

CANOPY FUNCTIONS



Trees provide many functions and benefits all at once simply by existing, such as:

- Catching rainfall in their crown so it drips to the ground with less of an impact or flows down their trunk.
- Helping stormwater soak into the ground by slowing down runoff.
- Creating more pore space in the soil with their roots, helping stormwater to move through the ground.
- Cooling the surrounding landscape by casting shade with their canopy and releasing water from their leaves.
- Catching airborne pollutants on their leaves and absorbing them with their roots when they wash off in the rain.
- Transforming some pollutants into less harmful substances and preventing other pollutants from forming.



Section 3:

Recommended Management

of the Public Tree Resource

SECTION 3: RECOMMENDED MANAGEMENT OF THE PUBLIC TREE RESOURCE

During the inventory, both a risk rating and a recommended maintenance activity were assigned to each tree. DRG recommends prioritizing and completing each tree's recommended maintenance activity based on the assigned risk rating. This ten-year tree management program takes a multi-faceted and proactive approach to tree resource management.

RISK MANAGEMENT AND RECOMMENDED MAINTENANCE

Although tree removal is usually considered a last resort, and may sometimes create a reaction from the community, there are circumstances in which removal is necessary. Trees fail from natural causes, such as diseases, insects, and weather conditions, and from physical injury due to vehicles, vandalism, and root disturbances. DRG recommends that trees be removed when corrective pruning will not adequately mitigate risk or when correcting problems would be cost-prohibitive. DRG recommends that tree maintenance activities are prioritized and completed based on the risk rating that was assigned to each tree during the inventory. The following section describes recommended maintenance for each risk rating category.

Trees that cause obstructions or interfere with power lines or other infrastructure should be removed when their defects cannot be corrected through pruning or other maintenance practices. Diseased and nuisance trees also warrant removal. Even though large short-term expenditures may be required, it is important to secure the funding needed to complete priority tree removals. Expedient removal reduces risk and promotes public safety. Figures 18 and 19 present tree pruning for the inventoried ROW and Parks trees by risk rating and diameter size class. Figures 16 and 17 present removals for the inventoried ROW and parks trees by risk rating and diameter size class. The following sections briefly summarize the recommended removals identified during the inventory.

EXTREME AND HIGH PRIORITY RECOMMENDED MAINTENANCE

Pruning or removing Extreme and High Risk trees is strongly recommended to be prioritized and completed as soon as possible. In general, maintenance activities should be completed first for the largest diameter trees (>25″) that pose the greatest risk. Once addressed, recommended tree maintenance activities should be completed for smaller diameter trees (<25″) that pose the greatest risk. Addressing Extreme and High Risk trees in a timely and proactive manner often requires significant resources to be secured and allocated. However, peforming this work expediently will mitigate risk, improve public safety, and reduce long-term costs.

High Priority Pruning Recommendations

Extreme and High Risk trees should be pruned immediately based on assigned risk rating, which generally requires removing defects such as dead and dying parts, broken and/or hanging branches, and missing or decayed wood that may be present in tree crowns, even when most of the tree is sound. In these cases, when pruning the defected branch(es) can correct the problem, risk associated with the tree is reduced while promoting healthy growth.

The inventory identified 3 total High Risk trees. The diameter size classes for trees with recommended high-priority pruning ranged between 19–24 inches DBH and 31–36 inches DBH. This maintenance should be performed immediately based on assigned risk rating and may be performed concurrently with other Extreme and High Risk removals.

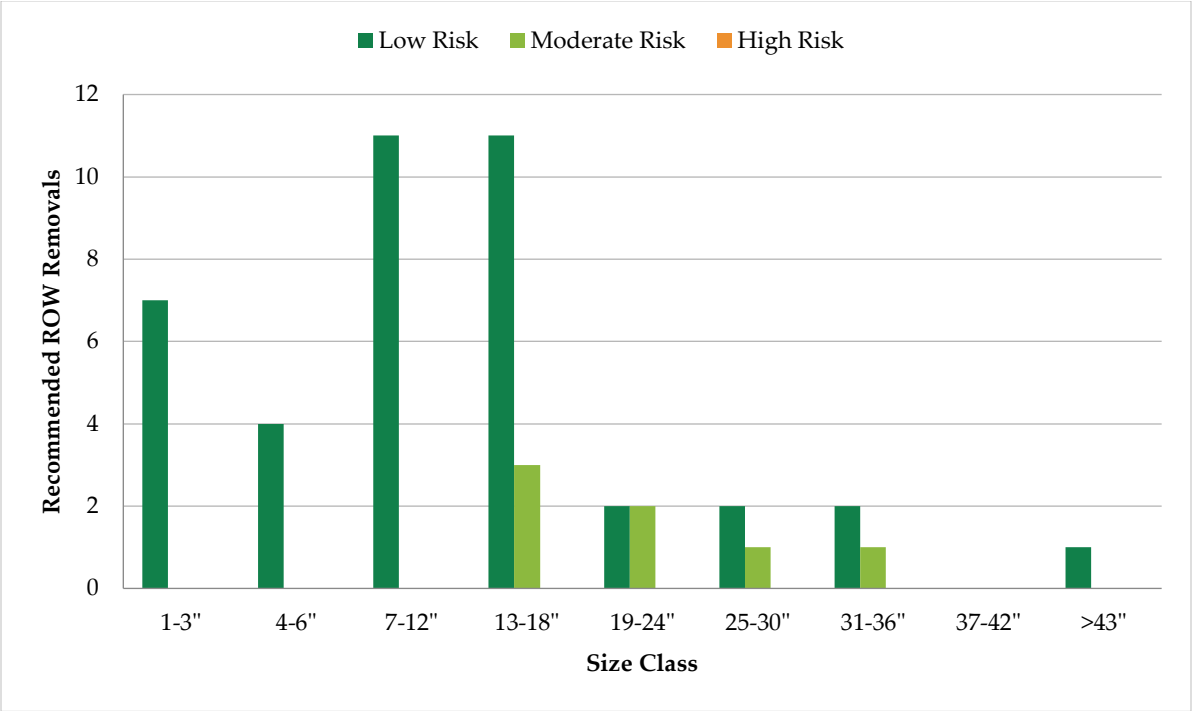


Figure 16. Recommended ROW pruning by size class and risk rating.

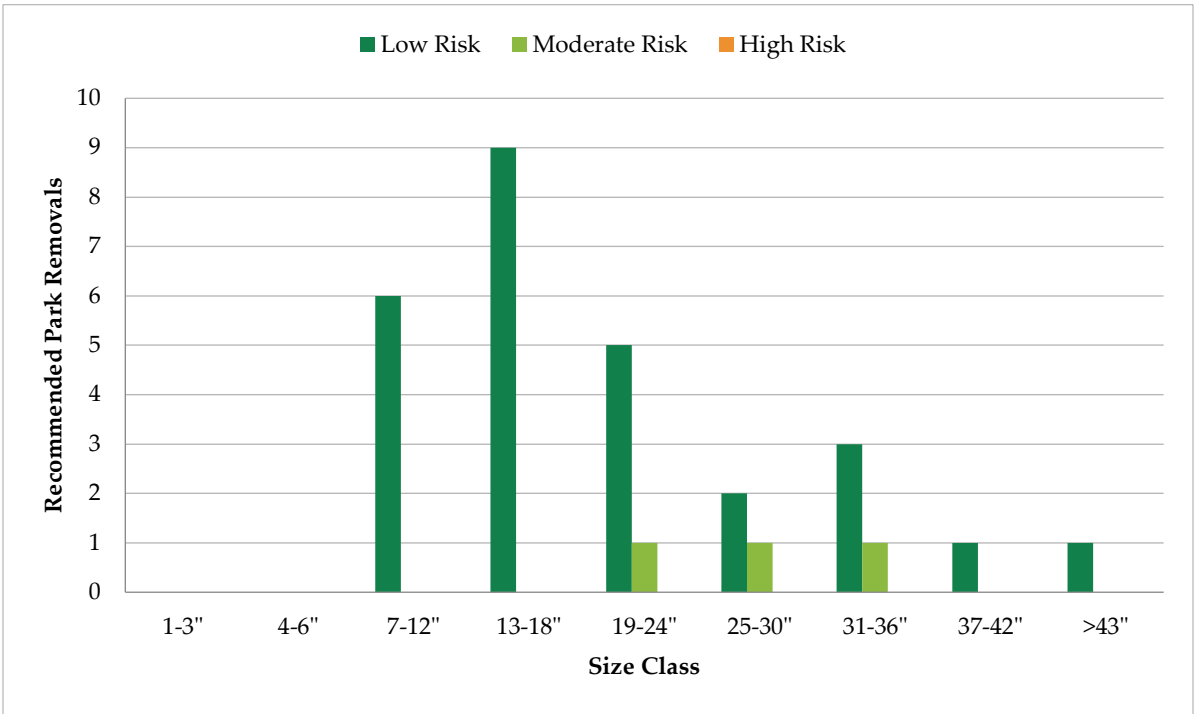


Figure 17. Recommended park pruning by size class and risk rating.

High Priority Removal Recommendations

DRG identified no High Risk trees recommended for removal. There were 10 trees identified as Moderate Risk. The diameter size classes for Moderate Risk trees ranged between 13–18 inches DBH and 31–36 inches DBH.

DRG recommends that trees be removed when pruning will not correct their defects, eliminate the risks that their defects cause, or when corrective pruning would be cost-prohibitive. These trees should be removed immediately based on their risk rating and size class.

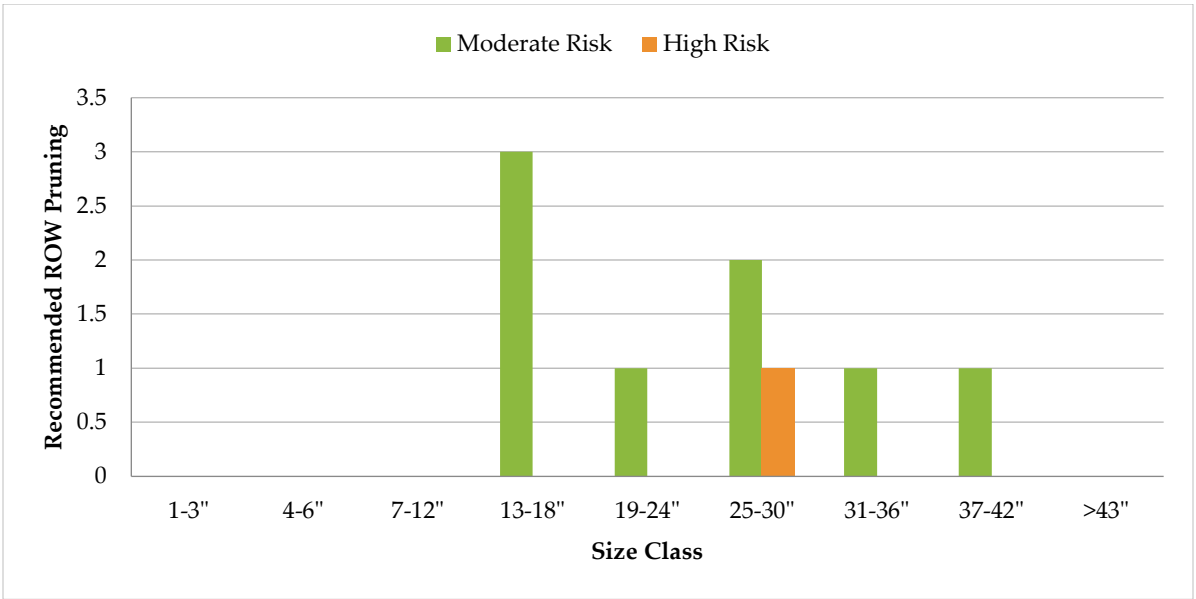


Figure 18. Recommended ROW removals by size class and risk rating.

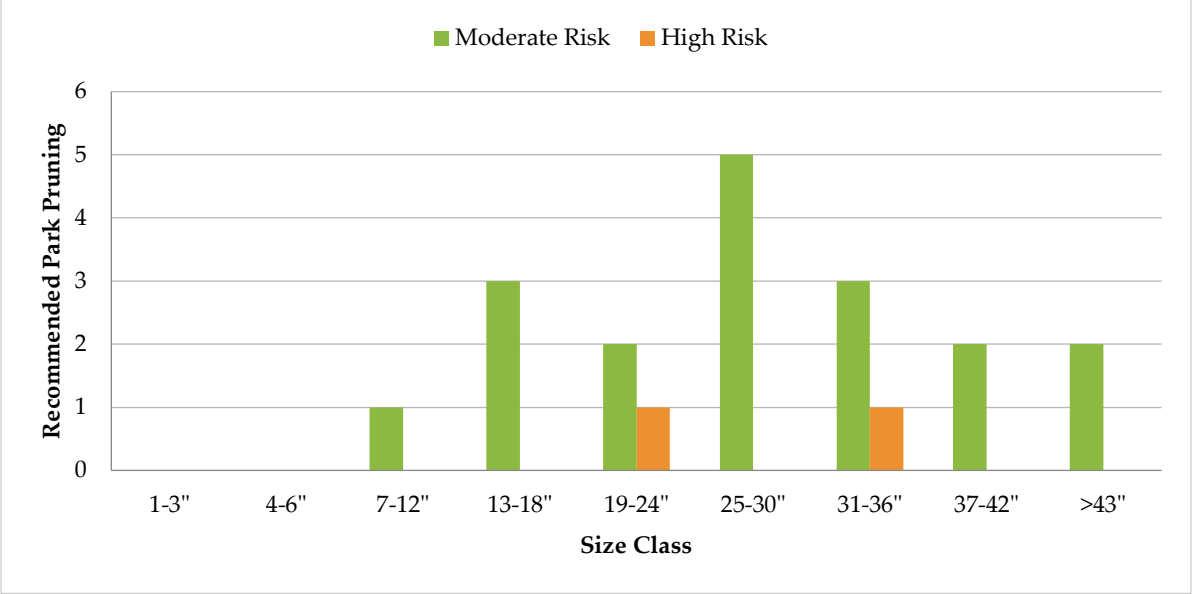


Figure 19. Recommended Park removals by size class and risk rating.

FURTHER INSPECTION

In the ANSI A300 system, there are three levels of risk assessment. Each level is built on the one before it. The lowest level is designed to be a cost-effective approach to quickly identifying tree risk concerns; whereas, the highest level is intended to provide in-depth information to decide about a tree. These levels are:

- **Level 1** inspection is defined as a Limited Visual assessment, which is often conducted as a walk through or windshield survey designed to identify obvious defects or specified conditions.
- **Level 2** inspection is defined as a Basic assessment and is a detailed, 360-degree visual inspection of a tree and its surrounding site, and a synthesis of the information collected.
- **Level 3** inspection is an Advanced assessment and is performed to provide detailed information about specific tree parts, defects, targets, or site conditions. A Level 3 inspection may use specialized tools or require the input of an expert.

The Further Inspection data field indicates whether a tree requires additional and/or future inspections to assess and/or monitor conditions that may cause it to become a risk to people, property, or other trees. The inventory identified 28 requiring one of three inspection types. Further Inspections are beyond the scope of a standard tree inventory, and can be one of the following:

- Recent Damage OR Multi-year Annual Inspection (e.g., a healthy tree that has been impacted by recent construction, weather, or other damage).
- Level 3 Risk Assessment (e.g., a tree with a defect requiring additional or specialized equipment for investigation).
- Insect/Disease Monitoring (e.g., a tree that appears to have an emerging insect or disease problem).
- No further inspection required.

A Level 3 inspection was recommended for trees in which a defect was observed during the inventory and it warranted a closer inspection by a TRAQ qualified arborist. These trees were inspected utilizing an aerial bucket to provide the inspector access to the canopy of the tree in which most of the defects are located. Trees with a Further Inspection requirement should be assessed by an ISA certified arborist as soon as possible, because the longer serious defects are left unaddressed, the greater a risk that a tree becomes. For the same reason, the management that the arborist recommends should be performed as soon as possible to minimize risk.

Further Inspection Recommendations

The inventory found 0 trees recommended for an advanced Level 3 Risk Assessment, 1 tree recommended for Annual/Multi-year Inspection, and 27 trees noted for insect and disease monitoring. Unless already designated for removal, the 111 trees noted as having "Missing or Decayed Wood" should be inspected on a regular basis. Corrective action should be taken as soon as possible unless it will not adequately eliminate the defect, in which case tree removal is likely to be the safest and most cost-effective management.

MODERATE AND LOW PRIORITY RECOMMENDED MAINTENANCE

Pruning or removing Moderate and Low Risk trees are generally the next priorities for maintenance activities. For efficiency, Moderate and Low Risk removals may also be addressed when removing adjacent higher risk trees. Most trees recommended for pruning with these risk levels can be maintained during proactive, routine pruning cycles. DRG recommends implementing proactive maintenance programs incrementally over time as the backlog of risk is reduced.

Moderate Risk Pruning Recommendations

Moderate Risk pruning should be performed after all Extreme and High Risk recommended maintenance is complete and may be performed concurrently with other Moderate Risk removals. The inventory identified 26 Moderate Risk trees recommended for pruning. The diameter size classes for Moderate Risk trees ranged between 7–12 inches DBH and >43 inches DBH.

Moderate Risk Removal Recommendations

DRG identified 10 Moderate Risk trees recommended for removal. Most Moderate Risk trees recommended for removal were smaller than 36 inches DBH. If corrective pruning cannot correct a tree's defects and/or adequately mitigate risk, then the tree should be removed. These trees should be removed as soon as possible after all Extreme High Risk removals and pruning have been completed.

Low Priority Pruning Recommendations

There were 208 Low Risk trees recommended for pruning. Low Risk trees with the assigned maintenance of either "Prune", "Discretionary Prune", or "None" should be included in a proactive Routine Pruning cycle after all the higher risk trees are addressed.

Low Priority Removal Recommendations

DRG identified 67 Low Risk trees recommended for removal. Low Risk removals pose little threat; these trees are generally small, dead, invasive, or poorly formed trees that need to be removed. Eliminating these trees will reduce breeding site locations for insects and diseases and will increase the aesthetic value of the area. Healthy trees growing in poor locations or undesirable species are also included in this category. If pruning cannot correct a tree's defects and/or adequately mitigate risk, then the tree should be removed. All Low Risk trees should be removed when convenient after all higher risk pruning and removals have been completed and may be performed concurrently with routine pruning.

ROUTINE INSPECTIONS

Inspections are essential to uncovering potential problems with trees. They should be performed by a qualified arborist who is trained in the art and science of planting, caring for, and maintaining individual trees. Arborists are knowledgeable about the needs of trees and are trained and equipped to provide proper care. Ideally, the arborist will be ISA Certified and also hold the ISA Tree Risk Assessment Qualification credential.

Routine Inspection Recommendations

All trees along the street ROW should be regularly inspected and attended to as needed. When trees require additional or new work, they should be added to the maintenance schedule. The budget should also be updated to reflect the additional work. Utilize computer management software such as TreeKeeper® to make updates, edits, and keep a log of work records. In addition to locating trees with unidentified defects, inspections also present an opportunity to look for signs and symptoms of pests and diseases. Fayette has a large population of trees that are susceptible to pests and diseases, including ash, maple, and oak.

DRG recommends that Fayette perform routine inspections of inventoried trees by windshield survey (inspections performed from a vehicle) in line with *ANSI A300 (Part 9)* annually and after all severe weather events, to identify defects with heightened risk, signs of pest activity, and symptoms of disease. When trees need additional maintenance, they should be added to the work schedule immediately. Use asset management software such as TreeKeeper® to update inventory data and schedule work records.

ROUTINE PRUNING CYCLE

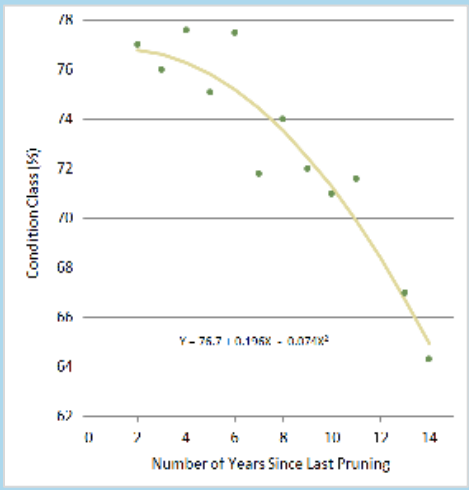
The Routine Pruning cycle includes all Low Risk trees that received a "Prune", "Discretionary Prune", or "None" maintenance recommendation. These trees pose some risk but have a smaller defect size and/or a lower probability of impacting a target. Over time, routine pruning can minimize reactive maintenance, limit instances of elevated risk, and provide the basis for a robust risk management program.

Based on Miller and Sylvester's research, DRG recommends five-year Routine Pruning cycles to maintain the condition of the inventoried tree resource. However, not all municipalities are able to remain proactive with a five-year cycle based on budgetary constraints, the size of the public tree resource, or both. In these cases, extending the length of the Routine Pruning cycle is an option; however, it is in the municipality's best interest to not approach or exceed a 10-year pruning cycle. The reason is that this is around when tree condition deteriorates significantly without regular pruning, because their once-minor defects have worsened, reducing tree health and potentially increasing risk (Miller and Sylvester 1981).

Routine Pruning Cycle Recommendations

Fayette's inventory has 632 trees that should be routinely pruned, and DRG recommends that the city establish a ten-year Routine Pruning cycle with approximately 63 trees pruned each year. DRG recommends that the Routine Pruning cycle begins in Year One of the proposed ten-year program, after all Extreme and High Risk Recommended Maintenance is complete.

PROACTIVE PRUNING



Relationship between tree condition and years since previous pruning. (adapted from Miller and Sylvester 1981)

Miller and Sylvester studied the pruning frequency of 40,000 street trees in Milwaukee, Wisconsin. Trees that had not been pruned for more than 10 years had an average condition rating 10% lower than trees that had been pruned in the previous several years. Their research suggests that a five-year pruning cycle is optimal for urban trees.

Routine pruning cycles help detect and correct most defects before they reach higher risk levels. DRG recommends that pruning cycles begin after all Extreme and High Risk tree maintenance has been completed.

DRG recommends two pruning cycles: a Young Tree Training cycle and a Routine Pruning cycle. Newly planted trees will enter the Young Tree Training cycle once they become established and will move into the Routine Pruning cycle when they reach maturity. A tree should be removed and eliminated from the Routine Pruning cycle when it outlives its usefulness.

Approximately 77% of the inventoried tree population would benefit from routine pruning. Figure 20 shows that a variety of size classes recommended for pruning; however, most of the trees were smaller than 31″–36″ or smaller DBH.

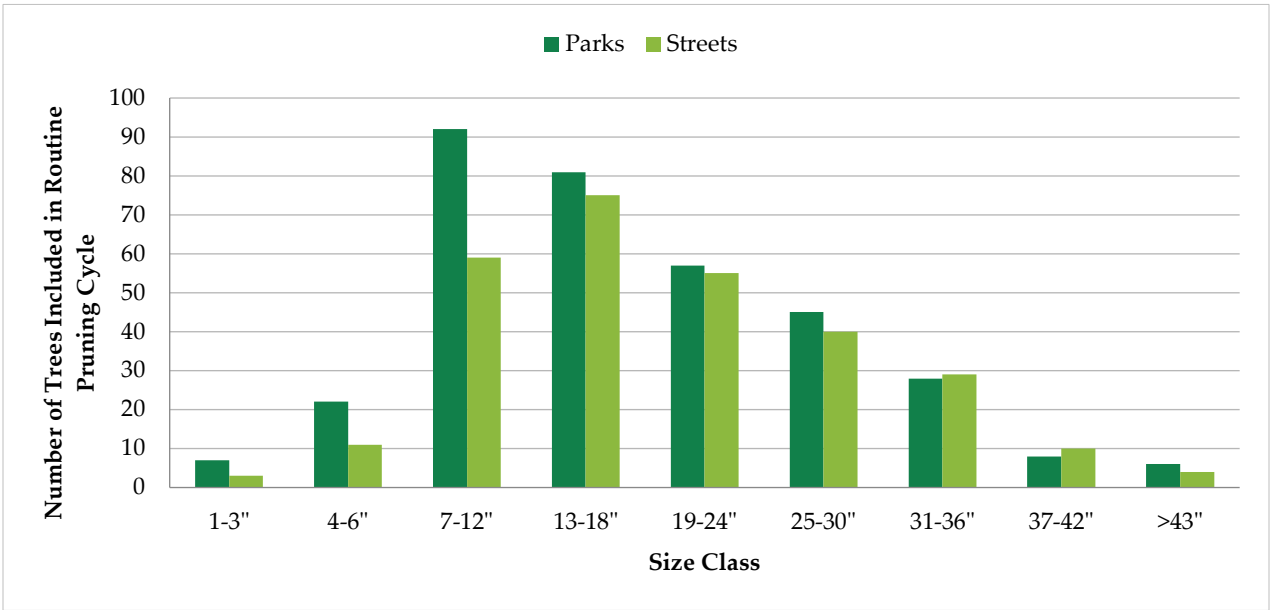


Figure 20. Routine pruning by diameter size class.

YOUNG TREE TRAINING CYCLE

Trees included in the Young Tree Training cycle are generally less than 8 inches DBH. These younger trees sometimes have branch structures that can lead to potential problems as the tree ages. Potential structural problems include codominant leaders, multiple limbs attaching at the same point on the trunk, or crossing/interfering limbs. If these problems are not corrected, they may worsen as the tree grows, increasing its risk rating and creating potential liability. The recommended length of a Young Tree Training cycle is three years because young trees tend to grow at faster rates than mature trees. The Young Tree Training cycle differs from the Routine Pruning cycle in that the Young Tree Training cycle generally only includes trees that can be pruned from the ground with a pole pruner or pruning shear.

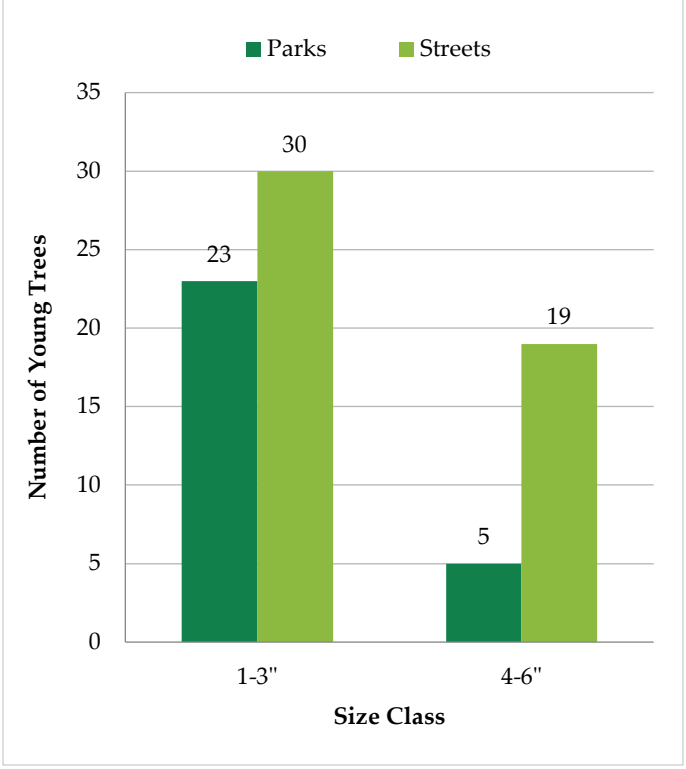


Figure 21. Three-year training cycle by diameter class.

Young Tree Training Cycle Recommendations

DRG recommends that Fayette implement a three-year Young Tree Training cycle beginning after the completion of all Extreme and High Risk Recommended Maintenance activities. During the inventory, 77 trees less than or equal to 6 inches DBH were inventoried and recommended for young tree training. Since Fayette has so few young trees, the Young Tree Training cycle is vital for the future condition of the inventoried tree population. DRG recommends that an average of 26 trees be trained with structural pruning each year over three years, beginning in Year One of the management program.

When new trees are planted, they should enter the Young Tree Training cycle after establishment, typically within 2–3 years after planting. In future years, the number of trees in the Young Tree Training cycle will be based on tree planting efforts and growth rates of young trees. The city should strive to training prune approximately one-third of its young trees each year.

Photograph 3. Young tree training can prevent future structural issues, such as overgrown low branches.

TREE PLANTING AND STUMP REMOVAL

Planting new trees in areas where there is sparse canopy already is the most important. It is also important to plant more trees in areas with poor canopy continuity or gaps in existing canopy. While the Fayette as a whole receives value from the ecosystem services provided by the public tree resource, those benefits usually are not distributed evenly across the city.

The Right Tree in the Right Place is a mantra for tree planting used by the Arbor Day Foundation and many utility companies nationwide. Trees come in many different shapes and sizes, and often change dramatically over their lifetimes. Before selecting a tree for planting, make sure it is the right tree—know how tall, wide, and deep it will be at maturity. Equally important to selecting the right tree is choosing the right spot to plant it. Blocking an unsightly view or creating some shade may be a priority, but it is important to consider how a tree may impact existing utility lines and hardscape as it grows taller, wider, and deeper. If the tree at maturity will reach overhead lines, or conflict with sidewalks and curbs, it is best to choose another tree or a different location.

Tree Planting and Stump Removal Recommendations

Creating larger growing sites for trees in the municipal ROW can be the single most beneficial management practice to improve the survival rate of planted and developing trees. Increasing planting space can also reduce the amount of tree-related infrastructure conflicts, as the trees will be planted further from curbs and sidewalks. Depending on the site, there are several methods available to create and/or increase the growing space for newly planted trees:

- Install or enlarge tree wells/pits in existing sidewalks of sufficient width. Ideally, the minimum growing space of a small-sized tree is 32 square feet. Where Fayette has sidewalks of a sufficient width and length, the city could install tree pits with enough space remaining for the sidewalk to still comply with American Disability Act (ADA) standards.
- Planting trees 4 feet behind a curb without a sidewalk, or 4 feet behind an existing sidewalk, can be a low-cost alternative to more construction intensive methods. This can result in less damage to the sidewalk and give tree roots room to grow into the open soil.
- Re-routing the sidewalk around an area to create designated large tree sites is a relatively cost-effective method to increase growing spaces. This method can also be applied to existing large tree sites, where tree roots have already come in conflict with the sidewalk.
- A landscape bump-out/curb extension is a vegetative area that protrudes into the parking lane of a street, to provide a growing space for plants or trees. These spaces can be used quite effectively by municipalities to beautify a streetscape, provide greater storm water retention, along with the added benefit of slowing car speeds at the bump-out location.

The inventory did not include the collection of stumps. Stump removals should occur when convenient and be included regular planting plans if the site would be feasible for planting after the stump is removed. For this reason, it is most convenient to remove all stumps in areas with scheduled tree planting work, so all feasible sites in an area are stocked at once.

A list of suggested tree species is provided in Appendix C. These tree species are specifically selected for the climate of Fayette. This list is not exhaustive but can be used as a guideline for species that meet community objectives and to enhance any existing list of approved species.

MAINTENANCE SCHEDULE AND BUDGET

Utilizing 2023 City of Fayette tree inventory data, an annual maintenance schedule was developed detailing the recommended tasks to complete each year. DRG made budget projections using industry knowledge and public bid tabulations. A complete table of estimated costs for Fayette' ten-year tree management program follows.

This schedule provides a framework for completing the recommended inventoried tree maintenance over the next ten years. Following this schedule can shift tree maintenance activities from being reactive to a more proactive tree care program.

To implement the maintenance schedule, Fayette's tree maintenance budget should be:

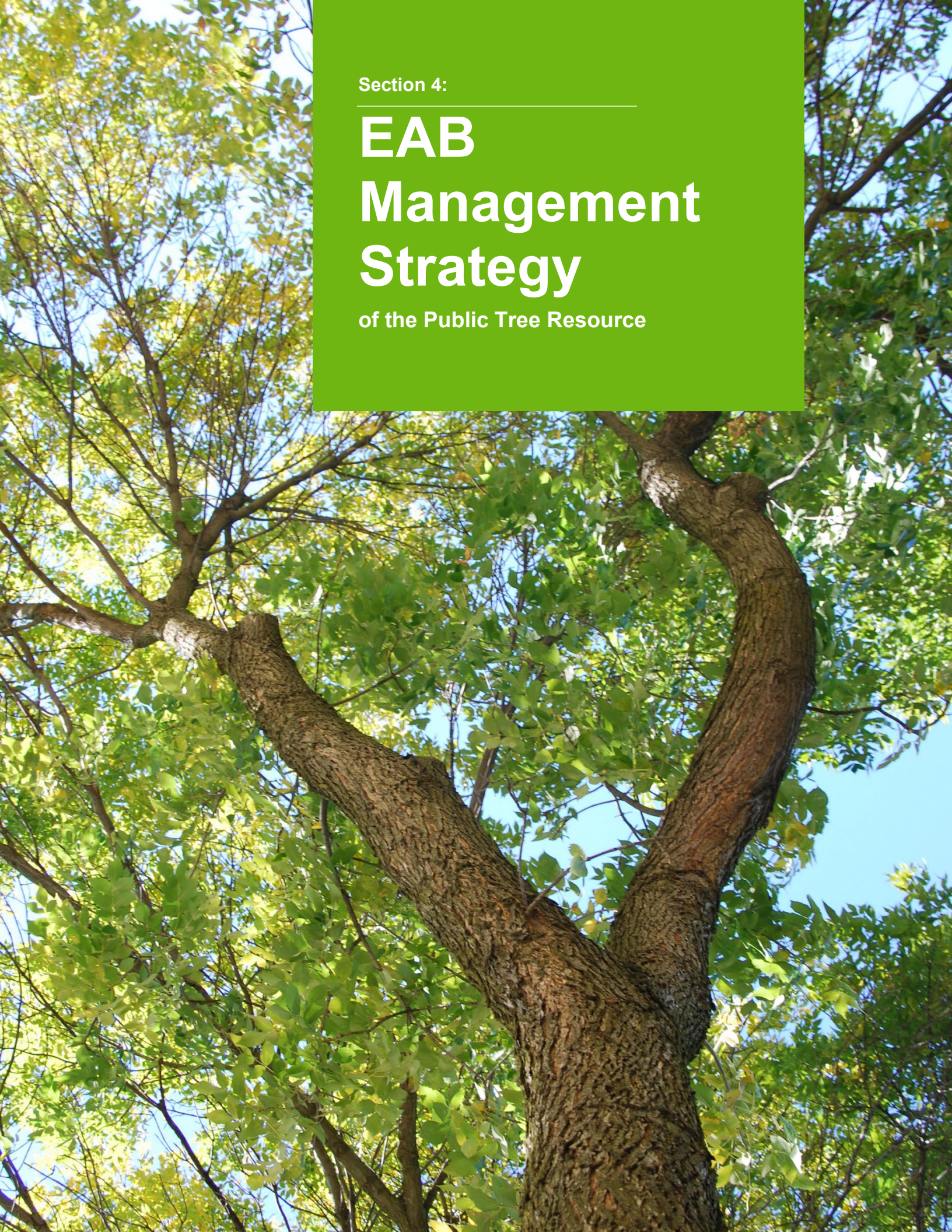
- No less than $70,328 for the first year of implementation.
- No less than $45,000 for each year from the second to the ninth year.
- No less than $35,000 for the final year of the maintenance schedule.

Annual budget funds are needed to ensure that Extreme and High Risk trees are expediently managed and that the vital Young Tree Training and Routine Pruning cycles can begin as soon as possible. If routing efficiencies and/or contract specifications allow more tree work to be completed in a given year, or if this maintenance schedule requires adjustment to meet budgetary or other needs, then it should be modified accordingly. Unforeseen situations such as severe weather events may arise and change the maintenance needs of trees. If maintenance needs change, then budgets, staffing, and equipment should be adjusted to meet the new demand.

Table 3. Estimated costs for ten-year tree management program.

Activity Cost			Year 1		Year 2		Year 3		Year 4		Year 5		Year 6		Year 7		Year 8		Year 9		Year 10		Ten-Year Cost
Activity	Diameter	Cost/Tree	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	
Moderate Priority Removals	1-3"	$50		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	4-6"	$100		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	7-12"	$1,000		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	13-18"	$1,500	3	$4,500		$0		$0		$0		$0		$0		$0		$0		$0		$0	$4,500
	19-24"	$1,500	3	$4,500		$0		$0		$0		$0		$0		$0		$0		$0		$0	$4,500
	25-30"	$2,000	2	$4,000		$0		$0		$0		$0		$0		$0		$0		$0		$0	$4,000
	31-36"	$2,500	2	$5,000		$0		$0		$0		$0		$0		$0		$0		$0		$0	$5,000
	37-42"	$3,000		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	>43"	$3,000		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
Activity Total(s)			**10**	**$18,000**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$18,000**
Low Priority Removals	1-3"	$50		$0		$0		$0		$0		$0		$0		$0		$0		$0	7	$350	$350
	4-6"	$100		$0		$0		$0		$0		$0		$0		$0		$0		$0	4	$400	$400
	7-12"	$1,000		$0		$0		$0		$0		$0		$0		$0	7	$7,000	10	$10,000		$0	$17,000
	13-18"	$1,500		$0		$0		$0		$0	2	$3,000	8	$12,000	8	$12,000	2	$3,000		$0		$0	$30,000
	19-24"	$1,500		$0		$0		$0	2	$3,000	5	$7,500		$0		$0		$0		$0		$0	$10,500
	25-30"	$2,000		$0		$0		$0	4	$8,000		$0		$0		$0		$0		$0		$0	$8,000
	31-36"	$2,500		$0	1	$2,500	4	$10,000		$0		$0		$0		$0		$0		$0		$0	$12,500
	37-42"	$3,000	1	$3,000	1	$3,000		$0		$0		$0		$0		$0		$0		$0		$0	$6,000
	>43"	$3,000	2	$6,000	2	$6,000		$0		$0		$0		$0		$0		$0		$0		$0	$12,000
Activity Total(s)			**3**	**$9,000**	**4**	**$11,500**	**4**	**$10,000**	**6**	**$11,000**	**7**	**$10,500**	**8**	**$12,000**	**8**	**$12,000**	**9**	**$10,000**	**10**	**$10,000**	**11**	**$750**	**$96,750**
High Priority Pruning	1-3"	$200		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	4-6"	$200		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	7-12"	$200		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	13-18"	$200		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	19-24"	$350	1	$350		$0		$0		$0		$0		$0		$0		$0		$0		$0	$350
	25-30"	$350	1	$350		$0		$0		$0		$0		$0		$0		$0		$0		$0	$350
	31-36"	$350	1	$350		$0		$0		$0		$0		$0		$0		$0		$0		$0	$350
	37-42"	$500		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	>43"	$500		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
Activity Total(s)			**3**	**$1,050**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$1,050**
Moderate Priority Pruning	1-3"	$200		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	4-6"	$200		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	7-12"	$200	1	$200		$0		$0		$0		$0		$0		$0		$0		$0		$0	$200
	13-18"	$200	6	$1,200		$0		$0		$0		$0		$0		$0		$0		$0		$0	$1,200
	19-24"	$350	3	$1,050		$0		$0		$0		$0		$0		$0		$0		$0		$0	$1,050
	25-30"	$350	7	$2,450		$0		$0		$0		$0		$0		$0		$0		$0		$0	$2,450
	31-36"	$350	4	$1,400		$0		$0		$0		$0		$0		$0		$0		$0		$0	$1,400
	37-42"	$500	3	$1,500		$0		$0		$0		$0		$0		$0		$0		$0		$0	$1,500
	>43"	$500	2	$1,000		$0		$0		$0		$0		$0		$0		$0		$0		$0	$1,000
Activity Total(s)			**26**	**$8,800**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$8,800**
Young Tree Training (3-year Cycle)	1-3"	$20	18	$360	18	$360	17	$340	17	$340	17	$340	17	$340	17	$340	17	$340	17	$340	17	$340	$3,440
	4-6"	$30	8	$240	8	$240	8	$240	8	$240	8	$240	8	$240	8	$240	8	$240	8	$240	8	$240	$2,400
	6"<	$40		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
Activity Total(s)			**26**	**$600**	**26**	**$600**	**25**	**$580**	**25**	**$580**	**25**	**$580**	**25**	**$580**	**25**	**$580**	**25**	**$580**	**25**	**$580**	**25**	**$580**	**$5,840**

Activity Cost			Year 1		Year 2		Year 3		Year 4		Year 5		Year 6		Year 7		Year 8		Year 9		Year 10		Ten-Year Cost
Activity	Diameter	Cost/Tree	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	
Routine Pruning (5-year Cycle)	1-3"	$200	1	$200	1	$200	1	$200	1	$200	1	$200	1	$200	1	$200	1	$200	1	$200	1	$200	$2,000
	4-6"	$200	3	$660	3	$660	3	$660	3	$660	3	$660	3	$660	3	$660	3	$660	3	$660	3	$660	$6,600
	7-12"	$200	15	$3,020	15	$3,020	15	$3,020	15	$3,020	15	$3,020	15	$3,020	15	$3,020	15	$3,020	15	$3,020	15	$3,020	$30,200
	13-18"	$200	16	$3,120	16	$3,120	16	$3,120	16	$3,120	16	$3,120	16	$3,120	16	$3,120	16	$3,120	16	$3,120	16	$3,120	$31,200
	19-24"	$350	11	$3,920	11	$3,920	11	$3,920	11	$3,920	11	$3,920	11	$3,920	11	$3,920	11	$3,920	11	$3,920	11	$3,920	$39,200
	25-30"	$350	9	$2,975	9	$2,975	9	$2,975	9	$2,975	9	$2,975	9	$2,975	9	$2,975	9	$2,975	9	$2,975	9	$2,975	$29,750
	31-36"	$350	6	$1,995	6	$1,995	6	$1,995	6	$1,995	6	$1,995	6	$1,995	6	$1,995	6	$1,995	6	$1,995	6	$1,995	$19,950
	37-42"	$500	2	$900	2	$900	2	$900	2	$900	2	$900	2	$900	2	$900	2	$900	2	$900	2	$900	$9,000
	>43"	$500	1	$500	1	$500	1	$500	1	$500	1	$500	1	$500	1	$500	1	$500	1	$500	1	$500	$5,000
Activity Total(s)			**63**	**$17,290**	**63**	**$17,290**	**63**	**$17,290**	**63**	**$17,290**	**63**	**$17,290**	**63**	**$17,290**	**63**	**$17,290**	**63**	**$17,290**	**63**	**$17,290**	**63**	**$17,290**	**$172,900**
Replacement Tree Planting and Maintenance	Purchasing	$350	7	$2,450	7	$2,450	7	$2,450	7	$2,450	7	$2,450	7	$2,450	7	$2,450	7	$2,450	7	$2,450	7	$2,450	$24,500
	Planting & Watering	$225	7	$1,575	7	$1,575	7	$1,575	7	$1,575	7	$1,575	7	$1,575	7	$1,575	7	$1,575	7	$1,575	7	$1,575	$15,750
	Mulching	$50	7	$350	7	$350	7	$350	7	$350	7	$350	7	$350	7	$350	7	$350	7	$350	7	$350	$3,500
Activity Total(s)			**21**	**$4,375**	**21**	**$4,375**	**21**	**$4,375**	**21**	**$4,375**	**21**	**$4,375**	**21**	**$4,375**	**21**	**$4,375**	**21**	**$4,375**	**21**	**$4,375**	**21**	**$4,375**	**$43,750**
New Tree Planting and Maintenance	Purchasing	$350	5	$1,750	5	$1,750	5	$1,750	5	$1,750	5	$1,750	5	$1,750	5	$1,750	5	$1,750	5	$1,750	5	$1,750	$17,500
	Planting & Watering	$225	5	$1,125	5	$1,125	5	$1,125	5	$1,125	5	$1,125	5	$1,125	5	$1,125	5	$1,125	5	$1,125	5	$1,125	$11,250
	Mulching	$50	5	$250	5	$250	5	$250	5	$250	5	$250	5	$250	5	$250	5	$250	5	$250	5	$250	$2,500
Activity Total(s)			**15**	**$3,125**	**15**	**$3,125**	**15**	**$3,125**	**15**	**$3,125**	**15**	**$3,125**	**15**	**$3,125**	**15**	**$3,125**	**15**	**$3,125**	**15**	**$3,125**	**15**	**$3,125**	**$31,250**
Natural Mortality (1%)	Tree Removal	$314	8	$2,512	8	$2,512	8	$2,512	8	$2,512	8	$2,512	8	$2,512	8	$2,512	8	$2,512	8	$2,512	8	$2,512	$25,120
	Stump Removal	$72	8	$576	8	$576	8	$576	8	$576	8	$576	8	$576	8	$576	8	$576	8	$576	8	$576	$5,760
	Replacement Tree	$625	8	$5,000	8	$5,000	8	$5,000	8	$5,000	8	$5,000	8	$5,000	8	$5,000	8	$5,000	8	$5,000	8	$5,000	$50,000
Activity Total(s)			**24**	**$8,088**	**24**	**$8,088**	**24**	**$8,088**	**24**	**$8,088**	**24**	**$8,088**	**24**	**$8,088**	**24**	**$8,088**	**24**	**$8,088**	**24**	**$8,088**	**24**	**$8,088**	**$80,880**
Activity Grand Total			**191**		**153**		**152**		**154**		**155**		**156**		**156**		**157**		**158**		**159**		**1,593**
Cost Grand Total				**$70,328**		**$44,978**		**$43,458**		**$44,458**		**$43,958**		**$45,458**		**$45,458**		**$43,458**		**$43,458**		**$34,208**	**$ 459,220**



Section 4:

EAB Management Strategy

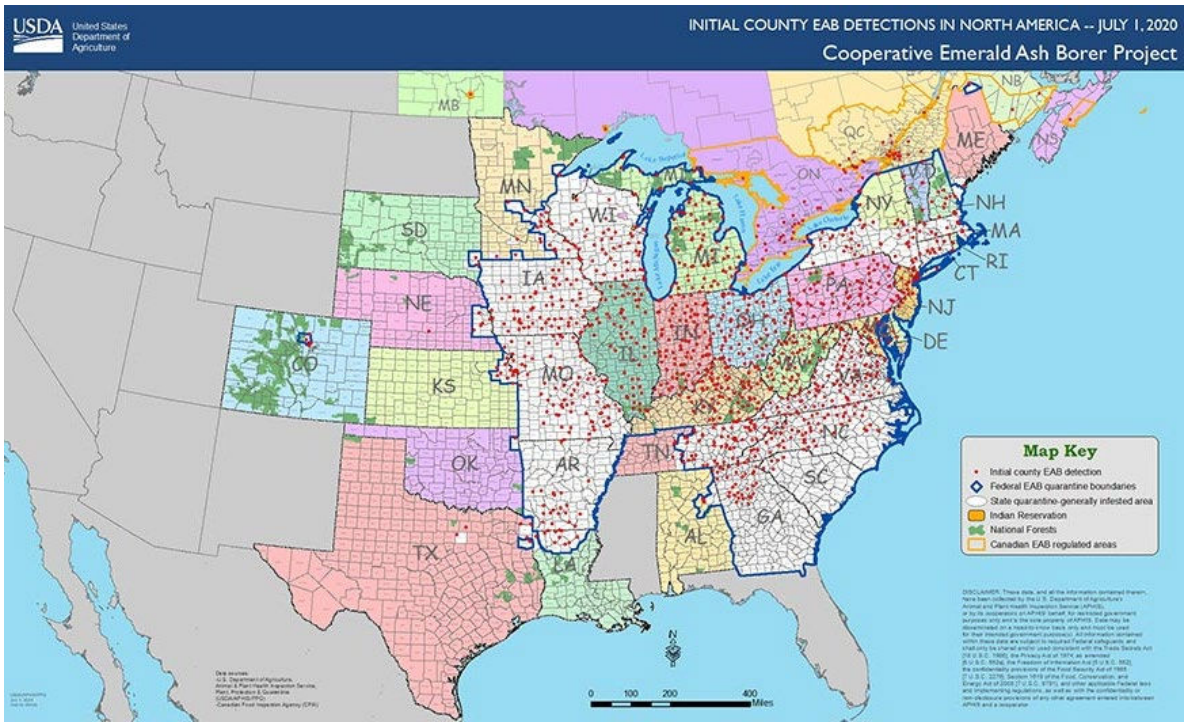
of the Public Tree Resource

SECTION 4. EAB MANAGEMENT STRATEGY

Throughout the United States, urban and community forests are under increased pressure from exotic and invasive insects and diseases. Exotic pests that arrive from overseas typically have no natural predators and become invasive when our native trees and shrubs do not have appropriate defense mechanisms to fight them off. Mortality from these pests can range from two weeks with oak wilt (*Ceratocystis fagacearum* (OW), to six years or more with EAB (Knight, Brown, and Long 2013).

An integral part of tree management is being aware of invasive insects and diseases in the area and how to best manage them. Depending on the tree diversity within Fayette's urban forest, an invasive insect or disease has the potential to negatively impact the tree population.

This section provides the different management strategies for dealing with EAB. Included is information on how to effectively monitor EAB, increase public education, handle ash debris, reforest, work with stakeholders, and utilize ash wood.



Map 1. ***EAB detections throughout North America as of July 2020. Map courtesy of USDA.***

EMERALD ASH BORER

Emerald ash borer is a small insect native to Asia. In North America, the borer is an invasive species that is highly destructive to ash trees in its introduced range. The potential damage of EAB rivals that of chestnut blight and Dutch elm disease. Chestnut blight is a fungus that was introduced in North America around 1900 and by 1940 it wiped out most of the mature American chestnut population. Dutch elm disease is a fungus spread by the elm bark beetle. Since its discovery in the United States in 1928, it has killed millions of elm trees. EAB is thought to have been introduced into the United States and Canada in the 1990s but was not positively identified in North America until 2002 in Canton, Michigan. It has now been confirmed in 14 states and has killed at least 50 to 100 million ash trees so far and threatens another 7.5 billion ash trees throughout North America. The EAB is a serious pest and is known to attack all native ash trees, including black, blue, green and white ash. The state is committed to early detection and thoughtful management of this pest.

EAB has been identified in Fayette and poses a serious threat to the health and condition of Fayette's ash tree population.

Photograph 4. EAB adults grow to 5/8 inch in length (Photo courtesy of https://bygl.osu.edu/node/681).

Photograph 5. EAB larvae (Photo courtesy of www.emeraldashborer.info).

Photograph 6. An adult EAB emerged from this D-shaped exit hole. (Photograph courtesy of Wisconsin's Emerald Ash Borer Information Source.)

Identification

The adult beetle is metallic green and 3⁄8- to 5⁄8-inch long. The adult beetle emerges from late May until early August, feeding on a small amount of foliage. The adult females then lay eggs on the trunk and branches of ash trees and in about a week the eggs hatch into larvae, which then bore into the tree. Larvae are creamy white in color, can grow up to an inch long, and are found underneath the bark of the trees. The larvae tunnel and feed on the inner bark and phloem, creating winding galleries as they feed. This cuts off the flow of the water and nutrients to the tree, causing dieback and death.

Photograph 7. Larvae consume the cambium and phloem, effectively girdling the tree and eventually causing death within a few years.

Photograph 8. This ash tree is declining from EAB infestation. The loss of water and nutrients from the intense larvae tunneling can cause the trees to lose between 30% and 50% of their canopy during the first year of infestation. Photograph courtesy of https://eab.russell.wisc.edu/signs-and-symptoms/.

EAB can be very difficult to detect. Initial symptoms include yellowing and/or thinning of the foliage and longitudinal bark splitting. The entire canopy may die back, or symptoms may be restricted to certain branches. Declining trees may sprout epicormic shoots at the tree base or on branches. Woodpecker injury is often apparent on branches of infested trees, especially in late winter. Removal of bark reveals tissue callusing and frass-filled serpentine tunneling. The S-shaped larval feeding tunnels are about 1⁄4 inch in diameter. Tunneling may occur from the upper branches to the trunk and root flare. Adults emerge from the trunk and branches in a characteristic D-shaped exit hole that is about 1/8 inch in diameter. The loss of water and nutrients from the intense larvae tunneling can cause trees to lose between 30% and 50% of their canopy during the first year of infestation. Trees often die within six years following infestation (Knight, Brown, and Long 2013).

Ash Population

With the threat of EAB nearing Fayette, it is crucial that the city have an action plan. Some of the most important questions to answer will be, "How many ash trees do we have, where are they located, and what actions should we take?" In order to answer these questions, Fayette needs to maintain an up-to-date inventory, know what resources are available, and understand city's priorities.

Based on the current public tree inventory, there are 38 ash trees distributed throughout the city. Most of the ash trees were rated in Fair condition. Table 5 shows the diameter class of each ash tree by its condition class. Of the 38 ash trees inventoried, a few currently show possible signs or symptoms of EAB.

Table 4. Tree condition versus diameter class matrix

		Diameter Class (inches)									
		1–3	4–6	7–12	13–18	19–24	25–30	31–36	37–42	43+	Total
Condition Class	Good						1	1			2
	Fair			4	8	2	2	4	2	2	24
	Poor			4	4	1	1	2			12
	Dead										
	Total			8	12	3	4	7	2	2	38

ASH TREE RISK REDUCTION PRUNING AND REMOVALS

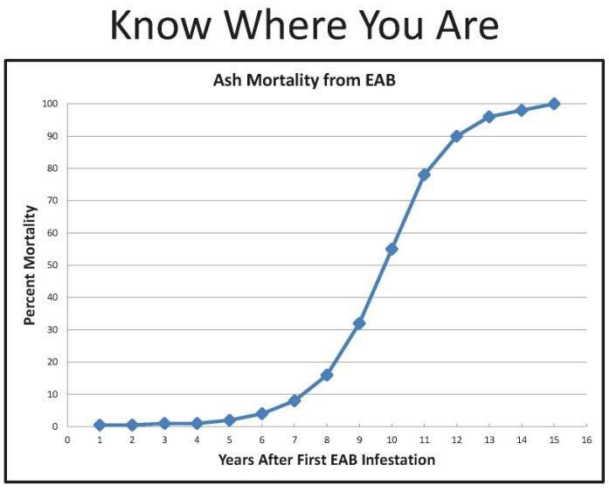
As EAB infestation has been found in Fayette, preparation for this threat becomes one of city's highest priorities. Budgeted funds and personnel should be refocused to concentrate on the ash tree population. DRG recommends the city perform both treatment and safety related activities on ash trees. These activities will end up saving the city money and increasing productivity. However, it is only recommended due to EAB and the eventual removal of infested ash trees.

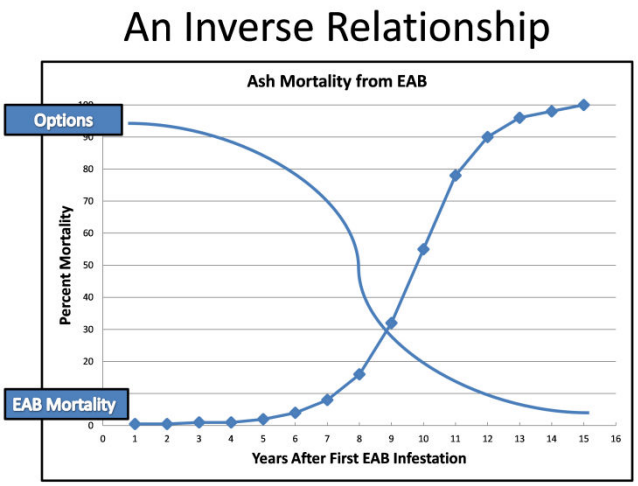
DRG also recommends that Fayette proactively remove ash trees during road reconstruction projects and other public works activities. By proactively removing ash trees during construction, the cost and impacts will be lower.

In the event that Fayette decides to proactively remove ash trees, DRG recommends that the city remove all ash trees less than 7 inches and trees that are rated as Dead, Poor, or Critical condition first. These trees are providing little benefit to the community and the cost for removals should be less significant.

EAB MANAGEMENT

The graphs below demonstrate how management options decrease with prolonged infestation. Fayette is currently placed at Year 6 or 7 on both graphs and management options are about to decline, so preparations should be made as quickly as possible.





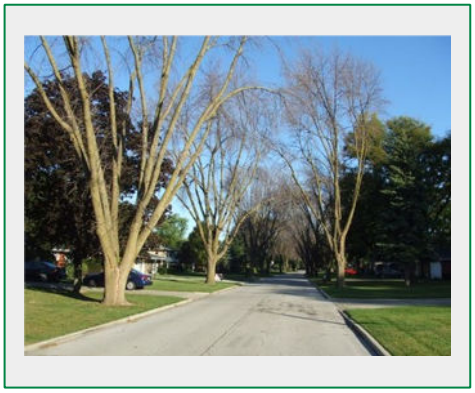
Source: Emerald Ash Borer University 2012

EAB Management Options

With no specific strategy or budget in place for the impending infestation of EAB, Fayette should explore strategies for managing EAB that provide the most economic benefit and increase public safety. These EAB management strategies include do nothing, remove and replace all ash, treat all ash, or a combination of the strategies. These strategies and their associated costs are described below.

EAB Strategy 1: Do Nothing

This means letting EAB run its course and having no plan for dealing with EAB. This strategy includes not removing and not treating any ash trees. This strategy is economical in the beginning of an infestation because it costs the city no money, but it would become a severe public safety issue within a few years. DRG does not recommend this management strategy.



Photograph 9. This is an example of a do nothing strategy. These ash trees became infested with EAB and eventually died. They have now become a public safety issue.

EAB Strategy 2: Remove and Replace all Ash

Remove and replace all 38 ash trees by 2025. This strategy would benefit public safety from the EAB infestation but would have an impact on the city's budget. In order to achieve this strategy and remove all of the ash trees by 2025, the city would most likely have to contract work out. Removing mature ash trees that are in Good and Fair condition would take away all of the valuable benefits that these trees provide to the city. Removal and replacement ultimately benefits the city by increasing public safety but will require a lot of upfront cost. It will be very important to replace all of these ash trees once they have been removed.

The total approximate cost for this strategy would be $99,350; $68,000 would be the approximate cost to remove all ash trees, $7,600 would be the approximate cost to remove all stumps, and $23,750 would be the approximate cost to replace all ash trees as shown in Table 5.

Table 5. Cost to remove and replace all ash

Management Strategy	Management Action	# of Trees	Cost
Remove and Replace All Ash Trees	Removal All	38	$68,000
	Replace All	38	$23,750
	Stump Removal	38	$7,600
	Total		$99,350

EAB Strategy 3: Treat all Ash

Treating all ash trees in Fayette could reduce the annual mortality rate, stabilize removals, and would be less expensive than removing and replacing them. Treating all ash would enable these trees to keep providing Fayette with the monetary benefits that they provide. On the other hand, treating all ash trees is not an ideal practice because some of these ash trees will eventually become infested with EAB and some of these ash trees are less desirable to retain.

Injection treatment loses its effectiveness against EAB after two years. It is recommended that no ash tree go without treatment after two years of initial application. If Fayette wanted to biennially treat all of its 26 ash trees that are not recommended for removal, it would cost approximately $6,530 every two years. This means that it would cost Fayette approximately $3,265 annually to treat all of Fayette's 26 ash trees for the remainder of their lives. The cost to remove the 12 ash trees recommended for removal is approximately $18,500 and approximately $2,400 to remove all stumps. Replacement of the removed trees would cost approximately $7,500. A two-year treatment period and removal of the recommended four trees would cost the city an estimated $34,930 as shown in Table 6.

Table 6. Cost to treat all ash

Management Strategy	Management Action	# of Trees	Cost
Treat All Ash Trees	Treat all Ash Trees for Two Years	26	$6,530
	Ash Trees Recommended for Removal	12	$18,500
	Stump Removal	12	$2,400
	Replace Removed	12	$7,500
	Total		$34,930

EAB Strategy 4: Combination of Removals and Treatment

This strategy is intended to give the city options for a combination of removing and treating ash trees to stabilize annual removals, annual budgets, and prolong the life of ash trees that are in Good and Fair condition. Table 7 is an EAB matrix table that is intended to organize trees that should be considered for removal and trees that should be considered for treatment. The description of this EAB matrix table goes into detail about why certain ash trees should be considered for removal or treatment.

Table 7. EAB matrix table

	Diameter size class (inches)								
Condition Class		1–3	4–6	7–12	13–18	19–24	25–30	≥31	Total
	Good						1	1	2
	Fair			4	8	2	2	8	24
	Poor			4	4	1	1	2	12
	Total			8	12	3	4	11	38

Based on these numbers, DRG makes the following recommendations:

Remove 12 Trees

- Trees in the "Poor" condition class are recommended for removal. These trees are recommended for removal because they are more susceptible to EAB infestation and if not removed could pose a public safety issue in the future. A total of 12 trees are recommended for removal and replacement.

Chemically Treat 24 Trees (Low–Moderate Priority for Treatment)

- The intent here is to defer removal of a large block of trees within the matrix of "Fair" condition class between 7 inches and 31+ inches DBH. These 24 trees are considered to be "low–moderate priority" for chemical treatment. Eventually, a lot of these trees will become infested with EAB and, therefore, have to be removed in a timely manner. However, treating these trees can stabilize annual budgets and removals each year. Treating these trees could be economically beneficial and reduce the chance for a public safety issue in the near future.

Chemically Treat 2 Trees (High Priority for Treatment)

- Candidates for chemical treatment shall exhibit "Good" condition or better, have no more than 30% dieback, and be located in an appropriate site (i.e., not under overhead utilities). Treating these 2 ash trees will help keep these trees around for a long time and the city will profit from the monetary benefits these ash trees provide.

Private Trees

In addition to ash trees located on public property, EAB will impact trees located on private property. The number of private ash trees is unknown but it could be equal or more than the ash trees located on public property. During the inventory, it was evident to the inventory arborists that there is an abundance of ash trees located on private properties. The cost to remove ash trees will be higher on private property because of the greater inaccessibility to these areas. It is crucial that the city promote public education about EAB so that it can reduce the potential of city involvement with regulating tree removals on private properties. The public education section will explain more on how to minimize anxiety from private homeowners and give examples on how to go about informing the public about managing their ash trees.

Dying and infested ash trees on private property will pose a threat to human and public safety. In the event that city officials have to get involved with private property owners about a potentially infested ash tree, Fayette should consider utilizing the city's tree ordinance.

Public Education

It is crucial for Fayette property owners to be well informed about EAB. Their assistance and cooperation will be vital in helping detect EAB, managing ash trees on private property, and the reforestation process that will come from the removal of ash trees. Fayette should inform the public when EAB has been discovered in the city. A well-informed public is more likely to accept what is happening without panicking and cooperate with the city's requests. The following are examples of how Fayette should go about informing the public:

- News releases
- City newsletter articles
- Post information about EAB on the city's website
- Display information packets at public buildings
- Postcard mailings to ash tree owners
- Door hangers explaining maintenance options
- Presentations to community groups
- Tie ribbons around ash trees and place tags on the trees with information about EAB

Reforestation

As the ash tree population is being reduced in Fayette, the city will need to develop a plan to replant where ash trees have been removed. The city could potentially lose over 4% of its tree population due to EAB. It will be vital to promptly reforest Fayette because of the numerous benefits that ash trees provide the community. Some of the benefits that these ash trees provide the city include, but are not limited to, removing pollutants from the air, helping improve summer temperatures, reducing stormwater runoff and energy consumption, and providing social and psychological benefits.

If the Fayette is to replace all ash trees, it will cost approximately $55,440. This would be a huge financial burden on the city, but replacement is important and has long-term benefits. The cost of replanting ash trees could be spread out over multiple years by establishing a goal for planting a certain amount of trees each year. Reduce costs by working with private property owners and volunteers. This could include giving private property owners the option of paying for the tree and getting to pick the tree they want from a list of approved species. Fayette should also explore grants for reforestation. Organizing volunteer groups to participate in planting trees can help decrease planting costs.

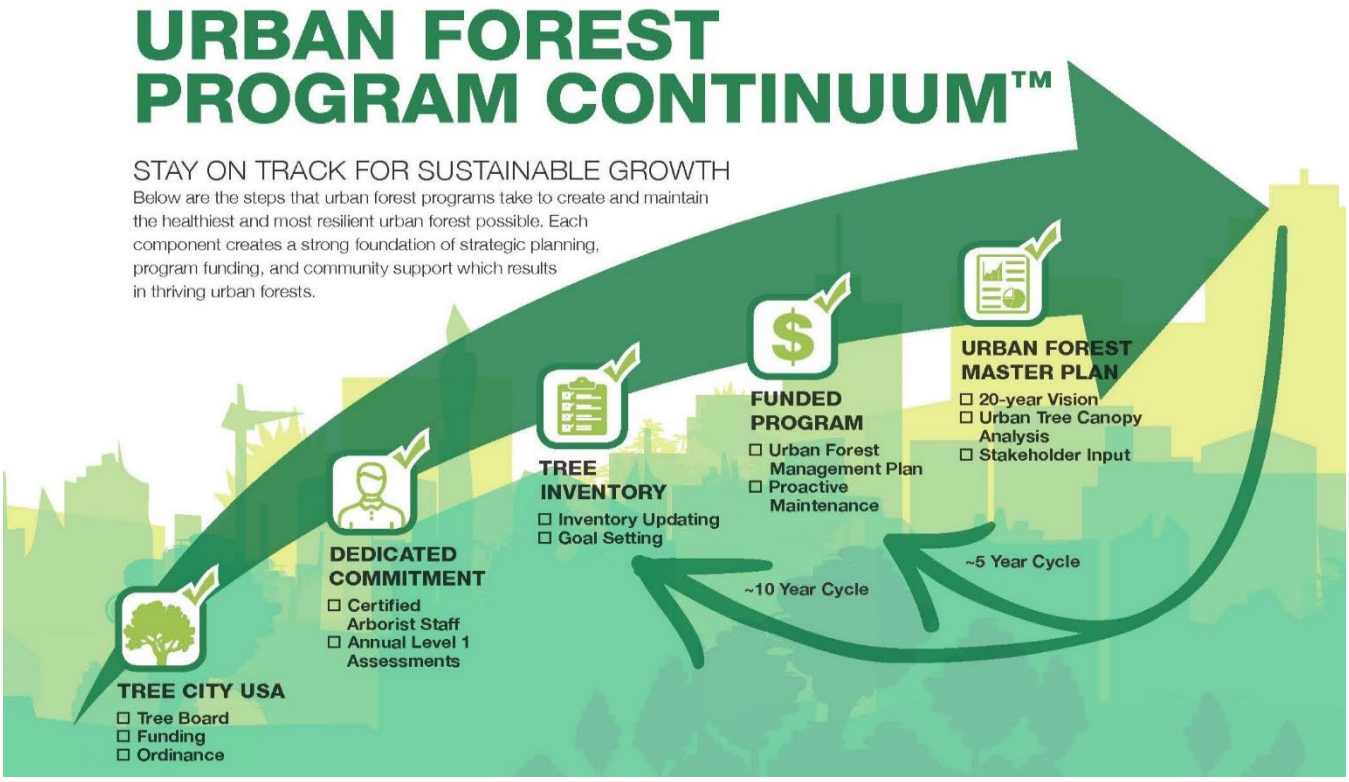
It is important to consider diversification when replacing ash trees. Without diversification, a community is much more vulnerable to catastrophic losses that impact budgets and community appearance. DRG recommends that no one species represents 10% and that no one genus comprises more than 20% of the total public tree population. Since EAB has hit local communities, there might be a possibility that local nurseries have a shortage of trees. Fayette might want to consider nurseries in other regions for trees or developing a relationship with local nurseries and encouraging price breaks for property owners who are replacing ash trees with approved species.

CONCLUSION

When properly maintained, the valuable benefits trees provide over their lifetime far exceed the time and money invested in planting, pruning, and inevitably removing them. The 815 public trees inventoried provide $92,154 in estimated annual economic value, which is over 900% of the city's annual tree maintenance budget of $10,000. Successfully implementing the ten-year program may increase Fayette's ROI over time, or at least maintain it over the years.

The program is ambitious and is a challenge to complete in ten years but becomes easier after all high priority tree maintenance is completed. This *Standard Inventory Analysis and Management Plan* could potentially help the city advocate for an increased urban forestry budget to fund the recommended maintenance activities. Getting started is the most difficult part because of the expensive maintenance in the first year, which represents the transition from reactive maintenance to proactive maintenance. Significant investment early on can reduce tree maintenance costs over time.

As the urban forest grows, the benefits enjoyed by the City of Fayette and its residents will increase as well. Inventoried trees are only a fraction of the total trees in Fayette when including private property, which is why it is important to also incentivize private landowners to care for their trees and to plant new ones. The city's urban forestry program is well on its way to creating a sustainable and resilient public tree resource, and can stay on track by setting goals, updating inventory data to check progress, and setting more ambitious goals once they are reached.



EVALUATING AND UPDATING THIS PLAN

This *Standard Inventory Analysis and Management Plan* provides management priorities for the next ten years, and it is important to update the tree inventory using TreeKeeper® as work is completed, so the software can provide updated species distribution and benefit estimates. This empowers Fayette to self-assess the City's progress over time and set goals to strive toward by following the adaptive management cycle. Below are some ways of implementing the steps of this cycle:

- Prepare planting plans well enough in advance to schedule and complete stump removal in the designated area, and to select species best suited to the available sites.
- Annually comparing the number of trees planted to the number of trees removed and the number of vacant planting sites remaining, then adjusting future planting plans accordingly.
- Annually comparing the species distribution of the inventoried tree resource with the previous year after completing planting plans to monitor recommended changes in abundance.
- Schedule and assign high-priority tree work so it can be completed as soon as possible instead of reactively addressing new lower priority work requests as they are received.
- Include data collection such as measuring DBH and assessing condition into standard procedure for tree work and routine inspections, so changes over time can be monitored.

REFERENCES

American National Standards Institute. 2017. *ANSI A300 (Part 1): Tree, Shrub, and Other Woody Plant Management—Standard Practices (Pruning)*. Tree Care Industry Association, Inc.

Coder, K. D. 1996. Identified Benefits of Community Trees and Forests. University of Georgia Cooperative Extension Service: Forest Resources Unit. Publication FOR96-39. Retrieved from https://nfs.unl.edu/documents/communityforestry/coderbenefitsofcommtrees.pdf

Evans, E. 2012. Americans are Planting Trees of Strength. North Carolina State University College of Agriculture & Life Sciences: Department of Horticultural Science. http://www.treesofstrength.org/benefits.htm

Heisler, G. M. 1986. Energy Savings with Trees. *Journal of Arboriculture* 12(5):113–125. Retrieved from https://www.nrs.fs.fed.us/pubs/jrnl/1986/nrs_1986_heisler_002.pdf

Karnosky, D. F. 1979. Dutch Elm Disease: A Review of the History, Environmental Implications, Control, and Research Needs. *Environmental Conservation* 6(4): 311–322.

Kuo, F. E., & Sullivan, W. C. 2001a. Environment and Crime in the Inner City: Does Vegetation Reduce Crime? *Environment and Behavior* 33(3): 343–367. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.644.9399&rep=rep1&type=pdf

Lovasi, G. S., Quinn, J. W., Neckerman, K. M., Perzanowski M., Rundle, A. 2008. Children living in areas with more street trees have lower prevalence of asthma. *Journal of Epidemiology and Community Health* 62(7): 647-649. Retrieved from https://www.researchgate.net/publication/5401459_Children_living_in_areas_with_more_trees_have_lower_prevalence_of_asthma

McPherson, E. G., Rowntree, R. A. 1989. Using Structural Measures to Compare Twenty-Two U.S. Street Tree Populations. *Landscape Journal* 8(1): 13–23. Retrieved from https://www.fs.fed.us/psw/topics/urban_forestry/products/1/psw_cufr745_structuralmeasures.pdf

Miller, R. W., & Sylvester, W.A. 1981. An Economic Evaluation of the Pruning cycle. *Journal of Arboriculture* 7(4): 109–112. Retrieved from http://webcache.googleusercontent.com/search?q=cache:VENBQXq9EmcJ:joa.isa-arbor.com/request.asp%3FJournalID%3D1%26ArticleID%3D1724%26Type%3D2+&cd=2&hl=en&ct=clnk&gl=us

Nowak, D. J., Greenfield, E. J., Hoehn, R. E., & Lapoint, E. 2013. Carbon storage and sequestration by trees in urban and community areas of the United States. *Environmental Pollution* 178: 229-236. Retrieved from https://www.fs.fed.us/nrs/pubs/jrnl/2013/nrs_2013_nowak_001.pdf

Richards, N. A. 1983. Diversity and Stability in a Street Tree Population. *Urban Ecology* 7(2): 159–171.

Santamour, F.S. 1990. Trees for Urban Planting: Diversity Uniformity, and Common Sense. *U.S. National Arboretum: Agricultural Research Service*. Retrieved from https://pdfs.semanticscholar.org/26a2/4c5361ce6d6e618a9fa307c4a34a3169e309.pdf?_ga=2.266051527.959145428.1587418896-558533249.1587418896

Ulrich, R. 1984. View through Window May Influence Recovery from Surgery. *Science* 224: 420–422. Retrieved from https://pdfs.semanticscholar.org/43df/b42bc2f7b212eb288d2e7be289d251f15bfd.pdf

Ulrich R.S., R.F. Simmons, B.D. Losito, E. Fiority, M.A. Miles and M. Zeison. 1991. Stress Recovery During Exposure to Natural and Urban Environments. *Journal of Environmental Psychology* 11(3): 201-230.

USDA Forest Service. 2003a. Benefits of Urban Trees—Urban and Community Forestry: Improving Our Quality of Life. *Southern Region Forestry Report* R8-FR 71. Retrieved from http://www.sci-links.com/files/Benefits_of_Urban_Trees.pdf

USDA Animal and Plant Health Inspection Service. 2020. Pest Tracker. https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/Pest-Tracker

Wolf, K. L. 1998a. Urban Nature Benefits: Psycho-Social Dimensions of People and Plants. *University of Washington: College of Forest Resources* Human Dimensions of the Urban Forest Fact Sheet #1. Retrieved from https://www.naturewithin.info/UF/PsychBens-FS1.pdf

———. 2020. Forest Health Highlights. https://www.fs.fed.us/foresthealth/protecting-forest/forest-health-monitoring/monitoring-forest-highlights.shtml

———. 2011. *ANSI A300 (Part 9): Tree, Shrub, and Other Woody Plant Management Standard Practices (Tree Risk Assessment a. Tree Failure).* Tree Care Industry Association, Inc.

———. 2009. Trees & Urban Streets: Research on Traffic Safety & Livable Communities. *University of Washington, Seattle USDA Forest Service: Pacific Northwest Research Station*. Retrieved from http://www.naturewithin.info/urban.html

———. 2007. City Trees and Property Values. *Arborist News* 16(4): 34-36. Retrieved from https://www.naturewithin.info/Policy/Hedonics.pdf

———. 2003. Social Aspects of Urban Forestry: Public Response to the Urban Forest in Inner-City Business Districts. *Journal of Arboriculture* 29(3): 117–126. Retrieved from https://www.naturewithin.info/CityBiz/JofA_Biz.pdf

———. 2003b. Is all your rain going down the drain? Look to Bioretainment—trees are a solution. *Center for Urban Forest Research: Pacific Southwest Research Station*. Retrieved from https://www.fs.fed.us/psw/topics/urban_forestry/products/cufr_392_rain_down_the_drain.pdf

———. 2001b. Aggression and Violence in the Inner City: Effects of Environment via Mental Fatigue. *Environment and Behavior* 33(4): 543–571. Retrieved from https://pdfs.semanticscholar.org/9ca8/a34eee31d42ac2235aa6d0b9b6e7a5f32386.pdf

———. 2000. Community Image: Roadside Settings and Public Perceptions. *University of Washington: College of Forest Resources* Human Dimensions of the Urban Forest Factsheet #10. Retrieved from https://www.naturewithin.info/Roadside/Rsd-Community-FS10.pdf

———. 1999. Grow for the Gold: Trees in Business Districts. *Washington State DNR: Community Forestry Program* Number 14. Retrieved from https://www.naturewithin.info/CityBiz/TreeLink.PDF

———. 1998b. Trees in Business Districts: Positive Effects on Consumer Behavior! *University of Washington: College of Forest Resources* Human Dimensions of the Urban Forest Fact Sheet #5. Retrieved from https://www.naturewithin.info/CityBiz/Biz3Ps-FS5.pdf

———. 1986. Human Responses to Vegetation and Landscapes. *Landscape and Urban Planning* 13: 29–44. Retrieved from https://www.researchgate.net/profile/Roger_Ulrich4/publication/254315158_Visual_Landscapes_and_Psychological_Well-Being/links/0c96053a3fe7796728000000/Visual-Landscapes-and-Psychological-Well-Being.pdf

APPENDIX A
DATA COLLECTION AND SITE LOCATION METHODS

DATA COLLECTION METHODS

DRG collects tree inventory data using a customized ArcPad program, called Rover, loaded onto pen-based field computers. At each site, the following data fields were collected:

- Address
- Condition
- Date of Inventory
- Defects
- Further Inspection
- Multi-stem
- Notes
- Overhead Utilities
- Primary Maintenance
- Risk Rating
- Species
- Tree Size*

* measured in inches in diameter at 4.5 feet above ground or diameter at breast height (DBH]).

Maintenance needs are based on *Best Management Practices: Tree Risk Assessment* (International Society of Arboriculture 2011). The knowledge, experience, and professional judgment of DRG's arborists ensure the high quality of inventory data.

SITE LOCATION METHODS

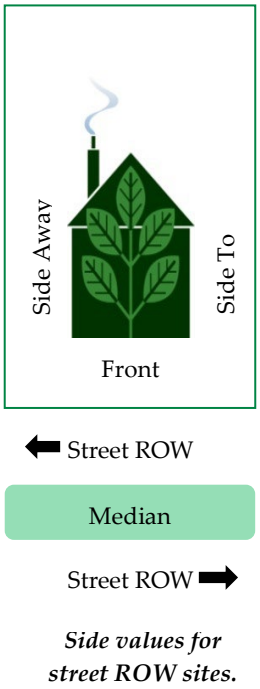
Equipment and Base Maps

Inventory arborists use FZ-G1 Panasonic Toughpad® units with internal GPS receivers. Geographic information system (GIS) map layers are loaded onto these units to help locate sites during the inventory. The table below lists these base map layers, along with each layer's source and format information.

Data Source	Data Year	Projection
Shapefile U.S. Census Bureau	2022	GCS_North_American_1983 WKID: 4269 Authority: EPSG
Aerial Imagery The Missouri Map, National Agriculture Imagery Program (NAIP), ESRI	2020	NAD_1983_UTM_Zone_15N WKID: 26915 Authority: EPSG

STREET ROW SITE LOCATION

Individual street ROW trees were located using a methodology that identifies sites by *address number*, *street name*, *side*, *site number*, and *on street*. This methodology was developed by DRG to help ensure consistent assignment of location.



Side values for street ROW sites.

Address Number and Street Name

Where there was no GIS parcel addressing data available for sites located by a vacant lot, or by an occupied lot without a posted address number on a building, the arborist used their best judgment to assign an address number based on opposite or adjacent addresses. An "X" was then added to the number in the database to indicate that it was assigned, for example, "37X Choice Avenue."

Sites in medians or islands were assigned an address number by Rover using parcel and streets geographical data. Each segment was numbered with an assigned address that was interpolated from addresses facing that median/island. If there were multiple median/islands between cross streets, each segment was assigned its own address. The *street name* assigned to a site was determined by street ROW parcel information and posted street name signage.

Side Value and Site Number

Each site was assigned a *side value*. Side values include *front*, *side*, *median*, or *rear* based on the site's location in relation to the lot's street frontage. The *front* is the side facing the address street. *Side* is either side of the lot that is between the front and rear. *Median* indicates a median or island surrounded by pavement. The *rear* is the side of the lot opposite of the address street.

PARK AND PUBLIC SPACE SITE LOCATION

Park and/or public space site locations were collected using the same methodology as street ROW sites, however nearly all of them have the "Assigned Address" field set to 'Yes' or 'X' and have the "Park Name" field filled.

i-TREE METHODOLOGY

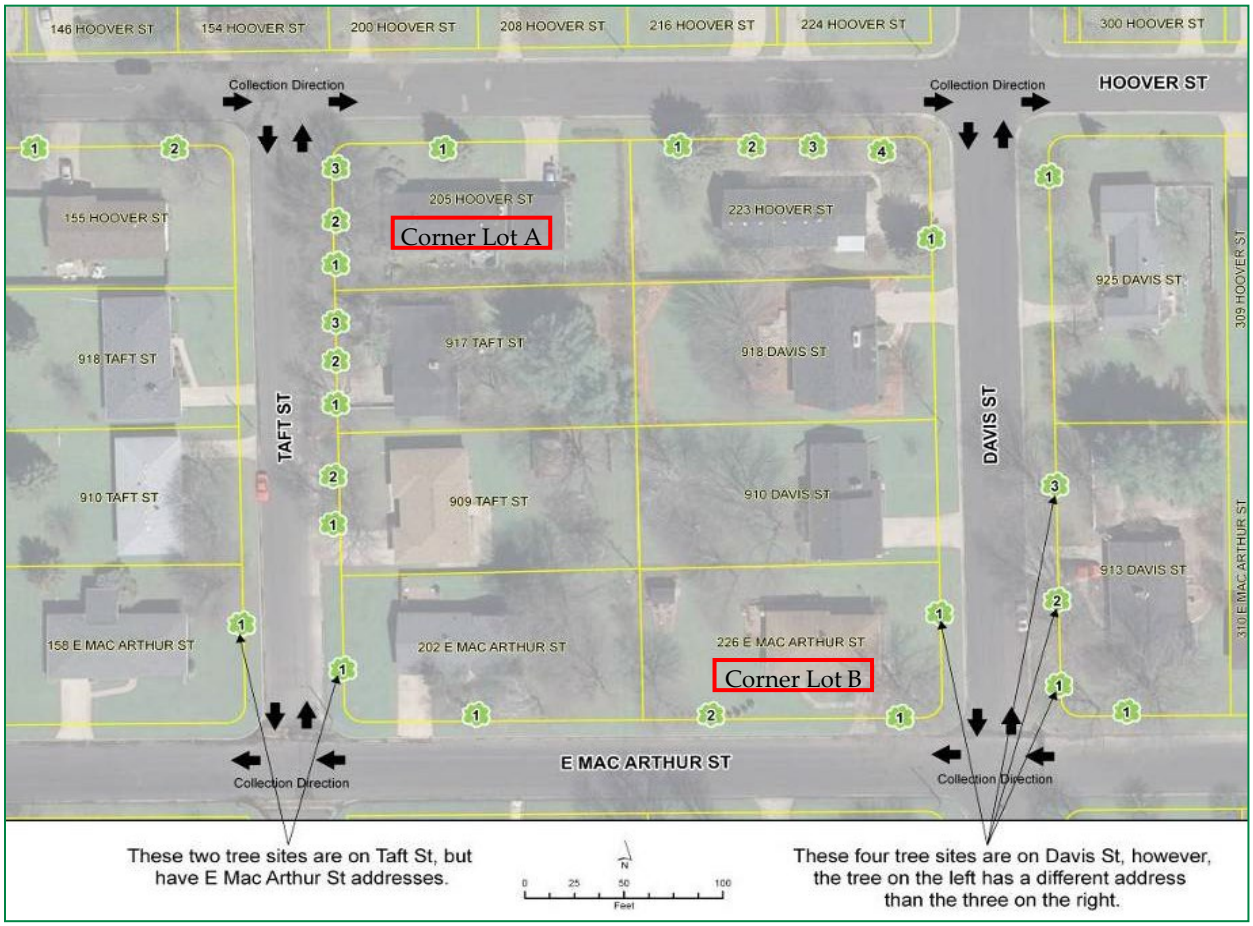
Structural value is a compensatory value calculated based on the local cost of having to replace a tree with a similar tree. In other words, it is a measurement of the value of the resource itself. The structural value of an urban forest is the sum of the structural values of all the individual trees contained within. Monetary values are assigned based on valuation procedures of the Council of Tree and Landscape Appraisers using information on species, diameter, condition, and location (McPherson 2007) and (Nowak et al. 2008).

Carbon sequestration refers to the capture and storage of carbon from the earth's atmosphere. i-Tree analysis reports on the gross annual amount of carbon sequestered as well as the total amount of carbon stored over the lifetime of the tree. For this analysis, carbon storage and sequestration values are calculated at a rate of $171 per ton. Carbon storage is considered both a functional benefit and a structural benefit of trees; the carbon is physically integrated into the wood of the tree.

Air pollution removal refers to the removal of ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and particulate matter less than 2.5 microns ($PM_{2.5}$). For this analysis, the pollution removal value is calculated based on the prices of $4,322 per ton of ozone, $427 per ton of sulfur dioxide, $952 per ton of nitrogen dioxide, $1,380 per ton carbon monoxide, and $150,053 per ton of particulate matter less than 2.5 microns.

Avoided runoff measures the amount of surface runoff avoided when trees intercept rainfall during precipitation events. Surface runoff from rainfall contributes to the contamination of streams, rivers, lakes, and wetlands by washing oils, pesticides, and other pollutants, either directly into waterways or into drainage infrastructure that ultimately empties into waterways. For this analysis, annual avoided runoff is calculated based on the estimated amount of intercepted rainfall and the local weather in Fayette, where annual precipitation equaled 43 inches. The monetary value of avoided runoff is based on the U.S. Forest Service's Community Tree Guide Series at a rate of $0.07 per cubic foot.

Site Location Example



Corner Lot A

Address/Street Name:	205 Hoover St.
Side:	Side
On Street:	Taft St.
Address/Street Name:	205 Hoover St.
Side:	Side
On Street:	Taft St.
Address/Street Name:	205 Hoover St.
Side:	Side
On Street:	Taft St.
Address/Street Name:	205 Hoover St.
Side:	Front
On Street:	Hoover St.

Corner Lot B

Address/Street Name:	226 E Mac Arthur St.
Side:	Side
On Street:	Davis St.
Address/Street Name:	226 E Mac Arthur St.
Side:	Front
On Street:	E Mac Arthur St.
Address/Street Name:	226 E Mac Arthur St.
Side:	Front
On Street:	E Mac Arthur St.

APPENDIX B
INVASIVE PESTS AND DISEASES

In today's worldwide marketplace, the volume of international trade brings increased potential for pests and diseases to invade our country. Many of these pests and diseases have seriously harmed rural and urban landscapes and have caused billions of dollars in lost revenue and millions of dollars in cleanup costs. Keeping these pests and diseases out of the country is the number one priority of the USDA's Animal and Plant Inspection Service (APHIS).

Updated pest range maps can be found at: https://www.nrs.fs.fed.us/tools/afpe/maps/ and updated pest information can be found at: https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/Pest-Tracker

Although some invasive species naturally enter the United States via wind, ocean currents, and other means, most invasive species enter the country with some help from human activities. Their introduction to the U.S. is a byproduct of cultivation, commerce, tourism, and travel. Many species enter the United States each year in baggage, cargo, contaminants of commodities, or mail.

Once they arrive, invasive pests grow and spread rapidly because controls, such as native predators, are lacking. Invasive pests disrupt the landscape by pushing out native species, reducing biological diversity, killing trees, altering wildfire intensity and frequency, and damaging crops. Some pests may even push species to extinction. The following sections include key pests and diseases that adversely affect trees in America at the time of this plan's development. This list is not comprehensive and may not include all threats.

It is critical to the management of community trees to routinely check APHIS, USDA Forest Service, and other websites for updates about invasive species and diseases in your area and in our country so that you can be prepared to combat their attack.

SPOTTED LANTERNFLY

The spotted lanternfly (SLF, *Lycorma delicatula*) is native to China and was first detected in Pennsylvania in September 2014. SLF feeds on a wide range of fruit, ornamental, and woody trees, with tree-of-heaven being one of its preferred hosts. SLF is a hitchhiker and can be spread long distances by people who move infested material or items containing egg masses.

If allowed to spread in the United States, this pest could seriously impact the country's grape, orchard, and logging industries. Be sure to inspect for the pest. Egg masses, juveniles, and adults can be on trees and plants, as well as on bricks, stone, metal, and other smooth surfaces. Also thoroughly check vehicles, trailers, and even the clothes you are wearing to prevent accidently moving SLF.

Symptoms of SLF are plants oozing or weeping with a fermented odor, buildup of a sticky fluid called honeydew on the plant or on the ground underneath them, and sooty mold growing on plants. The following trees are susceptible to SLF: almond, apple, apricot, cherry, maple, nectarine, oak, peach, pine, plum, poplar, sycamore, walnut, and willow, as well as grape vines and hop plants.

Pinned spotted lanternfly.

Photograph courtesy of PA Dept of Agriculture

Pinned spotted lanternfly nymph with wingspan open.

Photograph courtesy of USDA APHIS

ASIAN LONGHORNED BEETLE

The Asian longhorned beetle (ALB, *Anoplophora glabripennis*) is an exotic pest that threatens a wide variety of hardwood trees in North America. The beetle was introduced in Chicago, New Jersey, and New York City, and is believed to have been introduced in the United States from wood pallets and other wood-packing material accompanying cargo shipments from Asia. ALB is a serious threat to America's hardwood tree species.

Adult Asian longhorned beetle.

Photograph courtesy of New Bedford Guide (2011)

Adults are large (3/4- to 1/2-inch long) with very long, black and white banded antennae. The body is glossy black with irregular white spots. Adults can be seen from late spring to fall depending on the climate. ALB has a long list of host species; however, the beetle prefers hardwoods, including several maple species. Examples include: box elder (*Acer negundo*); Norway maple (*A. platanoides*); red maple (*A. rubrum*); silver maple (*A. saccharinum*); sugar maple (*A. saccharum*); buckeye (*Aesculus glabra*); horsechestnut (*A. hippocastanum*); birch (*Betula*); London planetree (*Platanus* × *acerifolia*); willow (*Salix*); and elm (*Ulmus*).

GYPSY MOTH

The gypsy moth (GM, *Lymantria dispar*) is native to Europe and first arrived in the United States in Massachusetts in 1869. This moth is a significant pest because its caterpillars have an appetite for more than 300 species of trees and shrubs. GM caterpillars defoliate trees, which makes the species vulnerable to diseases and other pests that can eventually kill the tree.

Close-up of male (darker brown) and female (whitish color) European gypsy moths.

Photograph courtesy of USDA APHIS (2019)

Male GMs are brown with a darker brown pattern on their wings and have a 1/2-inch wingspan. Females are slightly larger with a 2-inch wingspan and are nearly white with dark, saw-toothed patterns on their wings. Although they have wings, the female GM cannot fly.

The GMs prefer approximately 150 primary hosts but feed on more than 300 species of trees and shrubs. Some trees are found in these common genera: birch (*Betula*); cedar (*Juniperus*); larch (*Larix*); aspen, cottonwood, poplar (*Populus*); oak (*Quercus*); and willow (*Salix*).

SUDDEN OAK DEATH

Drooping tanoak shoot.

Photograph courtesy of Indiana Department of Natural Resources (2012)

The causal agent of sudden oak death (SOD), *Phytophthora ramorum* (also known as *Phytophthora* canker disease), was first identified in 1993 in Germany and the Netherlands on ornamental rhododendrons. In 2000, the disease was found in California. Since its discovery in North America, SOD has been confirmed in forests in California and Oregon and in nurseries in British Columbia, California, Oregon, and Washington. SOD has been potentially introduced into other states through exposed nursery stock. Through ongoing surveys, APHIS continues to define the extent of the pathogen's distribution in the United States and limit its artificial spread beyond infected areas through quarantine and a public education program.

Identification and symptoms of SOD may include large cankers on the trunk or main stem accompanied by browning of leaves. Tree death may occur within several months to several years after initial infection. Infected trees may also be infested with ambrosia beetle (*Monarthrum dentiger* and *M. scutellarer*), bark beetle (*Pseudopityophthorus pubipennis*), and sapwood rotting fungus (*Hypoxylon thouarsianum*). These organisms may contribute to the death of the tree. Infection on foliar hosts is indicated by dark grey to brown lesions with indistinct edges. These lesions can occur anywhere on the leaf blade, in vascular tissue, or on the petiole. Petiole lesions are often accompanied by stem lesions. Some hosts with leaf lesions defoliate and eventually show twig dieback.

This pathogen is devastating to oak (*Quercus*) but also affects several other plant species.

EMERALD ASH BORER

Close-up of the emerald ash borer.

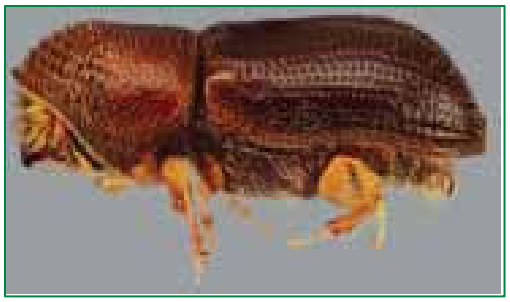
Photograph courtesy of USDA APHIS (2020)

Emerald ash borer *(EAB) (Agrilus planipennis*) is responsible for the death or decline of tens of millions of ash trees in 14 states in the American Midwest and Northeast. Native to Asia, EAB has been found in China, Japan, Korea, Mongolia, eastern Russia, and Taiwan. It likely arrived in the United States hidden in wood-packing materials commonly used to ship consumer goods, auto parts, and other products. The first official United States identification of EAB was in southeastern Michigan in 2002.

Adult beetles are slender and 1/2-inch long. Males are smaller than females. Color varies but adults are usually bronze or golden green overall with metallic, emerald-green wing covers. The top of the abdomen under the wings is metallic, purplish-red and can be seen when the wings are spread.

The EAB-preferred host tree species are in the genus ash (*Fraxinus*).

THOUSAND CANKERS DISEASE



Walnut twig beetle, side view.

Photograph courtesy of USDA Forest Service (2011)

A complex disease referred to as Thousand cankers disease (TCD) was first observed in Colorado in 2008 and is now thought to have existed in Colorado as early as 2003. TCD is considered to be native to the United States and is attributed to numerous cankers developing in association with insect galleries.

TCD results from the combined activity of the *Geosmithia morbida* fungus and the walnut twig beetle (WTB, *Pityophthorus juglandis*). The WTB has expanded both its geographical and host range over the past two decades, and coupled with the *Geosmithia morbida* fungus, *Juglans* (walnut) mortality has manifested in Arizona, California, Colorado, Idaho, New Mexico, Oregon, Utah, and Washington. In July 2010, TCD was reported in Knoxville, Tennessee. The infestation is believed to be at least 10 years old and was previously attributed to drought stress. This is the first report east of the 100th meridian, raising concerns that large native populations of black walnut (*J. nigra*) in the eastern United States may suffer severe decline and mortality.

The tree species preferred as hosts for TCD are walnut.

HEMLOCK WOOLY ADELGID

Hemlock woolly adelgids on a branch.

Photograph courtesy of Connecticut Agricultural Experiment Station, Bugwood.org (2011)

The hemlock woolly adelgid (HWA, *Adelges tsugae*) was first described in western North America in 1924 and first reported in the eastern United States in 1951 near Richmond, Virginia.

In their native range, populations of HWA cause little damage to the hemlock trees, as they feed on natural enemies and possible tree resistance has evolved with this insect. In eastern North America and in the absence of natural control elements, HWA attacks both eastern or Canadian hemlock (*Tsuga canadensis*) and Carolina hemlock (*T. caroliniana*), often damaging and killing them within a few years of becoming infested.

The HWA is now established from northeastern Georgia to southeastern Maine and as far west as eastern Kentucky and Tennessee.

REFERENCES

Connecticut Agricultural Experiment Station, Bugwood.org. 2011. *Hemlock woolly adelgid* (Adelges tsugae). Retrieved from https://www.invasive.org/browse/detail.cfm?imgnum=3225077

Cranshaw, W. 2004. *Garden Insects of North America: The Ultimate Guide to Backyard Bugs* (pp. 114, 118). Princeton University Press.

DiOrio, A. 2011. *Volunteers Needed for Asian Longhorned Beetle Survey*. New Bedford Guide. Retrieved from http://www.newbedfordguide.com/volunteers-needed-for-asian- longhorned-beetle-survey/2011/03/30

Indiana Department of Natural Resources. 2019. *Sudden Oak Death*. Entomology and Plant Pathology. Retrieved from http://www.in.gov/dnr/entomolo/4532.htm

Miller, F. 2016. *2016 Illinois Forest Health Highlights*. The Morton Arboretum. Retrieved from http://www.mortonarb.org/files/2016-FHH-Final-Version-12-28-16-Submitted.pdf

University of Georgia. *Invasive Species*. Center for Invasive Species and Ecosystem Health. Retrieved from www.bugwood.org

USDA Animal and Plant Health Inspection Service. 2019. *Hungry Pests: Your Move Gypsy Moth Free.* Retrieved from https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/thethreat/gypsy-moth-free

USDA Animal and Plant Health Inspection Service. 2019. *Pest Alert: Spotted Lantern Fly* (Lycorma delicatula). Retrieved from https://www.aphis.usda.gov/publications/plant_health/alert-spotted-lanternfly.pdf

USDA Animal and Plant Health Inspection Service. 2020. *Plant Pests and Diseases: Emerald Ash Borer.* Retrieved from https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases/emerald-ash-borer/emerald-ash-borer

USDA Forest Service. 2013. *Pest Alert: Thousand Cankers Disease*. Northeastern Area State and Private Forestry, NA–PR–02–10. Retrieved from https://www.fs.usda.gov/naspf/sites/default/files/thousand_cankers_disease_print_res.pdf

APPENDIX C
SUGGESTED TREE SPECIES

Proper landscaping and tree planting are critical components of the atmosphere, livability, and ecological quality of a community's urban forest. The tree species listed below have been evaluated for factors such as size, disease and pest resistance, seed or fruit set, and availability. The following list is offered to assist all relevant community personnel in selecting appropriate tree species. These trees have been selected because of their aesthetic and functional characteristics and their ability to thrive in the soil and climate conditions throughout Zone 6 on the USDA Plant Hardiness Zone Map.

DECIDUOUS TREES

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer rubrum	red maple	Red Sunset®
Acer saccharum	sugar maple	'Legacy'
*Aesculus flava**	yellow buckeye	
*Betula alleghaniensis**	yellow birch	
*Betula lenta**	sweet birch	
Betula nigra	river birch	Heritage®
Carpinus betulus	European hornbeam	'Franz Fontaine'
*Carya illinoensis**	pecan	
*Carya laciniata**	shellbark hickory	
*Carya ovata**	shagbark hickory	
*Castanea mollissima**	Chinese chestnut	
Celtis laevigata	sugar hackberry	
Celtis occidentalis	common hackberry	'Prairie Pride'
Cercidiphyllum japonicum	katsuratree	'Aureum'
*Diospyros virginiana**	common persimmon	
*Fagus grandifolia**	American beech	
*Fagus sylvatica**	European beech	(Numerous exist)
Ginkgo biloba	ginkgo	(Choose male trees only)
Gleditsia triacanthos inermis	thornless honeylocust	'Shademaster'
Gymnocladus dioica	Kentucky coffeetree	Prairie Titan®
*Juglans nigra**	black walnut	
*Larix decidua**	European larch	
Liquidambar styraciflua	American sweetgum	'Rotundiloba'
*Liriodendron tulipifera**	tuliptree	'Fastigiatum'
*Magnolia acuminata**	cucumbertree magnolia	(Numerous exist)
*Magnolia macrophylla**	bigleaf magnolia	
Metasequoia glyptostroboides	dawn redwood	'Emerald Feathers'
Nyssa sylvatica	black tupelo	
*Platanus occidentalis**	American sycamore	
Platanus × acerifolia	London planetree	'Yarwood'
Quercus alba	white oak	

Large Trees: Greater than 45 Feet in Height at Maturity (Continued)

Scientific Name	Common Name	Cultivar
Quercus bicolor	swamp white oak	
Quercus coccinea	scarlet oak	
Quercus lyrata	overcup oak	
Quercus macrocarpa	bur oak	
Quercus montana	chestnut oak	
Quercus muehlenbergii	chinkapin oak	
Quercus palustris	pin oak	
Quercus imbricaria	shingle oak	
Quercus phellos	willow oak	
Quercus robur	English oak	Heritage®
Quercus rubra	northern red oak	'Splendens'
Quercus shumardii	Shumard oak	
Styphnolobium japonicum	Japanese pagodatree	'Regent'
Taxodium distichum	common baldcypress	'Shawnee Brave'
Tilia americana	American linden	'Redmond'
Tilia cordata	littleleaf linden	'Greenspire'
Tilia × euchlora	Crimean linden	
Tilia tomentosa	silver linden	'Sterling'
Ulmus parvifolia	Chinese elm	Allée®
Zelkova serrata	Japanese zelkova	'Green Vase'

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Aesculus × carnea	red horsechestnut	
Alnus cordata	Italian alder	
*Asimina triloba**	pawpaw	
Cladrastis kentukea	American yellowwood	'Rosea'
Corylus colurna	Turkish filbert	
Eucommia ulmoides	hardy rubber tree	
Koelreuteria paniculata	goldenraintree	
Ostrya virginiana	American hophornbeam	
Parrotia persica	Persian parrotia	'Vanessa'
Phellodendron amurense	amur corktree	'Macho'
Pistacia chinensis	Chinese pistache	
Prunus maackii	amur chokecherry	'Amber Beauty'
Prunus sargentii	Sargent cherry	
*Pterocarya fraxinifolia**	Caucasian wingnut	
Quercus acutissima	sawtooth oak	
Quercus cerris	European turkey oak	
*Sassafras albidum**	sassafras	

Small Trees: 15 to 30 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer buergerianum	trident maple	Streetwise®
Acer campestre	hedge maple	Queen Elizabeth™
Acer cappadocicum	coliseum maple	'Aureum'
Acer ginnala	amur maple	Red Rhapsody™
Acer griseum	paperbark maple	
Acer nigrum	black maple	
*Acer pensylvanicum**	striped maple	
Acer triflorum	three-flower maple	
*Aesculus pavia**	red buckeye	
Amelanchier arborea	downy serviceberry	(Numerous exist)
Amelanchier laevis	Allegheny serviceberry	
*Carpinus caroliniana**	American hornbeam	
Cercis canadensis	eastern redbud	'Forest Pansy'
Chionanthus virginicus	white fringetree	
Cornus alternifolia	pagoda dogwood	
Cornus kousa	Kousa dogwood	(Numerous exist)
Cornus mas	corneliancherry dogwood	'Spring Sun'
Corylus avellana	European filbert	'Contorta'
*Cotinus coggygria**	common smoketree	'Flame'
*Cotinus obovata**	American smoketree	
*Crataegus phaenopyrum**	Washington hawthorn	Princeton Sentry™
Crataegus viridis	green hawthorn	'Winter King'
*Franklinia alatamaha**	Franklinia	
*Halesia tetraptera**	Carolina silverbell	'Arnold Pink'
Laburnum × watereri	goldenchain tree	
Maackia amurensis	amur maackia	
*Magnolia × soulangiana**	saucer magnolia	'Alexandrina'
*Magnolia stellata**	star magnolia	'Centennial'
*Magnolia tripetala**	umbrella magnolia	
*Magnolia virginiana**	sweetbay magnolia	Moonglow®
Malus spp.	flowering crabapple	(Disease resistant only)
Oxydendrum arboreum	sourwood	'Mt. Charm'
Prunus subhirtella	Higan cherry	'Pendula'
Prunus virginiana	common chokecherry	'Schubert'
*Staphylea trifolia**	American bladdernut	
Stewartia ovata	mountain stewartia	
*Styrax japonicus**	Japanese snowbell	'Emerald Pagoda'
Syringa reticulata	Japanese tree lilac	'Ivory Silk'

Note: * denotes species that are **not** recommended for use as street trees.

CONIFEROUS AND EVERGREEN TREES

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Abies balsamea	balsam fir	
Abies concolor	white fir	'Violacea'
Cedrus libani	cedar-of-Lebanon	
Chamaecyparis nootkatensis	Nootka falsecypress	'Pendula'
Cryptomeria japonica	Japanese cryptomeria	'Sekkan-sugi'
× *Cupressocyparis leylandii*	Leyland cypress	
Ilex opaca	American holly	
Picea omorika	Serbian spruce	
Picea orientalis	Oriental spruce	
Pinus densiflora	Japanese red pine	
Pinus strobus	eastern white pine	
Pinus sylvestris	Scotch pine	
Pinus taeda	loblolly pine	
Pinus virginiana	Virginia pine	
Psedotsuga menziesii	Douglas-fir	
Thuja plicata	western arborvitae	(Numerous exist)
Tsuga canadensis	eastern hemlock	

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Chamaecyparis thyoides	atlantic whitecedar	(Numerous exist)
Juniperus virginiana	eastern redcedar	
Pinus bungeana	lacebark pine	
Pinus flexilis	limber pine	
Pinus parviflora	Japanese white pine	
Thuja occidentalis	eastern arborvitae	(Numerous exist)

Small Trees: 15 to 30 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Ilex × *attenuata*	Foster's holly	
Pinus aristata	bristlecone pine	
Pinus mugo mugo	mugo pine	

Dirr's Hardy Trees and Shrubs (Dirr 2013) and *Manual of Woody Landscape Plants (5th Edition)* (Dirr 1988) were consulted to compile this suggested species list. Cultivar selections are recommendations only and are based on DRG's experience. Tree availability will vary based on availability in the nursery trade.