DAVEY Resource Group

May 2024

STANDARD INVENTORY ANALYSIS AND MANAGEMENT PLAN

City of Liberty, Missouri

Prepared for:

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Table of Contents

TABLES

FIGURES

APPENDICES

ACKNOWLEDGMENTS

This project supports the City of Liberty'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.

Liberty is thankful for the grant funding it received from the Missouri Department of Conservation (MDC) in cooperation with U.S. Forest Service through its Community Forestry Cost Share Program. The Cost Share Program is designed to encourage communities to create and support sustainable urban forestry programs throughout the United States.

Liberty also recognizes the support of the following key partners:

Mayor Greg Canuteson, Councilman Shelton Ponder, Councilman Harold A. Phillips, Councilman Adam Travis, Councilwoman Kelley Wrenn Pozel, Councilman Jeff Watt, Councilman Kevin Graham, Councilman Mike Hagan, Councilman Gene Gentrup, and The Tree Board of Liberty.

Notice of Disclaimer: Inventory data provided by Davey Resource Group, Inc. "DRG" are based on visual recording at the time of inspection. Visual records do not include individual testing or analysis, nor do they include aerial or subterranean inspection. DRG is not responsible for the discovery or identification of hidden or otherwise non-observable hazards. Records may not remain accurate after inspection due to the variable deterioration of inventoried material. DRG provides no warranty with respect to the fitness of the urban forest for any use or purpose whatsoever. Clients may choose to accept or disregard DRG's recommendations or to seek additional advice. Important: know and understand that visual inspection is confined to the designated subject tree(s) and that the inspections for this project are performed in the interest of facts of the tree(s) without prejudice to or for any other service or any interested party.

Five-Year Tree Resource Maintenance Schedule

EXECUTIVE SUMMARY

The City of Liberty *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 the Liberty in April 2024, 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 functions of Liberty's inventoried tree population provide benefits with an estimated total value of $595,376.00 annually. The City's proposed annual tree maintenance budget is $281,660.00, making Liberty's return on investment over 100% annually. The replacement value of Liberty's inventoried tree population throughout its trees' lifetimes are worth an estimated $11,561,344.67. 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 Year 1 of the five-year schedule, as shown in Figure 1. After high priority work has been completed, budgets are expected to decrease and stabilize as tree management transitions from reactive to proactive maintenance. This also reduces the number of new elevated risk trees over time by preventing deteriorating conditions of trees with initial minor defects.

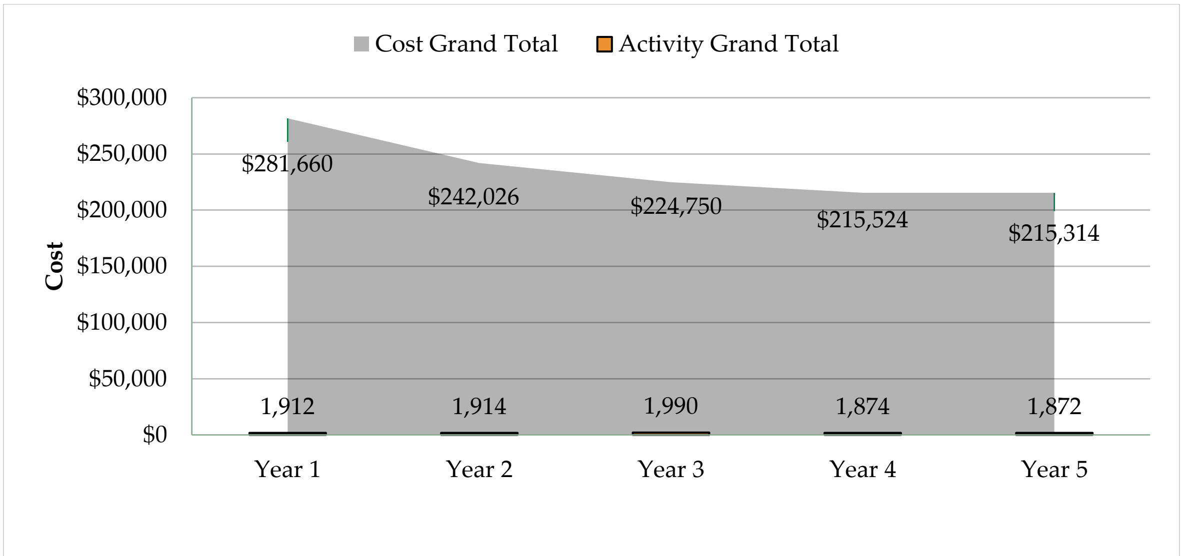


Figure 1. Five-year budget projections.

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 = 297 trees
High Priority = 0 trees
Moderate Priority = 7 trees
Low Priority = 290 trees
Stumps = 223

Priority Pruning

Priority pruning removes defects such as Dead and Dying Parts or Broken and/or Hanging Branches. Pruning the defected branch(es) can lower risk associated with the tree while promoting healthy growth.

Total = 42 trees
High Priority = 5 trees
Moderate Priority = 37 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 = 4,705 trees

Number in cycle each year = at least 941 trees

Young Tree Training Cycle

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

Total = 1,210 trees
Number in cycle each year = at least 242 trees

Tree Planting

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

Total replacement plantings = 180 trees/year
Total new plantings = 24 trees/year

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 = 6,440 existing trees + 390 new trees
Number in drive-by assessment cycle each year = near 1,366 trees
Number in walk-by assessment cycle each year = near 700 trees

INTRODUCTION

The City of Liberty is home to 30,161 residents (U.S. Census Bureau 2020, retrieved from: https://www.census.gov/quickfacts/fact/table/libertycitymissouri/PST045223 benefitting from public trees in their community. The City's public works and parks programs manage all trees, stumps, and planting sites along the street rights-of-way (ROW) and throughout public parks, respectively. Liberty's staff have shown continued commitment to developing a thriving public tree resource.

Urban forestry program budgets are funded by the City's General Fund. Liberty has a tree board, has a tree ordinance, spends more than $2 per capita on tree maintenance, celebrates Arbor Day, and has been a Tree City USA community for 20 years.

Past urban forestry projects have demonstrated Liberty's dedicated commitment to sustaining the public tree resource with higher levels of tree care, earning the city three Tree City USA Growth Awards. Liberty has three ISA Certified Arborists and 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.

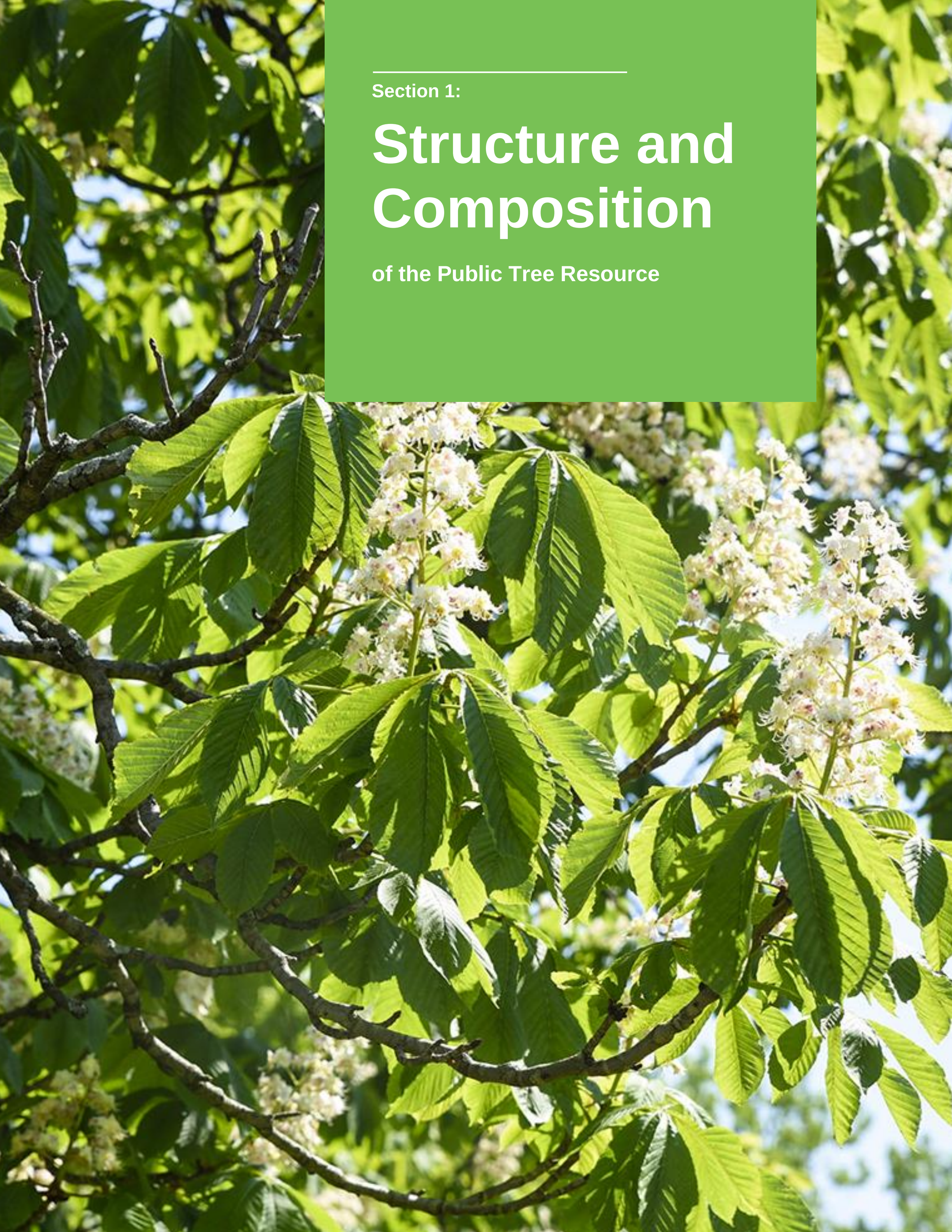
In April–May of 2024, Liberty worked with DRG to inventory its public trees and develop this management plan. Consisting of three sections, this plan considers the diversity, distribution, and condition of the inventoried tree population and provides a prioritized system for managing the City's public 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 five-year period.

Section 1:

Structure and Composition

of the Public Tree Resource



SECTION 1: STRUCTURE AND COMPOSITION OF THE PUBLIC TREE RESOURCE

In April 2024, DRG arborists collected site data on trees and stumps along the street ROW and in public parks for a tree inventory contracted by the city of Liberty. Of the total 6,440 sites inventoried, 47% were collected along the street ROW, and the remaining 53% were collected in parks. Figure 2 breaks down the total sites inventoried by type for each location, although planting sites were not collected in parks. See Appendix A for details about DRG's methodology for collecting site data.

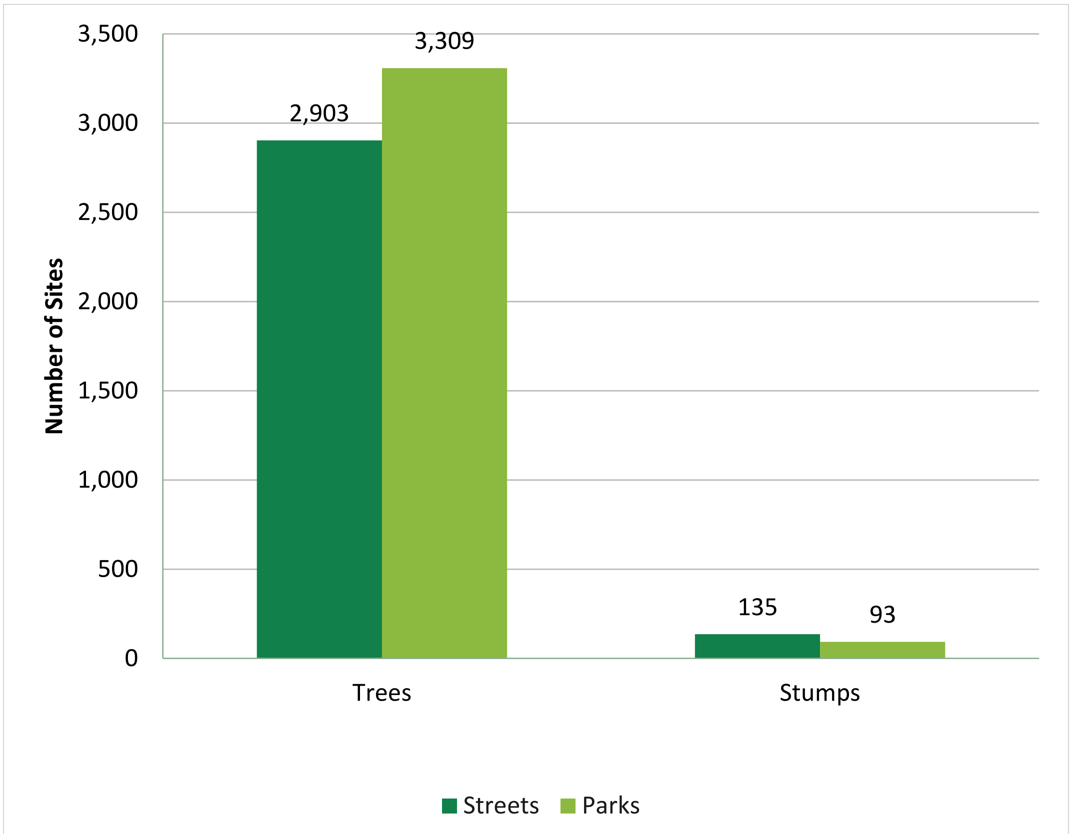


Figure 2. Number of inventoried sites by location and type.

The city of Liberty designated two project areas public street right-of-way, public parks, and public facilities for DRG to collect site data for the tree inventory.

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 Liberty's distribution of the most abundant tree species inventoried compared to the 10% threshold. Red maple (*Acer rubrum)* and northern hackberry (*Celtis occidentalis*) are the most abundant species, and while 11% and 14% of the population exceed the 10% threshold, it is not immediately concerning from this data alone.

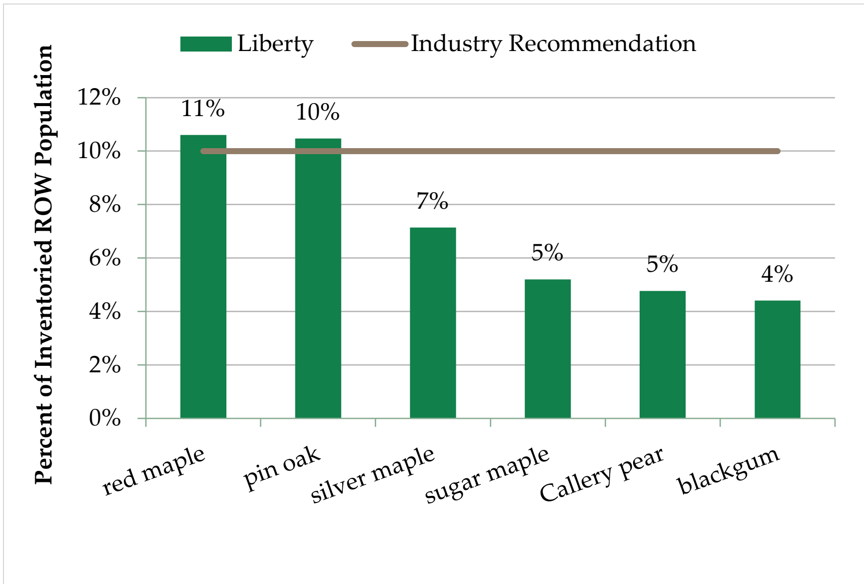


Figure 3. Species distribution of inventoried street trees.

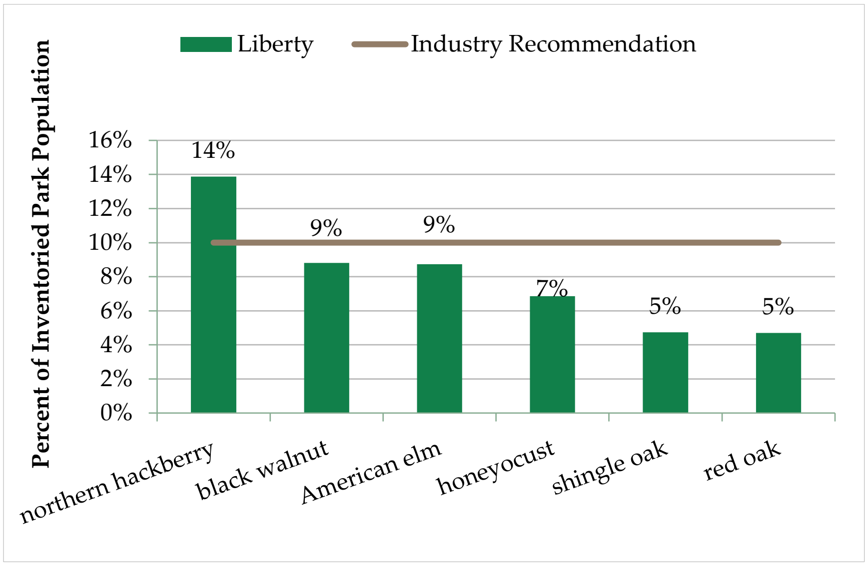


Figure 4. Species distribution of inventoried park trees.

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 and Northeastern 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.

However, Figure 5 shows the City's distribution of the most abundant tree genera inventoried, and maple (*Acer*) is notably higher than the 20% threshold. This means that red maple could be concerning after all, because maple comprise 26% of the inventoried population. For this reason, the city of Liberty should limit the planting of red maple or any other maple species until this distribution becomes more ideal.

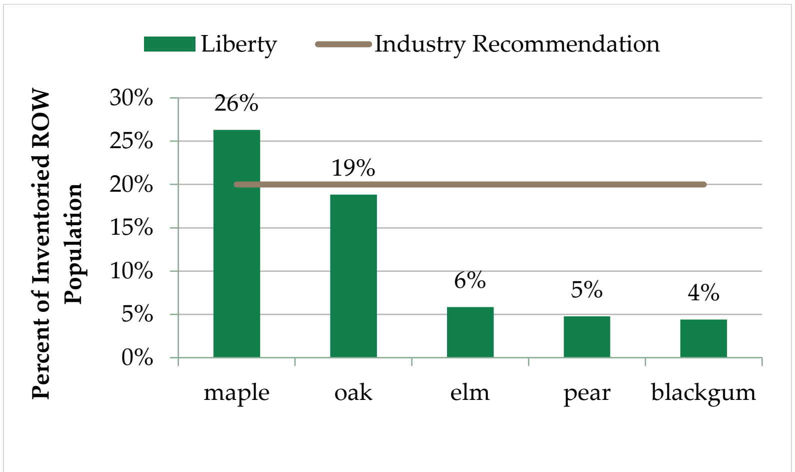


Figure 5. Genus distribution of inventoried street trees.

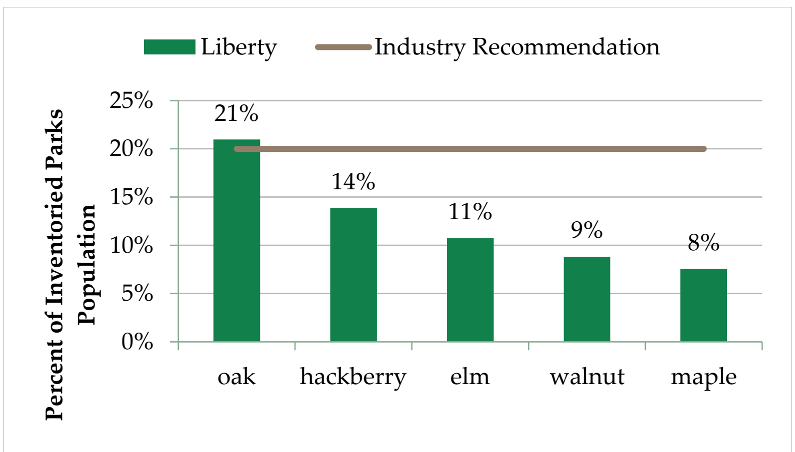


Figure 6. Genus distribution of inventoried park trees.

Red maple tree with a frost crack, in which maple are particularly susceptible. Limiting the planting of maple can also reduce this type of associated maintenance.

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.

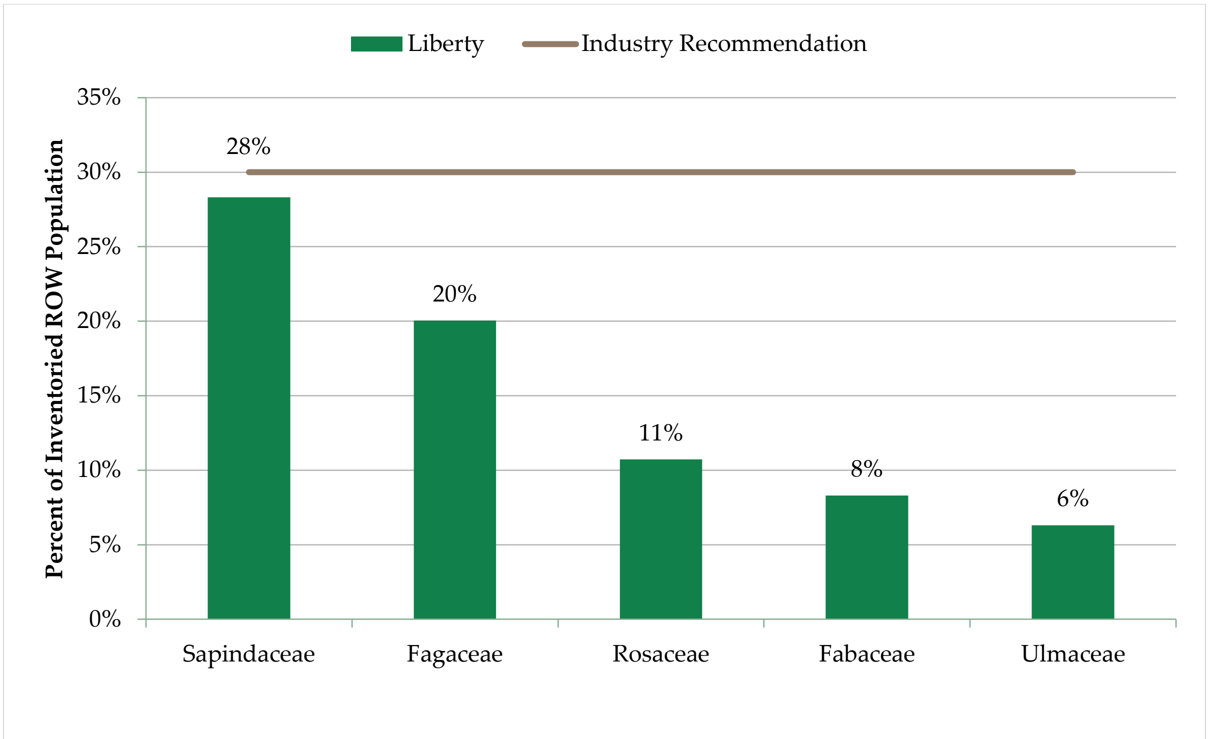


Figure 7. Family distribution of inventoried street trees.

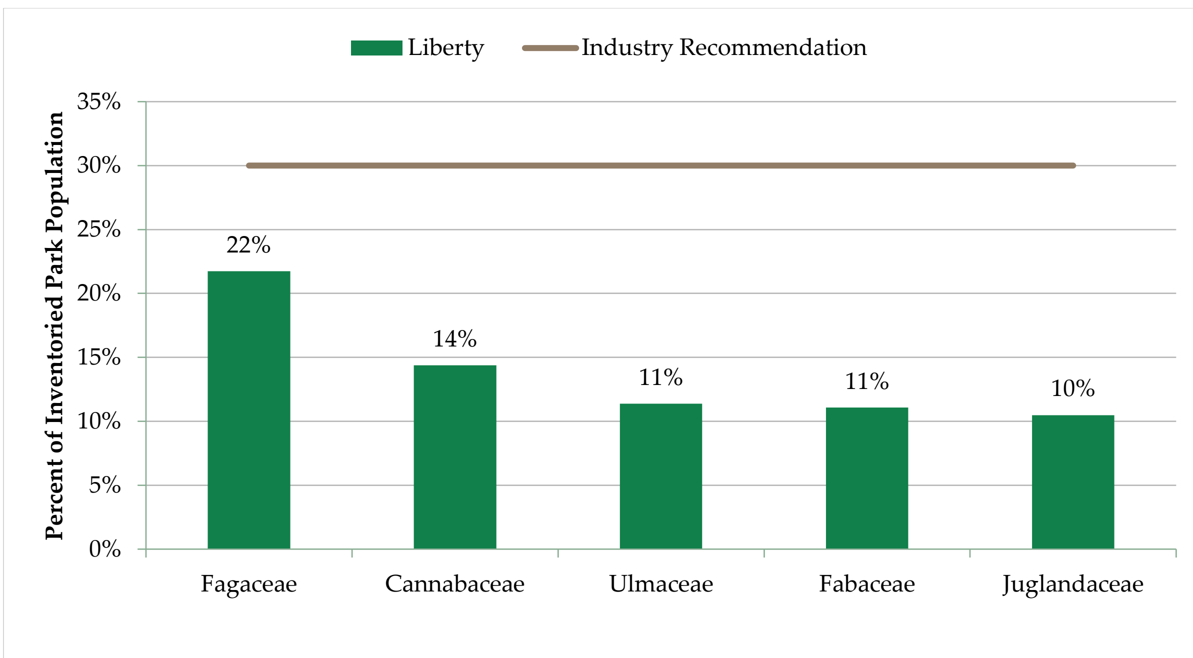


Figure 8. Family distribution of inventoried park trees.

Figure 8 shows the City's distribution of the most abundant tree families inventoried compared to the 30% threshold. While *Fagaceae* (22%) is fairly far from the threshold, *Sapindaceae* (28%) is the only family composing a greater proportion of the inventoried population, which is almost exceeding the threshold.

PEST SUSCEPTIBILITY

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

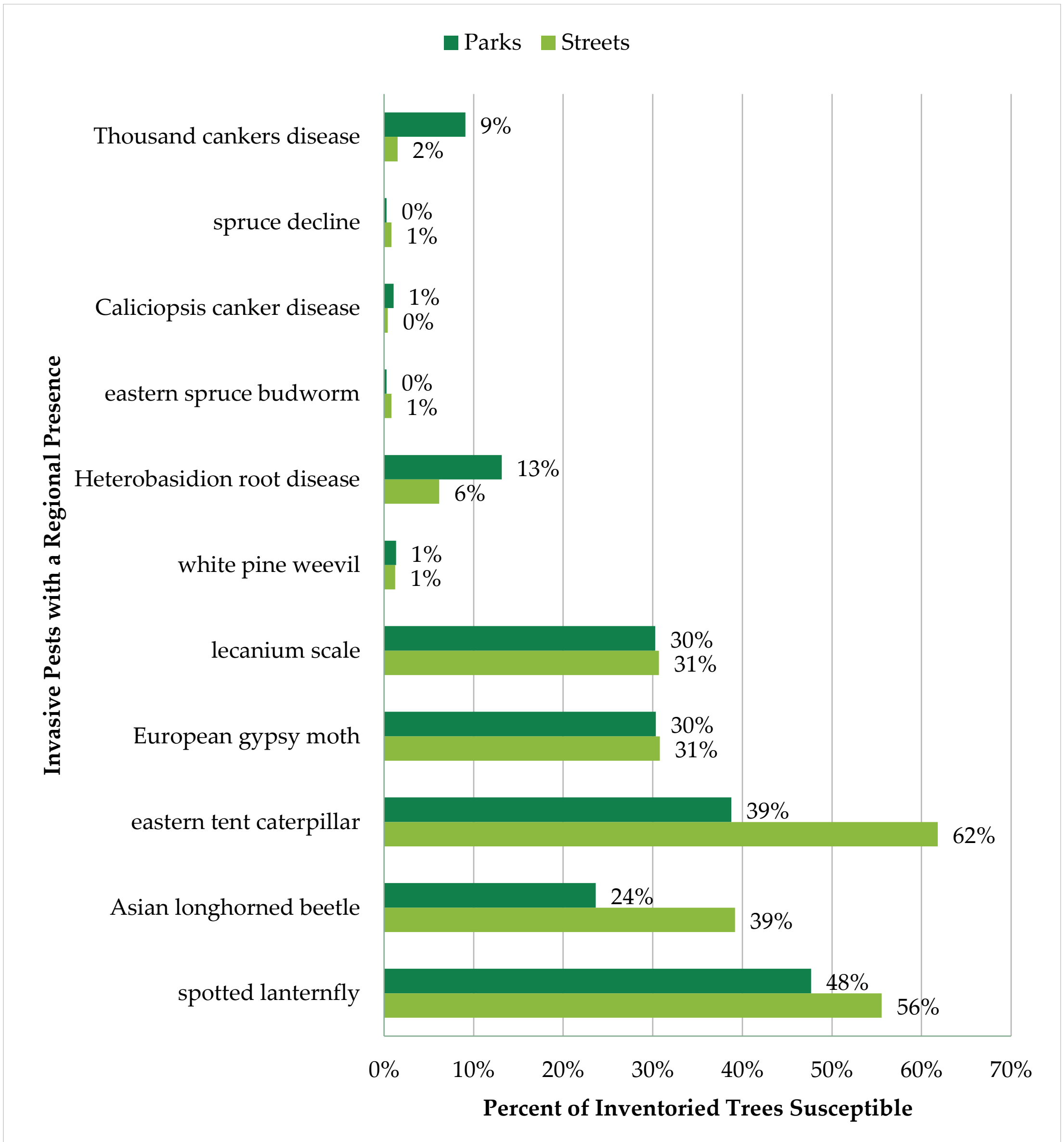


Figure 9. Tree resource susceptibility to invasive pests that have a regional presence.

Figure 9 shows the percent of inventoried trees susceptible to some of the known pests in and around Liberty. It is important to remember that this figure only represents data collected during the inventory. Many more trees throughout Liberty, especially those on private property, may be susceptible to hosting these invasive pests. As an example, spotted lantern fly (SLF, *Lycorma delicatula*) and Asian longhorned beetle (ALB, *Anoplophora glabripennis*) are known threats to a large percentage of the inventoried park tree resource, 39% and 56%, respectively.

Pest Susceptibility Recommendations

The overabundance of maple in Liberty'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. Increasing species diversity is a critical goal that will help Liberty'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 *Fagaceae* family to prevent it from approaching 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, Liberty 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, Critical, 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 were recorded in Good condition, 53% and 55%, respectively. Based on these data, the general health of the inventoried tree population is rated as Good. Liberty has a low percentage of Dead trees and trees in Critical condition.

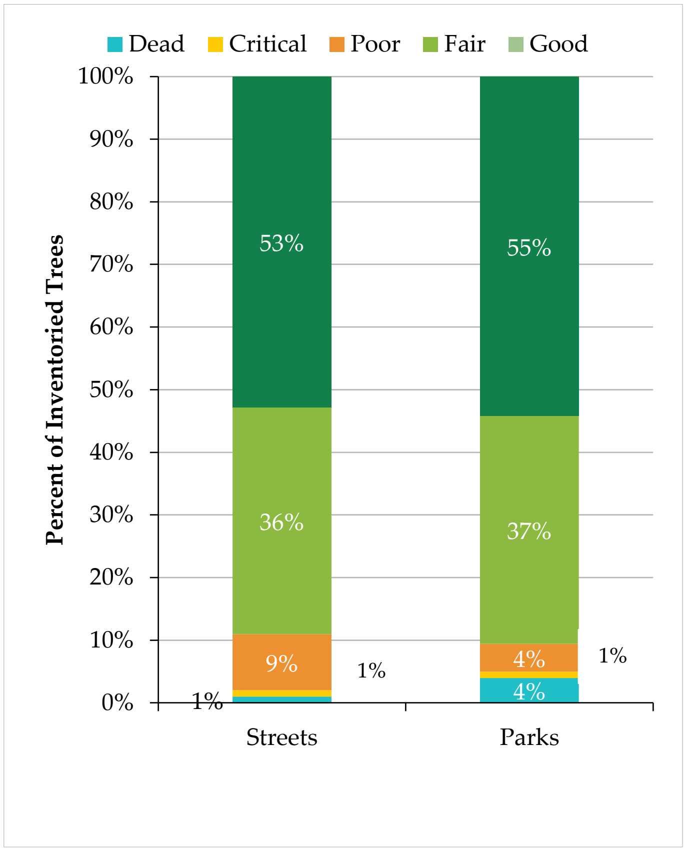


Figure 10. Condition of inventoried trees.

Condition Recommendations

- Dead trees and trees in Critical 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 Liberty'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.

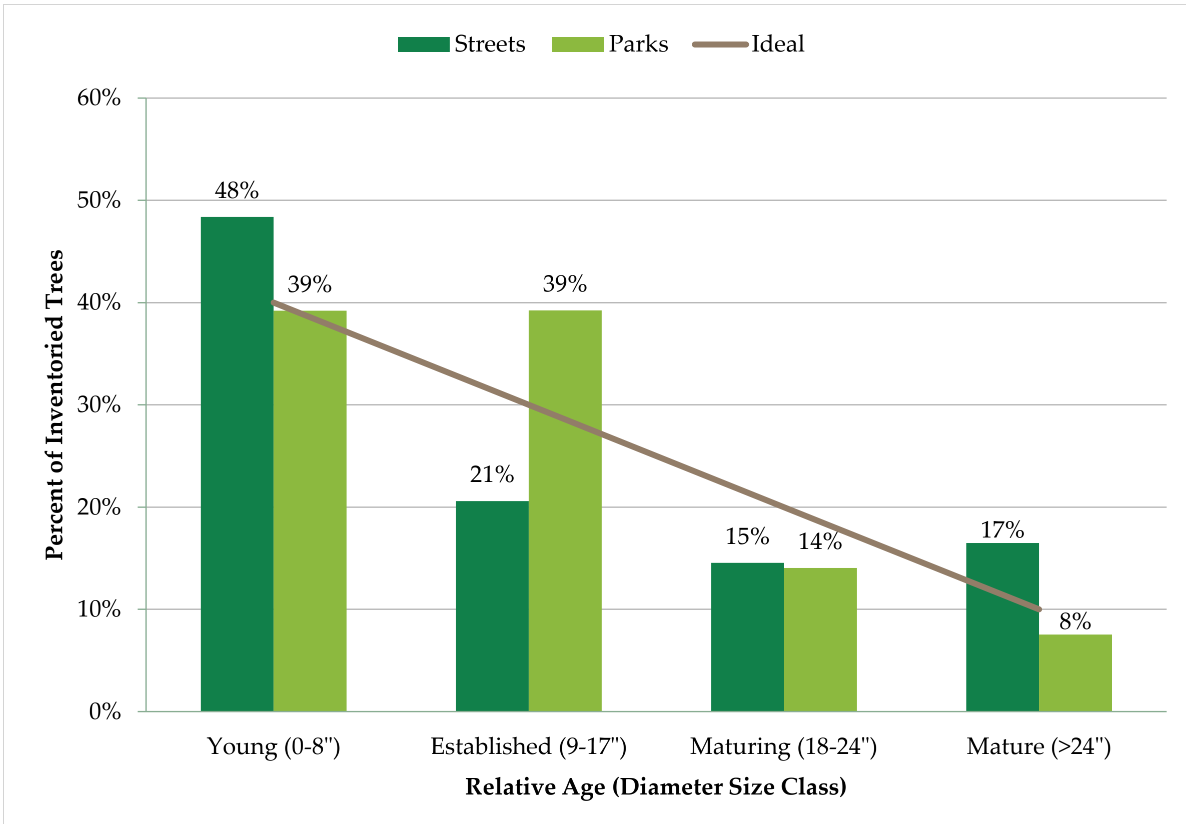


Figure 11. Relative age distribution of inventoried trees.

Figure 11 compares Liberty's relative age distribution of the inventoried tree population to the ideal. The City's inventoried tree resource is trending towards the ideal; however, young street trees exceed the ideal by 8%, while maturing trees fall short by 5%.

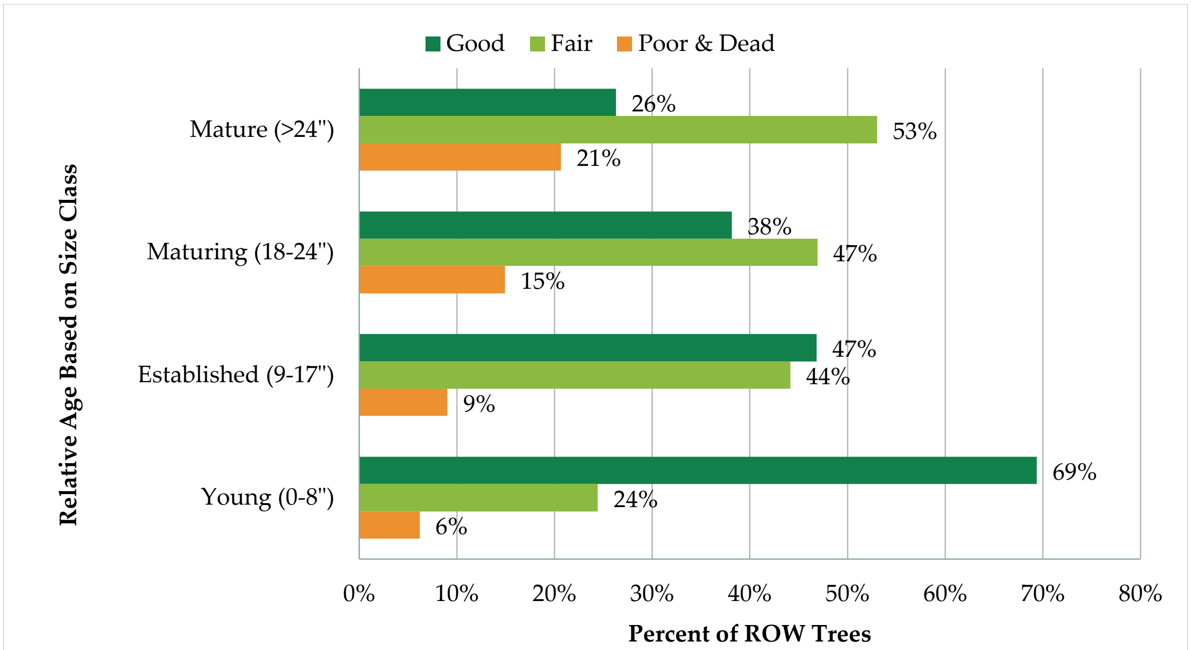


Figure 12. Condition of inventoried street trees by relative age class.

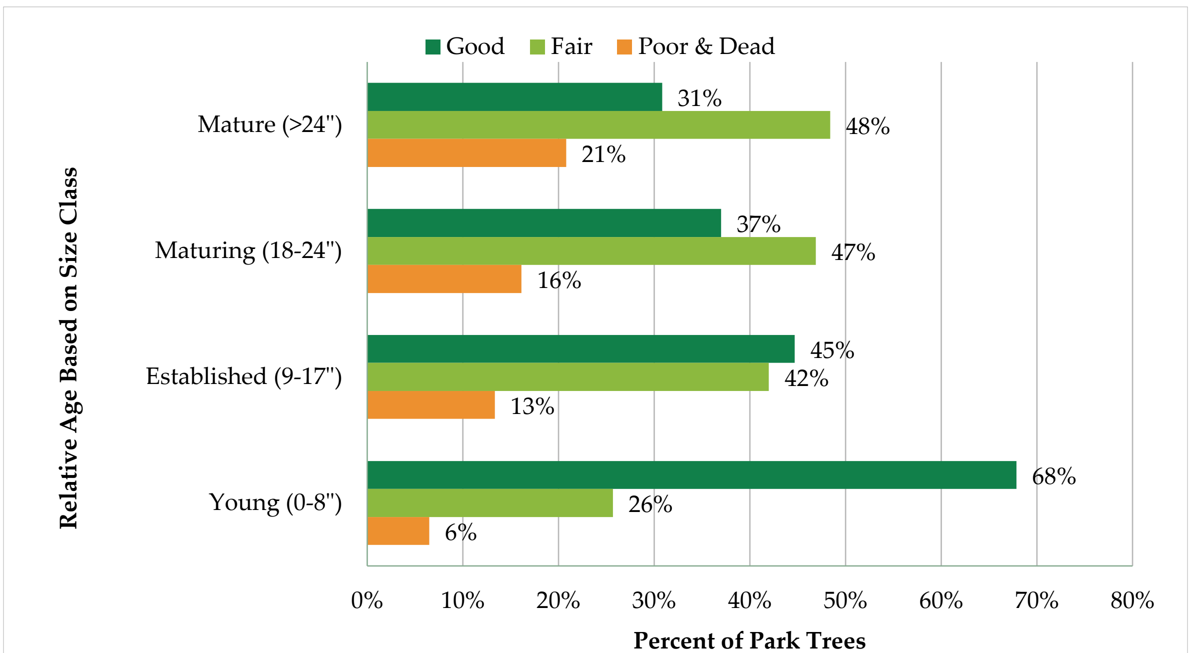


Figure 13. Condition of inventoried park trees by relative age class.

Figure 12 cross analyzes the condition of the inventoried tree resource with its relative age distribution, providing insight into the inventoried population's stability. 53% (street) and 48% (parks) of mature trees and 47% (both) 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. 91% (street) and 97% (parks) of established trees and 93% (street) and 94% (parks) 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.

Relative Age Recommendations

While Liberty has a slight excess of young trees and a slight shortage of maturing trees, the City has a low percentage of trees in Poor or worse condition, indicating that young trees have the potential of reaching maturity if they are well maintained. DRG recommends that Liberty implement a robust maintenance program, 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

Table 1. Tree defect categories recorded during the inventory.

Defect	Street Trees	Percent of Street Trees	Park Trees	Percent of Park Trees
Broken and/or hanging branches	30	1%	26	1%
Cracks	4	0%	10	0%
Dead and dying parts	301	10%	604	18%
Missing or decayed wood	146	5%	223	7%
None	1,728	60%	2,038	62%
Other	151	5%	66	2%
Root problem	11	0%	1	0%
Tree architecture	170	6%	86	3%
Weakly attached branches and codominant stems	362	12%	255	8%
Total	**2,903**	**100%**	**3,309**	**100%**

The two most frequently recorded defect categories were Dead & Dying Parts and Weakly Attached Branches/Codominant Stems at 10% (street) and 18% (parks), and 12% (street) and 8% (parks) of inventoried trees, respectively (Table 1). Of the 901 (both) trees with Dead & Dying Parts, 106 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 2024 Liberty 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.

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. Tree conflicts with overhead infrastructure recorded during the inventory.

Overhead Utilities	Street Trees	Percent of Street Trees	Park Trees	Percent of Park Trees
Present and Conflicting	213	7%	69	2%
Present and Not Conflicting	156	5%	39	1%
Not Present	2,669	88%	3,294	97%
Total	**3,038**	**100%**	**3,402**	**100%**

Table 2 shows 213 street trees recorded with an overhead utility conflict. There were 156 street trees with utilities directly above, or passing through, the tree canopy but not in immediate conflict.

There were 108 park trees with utilities directly above, or passing through, the tree canopy. Of those trees, 2% were in direct conflict.

Infrastructure Recommendations

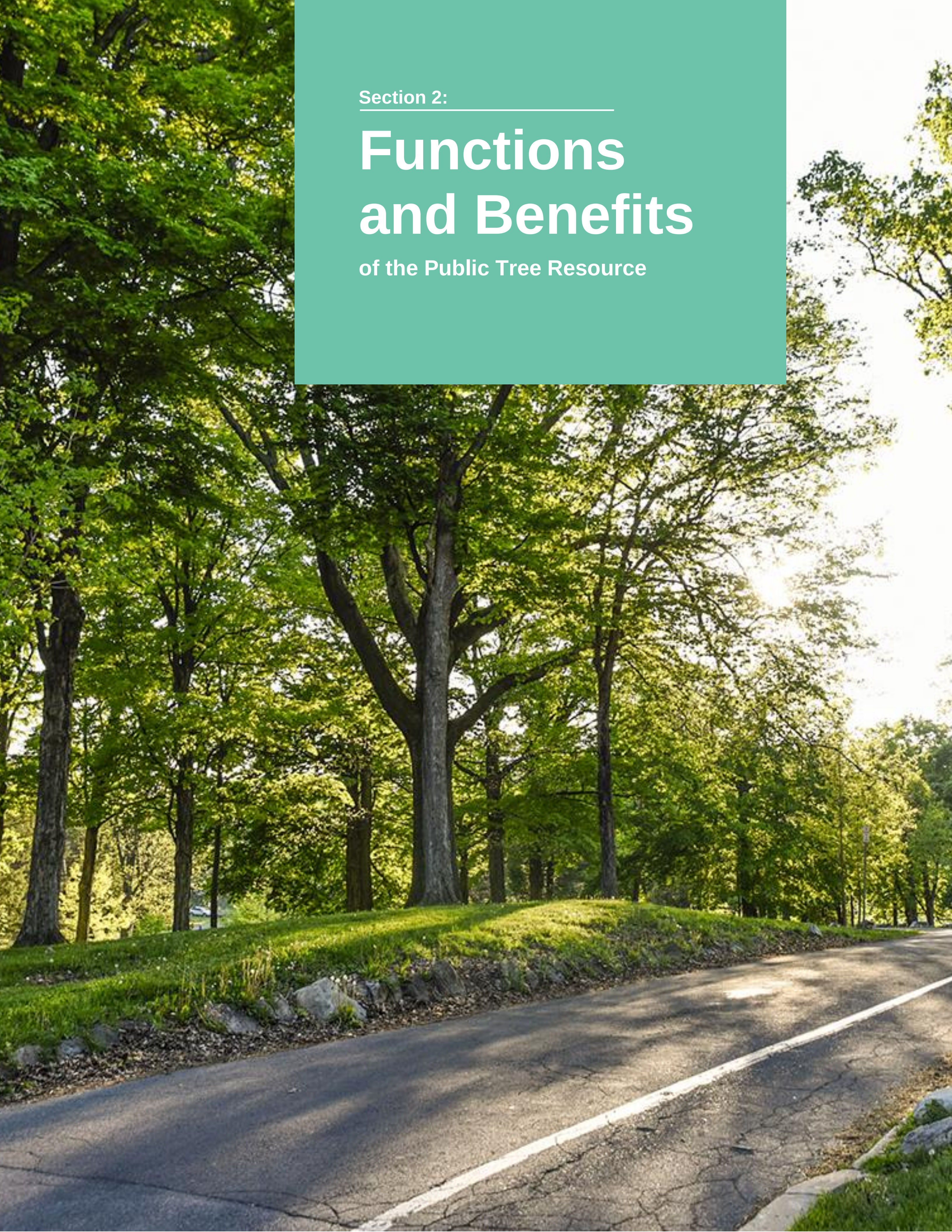
Planting only small-growing trees within 20 feet of overhead utilities, medium-sized trees within 20–40 feet, and large-growing trees outside 40 feet will help improve future tree conditions, minimize future utility line conflicts, and reduce the costs of maintaining trees under utility lines.

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 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. Using advanced analytics, such as i-Tree Eco and other models in the i-Tree software suite, understanding the importance of trees to a community continues to expand 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 ECO ANALYSIS

i-Tree Eco 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 Eco analysis of the city of Liberty'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 proposed annual tree maintenance budget is $281,660.00, making Liberty's return on investment almost over 100% annually.

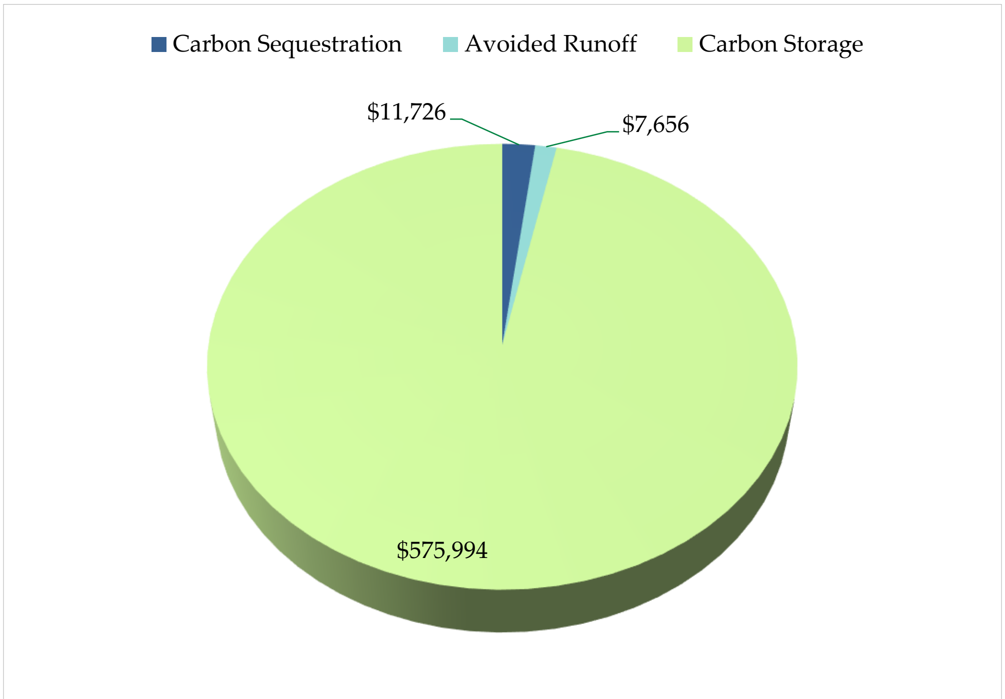


Figure 14. Estimated value of the benefits provided by inventoried trees.

Urban environments have unique challenges that make the estimated $595,376.00 of functional benefits provided by Liberty's inventoried tree population an essential asset to the City (Figure 14). Compared to rural landscapes, urban landscapes are characterized by high emissions in a relatively small area, valuing the 3,377 tons of airborne pollutants removed by Liberty's tree resource at an estimated $575,994.00. Avoiding stormwater runoff reduces the risk of flooding and combined sewer overflow, both of which impact people, property, and the environment, valuing the 856,769 gals. of runoff avoided with Liberty's tree resource at an estimated $7,656.00. Carbon dioxide (CO_2) also impacts people, property, and the environment as the primary greenhouse gas driving climate change, valuing the 69 tons sequestered by Liberty's tree resource at an estimated $11,726.00.

The replacement value of the City's inventoried tree population is estimated to be $11,561,344.67. In Liberty, only ten 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 D 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 Eco model estimates both the carbon sequestered each year and total carbon stored. Liberty's inventoried trees have stored 3,377 tons of carbon, which is all the carbon each tree has amassed throughout their lifetimes and is valued at $575,994.00. Silver maple (*Acer sacharinum*)] and northern pin oak (*Quercus palustris*) store the most carbon: 458.9 tons and 533.2 tons, respectively. Both species also sequester a large volume of carbon: 5.2 tons per year and 10.5 tons per year, respectively.

Table 3. Summary of benefits provided by inventoried trees ranked by species importance value.

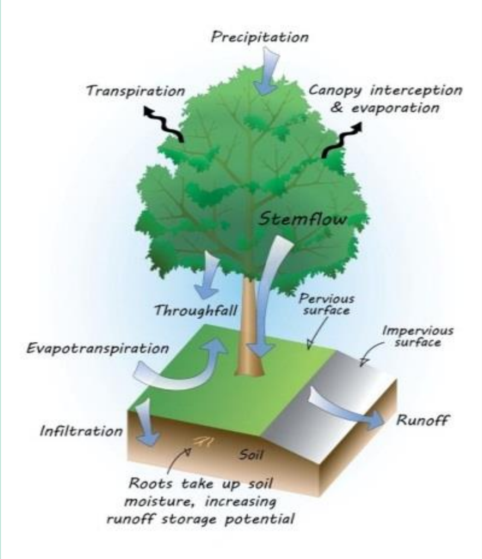
Most Common Trees Inventoried		Count	Percent of Total	Benefits Provided by Street Trees			
				CO_2 Stored	CO_2 Sequestered	Avoided Runoff	Structural Value
Common Name	**Botanical Name**		%	tons	tons/year	gal/year	Dollars
northern hackberry	*Celtis occidentalis*	513	8.3%	39.5	1.1	90,185	$1,073,231
red maple	*Acer rubrum*	428	6.9%	139.4	5.0	33,572	$567,129
pin oak	*Quercus palustris*	402	6.5%	533.2	10.5	192,698	$2,632,842
black walnut	*Juglans nigra*	344	5.5%	216.2	6.7	59,988	$667,325
American elm	*Ulmus americana*	308	5.0%	51.3	1.8	14,153	$162,431
red oak	*Quercus rubra*	288	4.6%	118.2	2.9	34,208	$514,903
silver maple	*Acer saccharinum*	245	3.9%	458.9	5.2	59,778	$699,801
honeylocust	*Gleditsia triacanthos*	235	3.8%	91.6	2.7	14,855	$293,860
sugar maple	*Acer saccharum*	208	3.3%	77.0	1.2	14,723	$275,103
swamp white oak	*Quercus bicolor*	192	3.1%	58.4	2.4	23,687	$286,510
eastern redbud	*Cercis canadensis*	188	3.0%	19.4	0.7	5,433	$88,958
Callery pear	*Pyrus calleryana*	171	2.8%	94.7	1.9	10,897	$215,741
shingle oak	*Quercus imbricaria*	164	2.6%	109.2	2.0	25,452	$334,270
apple species	*Malus*	163	2.6%	16.0	0.8	3,297	$73,663
blackgum	*Nyssa sylvatica*	140	2.3%	3.2	0.3	1,725	$31,228
All Other Trees Inventoried		2,361	38.0%	1,355	23.8	273,843	$3,644,350
Total		**6,210**	**102%**	**3,377**	**68.7**	**856,769**	**$11,561,344**

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 Liberty avoid 856,769 gals. of runoff annually. Avoided runoff accounts for 1.2% of the annual functional benefits provided by Liberty's public tree resource.

Of all species inventoried, pin oak (Q*uercus palustris*) contributed the most annual stormwater benefits. The pin oak population (6.5% of inventoried trees) avoided 192,698 gals. of runoff. The most abundant species in the inventoried tree population, northern hackberry (*Celtis occidentalis*) (8.3%), only avoided approximately 90,185 gals. of runoff. On a per-tree basis, large trees with leafy canopies provided the most functional benefits. Callery pear (*Pyrus calleryana*) and silver maple comprised 2.8% and 3.3% of the inventoried tree resource, respectively. Silver maple avoided 59,778 gals. of runoff, over twice as much as callery pear did, despite only having about 30 more trees in the entire population. This illustrates how large-statured trees with wide canopies provide significantly greater benefits.

CANOPY FUNCTIONS



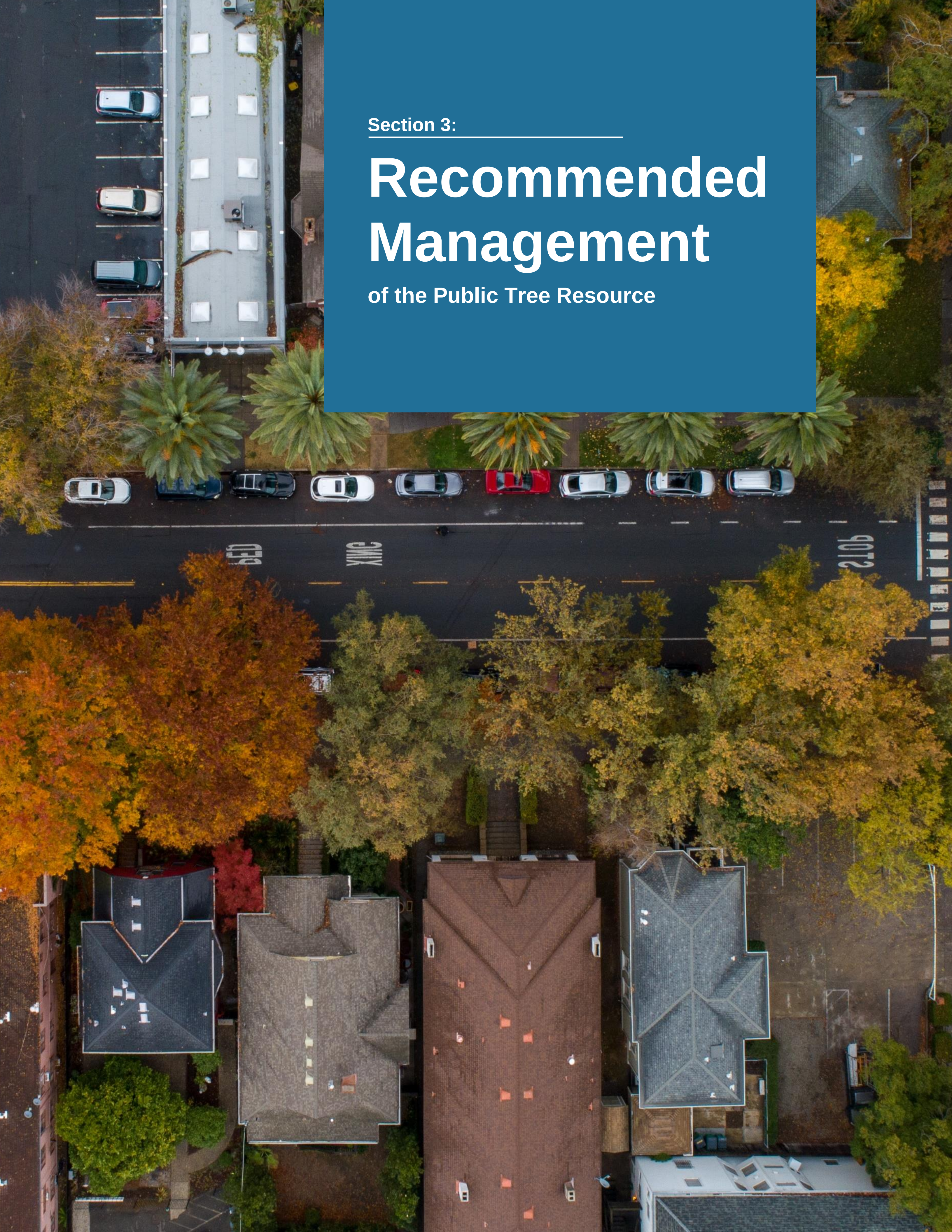
Trees provide many functions and benefits all at once simply by existing, such as:

- 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 five-year tree management program takes a multi-faceted and proactive approach to tree resource management.

High Priority
- All High Priority tree removals and pruning should be completed as soon as possible, because these trees have significant defects that will become severe over time.

Moderate Priority
- Moderate Priority tree removals and pruning should only start after most High Priority tree maintenance has been completed, and be performed concurrently.

Low Priority
- Low Priority tree maintenance should be performed after all High and Moderate Priority maintenance has been completed.

Stump Removal
- Stump removals should be performed either when a tree is removed or before a planting season begins, so planting sites become vacant for replacement trees.

Routine Inspection
- Routine Inspection from a drive-by perspective is important for detecting major defects before they worsen, and a walk-by perspective is important for updating inventory data.

Young Tree Training
- Young Tree Training Cycles improve tree structure so defects do not worsen and become more costly to correct as they grow, and should begin as soon as possible.

Routine Pruning
- Routine Pruning Cycles correct defects before they worsen, which is crucial for maintaining the overall condition of the inventoried tree resource over the long-term.

Replace Trees
- Removed trees should be replaced so there is no net loss of the tree resource, which should enter the Young Tree Training Cycle immediately.

Tree Planting
- Planting new trees is important for increasing population size and urban canopy, but can wait until higher priority maintenance is complete or at least in progress.

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 15 and 16 present tree pruning and tree removals by risk rating and diameter size class. The following sections briefly summarize the recommended removals identified during the inventory.

HIGH PRIORITY RECOMMENDED MAINTENANCE

Pruning or removing 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 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

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 5 High Risk park trees. The diameter size classes for trees with recommended high-priority pruning ranged between 25–42 inches DBH and >43 inches DBH. This maintenance should be performed immediately based on assigned risk rating and may be performed concurrently with other High Risk removals.

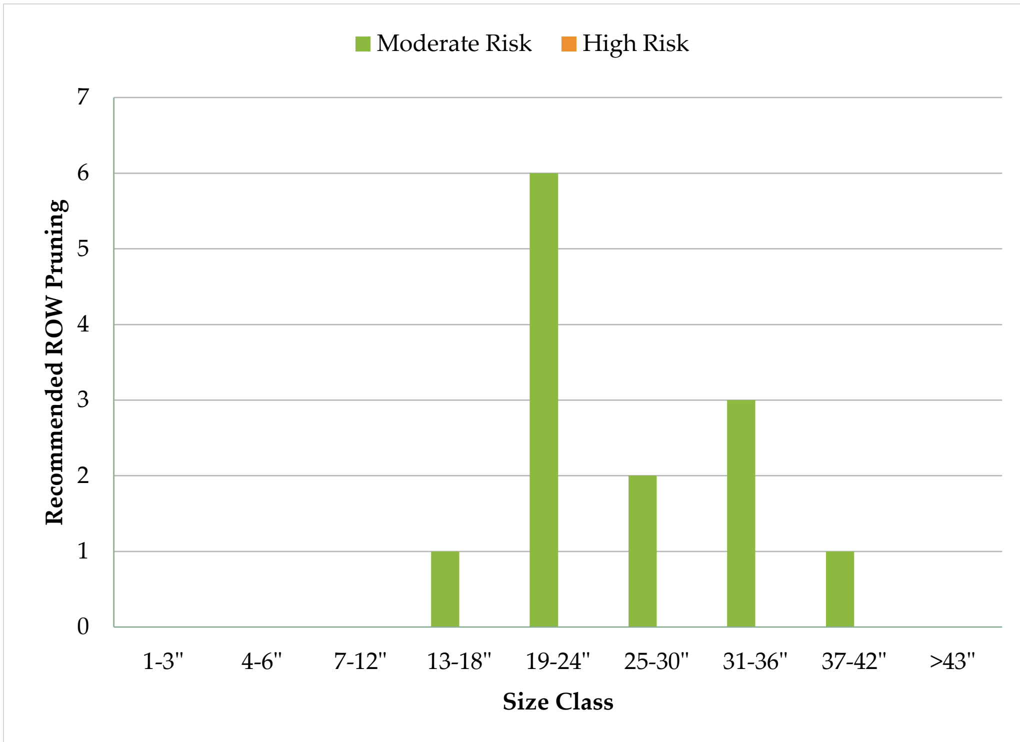


Figure 15. Recommended street tree pruning by size class and risk rating.

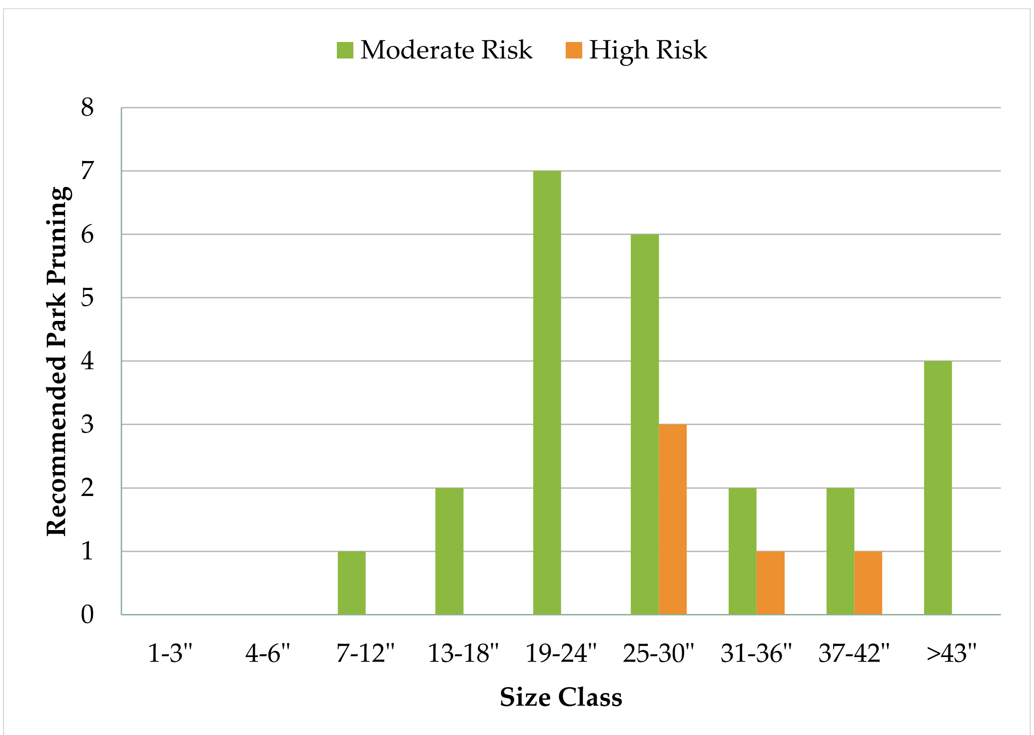


Figure 16. Recommended park tree pruning by size class and risk rating.

High and Moderate Removal Recommendations

DRG identified 0 High Risk and 7 Moderate Risk trees (both) recommended for removal. The diameter size classes ranged between 3–30 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.

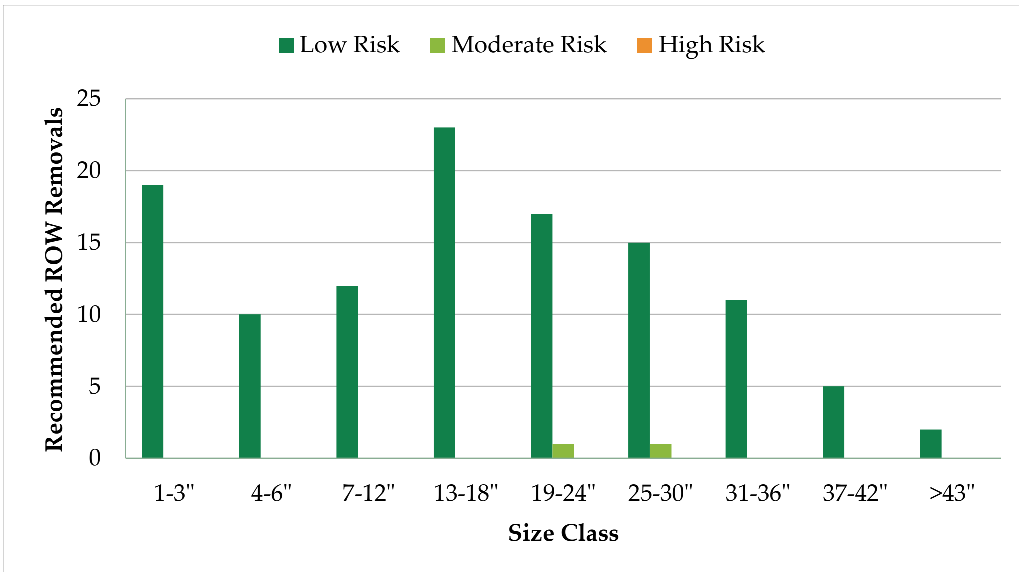


Figure 17. Recommended street tree removals by size class and risk rating.

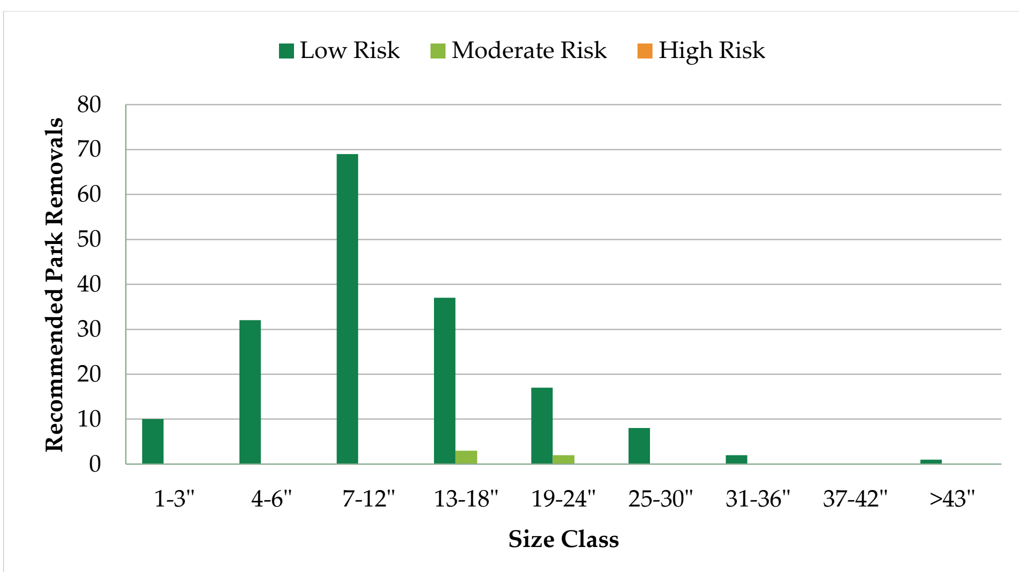


Figure 18. Recommended park tree removals by size class and risk rating.

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 37 Moderate Risk trees recommended for pruning. The diameter size classes for Moderate Risk trees ranged between 7–42 inches DBH and >43 inches DBH.

Low Priority Pruning Recommendations

There were 4,705 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 290 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. Liberty has a large population of trees that are susceptible to pests and diseases, including ash, maple, and oak.

DRG recommends that Liberty 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.

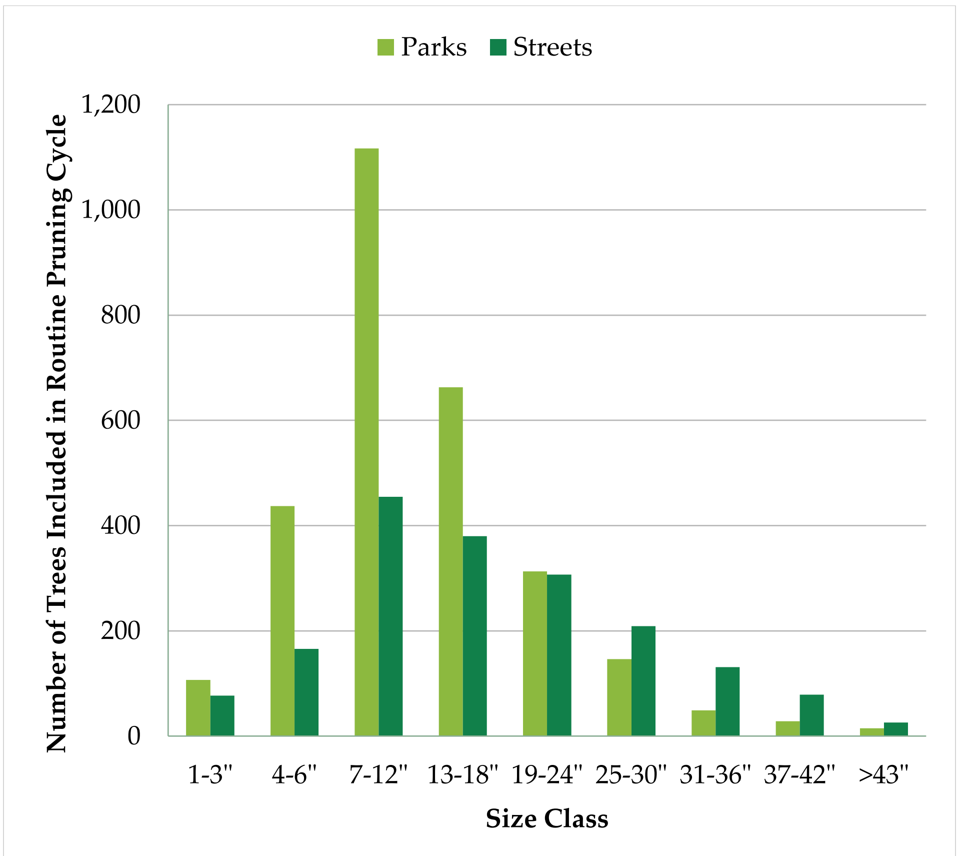


Figure 19. Five-year Routine Pruning cycle by size class.

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.

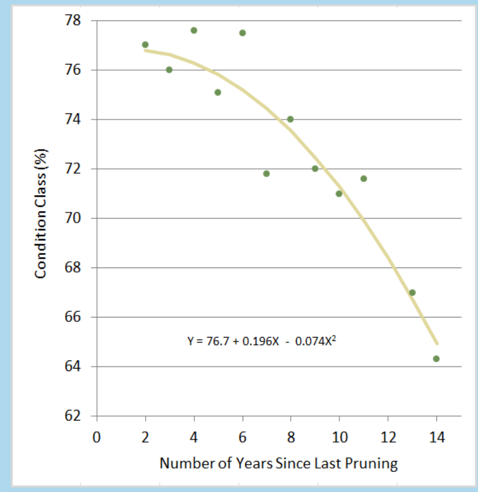
Based on Miller and Sylvester's research, DRG recommends five-year Routine Pruning cycles to maintain the condition of the inventoried tree resource. However, not all municipalities are able to remain proactive with a five-year cycle based on budgetary constraints, the size of the public tree resource, 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

Liberty's inventory has 4,705 trees that should be routinely pruned, and DRG recommends that the City establish a five-year Routine Pruning cycle with approximately 941] trees pruned each year. If this is not feasible for Liberty, a six-year Routine Pruning cycle with approximately 784 trees pruned each year, or a seven-year Routine Pruning cycle with approximately 672 trees pruned each year, is acceptable considering the inventoried tree population's size. DRG recommends that the Routine Pruning cycle begins in Year One of the proposed five-year program, after all High Risk Recommended Maintenance is complete.

Approximately 72% of the inventoried tree population would benefit from routine pruning. Figure 19 shows that a variety of size classes recommended for pruning; however, most of the trees were smaller than 1"-42" or smaller DBH.

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.

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.

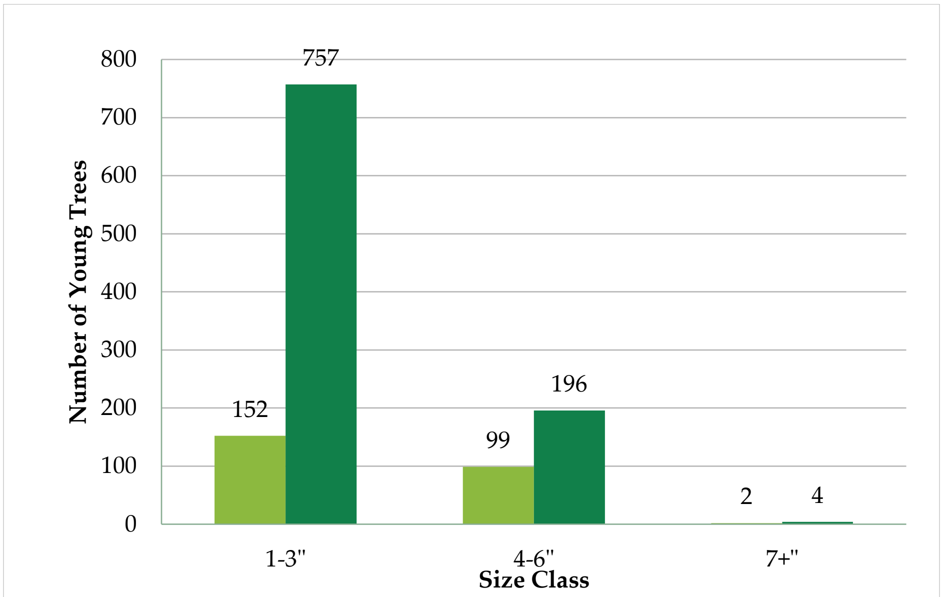


Figure 20. Three-year Young Tree Training cycle by size class.

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.

Young Tree Training Cycle Recommendations

DRG recommends that Liberty implement a three-year Young Tree Training cycle beginning after the completion of all Extreme and High Risk Recommended Maintenance activities. During the inventory, 1,210 trees less than or equal to 8 inches DBH were inventoried and recommended for young tree training. Since Liberty has so many young trees, the Young Tree Training cycle is vital for the future condition of the inventoried tree population. DRG recommends that an average of 403 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.

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 Liberty 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 Liberty 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 identified 228 stumps recommended for removal, with a wide range of sizes from 1″ to 82″ in diameter. 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 D. These tree species are specifically selected for the climate of Liberty. 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 2024 city of Liberty 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 Liberty's five-year tree management program follows.

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

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

- No less than $291,660.00 for the first year of implementation.
- No less than $466,776.00 for the second and third years.
- No less than $430,838.00 for the final two years of the maintenance schedule.

Annual budget funds are needed to ensure that 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 4. Estimated Budget for Recommended Five-Year Tree Resource Management Program

Activity Cost			Year 1		Year 2		Year 3		Year 4		Year 5		Five-Year Cost
Activity	Diameter	Cost/Tree	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	
	1-3"	$28		$0		$0		$0		$0		$0	$0
	4-6"	$58		$0		$0		$0		$0		$0	$0
	7-12"	$138		$0		$0		$0		$0		$0	$0
	13-18"	$314		$0		$0		$0		$0		$0	$0
High Priority Removals	19-24"	$605		$0		$0		$0		$0		$0	$0
	25-30"	$825		$0		$0		$0		$0		$0	$0
	31-36"	$1,045		$0		$0		$0		$0		$0	$0
	37-42"	$1,485		$0		$0		$0		$0		$0	$0
	>43"	$2,035		$0		$0		$0		$0		$0	$0
Activity Total(s)			**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$0**
	1-3"	$28		$0		$0		$0		$0		$0	$0
	4-6"	$58		$0		$0		$0		$0		$0	$0
	7-12"	$138		$0		$0		$0		$0		$0	$0
	13-18"	$314	3	$942		$0		$0		$0		$0	$942
Moderate Priority Removals	19-24"	$605	3	$1,815		$0		$0		$0		$0	$1,815
	25-30"	$825	1	$825		$0		$0		$0		$0	$825
	31-36"	$1,045		$0		$0		$0		$0		$0	$0
	37-42"	$1,485		$0		$0		$0		$0		$0	$0
	>43"	$2,035		$0		$0		$0		$0		$0	$0
Activity Total(s)			**7**	**$3,582**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$3,582**
	1-3"	$28		$0		$0	29	$812		$0		$0	$812
	4-6"	$58		$0		$0	42	$2,436		$0		$0	$2,436
	7-12"	$138		$0	41	$5,658	40	$5,520		$0		$0	$11,178
	13-18"	$314		$0	60	$18,840		$0		$0		$0	$18,840
Low Priority Removals	19-24"	$605	20	$12,100	14	$8,470		$0		$0		$0	$20,570
	25-30"	$825	23	$18,975		$0		$0		$0		$0	$18,975
	31-36"	$1,045	13	$13,585		$0		$0		$0		$0	$13,585
	37-42"	$1,485	5	$7,425		$0		$0		$0		$0	$7,425
	>43"	$2,035	3	$6,105		$0		$0		$0		$0	$6,105
Activity Total(s)			**64**	**$58,190**	**115**	**$32,968**	**111**	**$8,768**	**0**	**$0**	**0**	**$0**	**$99,926**
	1-3"	$18		$0		$0	4	$72	4	$72	4	$72	$216
	4-6"	$28		$0		$0	4	$112	4	$112	3	$84	$308
	7-12"	$44		$0		$0	13	$572	12	$528	12	$528	$1,628
	13-18"	$72		$0		$0	17	$1,224	16	$1,152	16	$1,152	$3,528
Stump Removals	19-24"	$94		$0		$0	19	$1,786	18	$1,692	18	$1,692	$5,170
	25-30"	$110		$0		$0	10	$1,100	9	$990	9	$990	$3,080
	31-36"	$138		$0		$0	5	$690	4	$552	4	$552	$1,794
	37-42"	$160		$0		$0	4	$640	4	$640	4	$640	$1,920
	>43"	$182		$0		$0	4	$728	4	$728	3	$546	$2,002
Activity Total(s)			**0**	**$0**	**0**	**$0**	**80**	**$6,924**	**75**	**$6,466**	**73**	**$6,256**	**$19,646**
	1-3"	$20		$0		$0		$0		$0		$0	$0
	4-6"	$30		$0		$0		$0		$0		$0	$0
	7-12"	$75		$0		$0		$0		$0		$0	$0
	13-18"	$120		$0		$0		$0		$0		$0	$0
High Priority Pruning	19-24"	$170		$0		$0		$0		$0		$0	$0
	25-30"	$225	3	$675		$0		$0		$0		$0	$675
	31-36"	$305	1	$305		$0		$0		$0		$0	$305
	37-42"	$380	1	$380		$0		$0		$0		$0	$380
	>43"	$590		$0		$0		$0		$0		$0	$0
Activity Total(s)			**5**	**$1,360**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$1,360**

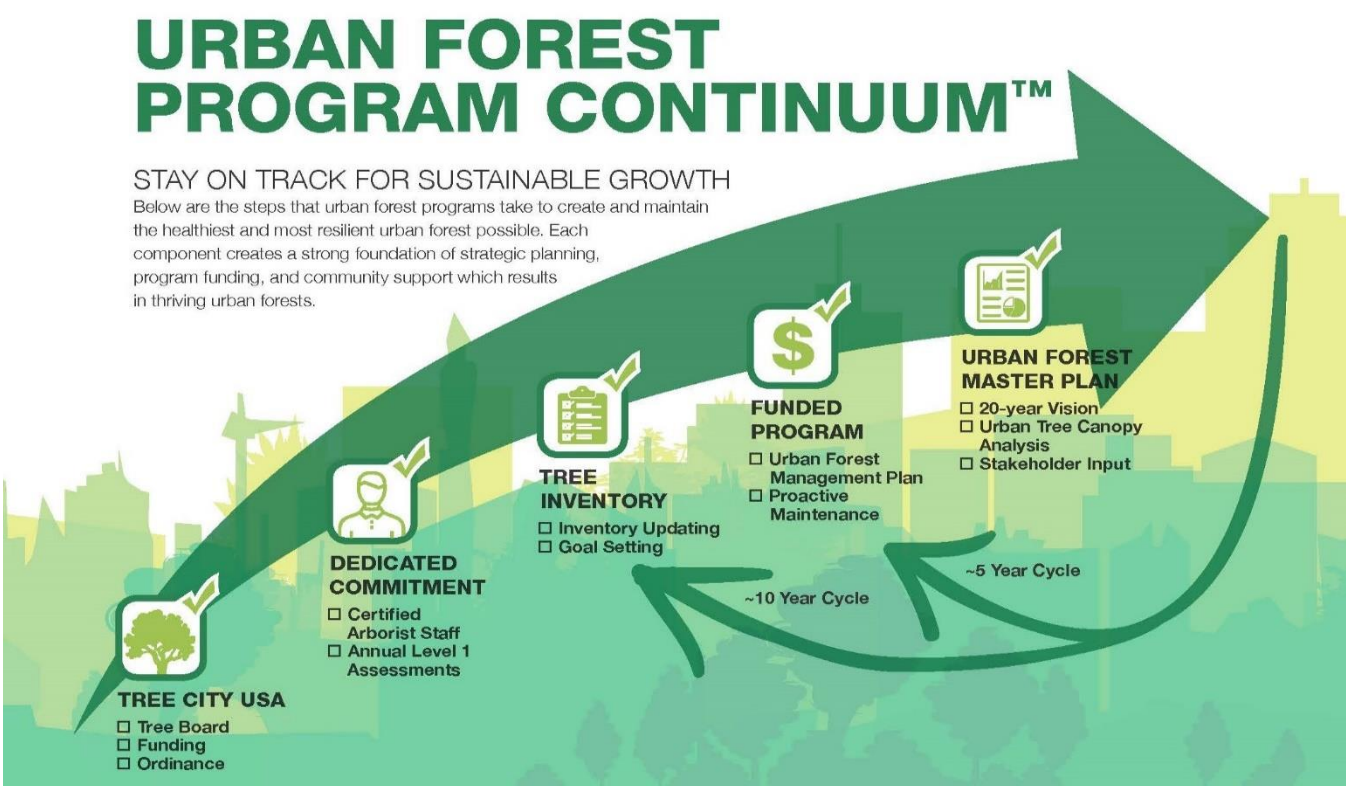
Activity Cost			Year 1		Year 2		Year 3		Year 4		Year 5		Five-Year Cost
Activity	Diameter	Cost/Tree	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	
Moderate Priority Pruning	1-3"	$20		$0		$0		$0		$0		$0	$0
	4-6"	$30		$0		$0		$0		$0		$0	$0
	7-12"	$75	1	$75		$0		$0		$0		$0	$75
	13-18"	$120	3	$360		$0		$0		$0		$0	$360
	19-24"	$170	13	$2,210		$0		$0		$0		$0	$2,210
	25-30"	$225	8	$1,800		$0		$0		$0		$0	$1,800
	31-36"	$305	5	$1,525		$0		$0		$0		$0	$1,525
	37-42"	$380	3	$1,140		$0		$0		$0		$0	$1,140
	>43"	$590	4	$2,360		$0		$0		$0		$0	$2,360
Activity Total(s)			**37**	**$9,470**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$9,470**
Routine Inspection	Drive-by Assessment	$1	1,000	$1,000	1,000	$1,000	1,000	$1,000	1,000	$1,000	1,000	$1,000	$5,000
	Walk-by Assessment	$5	65	$325	65	$325	65	$325	65	$325	65	$325	$1,625
Activity Total(s)			**65**	**$325**	**65**	**$325**	**65**	**$325**	**65**	**$325**	**65**	**$325**	**$1,625**
Young Tree Training (3-year Cycle)	1-3"	$20	303	$6,060	303	$6,060	303	$6,060	303	$6,060	303	$6,060	$30,300
	4-6"	$30	98	$2,940	98	$2,940	98	$2,940	98	$2,940	98	$2,940	$14,700
	6"<	$40	2	$80	2	$80	2	$80	2	$80	2	$80	$400
Activity Total(s)			**403**	**$9,080**	**403**	**$9,080**	**403**	**$9,080**	**403**	**$9,080**	**403**	**$9,080**	**$45,400**
Routine Pruning (5-year Cycle)	1-3"	$20	37	$736	37	$736	37	$736	37	$736	37	$736	$3,680
	4-6"	$30	121	$3,618	121	$3,618	121	$3,618	121	$3,618	121	$3,618	$18,090
	7-12"	$75	314	$23,580	314	$23,580	314	$23,580	314	$23,580	314	$23,580	$117,900
	13-18"	$120	209	$25,032	209	$25,032	209	$25,032	209	$25,032	209	$25,032	$125,160
	19-24"	$170	124	$21,080	124	$21,080	124	$21,080	124	$21,080	124	$21,080	$105,400
	25-30"	$225	71	$15,975	71	$15,975	71	$15,975	71	$15,975	71	$15,975	$79,875
	31-36"	$305	36	$10,980	36	$10,980	36	$10,980	36	$10,980	36	$10,980	$54,900
	37-42"	$380	21	$8,132	21	$8,132	21	$8,132	21	$8,132	21	$8,132	$40,660
	>43"	$590	8	$4,838	8	$4,838	8	$4,838	8	$4,838	8	$4,838	$24,190
Activity Total(s)			**941**	**$113,971**	**941**	**$113,971**	**941**	**$113,971**	**941**	**$113,971**	**941**	**$113,971**	**$569,855**
Replacement Tree Planting and Maintenance	Purchasing	$250	60	$15,000	60	$15,000	60	$15,000	60	$15,000	60	$15,000	$75,000
	Planting & Watering	$200	60	$12,000	60	$12,000	60	$12,000	60	$12,000	60	$12,000	$60,000
	Mulching	$25	60	$1,500	60	$1,500	60	$1,500	60	$1,500	60	$1,500	$7,500
Activity Total(s)			**180**	**$28,500**	**180**	**$28,500**	**180**	**$28,500**	**180**	**$28,500**	**180**	**$28,500**	**$142,500**
New Tree Planting and Maintenance	Purchasing	$250	8	$2,000	8	$2,000	8	$2,000	8	$2,000	8	$2,000	$10,000
	Planting & Watering	$200	8	$1,600	8	$1,600	8	$1,600	8	$1,600	8	$1,600	$8,000
	Mulching	$25	8	$200	8	$200	8	$200	8	$200	8	$200	$1,000
Activity Total(s)			**24**	**$3,800**	**24**	**$3,800**	**24**	**$3,800**	**24**	**$3,800**	**24**	**$3,800**	**$19,000**
Natural Mortality (1%)	Tree Removal	$314	62	$19,468	62	$19,468	62	$19,468	62	$19,468	62	$19,468	$97,340
	Stump Removal	$72	62	$4,464	62	$4,464	62	$4,464	62	$4,464	62	$4,464	$22,320
	Replacement Tree	$475	62	$29,450	62	$29,450	62	$29,450	62	$29,450	62	$29,450	$147,250
Activity Total(s)			**186**	**$53,382**	**186**	**$53,382**	**186**	**$53,382**	**186**	**$53,382**	**186**	**$53,382**	**$266,910**
Activity Grand Total			**1,912**		**1,914**		**1,990**		**1,874**		**1,872**		**9,562**
Cost Grand Total				**$281,660**		**$242,026**		**$224,750**		**$215,524**		**$215,314**	**$1,179,274**

CONCLUSION

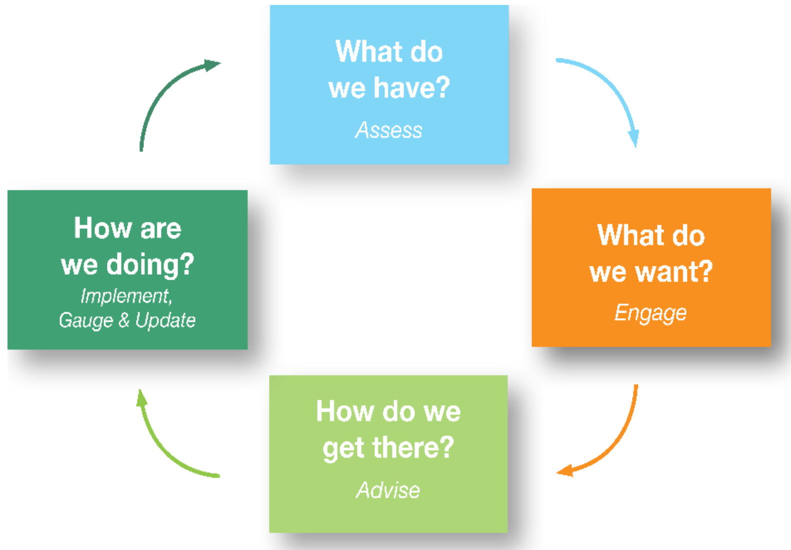
When properly maintained, the valuable benefits trees provide over their lifetime far exceed the time and money invested in planting, pruning, and inevitably removing them. The 6,440 public trees inventoried provide $595,376.00 in estimated annual economic value, which is over 200% of the City's proposed annual tree maintenance budget of ~$281,660.00. Successfully implementing the five-year program may increase Liberty's ROI over time, or at least maintain it over the years.

The program is ambitious and is a challenge to complete in five 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 Liberty and its residents will increase as well. Inventoried trees are only a fraction of the total trees in Liberty 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 five 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 Liberty 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.

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APPENDIX A
DATA COLLECTION AND SITE LOCATION METHODS

DATA COLLECTION METHODS

DRG collects tree inventory data using their proprietary GIS software, called Rover, loaded onto pen-based field computers. At each site, the following data fields were collected:

- Address
- Comments
- Condition
- Date of Inventory
- Maintenance Recommendation
- Multi-stem Tree
- Notes
- Relative Location
- Size*
- Species and Identification Confidence Level
- Utility Interference
- X and Y Coordinates

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

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. This table lists these base map layers, along with each layer's source and format information.

Data Source	Data Year	Projection
Shapefile US Census Bureau TIGER Data	2023	NAD 1983 StatePlane Missouri West FIPS 2403 Feet
Aerial Imagery NearMap Inc.	2024	NAD 1983 StatePlane Missouri West FIPS 2403 Feet

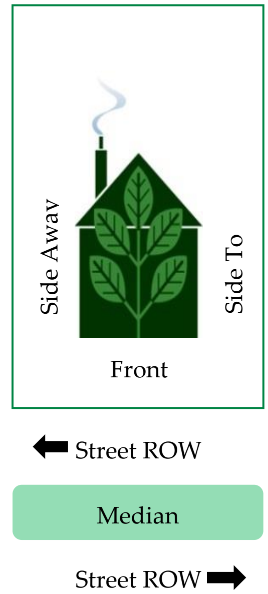
STREET ROW SITE LOCATION

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

Address Number and Street Name

Where there was no GIS parcel addressing data available for sites located adjacent to a vacant lot, or adjacent to an occupied lot without a posted address number, the arborist used their best judgment to assign an address number based on nearby 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 were assigned an address number by the arborist in Rover using parcel and streets geographical data. Each segment was numbered with an assigned address that was interpolated from addresses facing that median and addressed on that same street as the median. If there were multiple medians between cross streets, each segment was assigned its own address. The *street name* assigned to a site was determined by street centerline information.



Side Value

Each site was assigned a *side value*, including *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 'X' and have the "Park Name" data field filled.

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.

APHIS, Plant Health, Plant Pest Program Information
- www.aphis.usda.gov/plant_health/plant_pest_info

The University of Georgia, Center for Invasive Species and Ecosystem Health
- www.bugwood.org

USDA National Agricultural Library
- www.invasivespeciesinfo.gov/microbes

USDA Northeastern Areas Forest Service, Forest Health Protection
- www.na.fs.fed.us/fhp

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

EASTERN TENT CATERPILLAR

Eastern tent caterpillar (*Malacosoma americanum*) was first observed in the United States in 1646. In spring, caterpillars make nests in the forks and crotches of tree branches. Caterpillars do not feed within the nest; they leave the nest to feed up to 3 feet from nest and return to rest and take shelter in wet weather. Large infestations may occur at 8- to 10-year intervals. Egg masses overwinter on twigs. Trees are rarely killed by eastern tent caterpillar, but health is compromised that year and aesthetic value is decreased.

Easter tent caterpillar have a wide range of hosts, including apple (*Malus*) and cherry (*Prunus*).

Eastern tent caterpillar nest.

Photograph courtesy of Prairie Haven (2008)

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*).

EUROPEAN 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.

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.

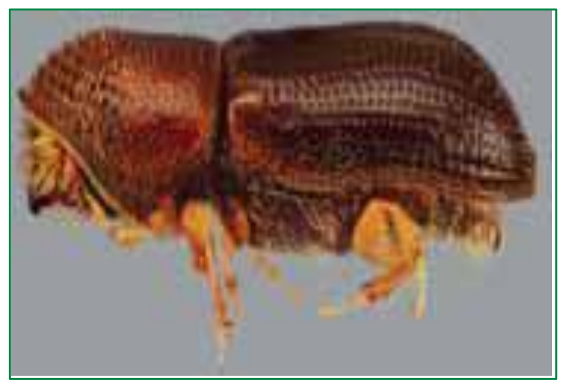
Close-up of male (darker brown) and female (whitish color) European gypsy moths.

Photograph courtesy of USDA APHIS (2019)

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*).

THOUSAND CANKERS DISEASE

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.



Walnut twig beetle, side view.

Photograph courtesy of USDA Forest Service (2011)

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, walnut (*Juglans*) 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.

OAK WILT

Oak wilt symptoms on red and white oak leaves.

Photograph courtesy of USDA Forest Service (2011a)

Oak wilt was first identified in 1944 and is caused by the fungus *Ceratocystis fagacearum*. While considered an invasive and aggressive disease, its status as an exotic pest is debated since the fungus has not been reported in any other part of the world. This disease affects the oak genus and is most devastating to those in the red oak subgenus, such as scarlet oak (*Quercus coccinea*), shingle oak (*Q. imbricaria*), pin oak (*Q. palustris*), willow oak (*Q. phellos*), and red oak (*Q. rubra*). It also attacks trees in the white oak subgenus, although it is not as prevalent and spreads at a much slower pace in these trees.

Just as with DED, oak wilt disease is caused by a fungus that clogs the vascular system of oak and results in decline and death of the tree. The fungus is carried from tree to tree by several borers common to oak, but the disease is more commonly spread through root grafts. Oak species within the same subgenus (red or white) will form root colonies with grafted roots that allow the disease to move readily from one tree to another.

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.

EMERALD ASH BORER

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.

Close-up of an emerald ash borer.

Photograph courtesy of USDA APHIS (2020)

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 *Fraxinus* (ash).

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APPENDIX C
i-TREE METHOLOGY

i-Tree regionalizes the calculations of its output by incorporating detailed reference city project information for 16 climate zones across the United States. Liberty falls within the Midwest Climate Zone. Sample inventory data from Minneapolis represent the basis for the Midwest Reference City Project for the Midwest Community Tree Guidelines. The basis for the benefit modeling in this study compares the inventory data from Liberty to the results of Midwest Reference City Project to obtain an estimation of the annual benefits provided by Liberty's tree resource.

Growth rate modeling information was used to perform computer-simulated growth of the existing tree population for one year and account for the associated annual benefits. This "snapshot" analysis assumed that no trees were added to or removed from the existing population. Calculations of carbon dioxide (CO_2) released due to decompositions of wood from removed trees did consider average annual mortality. This approach directly connects benefits with tree-size variables such as diameter at breast height (DBH) and leaf-surface area. Many benefits of trees are related to processes that involve interactions between leaves and the atmosphere (e.g., interception, transpiration, photosynthesis); therefore, benefits increase as tree canopy cover and leaf surface area increase.

For each of the modeled benefits, an annual resource unit was determined on a per-tree basis. Resource units are measured as megawatt-hours of electricity saved per tree; therms of natural gas conserved per tree, pounds of atmospheric CO_2 reduced per tree; pounds of nitrogen dioxide (NO_2), particulate matter (PM_{10}), and volatile organic compounds (VOCs) reduced per tree; cubic feet of stormwater runoff reduced per tree; and square feet of leaf area added per tree to increase property values.

Prices were assigned to each resource unit using economic indicators of society's willingness to pay for the environmental benefits trees provide. Estimates of benefits are initial approximations as some benefits are difficult to quantify (e.g., impacts on psychological health, crime, and violence). In addition, limited knowledge about the physical processes at work and their interactions make estimates imprecise (e.g., fate of air pollutants trapped by trees and then washed to the ground by rainfall). Therefore, this method of quantification provides first-order approximations. It is meant to be a general accounting of the benefits produced by urban trees—an accounting with an accepted degree of uncertainty that can, nonetheless, provide science-based platform for decision-making.

A detailed description of how the default benefit prices are derived, refer to the *City of Minneapolis, Minnesota Municipal Tree Resource Analysis* (McPherson *et al.* 2005) and the *Midwest Community Tree Guide: Benefits, Costs, and Strategic Planning* (McPherson *et al.* 2009). i-Tree Streets' default values from the Midwest Climate Zone were used for air quality and stormwater benefit prices and local values were used for energy usage, aesthetics, and other benefits.

APPENDIX D
SUGGESTED TREE SPECIES
FOR USDA HARDINESS ZONE 6A

DECIDUOUS TREES

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer rubrum	red maple	Red Sunset®
Acer nigrum	black maple	
Acer saccharum	sugar maple	'Legacy'
*Aesculus flava**	yellow buckeye	
Betula nigra	river birch	Heritage®
Carpinus betulus	European hornbeam	'Franz Fontaine'
*Castanea mollissima**	Chinese chestnut	
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	(male trees only)
Gleditsia triacanthos inermis	thornless honeylocust	'Shademaster'
Gymnocladus dioica	Kentucky coffeetree	Prairie Titan®
*Juglans regia**	English walnut	'Hansen'
*Larix decidua**	European larch	
Liquidambar styraciflua	American sweetgum	Cherokee™
Liriodendron tulipifera	tuliptree	'Fastigiatum'
Maclura pomifera	osage-orange	'White Shield','Witchita'
*Magnolia acuminata**	cucumbertree magnolia	(numerous exist)
*Magnolia macrophylla**	bigleaf magnolia	
Metasequoia glyptostroboides	dawn redwood	'Emerald Feathers'
Nyssa sylvatica	black tupelo	
Platanus × acerifolia	London planetree	'Yarwood'
*Platanus occidentalis**	American sycamore	
Quercus alba	white oak	
Quercus bicolor	swamp white oak	
Quercus coccinea	scarlet oak	
Quercus ellipsoidalis	northern pin oak	

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

Scientific Name	Common Name	Cultivar
Quercus frainetto	Hungarian oak	
Quercus imbricaria	shingle oak	
Quercus lyrata	overcup oak	
Quercus macrocarpa	bur oak	
Quercus montana	chestnut oak	
Quercus muehlenbergii	chinkapin oak	
Quercus phellos	willow oak	
Quercus robur	English oak	Heritage®
Quercus rubra	northern red oak	'Splendens'
Quercus shumardii	Shumard oak	
Quercus texana	Texas oak	
Styphnolobium japonicum	Japanese pagodatree	'Regent'
Taxodium distichum	common baldcypress	'Shawnee Brave'
Tilia americana	American linden	'Redmond'
Tilia cordata	littleleaf linden	'Greenspire'
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	
Cladrastis kentukea	American yellowwood	'Rosea'
Eucommia ulmoides	hardy rubbertree	
Koelreuteria paniculata	goldenraintree	
Ostrya virginiana	eastern hophornbeam	
Parrotia persica	Persian parrotia	'Vanessa'
Phellodendron amurense	amur corktree	'Macho'
Prunus maackii	amur chokecherry	'Amber Beauty'
Prunus sargentii	Sargent cherry	
Quercus acutissima	sawtooth oak	
Quercus cerris	European turkey oak	
Sorbus alnifolia	Korean mountainash	'Redbird'

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 pensylvanicum**	striped maple	
Acer truncatum	Shantung 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 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'
*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'
Styrax japonicus	Japanese snowbell	'Emerald Pagoda'
Syringa reticulata	Japanese tree lilac	'Ivory Silk'

Note: * denotes species **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'
Chamaecyparis nootkatensis	Nootka falsecypress	'Pendula'
Cryptomeria japonica	Japanese cryptomeria	'Sekkan-sugi'
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	
Psedotsuga menziesii	Douglasfir	
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	
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.