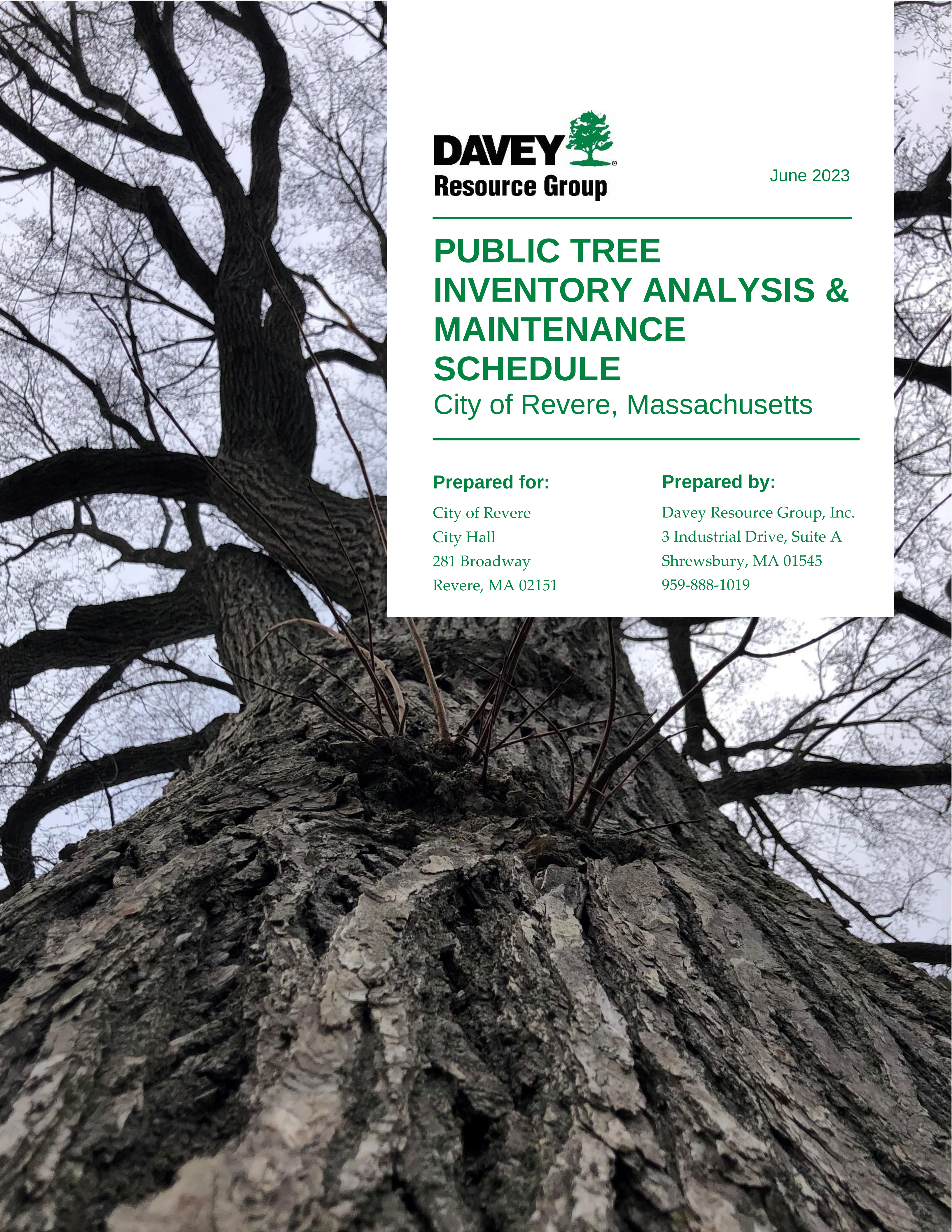

June 2023

PUBLIC TREE INVENTORY ANALYSIS & MAINTENANCE SCHEDULE

City of Revere, Massachusetts

Prepared for:

City of Revere
City Hall
281 Broadway
Revere, MA 02151

Prepared by:

Davey Resource Group, Inc.
3 Industrial Drive, Suite A
Shrewsbury, MA 01545
959-888-1019

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ACKNOWLEDGMENTS

This project supports the city of Revere's vision to promote and enhance community well-being through public tree conservation and improved forestry management practices. This *Public Tree Inventory Analysis & Maintenance Schedule* offers expertise in preserving and expanding urban canopy so the environmental, economic, and social benefits it provides continue for generations. Revere is an equal opportunity provider.

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Revere City Council –

Patrick M. Keefe, Jr. – City Council President and Ward 4 City Councilor

Joanne McKenna – City Council Vice-President and Ward 1 City Councilor

Ira Novoselsky – Ward 2 City Councilor

Anthony S. Cogliandro – Ward 3 City Councilor

John Powers – Ward 5 City Councilor

Richard Serino – Ward 6 City Councilor

Councilors At Large: Steven Morabito, Dan Rizzo, Anthony T. Zambuto, Marc Silvestri, and Gerry Visconti

EXECUTIVE SUMMARY

The city of Revere's *Tree Inventory Analysis and Maintenance Schedule*, 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 Revere in March and April of 2023 and analyzed the inventory data to understand the structure of the city's inventoried tree resource. DRG also estimated the economic value of the various environmental benefits provided by this public tree resource by analyzing inventory data with i-Tree Eco and recommended a prioritized maintenance program for future tree care.

Key Findings

- The inventory included 4,400 trees, stumps, and vacant planting sites.
- 91% of the inventoried trees were rated in fair or good condition.
- About 21% of Revere's street trees were causing hardscape damage. Aside from safety concerns, this can also be a frequent point of contention with nearby residents.
- Callery pears are the most common public tree, making up 29% of Revere's total tree resource, followed by Norway maple at 19%. This is significant from the standpoint of pest/disease susceptibility and should be considered when making future planting decisions.
- During the inventory, 215 vacant planting sites were collected. This makes up about 4.8% of the collected sites. This means the city is utilizing available planting space efficiently but speaks to a potential shortage of good planting sites for future trees.
- All 215 planting sites were suitable only for small-stature trees.
- Revere's trees provide air pollution removal, stormwater runoff reduction, and carbon sequestration benefits with an estimated annual value of $24,930.
- The inventoried trees store over 1,374 tons of carbon, valued at $234,343.
- Young trees make up more than 50.2% of the trees inventoried. Because stocking level is at 89%, investing in continued maintenance of young trees can effectively increase all the benefits of the urban forest.

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 = 119 trees

Stumps = 234

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 = 699 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 = 1,565 trees

Number of trees in five-year cycle each year = approximately 313

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 75

Young Tree Training Cycle

Younger trees may have structural issues 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 = 1,568 trees

Number of trees in three-year cycle = at least 314 per 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 = 3,832 trees

Number of trees in five-year cycle = approximately 766 per year

INTRODUCTION

The city of Revere is home to around 58,528 residents[1] benefitting from public trees in their community. The city's Department of Public Works (DPW) manages all trees, stumps, and planting sites along the street rights-of-way (ROW) and throughout public parks.

Revere has been a Greening the Gateway Cities (GGC) community for the past six years and has partnered with this program to plant over 2,000 trees throughout the city during that time, primarily on private property. Within the past year Revere's DPW has also partnered with the city's Community Development Department, which has committed approximately $125,000 of Community Development Block Grant Program money toward tree planting and site work. Revere's last tree inventory was done approximately 35 years ago. Given the amount of time that has passed, this new inventory can offer new insights into the current state of Revere's urban canopy and inform suggestions on how to improve it going forward.

This *Public Tree Inventory Analysis & Maintenance Schedule* is designed to help the city advance the initiatives discussed above, understand the current state of its public tree resource, set future goals and benchmarks, anticipate future program needs, and shift from a reactive to a proactive maintenance program. The sections of this plan are as follows:

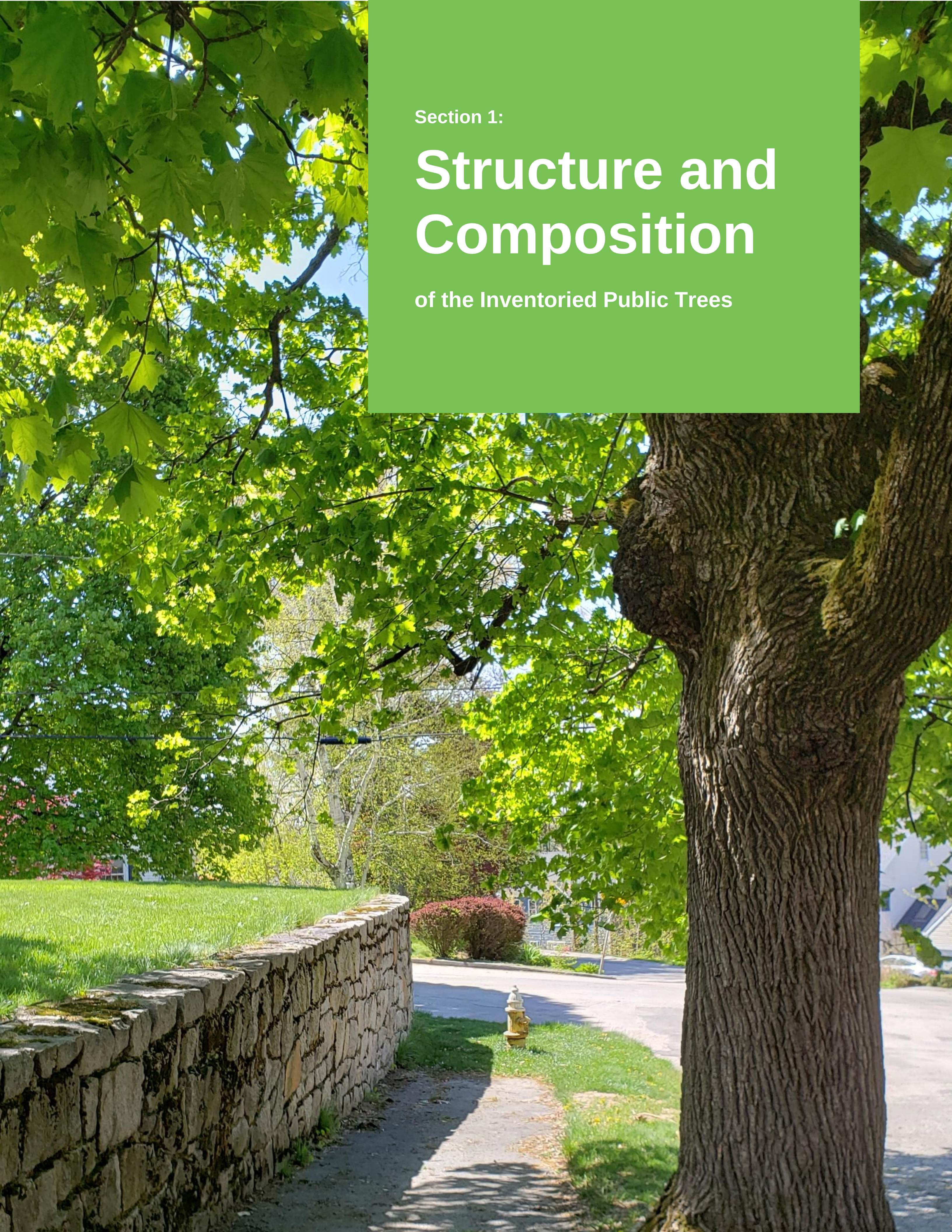
- *Section 1: Structure and Composition of the Inventoried Public Trees* summarizes the inventory data with trends representing the current state of the tree resource.
- *Section 2: Functions and Benefits of the Inventoried Public Trees* summarizes the estimated value of benefits provided to the community by public trees' various functions.
- *Section 3: Recommended Maintenance of the Inventoried Public Trees* details a prioritized maintenance schedule and provides an estimated budget for recommended maintenance activities over a ten-year period.

[1] U.S. Census Bureau. 2020. Quick Facts: Revere, Massachusetts. Retrieved from https://www.census.gov/quickfacts/reverecitymassachusetts,US.

Section 1:

Structure and Composition

of the Inventoried Public Trees



SECTION 1: STRUCTURE AND COMPOSITION OF THE INVENTORIED PUBLIC TREES

During March 2023, DRG arborists collected data on trees, stumps, and planting sites along the street ROW and in 13 public parks throughout the City of Revere (Table 1). A total of 4,400 sites were inventoried, with 93.1% collected along the street ROW and 6.9% collected in parks. Figure 1 breaks down the inventoried sites by type (tree, stump, or planting site) and locations (street ROW versus parks). See Appendix A for details about DRG's methodology for collecting inventory data.

Table 1. Parks included in the 2023 inventory.

Inventoried Parks
Ambrose Park
Crescent Avenue Park
Curtis Park
Destasio Park
Erricola Park
Gibson Park
Griswold Park
Harmon Park
Hill Park
Jacob's Park
Louis Pasteur Park
Paws N' Play Dog Park
Sonny Myers Park

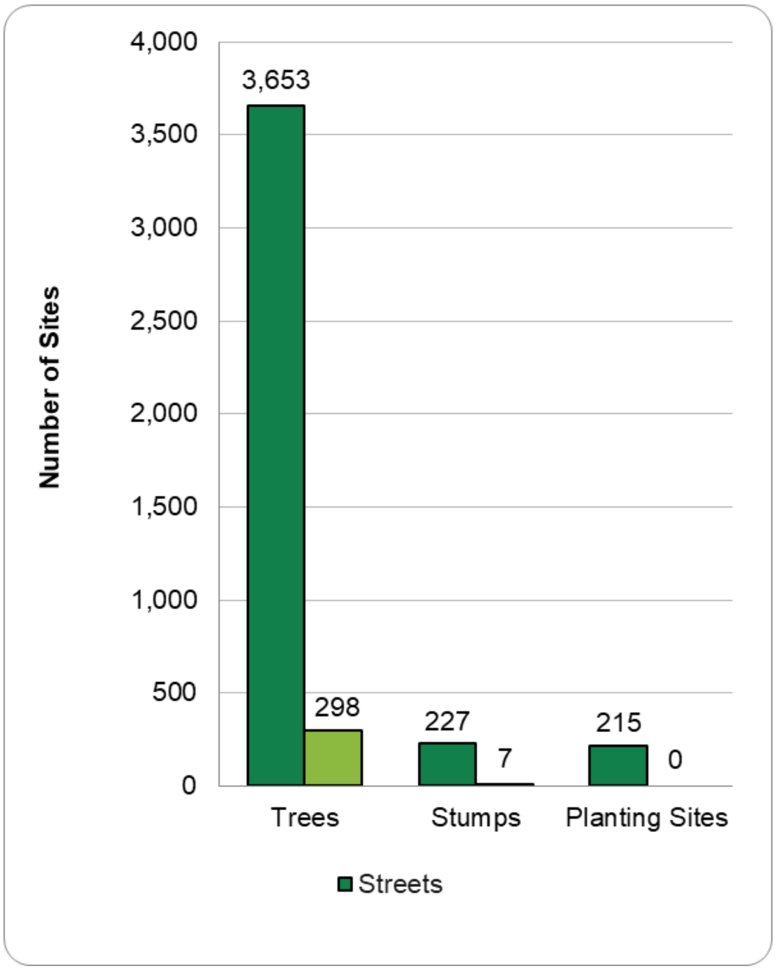


Figure 1. Number of inventoried sites by location and type.

HISTORIC EXAMPLES OF THE IMPORTANCE OF DIVERSITY

The Dutch elm disease epidemic of the 1930s provides a key historical lesson on the importance of diversity. The disease killed millions of American elm trees, leaving behind enormous gaps in the urban canopy of many 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 United States. This invasive beetle devastated ash tree populations across the country. Other invasive pests and diseases, severe weather events, and climate change threaten our urban forests today, so it's vital that we learn from history and plant a wider variety of tree species and genera to develop a resistant and resilient public tree resource.

Emerald ash borer damage.

Photo courtesy of Eric R. Day, Virginia Polytechnic Institute and State University, Bugwood.org

SPECIES & GENERA DIVERSITY

Diversity within plant communities is important for increasing their resistance and resilience to disturbance. The 10-20-30 rule is a common industry metric for tree species diversity in which a single species should compose no more than 10% of the population, a single genus no more than 20%, and a single family no more than 30%[2].

Disturbance: an event or force that brings about mortality to plants and/or changes their spatial distribution.

Resistance: the ability of a plant community to remain essentially unchanged despite disturbance.

Resilience: the ability of a plant community to recover after disturbance.

The graphs on the following page provide a breakdown of the species diversity in the City of Revere. Figure 2 provides a species diversity breakdown for Revere's street trees and includes all species which made up at least 2% of the inventoried trees. **Callery pear is the most common species among street trees (29%)**, followed by Norway maple (19%), honeylocust (6%), and green ash (5%). **There are a total of 89 different tree species represented within Revere's right of way.**

Figure 3 on the following page provides the species diversity breakdown for park trees and includes all species which made up at least 2% of the inventoried park trees. **Honeylocust is the most common park tree species,** making up 13.4% of the park inventory. Other common species found in Revere's parks include red maple (12.8%), Norway maple (10%), Callery pear (9%), green ash (7%), and black cherry (5%). **A total of 44 different tree species are represented in the inventoried parks and public areas of Revere.**

[2] 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/.

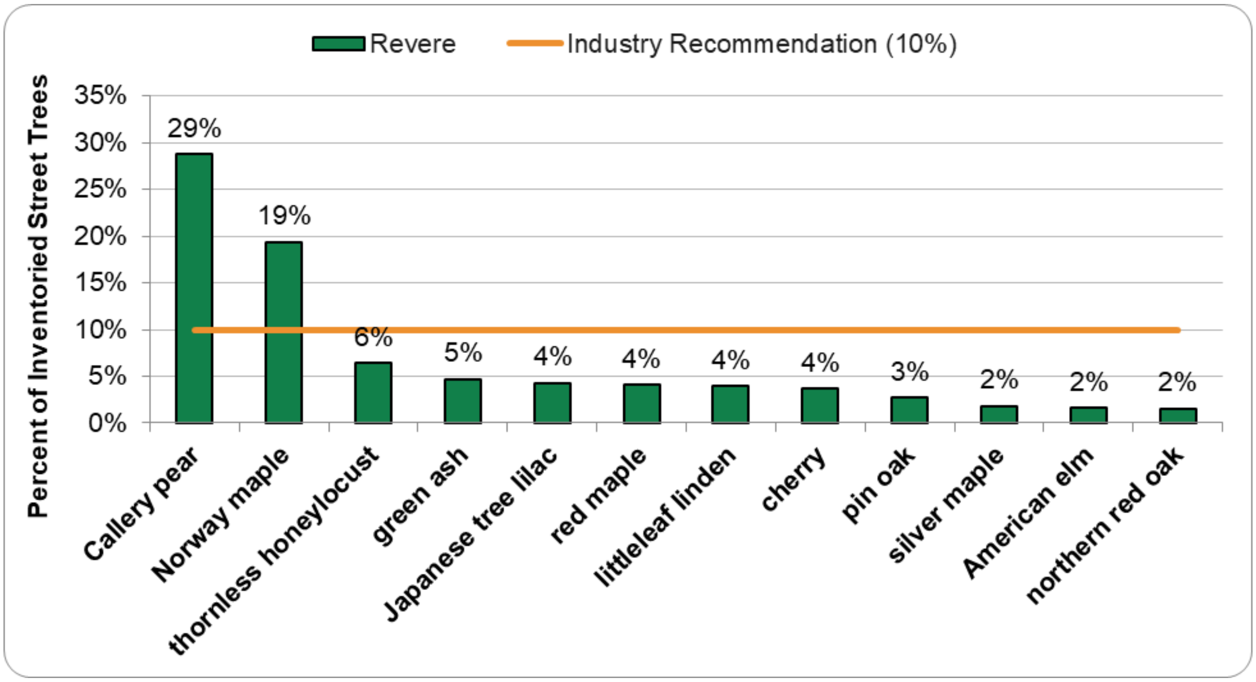


Figure 2. Species diversity of street trees which make up at least 2% of the inventoried population.

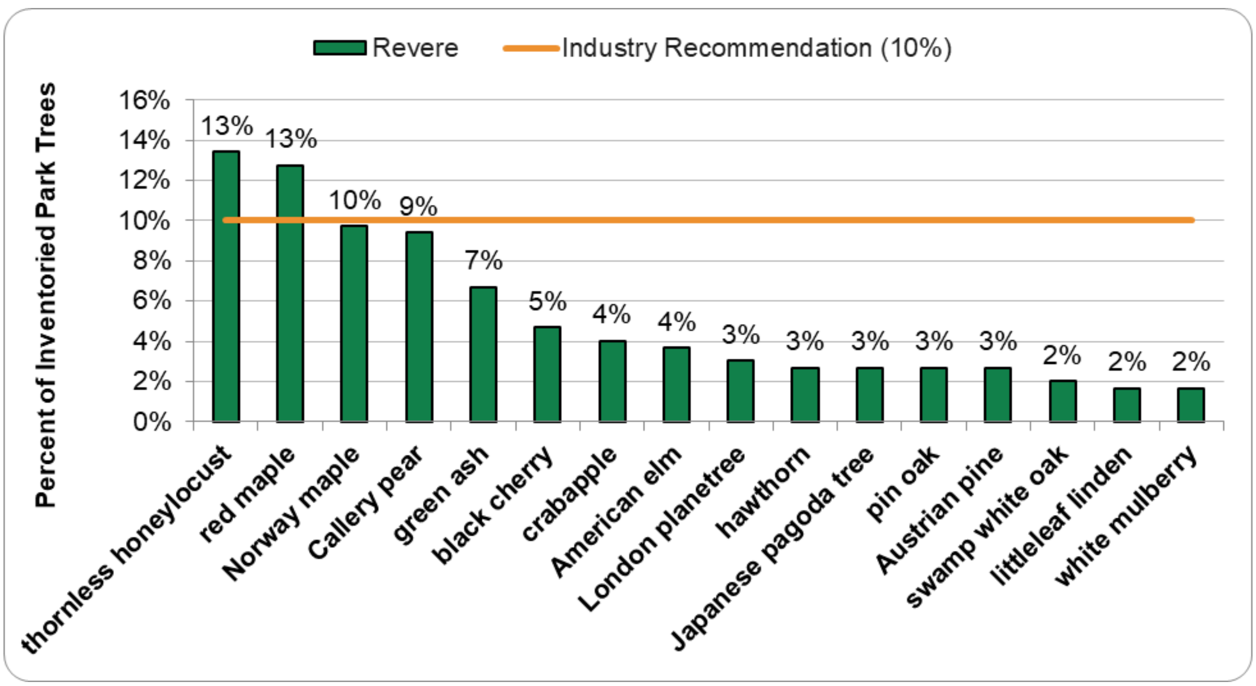


Figure 3. Species diversity of park trees which make up at least 2% of the inventoried population.

Figure 4 on the following page provides a genera diversity breakdown for Revere's inventoried street trees and includes all genera which made up at least 2% of the inventoried trees. **Pear (29%) and maple (27%) are by far the most common street tree genera**, followed by honeylocust (6%), oak (5%), cherry (5%) and ash (5%). There are 49 distinct genera represented among Revere's street trees.

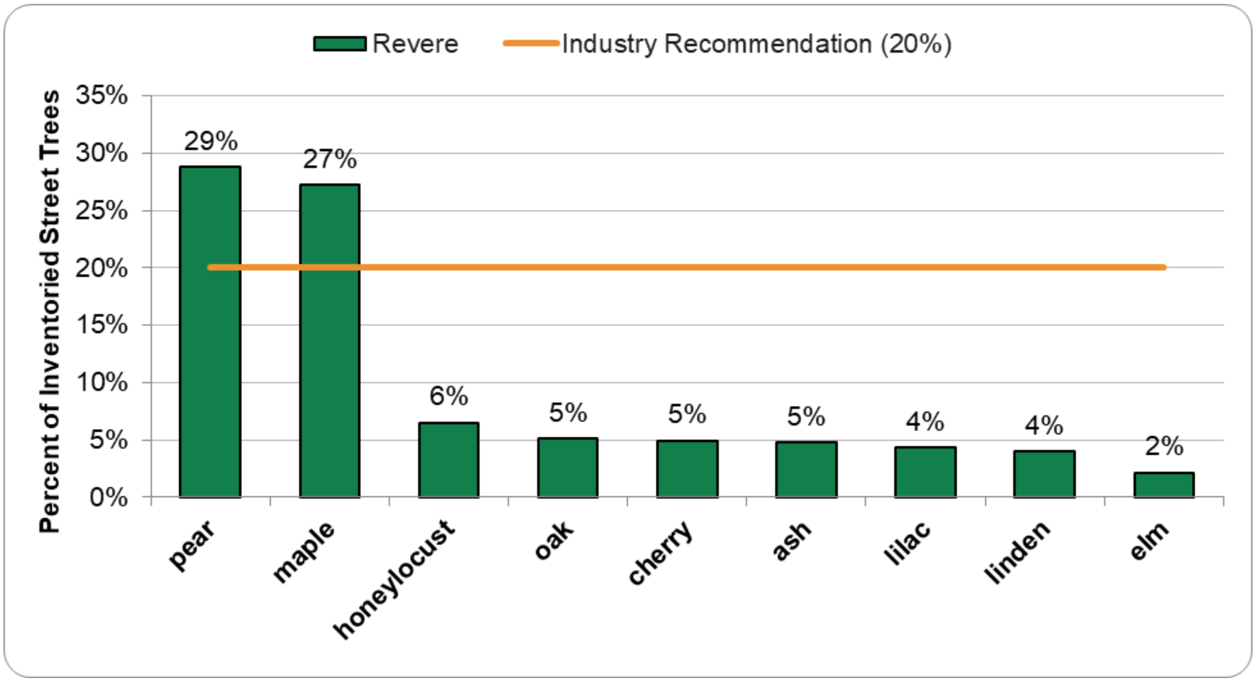


Figure 4. **Genera diversity of street trees which make up at least 2% of the inventoried population.**

Figure 5, below, shows the genus diversity breakdown for park trees and includes all genera which made up at least 2% of the inventoried park trees. **Maple is the most common genus among the inventoried park trees (23%).** Honeylocust (13%), pear (9%), ash (7%), oak (6%), pine (6%) and cherry (5%) were other common park tree genera. The city's inventoried park trees represent 28 distinct genera.

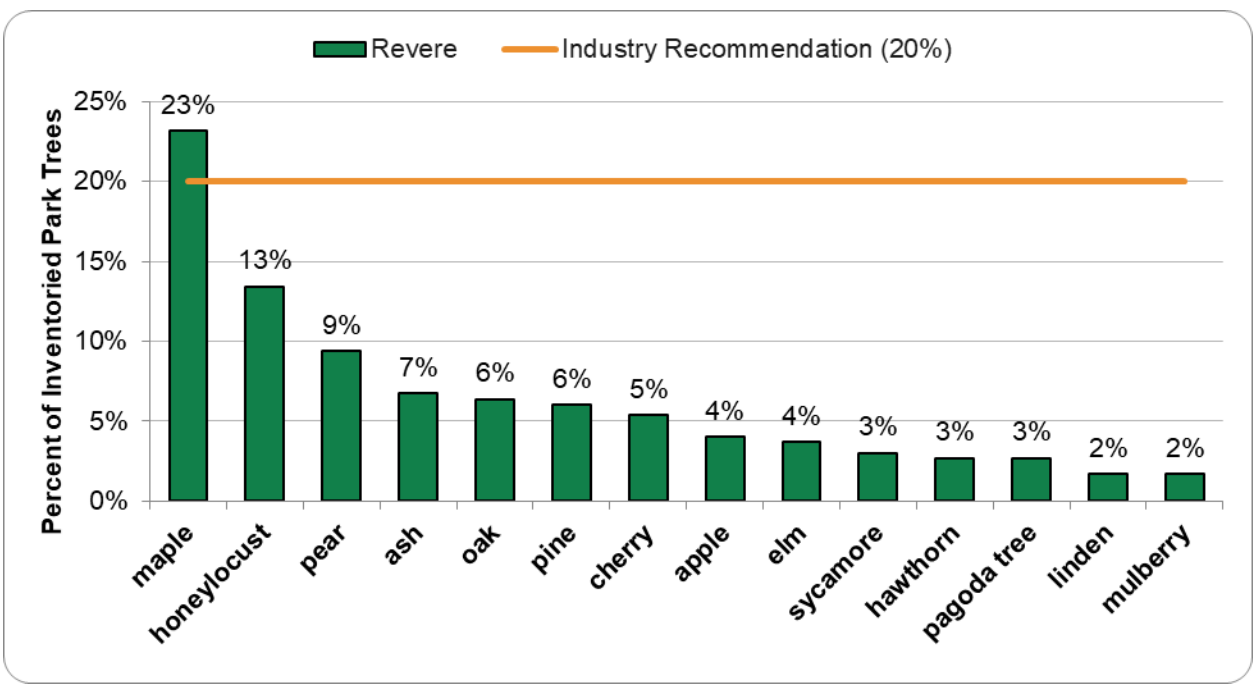


Figure 5. **Genera diversity of park trees which make up at least 2% of the inventoried population.**

Species & Genera Diversity Recommendations

- Avoid or limit planting of pears and maples, particularly Callery pear and Norway maple. Increase planting of other genera and species until pears and maples make up less than 20% of the public tree resource.
- Remove Callery pear and Norway maple volunteers from maintained public areas while small.
- Increase planting of uncommon species and genera which are well-suited to urban environments.

PEST SUSCEPTIBLITY

Early identification of tree pests and diseases can reduce the impact of infestations on the urban forest. Infestations which are caught while still limited to a small number of trees can be more easily and cost-effectively managed and further spread of the pest or disease prevented. Since pests and diseases prefer certain host tree species and genera, the susceptibility of an urban forest to a pest or disease can be predicted based on its species and genus diversity. Figure 6 on the following page presents the percentage of inventoried trees which are susceptible to pests and diseases of concern in Massachusetts. See Appendix B for additional information about these pests and diseases.

A total of 48% of Revere's collected park trees and 41% of the street trees are susceptible to spotted lanternfly. Other pests which could affect a large portion of the public tree resource include Asian longhorned beetle (39% of park trees and 63% of street trees) and spongy moth (27% of collected park trees and 41% of street trees). Additionally, pests that could affect a smaller, yet still sizeable number of trees are oak wilt (6% of collected park trees and 5% of street trees), needlecast diseases (7% of collected park trees and 1% of street trees) and emerald ash borer (7% of collected park trees and 5% of street trees).

Pest Susceptibility Recommendations

- Monitor trees for signs and symptoms of pests and diseases on a regular basis. This can be done as part of other routine maintenance activities such as routine pruning.
- When a pest or disease is suspected, act quickly to confirm the identification and begin management.
- Prepare an invasive species management plan to guide the response to future pest or disease infestations.
- When planting trees, select pest or disease-resistant species or cultivars whenever possible.

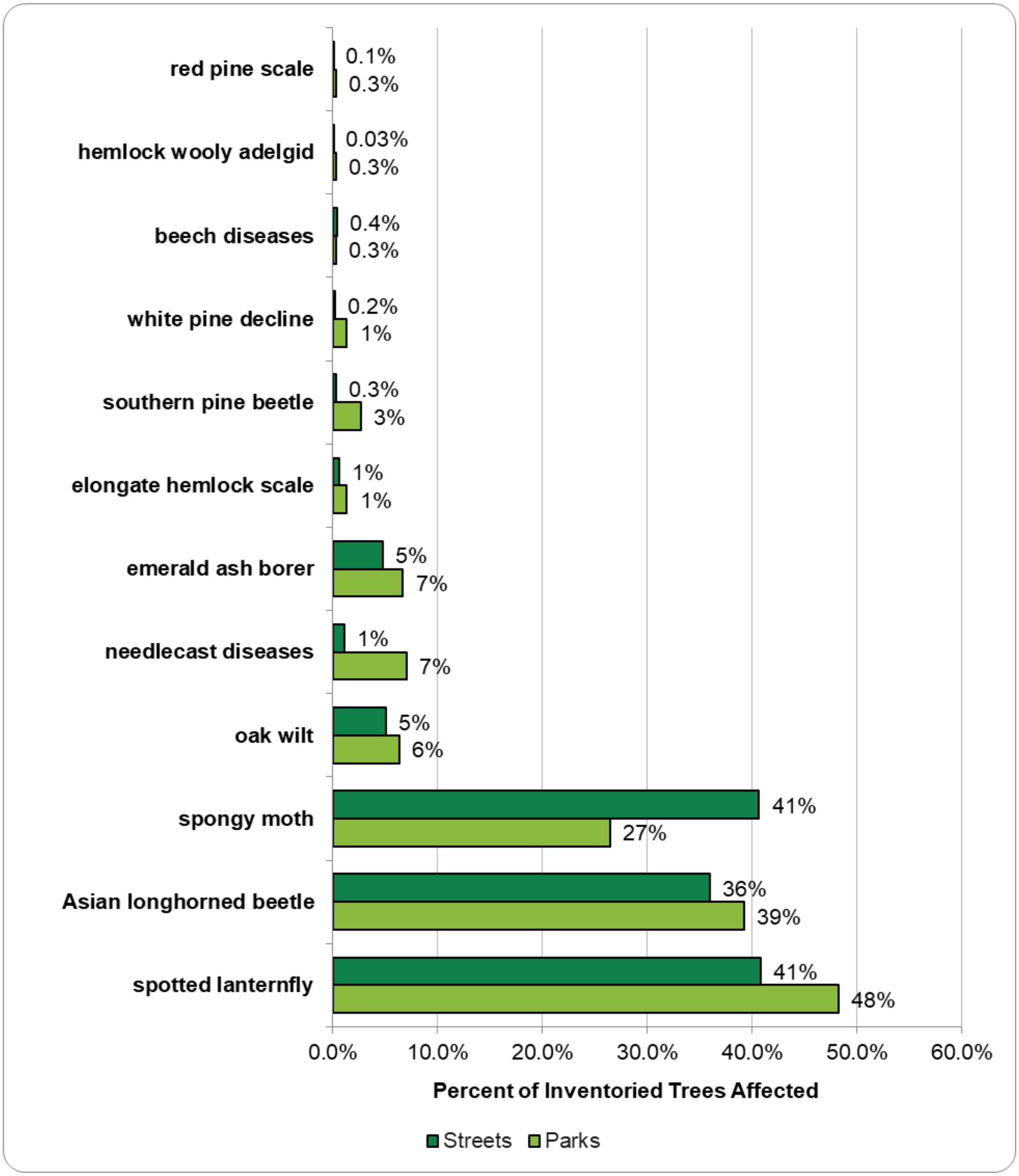


Figure 6. Susceptibility of the tree resource to pests and diseases of concern in Massachusetts.

CONDITION

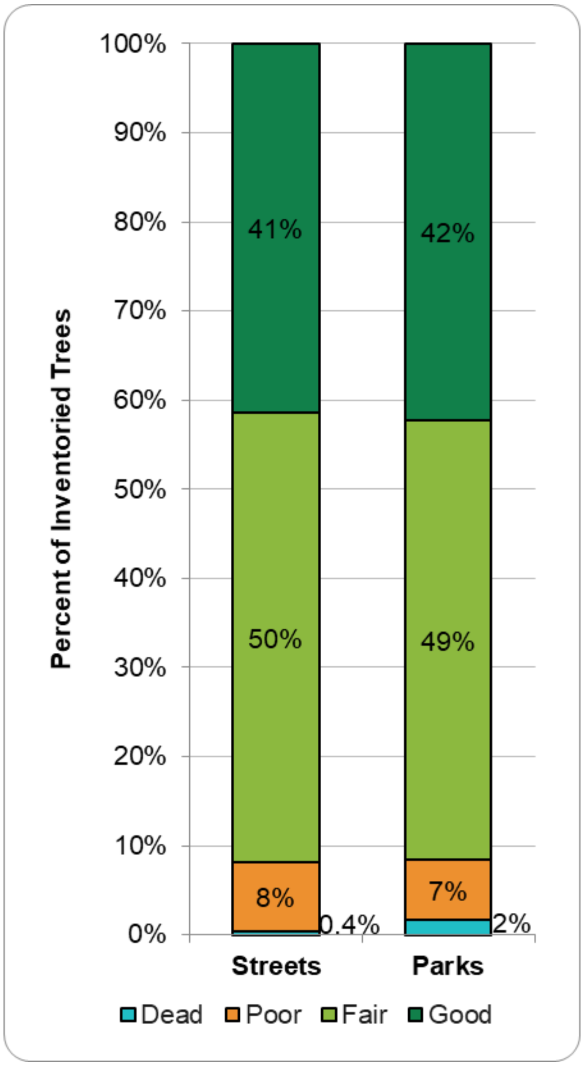


Figure 7. Condition ratings of street and park trees.

Each tree assessed during the inventory was assigned a condition rating based on multiple factors including root characteristics, branch structure, trunk, canopy, foliage condition, and the presence of pests or disease. Condition ratings included good, fair, poor, and dead.

Condition Ratings

Good: trees in good condition have no significant issues.

Fair: trees in fair condition may have some issues which are likely to improve with time or maintenance (e.g., dead branches that can be removed during pruning, minor trunk wounds that the tree can heal with time).

Poor: these trees have more significant issues which are not likely to improve with time or maintenance (e.g., large sections of dead canopy, decay cavities in the stem or roots).

Dead: dead trees show no signs of life.

Figure 7 provides the condition rating breakdown for park and street trees in Revere. **Most trees in Revere were in good or fair condition** – 91% of street trees and park trees. About 9% of street trees and park trees were in poor or dead condition.

Condition Recommendations

- Remove dead trees as soon as possible to free up space for new plantings and improve the appearance of Revere's streets and parks.
- Trees in poor condition not recommended for removal should be maintained to reduce risk associated with defects and may need continued monitoring for further decline that would necessitate removal.
- Condition ratings can be improved over time by instituting proactive maintenance cycles such as a routine pruning cycle and young tree training cycle. Pruning should follow *ANSI A300 (Part 1)* guidelines.

RELATIVE AGE DISTRIBUTION

Analysis of a tree population's relative age distribution can be performed by assigning age classes to the diameter of inventoried trees. Although actual tree age cannot be determined by diameter alone, this method of approximation is an industry standard technique that can help identify potential challenges and maintenances needs of an urban tree population.

Age/Size Classes

Young: 0-8 inches diameter at breast height (DBH)

Established: 9-17 inches DBH

Maturing: 18-24 inches DBH

Mature: 25+ inches DBH

The size classes (left) were chosen so that the inventoried trees could be compared to the ideal relative age distribution as proposed by N.A. Richards, which holds that the largest proportion of the inventoried tree population (40%) should be young trees, smaller portions should be established and maturing trees (30% and 20%, respectively), and the smallest proportion (10%) should be mature trees[3].

Figure 8 compares the age distribution of the park and street tree populations to Richard's industry recommendation. **In general, both street trees and park trees in Revere skew towards young and established trees.** Young trees in the ROW and in parks are over the industry recommendation by 11% and 14% respectively. Established trees are over the industry recommendation by 6% and 8% respectively. Older trees are under-represented in the ROW and parks - maturing trees are below the suggested 20% threshold (9% in the ROW and 6% in parks) and mature trees are below the suggested 10% threshold (4% in the ROW and 2% in parks).

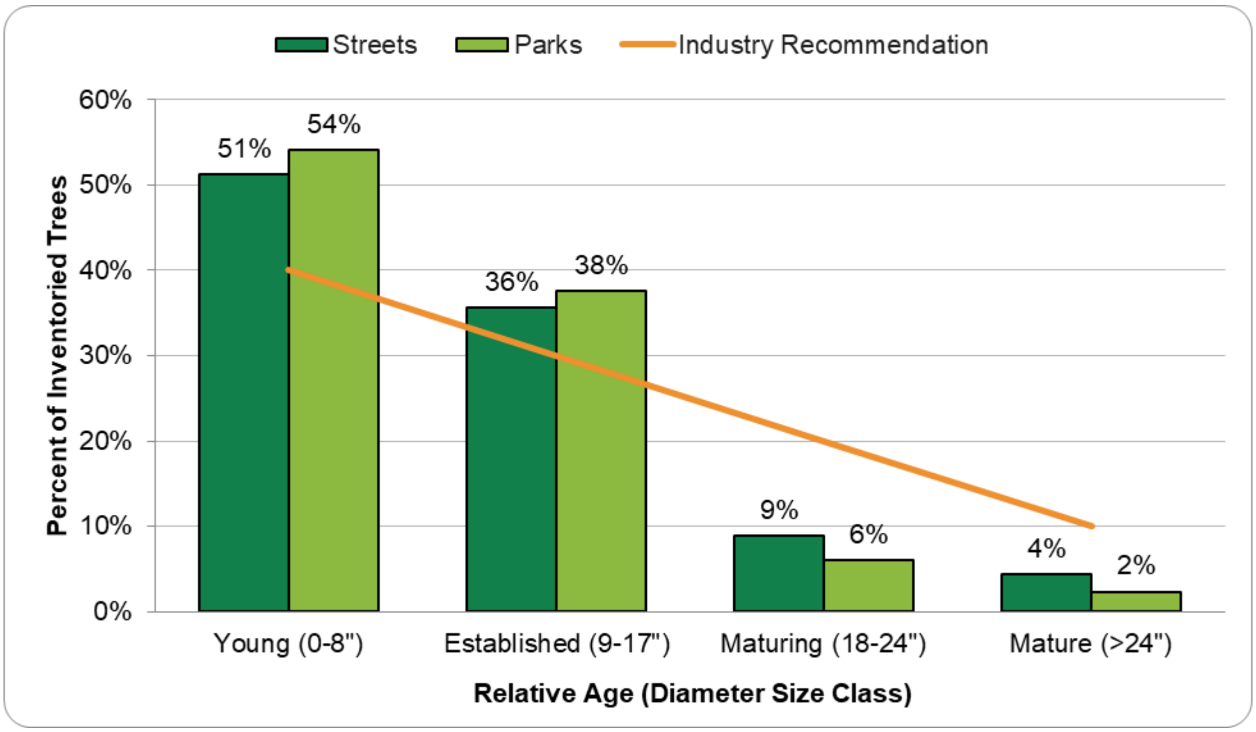


Figure 8. Relative age distribution of the inventoried trees.

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

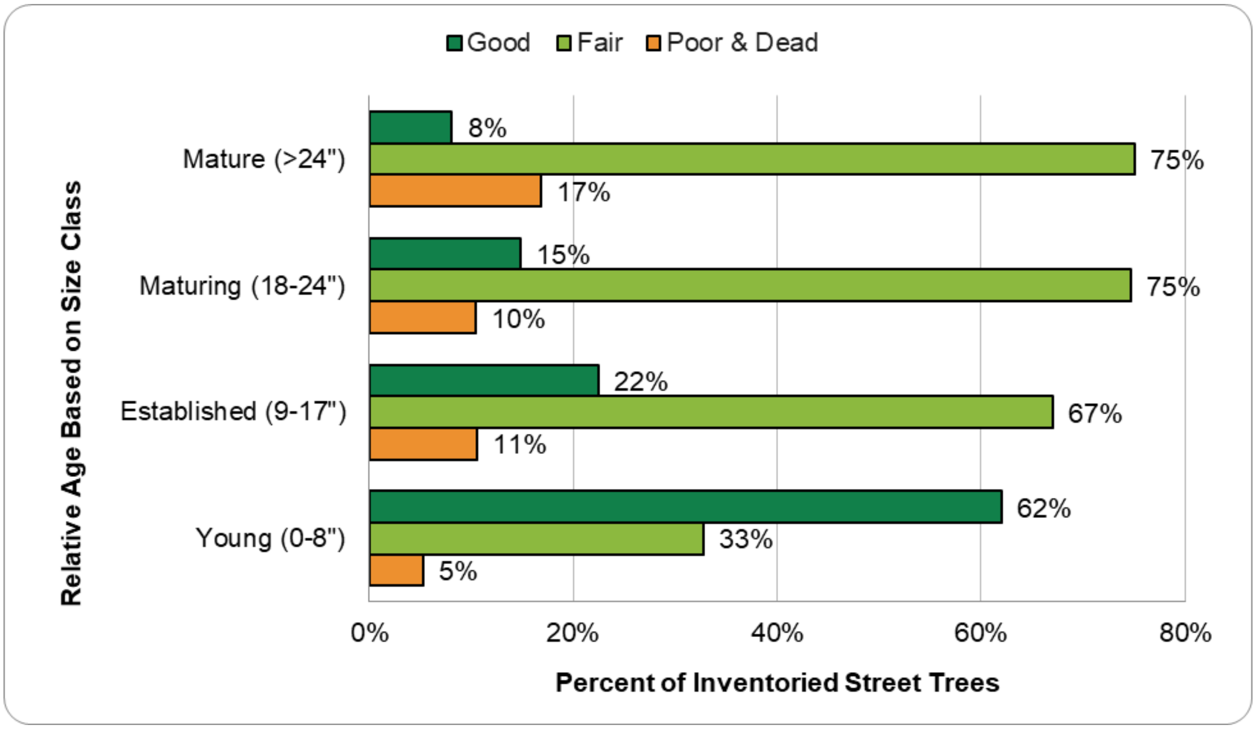


Figure 9. **Street tree condition ratings compared to age class.**

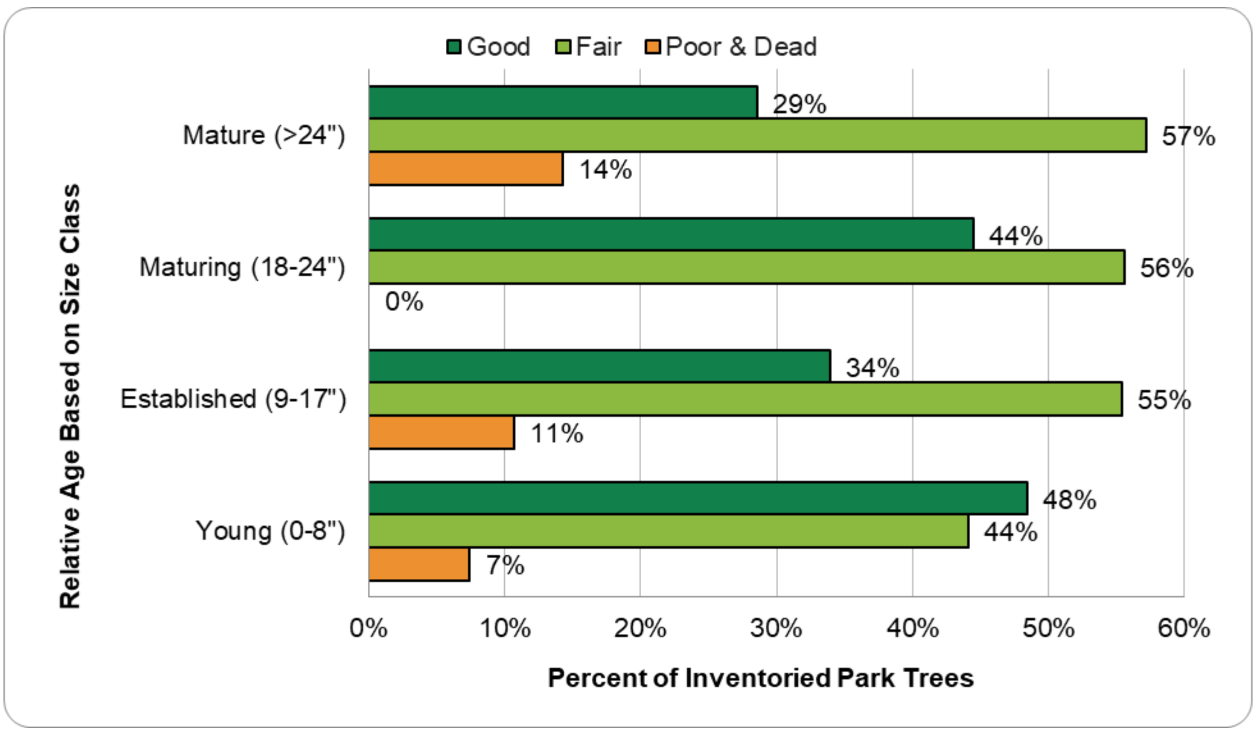


Figure 10. **Park tree condition ratings compared to age class.**

Figures 9 and 10 compare tree condition ratings across the relative age classes for street and park trees. Both park and street trees across all age classes are generally in fair condition, except for the young age class. Young trees in parks and along streets are more likely to be in good condition than older trees. Mature trees are more likely to be in poor condition than young trees. Park trees across most ages are more likely to be in good condition than street trees.

Relative Age Recommendations

- Across both streets and parks, maturing and mature trees are underrepresented. The city should focus on tree preservation and proactive care for these large-stature trees, as they provide the greatest benefit to the residents of Revere. If young and established trees are protected and preserved, they will eventually reach the maturing and mature age classes and replenish those segments of the population.
- A large proportion of street and park trees are young or established (51% and 54%, respectively). A young tree training cycle should be instituted to structurally prune these younger trees to ensure good form and improve health as they mature.
- Mature street and park trees were more likely to be evaluated in poor condition (17% and 14%, respectively). Routine, proactive maintenance, such as young tree training and routine pruning, may help improve tree condition, particularly among maturing and mature trees, in the future.

DEFECT OBSERVATIONS

During the inventory, DRG arborists took note of any damage, decay, structural flaws, pests/diseases, or dead portions of inventoried trees and recorded these defect observations for each tree. Where a tree had more than one defect, only the most significant defect, i.e. the defect causing the greatest detriment to the tree was recorded.

Poor branch attachments were the most common issue reported among street trees (24%), and the second most common defect for park trees (22%). Dead and dying branches was the most common recorded defect for park trees (26%) and the second most common defect for street trees (17%). No significant defect was reported for 14% of street trees and 13% of park trees at the time of inventory.

Defects

Branch Attachment: acute branch angles, included bark, codominant stems or limbs, multiple branch attachments at same point on stem

Broken and/or Hanging Branches: untrimmed branch stubs, torn or split branches, “hangers”

Cracks: frost cracks, splitting branch unions, torsion cracks, stress cracks

Dead and Dying Branches: dead branches or crown

Decay or Cavity: cavities, decay columns, fungal fruiting bodies, trunk wounds

No Significant Defect: no major issues present

Root Problems: dead roots, cut roots, root plate lifting, soil cracking, root damage/decay, girdling roots

Tree Architecture: lean, utility pruning, unbalanced crown

Trunk Condition: notable damage or decay specific to a tree’s main leader

Table 2. **Defect observations for street and park trees.**

Defect	Street Trees	Percent of Street Trees	Park Trees	Percent of Park Trees
Branch Attatchment	883	24%	65	22%
Broken and/or Hanging Branches	170	5%	20	7%
Cracks	22	1%	0	0%
Dead and Dying Branches	636	17%	76	26%
Decay or Cavity	282	8%	27	9%
No Significant Defect	499	14%	40	13%
Root Problems	137	4%	16	5%
Tree Architecture	524	14%	24	8%
Trunk Condition	500	14%	30	10%
Total	**3,653**	**100%**	**298**	**100%**

Defect Observation Recommendations

- Branch attachment issues was the most common defect observation for trees in Revere. These types of defects can often be resolved by structural pruning within the first 10 to 20 years of the tree's life. Instituting a young tree training program could reduce instances of these defects over time and lower maintenance costs over the long term.
- Dead or Dying Branches was the second most common defect observation. Many of the risks associated with dead and dying branches can be mitigated through the implementation of a routine pruning program.

INFRASTRUCTURE CONFLICTS

In an urban setting, growing space for trees is limited both above and below ground, and conflicts between infrastructure such as buildings, sidewalks, utility wires, and pipes are common. Trees which cause damage to infrastructure may be a nuisance and may even threaten public safety. At the same time, trees which conflict with infrastructure are often damaged or removed during infrastructure repair or upgrades. Reducing conflicts between city infrastructure and trees benefits the city, city residents, public and private utility companies, and trees. During the Revere inventory, tree conflicts with overhead utilities and hardscape were observed and recorded.

Overhead Utilities: Any primary electric distribution lines that are currently or could potentially conflict with the canopy of a tree

Hardscape Damage: diversion of the sidewalk or curb by at least 1" due to the current or past presence of a tree

Table 3 shows the number and percentage of street and park trees observed to conflict with overhead and underground utilities or surrounding hardscape. At the time of inventory, **31% of street trees conflicted with overhead utilities.** In park settings, only 8% of trees had overhead conflicts. At least 230 trees had additional comments like "utility pruned" or "topped for utility", where inventory arborists noticed severe or structurally unsafe pruning done to mitigate conflict with overhead utilities. While this type of pruning avoids conflict in the short term, it can cause major structural issues in street trees over time and provide opportunities for decay and disease to access the heartwood of a tree.

Table 3. Infrastructure conflicts recorded during the inventory.

Conflict	Street Trees	Percent of Street Trees	Park Trees	Percent of Park Trees
Overhead Utilities				
Not present	1,707	47%	258	87%
Present & conflicting	1,150	31%	25	8%
Present & not conflicting	796	22%	15	5%
Total	3,653	100%	298	100%
Hardscape Damage				
Yes	768	21%	6	2%
No	2885	79%	292	98%
Total	3,653	100%	298	100%

Approximately 21% of street trees were recorded as having caused hardscape damage. Only 2% of park trees were causing hardscape damage. As Revere's street tree population matures, hardscape damage could become more common.

Infrastructure Recommendations

- Strategic pruning of trees near electric distribution lines, often called utility pruning, may unbalance tree crowns, reduce benefits provided by street trees, cause or worsen tree defects, and impact the aesthetic value of trees. However, tree conflicts with electric distribution lines can cause fires, power outages, and significant expenses and conflicts between tree managers and utility owners. Revere should:
    - Reduce tree conflicts with electric distribution lines by planting only small stature trees beneath or near overhead electric utilities (see Eversource's recommended "30 Trees Under 30 Feet Tall" list for some approved trees for this purpose). Consider looking for dwarf or small cultivars of typically large-stature trees, such as 'City Sprite' or 'Wireless' zelkovas or 'Summer Sprite' linden, to diversify small-stature planting lists.
    - Develop and maintain good working relationships with electricity providers for the city. Open lines of communication and strategic contacts can simplify emergency response efforts, ease tensions between competing interests, and potentially limit excessive utility pruning of city trees.
    - Consider developing or reviewing and revising permitting processes for utility pruning work. This can allow Revere greater oversight on utility pruning operations and ensure that the work is done in a way that meets the needs of the utility company without doing undue damage to city trees.

DRG Recommended Overhead Utility Clearances

Small Trees up to 25 feet tall *can* be planted under and within 20 feet of overhead utilities

Medium Trees 25 to 40 feet tall should be planted 20 feet or further from overhead utilities

Large Trees over 40 feet tall should be planted 40 feet or further from overhead utilities

DRG RECOMMENDED CLEARANCES FOR TREE PLANTING

40 feet between: large trees

30 feet from: intersections (approaching traffic)

30 feet between: medium trees

20 feet from: fire hydrants

20 feet between: small trees

15 feet from: utility poles, streetlights, buildings

10 feet from: driveways, intersections (retreating traffic), crosswalks, important street signage

5 feet from: underground utilities

Example tree planting specifications

Courtesy of the City of Ithaca, NY

Potential Alternatives to Street Trees

Setback planting program

Planting behind sidewalk when ROW is sufficiently wide

Encouraging private tree planting and tree preservation

Creation of pocket parks

Maintenance and improvement of nearby public grounds

- Limited soil volume and root space available for trees, compounded by planting large trees in very constrained spaces, is a common cause of hardscape damage. Hardscape damage can reduce the walkability of the city, cause Americans with Disabilities Act (ADA) compliance issues, lead to injuries and public complaints, impact tree health and vigor, and require expensive repairs which may damage street trees or even require their removal. Revere should:

DRG Recommended Minimum Growing Space Dimensions

Small Trees: 4 feet x 4 feet

Medium Trees: 6 feet x 6 feet

Large Trees: 8 feet x 8 feet

  - Develop and document standards for tree planting which require specific growing space dimensions and/or soil volumes for various sizes of tree. Planting only small trees where the growing space and soil volume is restricted will help reduce hardscape damage issues due to tree root growth.
  - Encourage collaboration between city planning, engineering, and tree management departments and staff. Considering trees early in the planning process when repairing or redesigning streets and sidewalks allows greater flexibility in the strategies used to ensure trees can be a productive part of the new streetscape.
  - Consider a variety of strategies for incorporating sufficient growing space into street and sidewalk designs, including enlarging planting wells or siting them on the back edge of the sidewalk adjacent to lawns, installing new tree wells or lawns, creating traffic bump outs, and incorporating 'Silva Cell' or structural soil technology into designs.
  - Implement a variety of techniques for retaining mature street trees despite conflicts with hardscape. If possible, reroute sidewalks or build temporary ramps of pavement or wood over tree roots rather than remove healthy, mature trees.
- Tree conflicts with underground utilities can damage water and sewer piping, gas lines, and electric conduits. Maintenance of these utilities often results in cut tree roots, which may destabilize trees and cause tree failure, or may simply reduce tree vigor or kill the tree.

    - Plant trees at least 5 feet from any underground utility to allow room for large, structural roots to develop without impacting the utility.
- Conflicts with other infrastructure such as buildings, road signage, streetlights, and driveways should also be considered. Revere should:
    - Develop and document planting guidelines which dictate required clearances for different types of infrastructure. See the sidebar on the previous page for a list of clearances recommended by DRG.
- Recognize that many competing needs intersect when trying to site street trees. City streetscapes must balance needs for driving, parking, pedestrian access, overhead and underground utilities, street furniture, signage, lighting, winter snow removal, and many other considerations. Some areas will not be suitable for trees, and alternatives to street planting should be used in these areas instead of planting street trees.

STOCKING LEVEL

"Stocking" is a traditional forestry term used to measure the density and distribution of trees. In an urban forest, stocking level is the ratio of street ROW spaces occupied by trees to the total street ROW spaces suitable for trees. Park trees and other non-ROW public property trees are excluded from this measurement. Revere has a total of 4,095 current and potential tree sites along streets (3,653 trees + 215 planting sites + 227 stumps), 3,653 of which are currently occupied by a tree. Therefore, **the city's current stocking level is** $(\mathbf{3,653}\ \boldsymbol{trees} \div \mathbf{4,095}\ \boldsymbol{potential\ tree\ sites}) \times \mathbf{100} = \mathbf{89\%}$**.**

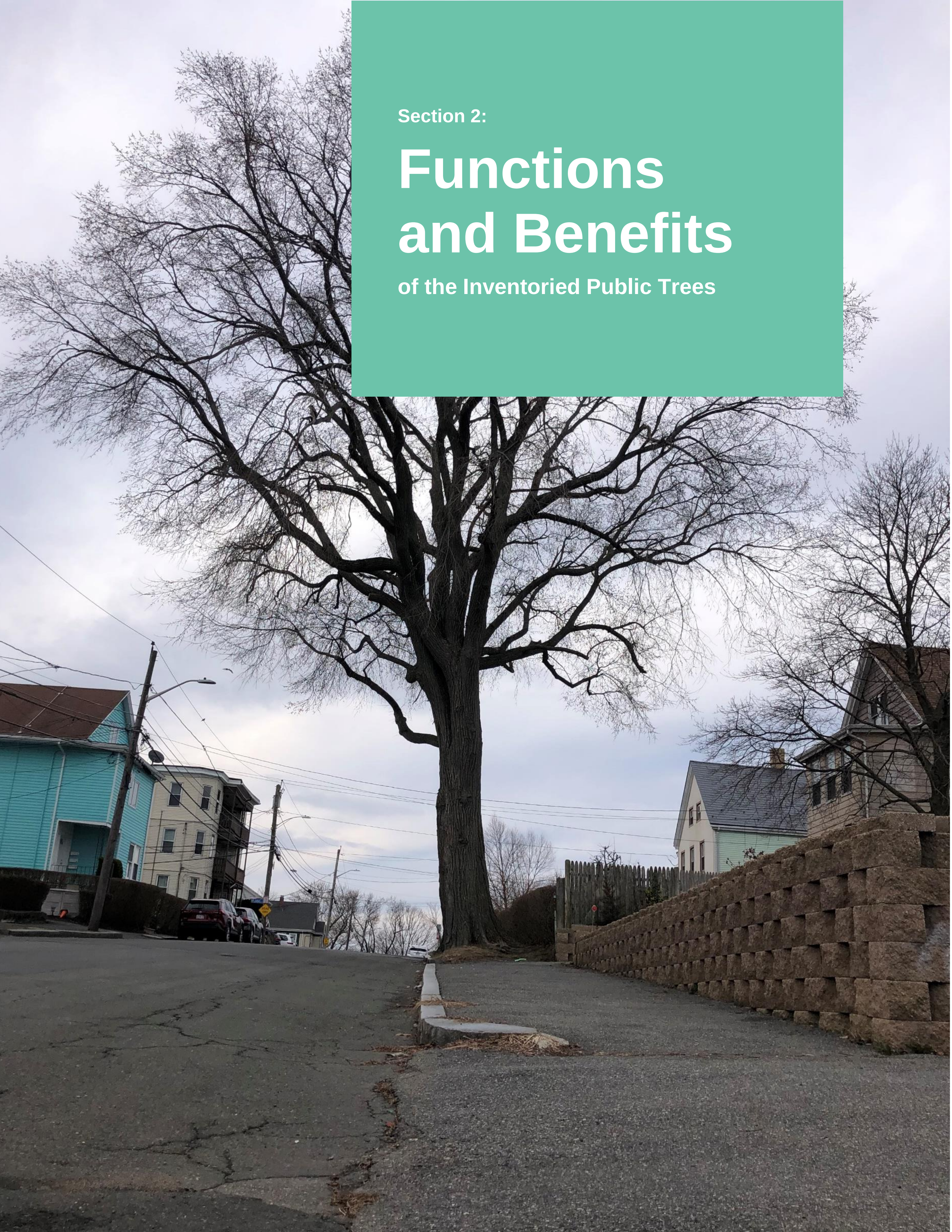
Stocking Level Recommendations

- Stocking level can be used to set, measure, and track progress toward tree planting goals. Revere should consider what its tree planting goals are and use metrics such as these to chart progress toward those goals.
    - Although "ideal" stocking level goals have been debated in the past, there is no single "one size fits all" goal for every community. Goals should be achievable and tailored to the specific needs and challenges facing Revere.
    - Once initial goals are achieved, further goals can be set. This method of progress can help ensure that goals are achievable and build capacity and public support for tree planting and care over time.
- At a stocking level of 89%, Revere's streets are close to being fully stocked and planting opportunities along streets are currently limited. To continue growing the urban forest, Revere could:
    - Consider alternatives to street tree planting, such as planting in parks, public grounds, and cemeteries; setback plantings on private property; and incorporating more space for trees in street redesigns and new developments.

Section 2:

Functions and Benefits

of the Inventoried Public Trees



SECTION 2: FUNCTIONS AND BENEFITS OF THE PUBLIC TREE RESOURCE

Trees play a vital role in the urban environment by providing a wide array of economic, environmental, and social benefits which can far exceed the investments in planting, maintaining, and removing them. Trees reduce air pollution, improve public health outcomes, reduce

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).
- When surrounded by trees, physical signs of personal stress, such as muscle tension and pulse rate, were measurably reduced within three to four minutes (Ulrich 1991).

stormwater runoff, sequester and store carbon, reduce energy use, and increase property value, among other benefits.

I-TREE ANALYSES

DRG used i-Tree Eco, a tool within the i-Tree suite, to model benefits provided by Revere's inventoried public trees. i-Tree Eco combines tree inventory data with local air pollution and meteorological records to quantify several of the functional benefits of a community's tree resource. By framing trees and their benefits in a way that everyone can understand, as dollars saved per year, i-Tree Eco can help communities 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.

ANNUAL BENEFITS

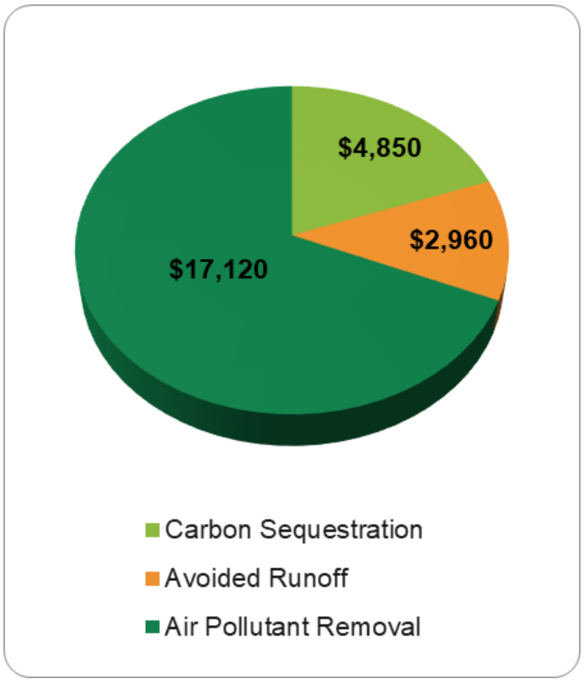


Figure 11. Breakdown of three annual benefits provided by the inventoried trees.

The i-Tree Eco model estimates the annual value of three major tree benefits: carbon sequestration, airborne pollutant removal, and stormwater runoff reduction. The model also calculates the amount and value of carbon storage done by the inventoried trees and the replacement value of the tree resource. For these analyses, street and park trees were grouped together to give an overall estimate of the benefits provided by the inventoried public trees. **The inventoried trees provide $24,930 of air quality, stormwater management, and carbon sequestration benefits each year** (Figure 11). Keep in mind that the model only calculates this small number of key benefits – many other benefits provided by trees are not so easy to quantify but all add to the value that public trees provide.

Compared to rural landscapes, urban landscapes are characterized by high pollutant emissions in a relatively small area. **Air pollutant removal was the most valuable benefit estimated by i-Tree Eco for Revere, with an annual value of $17,120**. Avoiding stormwater runoff reduces the risk of flooding and combined sewer overflow, both of which impact people, property, and the environment. I-Tree Eco estimated the value of this benefit at $2,960 annually. Carbon dioxide (CO_2) also impacts people, property, and the environment as the primary greenhouse gas driving climate change. Revere receives an estimated $4,850 of carbon sequestration benefits each year.

SEQUESTERING AND STORING CARBON

Trees are carbon sinks – the opposite of carbon sources. While carbon is released from cars and smokestacks as fossil fuels are consumed, it is absorbed into trees during photosynthesis and stored in their tissues as they grow. The i-Tree Eco model estimates the amount and value of carbon sequestered each year and the total carbon stored by the inventoried trees over their lifetimes. **Revere's inventoried public trees sequester 28.44 tons of carbon each year valued at $4,850 annually, and currently store 1374.04 tons of carbon valued at $234,343.**

Using the i-Tree Eco results, tree species that contribute significantly to the benefits experienced by Revere can be identified. Tables 4 and 5 provide side by side comparison of carbon storage and carbon sequestration by both the most common public tree species and the species that are proving the greatest carbon benefits per tree. Callery pears are the most common public tree in Revere and store about 339 pounds of carbon per tree on average. The highest performing species per tree is white willow, which stores 9,100 pounds of carbon per tree, almost 30 times the amount of carbon the average Callery pear stores. The same white willow sequesters a very small amount of carbon per year when compared to the 1,080 Callery pears in city, but the dollar value of carbon

Table 4. Inventoried species providing the greatest carbon storage benefits.

Carbon Storage by the Most Common Public Tree Species						
Species (Common Name)	Species (Botanical Name)	# Trees	Carbon (tons)	Carbon (lbs/tree)	Total Value ($)	Per Tree Value ($/tree)
Callery pear	*Pyrus calleryana*	1,080	182.9	338.63	$31,187.79	$28.88
Norway maple	*Acer platanoides*	737	444.0	1204.86	$75,723.08	$102.75
honeylocust	*Gleditsia triacanthos*	277	44.6	322.17	$7,610.68	$27.48
green ash	*Fraxinus pennsylvanica*	192	51.0	531.15	$8,695.58	$45.29
red maple	*Acer rubrum*	189	43.6	460.95	$7,429.90	$39.31
Japanese tree lilac	*Syringa reticulata*	157	3.6	45.48	$609.48	$3.88
littleleaf linden	*Tilia cordata*	148	75.7	1022.43	$12,904.68	$87.19
cherry spp.	*Prunus species*	137	15.8	229.93	$2,687.01	$19.61
pin oak	*Quercus palustris*	108	84.7	1568.70	$14,447.39	$133.77
American elm	*Ulmus americana*	71	23.6	663.38	$4,017.15	$56.58
Carbon Storage by the Most Productive Public Tree Species						
Species (Common Name)	Species (Botanical Name)	# Trees	Carbon (tons)	Carbon (lbs/tree)	Total Value ($)	Per Tree Value ($/tree)
white willow	*Salix alba*	1	4.55	9100.00	$776.67	$776.67
northern red oak	*Quercus rubra*	58	131.86	4546.90	$22,489.55	$387.75
silver maple	*Acer saccharinum*	67	126.58	3778.51	$21,589.16	$322.23
Amur corktree	*Phellodendron amurense*	1	1.24	2480.00	$211.38	$211.38
dawn redwood	*Metasequoia glyptostroboides*	1	0.99	1980.00	$168.55	$168.55
tree-of-heaven	*Ailanthus altissima*	20	19.04	1904.00	$3,247.98	$162.40
Siberian elm	*Ulmus pumila*	17	16.01	1883.53	$2,731.09	$160.65
pin oak	*Quercus palustris*	108	84.71	1568.70	$14,447.39	$133.77
Norway maple	*Acer platanoides*	737	443.99	1204.86	$75,723.08	$102.75
goldenraintree	*Koelreuteria paniculata*	8	4.69	1172.50	$800.19	$100.02

sequestration occurring per year for the white willow is $4.28 while a Callery pear has an annual dollar value of $0.96. Some of this difference has to do with tree size. Most Callery pears in Revere are under 10 DBH and can physically not store or sequester the same amount of carbon as larger stature mature trees, such as the single inventoried white willow, can. This highlights the importance of planting broadleaf, large-stature trees wherever possible, as these species can provide far greater benefits than smaller trees.

Table 5. Inventoried species providing the greatest carbon sequestration benefits.

Species (Common Name)	Species (Botanical Name)	# Trees	Carbon (tons/yr)	Carbon (lbs/tree/yr)	Total Value ($/yr)	Per Tree Value ($/tree/yr)
Carbon Sequestration by the Most Common Public Tree Species						
Callery pear	*Pyrus calleryana*	1,080	6.1	11.22	$1,032.87	$0.96
Norway maple	*Acer platanoides*	737	9.4	25.45	$1,600.10	$2.17
honeylocust	*Gleditsia triacanthos*	277	1.4	10.11	$238.19	$0.86
green ash	*Fraxinus pennsylvanica*	192	1.2	12.08	$197.54	$1.03
red maple	*Acer rubrum*	189	1.4	14.39	$231.36	$1.22
Japanese tree lilac	*Syringa reticulata*	157	0.3	4.33	$57.83	$0.37
littleleaf linden	*Tilia cordata*	148	1.2	16.62	$209.61	$1.42
cherry spp.	*Prunus species*	137	0.4	5.84	$68.33	$0.50
pin oak	*Quercus palustris*	108	1.3	24.81	$228.86	$2.12
American elm	*Ulmus americana*	71	0.3	8.45	$50.88	$0.72
Carbon Sequestration by the Most Productive Public Tree Species						
Species (Common Name)	Species (Botanical Name)	# Trees	Carbon (tons/yr)	Carbon (lbs/tree/yr)	Total Value ($/yr)	Per Tree Value ($/tree/yr)
white willow	*Salix alba*	1	0.0	0.00	$4.28	$4.28
northern red oak	*Quercus rubra*	58	1.1	38.28	$188.93	$3.26
Amur corktree	*Phellodendron amurense*	1	0.0	0.00	$3.06	$3.06
dawn redwood	*Metasequoia glyptostroboides*	1	0.0	0.00	$3.00	$3.00
Siberian elm	*Ulmus pumila*	17	0.3	34.12	$50.13	$2.95
silver maple	*Acer saccharinum*	67	1.1	34.03	$193.81	$2.89
honeylocust	*Gleditsia triacanthos*	3	0.1	33.33	$7.71	$2.57
Norway maple	*Acer platanoides*	737	9.4	25.45	$1,600.10	$2.17
pin oak	*Quercus palustris*	108	1.3	24.81	$228.86	$2.12
black oak	*Quercus velutina*	7	0.1	22.86	$13.76	$1.97

Table 6. **Summary of benefits provided by the most common inventoried tree species.**

Most Common Tree Species Inventoried		Count**	Percent of Total	Benefits Provided by Inventoried Public Trees				
				CO_2 Stored	CO_2 Sequestered	Avoided Runoff	Air Pollution Removed	Replacement Value
Common Name	Botanical Name		%	tons	tons/year	gal/year	lbs/year	$
Callery pear	*Pyrus calleryana*	1,080	27.3%	182.9	6.1	56,298	260	$875,820
Norway maple	*Acer platanoides*	737	18.6%	444.0	9.4	81,766	360	$1,359,647
honeylocust	*Gleditsia triacanthos*	277	7.0%	44.6	1.4	16,532	800	$286,266
green ash	*Fraxinus pennsylvanica*	192	4.9%	51.0	1.2	28,622	120	$309,371
red maple	*Acer rubrum*	189	4.8%	43.6	1.4	13,208	60	$190,004
Japanese tree lilac	*Syringa reticulata*	157	4.0%	3.6	0.3	1,250	0*	$31,472
littleleaf linden	*Tilia cordata*	148	3.7%	75.7	1.2	21,560	100	$392,660
cherry species	*Prunus species*	137	3.5%	15.8	0.4	4,655	20	$57,265
pin oak	*Quercus palustris*	108	2.7%	84.7	1.3	28,785	120	$369,066
American elm	*Ulmus americana*	71	1.8%	23.6	0.3	4,183	20	$66,508
silver maple	*Acer saccharinum*	67	1.7%	126.6	1.1	19,836	80	$216,995
crabapple	*Malus species*	63	1.6%	3.2	0.2	764	0*	$21,712
northern red oak	*Quercus rubra*	58	1.5%	131.9	1.1	11,979	60	$363,950
London planetree	*Platanus hybrida*	49	1.2%	7.3	0.2	5,727	20	$69,517
hawthorn	*Crataegus species*	45	1.1%	1.8	0.1	584	0*	$14,383
All Other Trees Inventoried		577	14.6%	134	2.7	35,481	0*	$461,801
Total		**3,955**	**100%**	**1,374**	**28.4**	**331,230**	**1,480**	**$5,086,436**

*0 values in the air pollution column indicate less than one pound of pollutant removal per year.

**Dead trees of unknown species are excluded from the i-Tree Eco analysis, so total tree count in this table may differ from the total number of inventoried trees.

Table 6 summarizes the i-Tree Eco benefits provided by the most common tree species in Revere's inventory. Although the more commonly planted tree species in the city are generally smaller-stature than the highest performing trees, there is still power in numbers. The net benefits that trees like Callery pears provide are significant, largely due to the quantity of these species present in Revere. The Callery pears store 13% of the total estimated stored carbon and 22% of carbon sequestered by the inventoried trees. They also absorb 17% of the estimated avoided runoff and 18% of estimated air pollution removal by the urban forest. Notice, however, that Callery pears make up 27.3% of the inventoried trees, demonstrating that while the benefits they provide are significant, they are providing fewer benefits than would be predicted by their prevalence alone.

Conversely, large-stature trees like pin oak, which makes up only 2.7% of the inventoried trees, are providing greater benefits than would be expected from their numbers alone. Pin oaks store 6.2% of the total carbon held by the inventoried trees and sequester 4.6% of the total annual carbon sequestered by the inventoried trees. They also provide 8.7% of the avoided runoff benefits and 8.1% of the air pollution removal benefits.

CONTROLLING STORMWATER

Trees play a significant role in local hydrology and water cycling (see sidebar), helping to reduce the amount of stormwater runoff generated during rain events. **The inventoried trees avoid 331,230 gallons of runoff annually**. Avoided runoff accounts for 12.3% of the annual modeled benefits provided by Revere's public tree resource and is valued at $2,960 annually. White willow, dawn redwood, silver maple, and pin oak were among the top contributors to runoff reduction per tree, providing between 5 and 7.5 times more stormwater runoff reduction per tree than Callery pears (Table 7, next page). Strategic planting of these high-performing species in areas which experience frequent flooding could help mitigate this challenge.

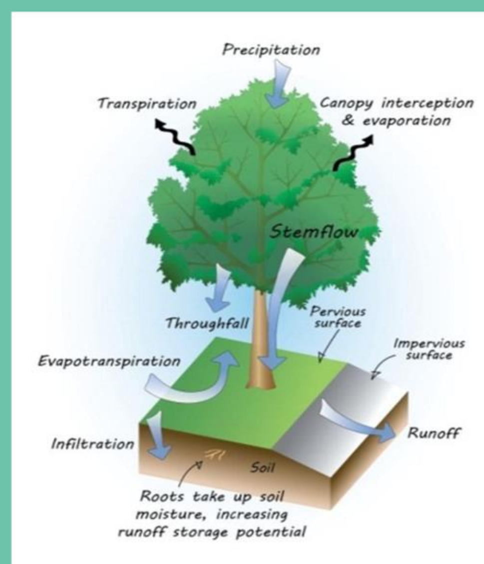
IMPROVING AIR QUALITY

Trees and other types of vegetation help to improve urban air quality in several ways. They absorb some gaseous pollutants through leaf stomata, while other solid particulate pollutants accumulate on leaf surfaces and are washed away during rain events. Trees also help to decrease air pollutant levels by providing shade or windbreaks and thus reducing the need for energy consumption to cool or heat buildings. Since airborne pollutants can have serious effects on human health, this function of the urban canopy

HYDROLOGIC FUNCTIONS OF TREES

Trees play a significant role in local hydrology and water cycling by:

- Catching rainfall in their crowns, reducing the impact with the ground and mitigating erosion and compaction of soils
- Slowing runoff, allowing time for water to be absorbed into the soil and reducing erosion
- Increasing pore space in the soil with their roots and aiding in permeation of water into the ground
- Cooling the surrounding landscape by casting shade with their canopies and releasing water from their leaves (evaporative cooling)
- Diverting stormwater runoff, thereby mitigating flooding, combined sewer overflow, and other infrastructure damage



Hydrological functions of trees

Diagram and information from Stormwater to Street Trees: Engineering Urban Forests for Stormwater Management, EPA publication 841 B 13 001

Table 7. **Inventoried species providing the greatest stormwater control benefits.**

Runoff Reduction by the Most Common Public Tree Species						
Species (Common Name)	Species (Botanical Name)	# Trees	Total Runoff Avoided (gal/yr)	Per Tree Runoff Avoided (gal/tree/yr)	Total Value ($/yr)	Per Tree Value ($/tree/yr)
Callery pear	*Pyrus calleryana*	1,080	56,298.36	52.13	$503.08	$0.47
Norway maple	*Acer platanoides*	737	81,765.79	110.94	$730.66	$0.99
honeylocust	*Gleditsia triacanthos*	277	16,532.45	59.68	$147.73	$0.53
green ash	*Fraxinus pennsylvanica*	192	28,621.78	149.07	$255.76	$1.33
red maple	*Acer rubrum*	189	13,207.55	69.88	$118.02	$0.62
Japanese tree lilac	*Syringa reticulata*	157	1,250.13	7.96	$11.17	$0.07
littleleaf linden	*Tilia cordata*	148	21,559.89	145.67	$192.66	$1.30
cherry species	*Prunus species*	137	4,654.80	33.98	$41.60	$0.30
pin oak	*Quercus palustris*	108	28,784.94	266.53	$257.22	$2.38
American elm	*Ulmus americana*	71	4,183.13	58.92	$37.38	$0.53
Runoff Reduction by the Most Productive Public Tree Species						
Species (Common Name)	Species (Botanical Name)	# Trees	Total Runoff Avoided (gal/yr)	Per Tree Runoff Avoided (gal/tree/yr)	Total Value ($/yr)	Per Tree Value ($/tree/yr)
white willow	*Salix alba*	1	393.70	393.70	$3.52	$3.52
dawn redwood	*Metasequoia glyptostroboides*	1	368.32	368.32	$3.29	$3.29
silver maple	*Acer saccharinum*	67	19,835.59	296.05	$177.25	$2.65
pin oak	*Quercus palustris*	108	28,784.94	266.53	$257.22	$2.38
Douglas fir	*Pseudostuga menziesii*	1	241.28	241.28	$2.16	$2.16
Amur corktree	*Phellodendron amurense*	1	217.80	217.80	$1.95	$1.95
northern red oak	*Quercus rubra*	58	11,979.14	206.54	$107.05	$1.85
Scots pine	*Pinus sylvestris*	3	592.72	197.57	$5.30	$1.77
goldenraintree	*Koelreuteria paniculata*	8	1,393.99	174.25	$12.46	$1.56
Siberian elm	*Ulmus pumila*	17	2,759.21	162.31	$24.66	$1.45

can be very valuable in heavily developed areas[4]. Revere's inventoried tree population removes 1,420 lbs. of air pollutants each year, including sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), and particulate matter ($PM_{2.5}$). **The i-Tree Eco model estimated the value of this benefit at $17,120, which is 71% of the value of all annual benefits modeled.** As shown in Figure 12, a small reduction of $PM_{2.5}$ is the most valuable pollutant removal service provided by the trees. White willow, dawn redwood, silver maple, pin oak, and Douglas fir were again among the top performing trees on a per tree basis (Table 8, next page), providing between.

[4] National Park Service. 2022. "Air Pollution Removal by Urban Forests." nps.gov/articles/000/uerla-trees-air-pollution.htm.

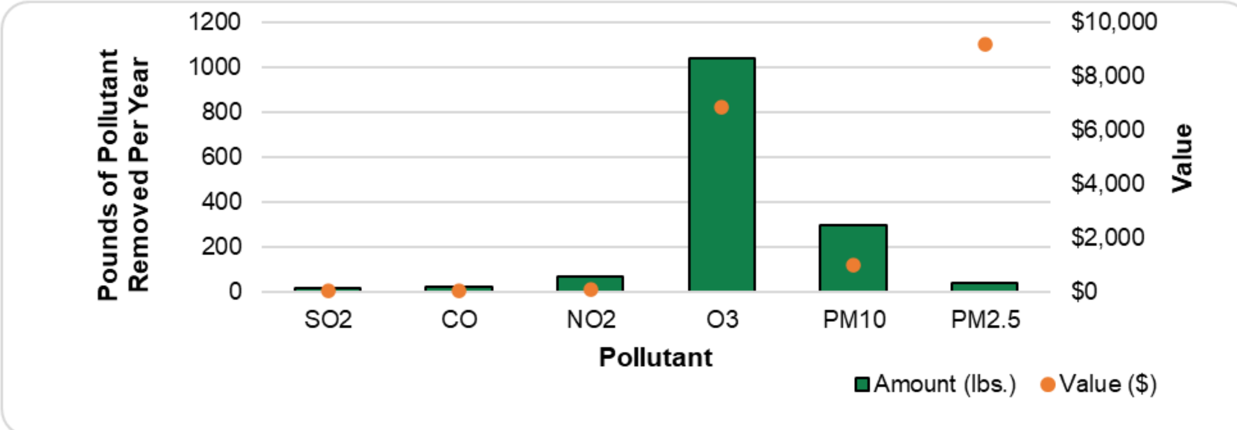


Figure 12. **Amount and value of annual air pollutant removal done by the inventoried trees.**

Table 8. **Inventoried species providing the greatest air pollutant removal benefits.**

Air Pollutant Removal by the Most Common Public Tree Species						
Species (Common Name)	Species (Botanical Name)	# Trees	Total Pollutant Removal (lbs/yr)	Per Tree Pollutant Removal (lbs/tree/yr)	Total Value ($/yr)	Per Tree Value ($/tree/yr)
Callery pear	*Pyrus calleryana*	1,080	260.00	0.24	$2,909.820	$2.69
Norway maple	*Acer platanoides*	737	360.00	0.49	$4,226.120	$5.73
honeylocust	*Gleditsia triacanthos*	277	800.00	2.89	$854.490	$3.08
green ash	*Fraxinus pennsylvanica*	192	120.00	0.63	$1,479.340	$7.70
red maple	*Acer rubrum*	189	60.00	0.32	$682.640	$3.61
Japanese tree lilac	*Syringa reticulata*	157	0.00	0.00	$64.61	$0.41
littleleaf linden	*Tilia cordata*	148	100.00	0.68	$1,114.34	$7.53
cherry species	*Prunus species*	137	20.00	0.15	$240.59	$1.76
pin oak	*Quercus palustris*	108	120.00	1.11	$1,487.77	$13.78
American elm	*Ulmus americana*	71	20.00	0.28	$216.21	$3.05
Air Pollutant Removal by the Most Productive Public Tree Species						
Species (Common Name)	Species (Botanical Name)	# Trees	Total Pollutant Removal (lbs/yr)	Per Tree Pollutant Removal (lbs/tree/yr)	Total Value ($/yr)	Per Tree Value ($/tree/yr)
while willow	*Salix alba*	1	0.00	0.00	$20.350	$20.35
dawn redwood	*Metasequoia glyptostroboides*	1	0.00	0.00	$19.040	$19.04
silver maple	*Acer saccharinum*	67	80.00	1.19	$1,025.220	$15.30
pin oak	*Quercus palustris*	108	120.00	1.11	$1,487.770	$13.78
Douglas fir	*Pseudostuga menziesii*	1	0.00	0.00	$12.470	$12.47
Amur corktree	*Phellodendron amurense*	1	0.00	0.00	$11.26	$11.26
northern red oak	*Quercus rubra*	58	60.00	1.03	$619.15	$10.68
Scots pine	*Pinus sylvestris*	3	0.00	0.00	$30.64	$10.21
goldenraintree	*Koelreuteria paniculata*	8	0.00	0.00	$72.05	$9.01
Siberian elm	*Ulmus pumila*	17	20.00	1.18	$142.61	$8.39
The i-Tree Eco model calculates pollutant removal in tons per year. Where the cumulative air pollutant removal per species is very low, as with white willow or dawn redwood, the model does not report the value to sufficient decimal places for conversion to pounds, and a zero value results.						

REPLACEMENT VALUE

Replacement value is the approximate cost that would be required to replace an existing tree with a tree of similar size and species. While doing this is not usually possible – for example, it is impossible to replace a 20-inch diameter tree with another tree of similar size instantly – replacement value can provide an idea of the overall value of the inventoried trees in Revere's public tree resource.

In total, **Revere's inventoried trees have a replacement value of $ 5,086,436.** Table 9 compares the per-tree replacement value of the most common inventoried trees with the species with the overall highest replacement values per tree. Large, mature trees generally have a greater per-tree replacement value than smaller, younger trees, partially due to the greater age and larger size of these trees. The dawn redwood, the species example with the highest replacement value has a DBH of 30 inches, 55% of the northern red oaks inventoried are 24-45 inches DBH, and the white willow is 36 inches DBH.

Table 9. Inventoried species with the highest replacement values.

Replacement Value of the Most Common Public Tree Species				
Species (Common Name)	Species (Botanical Name)	# Trees	Total Value ($)	Per Tree Value ($/tree)
Callery pear	*Pyrus calleryana*	1,080	$875,819.98	$810.94
Norway maple	*Acer platanoides*	737	$1,359,647.40	$1,844.84
honeylocust	*Gleditsia triacanthos*	277	$286,265.80	$1,033.45
green ash	*Fraxinus pennsylvanica*	192	$309,370.86	$1,611.31
red maple	*Acer rubrum*	189	$190,004.32	$1,005.31
Japanese tree lilac	*Syringa reticulata*	157	$31,471.79	$200.46
littleleaf linden	*Tilia cordata*	148	$392,659.69	$2,653.11
cherry species	*Prunus species*	137	$57,264.87	$417.99
pin oak	*Quercus palustris*	108	$369,065.73	$3,417.28
American elm	*Ulmus americana*	71	$66,508.26	$936.74
Replacement Value of the Most Valuable Public Tree Species				
Species (Common Name)	Species (Botanical Name)	# Trees	Total Value ($)	Per Tree Value ($/tree)
dawn redwood	*Metasequoia glyptostroboides*	1	$11,711.62	$11,711.62
northern red oak	*Quercus rubra*	58	$363,950.30	$6,275.01
white willow	*Salix alba*	1	$3,829.23	$3,829.23
Douglas fir	*Pseudostuga menziesii*	1	$3,642.83	$3,642.83
Amur corktree	*Phellodendron amurense*	1	$3,604.47	$3,604.47
pin oak	*Quercus palustris*	108	$369,065.73	$3,417.28
silver maple	*Acer saccharinum*	67	$216,994.50	$3,238.72
littleleaf linden	*Tilia cordata*	148	$392,659.69	$2,653.11
honeylocust	*Gleditsia triacanthos*	3	$6,947.57	$2,315.86
Scots pine	*Pinus sylvestris*	3	$6,630.79	$2,210.26

Tree Benefit Recommendations

- The benefits provided by Revere's street trees could be increased by planting large-stature, broad-leaf trees wherever possible, enlarging existing tree planting spaces or creating new large tree planting spaces to accommodate large street trees, preserving existing large-stature trees along streets, and providing proactive care to young street trees to ensure they achieve mature status in the future.
    - Revere currently has very limited opportunities to plant large-stature trees along streets. Options to increase planting opportunities for large-stature trees may include:
        - Setback planting program: planting large trees in private lawns behind sidewalks. These trees can still be considered public street trees under Massachusetts General Law 87.
        - Planting large trees in parks, cemeteries, and on other public grounds.
        - Enlarging existing planting wells or tree lawns to accommodate large-stature trees where sidewalk and/or roadway width permit.
        - Incorporating trees early in the design process when developing or redeveloping streets. Early consideration of the needs of large trees can help ensure that adequate space for large trees is reserved.
        - Programs that encourage planting of large trees on private properties.
- The protection of existing park and street trees should be a priority to retain their essential benefits.
- While the benefits provided by the inventoried public trees are substantial, the benefits provided by the entire urban forest (which includes all trees in Revere on both public and private properties) are even greater. Revere should promote new tree planting on private property throughout the city to increase the benefits provided by the urban canopy as a whole.

Section 3:

Recommended Maintenance

of the Inventoried Public Trees

SECTION 3: RECOMMENDED MAINTENANCE OF THE PUBLIC TREE RESOURCE

During the inventory, a recommended maintenance activity was assigned to each tree. DRG usually recommends prioritizing and completing recommended maintenance based on risk rating; however, risk rating was not collected during this survey. While DRG recommends risk assessment as the best way to identify hazards and prioritize tree work, the recommended work has been prioritized here based on tree size and type of maintenance.

PRIORITY PRUNING AND TREE REMOVALS

Priority Pruning Recommendations

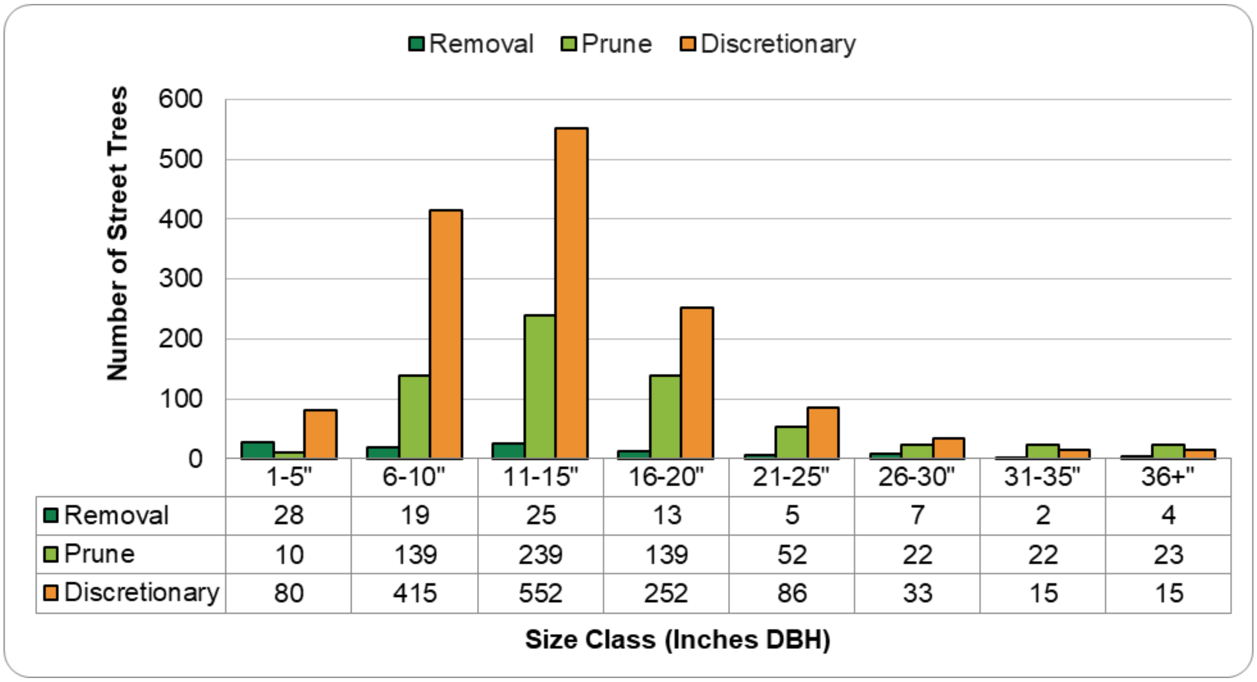
During the 2023 inventory, trees could receive a pruning recommendation of either "Prune" or "Discretionary Prune". Trees recommended for priority pruning received the "Prune" maintenance type while trees which could be maintained during routine, proactive pruning cycles were given a maintenance type of "Discretionary". The primary difference between these two types of recommended maintenance was the size of the defect requiring mitigation – generally dead, broken, cracked, or otherwise defective branches larger than 2 inches in diameter triggered a priority "Prune" recommendation, as these larger parts can cause greater damage in the event of branch failure. Trees with smaller defective parts were assigned the "Discretionary" maintenance and are included in the routine pruning cycle in the budget at the end of this section. **The inventory identified 699 trees for priority corrective pruning**, 646 along streets and 53 in parks (Figures 13 & 14).

- These trees should be pruned as soon as possible in priority order from largest to smallest. Corrective pruning 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.

Removal Recommendations

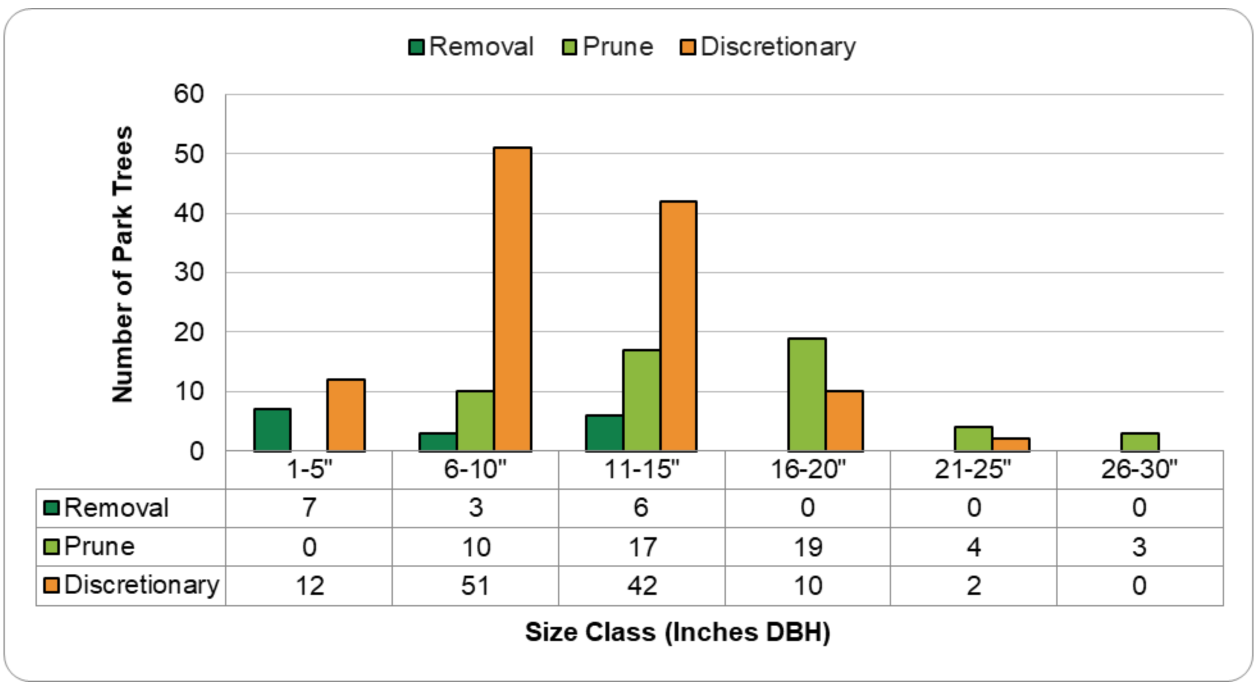
Tree removal is generally a last resort, since removing the tree eliminates all the benefits the tree is providing. However, in instances where the tree is in very poor condition, dead, diseased, or has significant structural issues, removal may be the best option to ensure public safety. **DRG identified 119 trees recommended for removal** – 103 along streets and 16 in parks (Figures 13 & 14). 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 as soon as possible and in priority order from largest to smallest.



	1-5"	6-10"	11-15"	16-20"	21-25"	26-30"	31-35"	36+"
Removal	28	19	25	13	5	7	2	4
Prune	10	139	239	139	52	22	22	23
Discretionary	80	415	552	252	86	33	15	15

Figure 13. **Recommended maintenance by size class for street trees.**



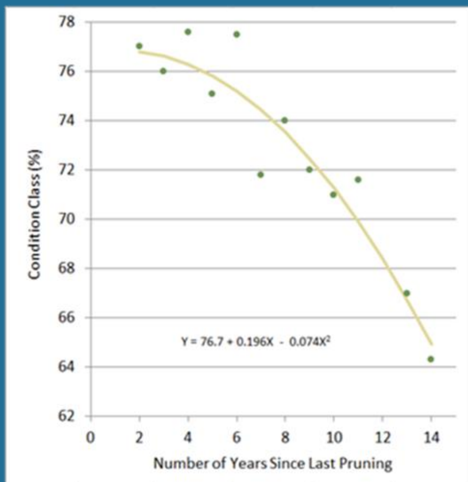
	1-5"	6-10"	11-15"	16-20"	21-25"	26-30"
Removal	7	3	6	0	0	0
Prune	0	10	17	19	4	3
Discretionary	12	51	42	10	2	0

Figure 14. **Recommended maintenance by size class for park trees.**

ROUTINE INSPECTIONS & INVENTORY UPDATES

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

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.

maintaining individual trees. Ideally, the arborist will be ISA Certified and hold the ISA Tree Risk Assessment Qualification credential. Routine inspections can be completed during regular tree maintenance activities, such as routine pruning, to streamline the process and reduce workloads and costs. When trees need additional maintenance, they should be added to the work schedule immediately. Use asset management software to update inventory data and track work records.

Routine Inspection & Inventory Update Recommendations

- All public trees should be regularly inspected and attended to as needed. Inspections can be particularly effective and necessary after major storms which may cause damage to trees or increase the risk posed by trees.
  - Walk-by or drive-by assessments can be a cost-effective method of inspection for the public tree resource after storm events and can help identify trees which need further, detailed inspection.
- 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 asset management software such as TreeKeeper® to make updates, edits, and keep a log of work records.
- Level 2 risk assessments and inventory updates should also be completed on a routine basis, ideally every 5 to 10 years, to identify defects that are not easily observed during Level 1 assessments and to update tree inventory information.
- **To keep costs regular, 1/5 of the public tree resource should be re-inventoried each year**. With a total of around 7,613 public trees in the current inventory not recommended for removal, approximately 1,525 would need to be updated each year during a five-year inventory update cycle.

ROUTINE PRUNING CYCLE

The Routine Pruning cycle includes all trees that received a "Discretionary" maintenance recommendation. These trees have a smaller defect size than trees recommended for priority pruning. 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 (see side panel, previous page), DRG recommends a five-year routine pruning cycle to maintain the condition of the inventoried tree resource. However, it is not always possible to remain proactive with a five-year cycle based on budgetary constraints, the size of the inventoried tree resource, or both. In these cases, extending the length of the routine pruning cycle is an option; however, best practice is to not exceed a 10-year pruning cycle. Tree condition has been shown to deteriorate significantly after 10 years without regular pruning as once-minor defects worsen, reducing tree health and potentially increasing risk[5].

A total of 1,565 trees (1,448 street trees and 117 park trees) were recommended for discretionary pruning at the time of the inventory (Figures 13 & 14).

Routine Pruning Recommendations

- **Revere should aim to prune 1/5 of its public trees each year during a five-year routine pruning cycle**. A five-year cycle would see around 290 street trees and around 23 park trees assessed and pruned, if needed, each year.
- Trees which are currently recommended for priority pruning should be added to the routine pruning cycle once their immediate defects are mitigated.
- Young trees which grow out of the young tree training cycle (see next section) should also be included in the routine pruning cycle.
- Trees which die and are removed should be removed from the routine pruning cycle.
- The number of trees to be assessed and routinely pruned each year will vary depending on the number of trees which are planted and the number of trees which are removed in future years.
- Not every tree in the routine pruning cycle will need to be pruned each cycle – thus, the actual cost to maintain a routine pruning cycle will likely be lower than projected in the budget table at the end of this section.

YOUNG TREE TRAINING

Trees included in the young tree training cycle are generally less than 8 inches DBH. These younger trees may 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, and crossing or interfering limbs. If these problems are not corrected, they are likely to worsen as the tree grows, increasing the risk associated with the tree and creating potential liability for the city.

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 also differs from the

[5] Miller, R. W., & Sylvester, W.A. 1981. An Economic Evaluation of the Pruning cycle. Journal of Arboriculture 7(4): 109–112.

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.

The inventory identified 1,568 small, young trees which should be included in a young tree training cycle. 1,456 of these trees were located along the street ROW and the remaining 112 were located in parks. These **young trees make up around 41% of the total inventoried public tree resource** not recommended for removal.

Young Tree Training Cycle Recommendations

- Revere should institute a three-year young tree training cycle beginning after the completion of all recommended priority work. Since Revere has so many young trees, maintaining this cycle will be vital for the future condition of the public tree resource. With 1,568 young trees recommended for training at the time of the inventory, approximately 523 need to be assessed and pruned each year during the three-year cycle.
- When new trees are planted, they should ideally be pruned to correct major structural defects at the time of planting. After two to three years of establishment, the trees should be included in the young tree training cycle.
- Trees which have reached maturity should be removed from the young tree training cycle and moved into the routine pruning cycle.
- In future years the number of trees in the young tree training cycle will depend on the growth rates of young trees in the city and the number of new plantings.
- Not every tree in the young tree training cycle will need to be pruned each cycle – thus, the actual cost to maintain a routine pruning cycle will likely be lower than projected in the budget table provided at the end of this section.

TREE PLANTING AND STUMP REMOVAL

The “right tree in the right place” mantra for tree planting is 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 shade may be a priority, but it is important to consider how a tree may impact existing overhead and underground utilities and hardscape as it grows taller, wider, and deeper. If the tree at maturity will reach overhead lines, or conflict with sidewalks, curbs, nearby buildings, or buried utilities, it is best to choose another tree or a different location. A list of suggested tree species for planting in Revere is provided in Appendix C. 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.

During the inventory, **215 potential planting sites and 234 stumps were identified throughout Revere**. All of the planting sites and most of these stumps were located along streets. Park planting sites were not inventoried as part of this inventory project. Due to the restricted growing space available along streets in Revere, **all the inventoried planting sites were suitable for only small-stature trees.**

Tree Planting and Stump Removal Recommendations

- Stump removal should ideally be included in any tree removal contracts made by the city. The city should conduct quality assurance and control checks of contractor work to ensure that stumps are being removed fully and efficiently as part of the tree removal work.
- Stump removal should be done prior to targeted planting of any area to open up locations for new tree planting.
- Where possible, Revere should enlarge and improve tree planting areas along streets by
  - Enlarging the dimensions and soil volume of planting strips and planting wells
  - Considering use of structural soils or Silva Cells to improve root movement through soils and reduce infrastructure conflicts
  - Working with other city departments, such as engineering, to ensure that plans for new development or street improvement explicitly consider trees during the design process. This can help ensure that provisions made for trees are realistic and adequate to support healthy urban canopy.
- Revere should strive to plant the largest possible tree in each vacant planting site. Large-stature, broad-leaf trees provide the greatest benefits to the community.
  - Only small-stature trees (up to 25 feet at maturity) should be planted underneath and within 20 feet of overhead utility lines to minimize conflicts with the lines. Any small vacant site identified in the inventory can potentially support a small stature tree.
  - Medium-stature trees (between 25 and 40 feet tall at maturity) may be planted in medium vacant sites.
  - Large-stature trees (greater than 40 feet tall at maturity) may be planted in large vacant sites.
- To avoid loss of public tree canopy, Revere should aim for, at minimum, a 1-for-1 replacement rate of planted trees to removed trees. Ideally, the city will surpass this and hit a 2-for-1 or even a 3-for-1 replacement rate, which will ultimately help to increase the public canopy of the city. The budget table at the end of this section assumes a 1-for-1 replacement strategy with a gradual increase in additional plantings to show the costs of maintaining such a planting program.
- Trees selections for planting should be assessed for their tolerance to heat, drought, salt, and climate change, among other factors, and appropriate trees should be selected for each individual planting location. Planting the "right tree in the right place" will minimize conflicts with other infrastructure, improve tree survival rates and tree condition, and reduce maintenance costs.
- Where planting space along streets is limited and traditional street tree planting is not possible, the city should consider alternate options for installing and increasing public tree canopy, including:
  - Creation of pocket parks
  - Improvement and maintenance of existing nearby parks and public grounds

  - Setback planting programs designed to install city trees behind the ROW but within 20 feet of the public way as described in Massachusetts General Law, Chapter 87[6]
  - Encouraging planting of trees on private property via education, tree giveaways, tax breaks, and other methods
- Continue to seek out and apply for grant funding to support tree planting projects. Significant funding is available at the state and federal level, particularly for planting projects within Environmental Justice areas.
- Revere should continue to develop and foster partnerships with groups such as the Greening the Gateway Cities Program who can help promote and support tree planting goals in the city.

MAINTENANCE SCHEDULE AND BUDGET

Using the Revere tree inventory data, an annual maintenance schedule and budget were developed detailing the recommended tasks to complete each year over the next five years (Table 10). DRG made budget projections using industry knowledge and public bid tabulations. Following this schedule can help shift the city's tree care program from reactive toward a more proactive model.

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

- No less than $345,134 for the first year of implementation.
- No less than $354,442 for the second year.
- No less than $367,795 for the third year.
- No less than $382,368 for the fourth year.
- No less than $424,917 for the fifth year.

These annual budget funds are needed to ensure that elevated risk trees are managed efficiently 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 each 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.

[6] Massachusetts General Law Chapter 87, Section 7.

Table 10. Estimated costs for a five-year tree maintenance program.

Activity Cost			2024		2025		2026		2027		2028		Five-Year Cost
Activity	Diameter	Cost/Tree	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	
Removals	1-5"	$90		$0		$0		$0		$0	35	$3,843	$3,843
	6-10"	$225		$0		$0		$0		$0	22	$6,039	$6,039
	11-15"	$575		$0		$0	10	$6,440	21	$14,128		$0	$20,568
	16-20"	$1,080		$0	3	$3,499	10	$12,096		$0		$0	$15,595
	21-25"	$1,820		$0	5	$9,828		$0		$0		$0	$9,828
	26-30"	$2,430	3	$7,582	4	$10,498		$0		$0		$0	$18,079
	31-35"	$2,900	2	$6,032		$0		$0		$0		$0	$6,032
	>35"	$3,900	4	$16,224		$0		$0		$0		$0	$16,224
Activity Total(s)			**9**	**$29,838**	**12**	**$23,825**	**20**	**$18,536**	**21**	**$14,128**	**57**	**$9,882**	**$96,208**
Priority Pruning	1-5"	$62		$0		$0		$0		$0	10	$756	$756
	6-10"	$126		$0		$0		$0		$0	149	$22,904	$22,904
	11-15"	$183		$0		$0	70	$14,347	146	$31,260	40	$8,930	$54,538
	16-20"	$223		$0	90	$21,676	68	$16,984		$0		$0	$38,659
	21-25"	$275	20	$5,720	36	$10,692		$0		$0		$0	$16,412
	26-30"	$312	25	$8,112		$0		$0		$0		$0	$8,112
	31-35"	$415	22	$9,495		$0		$0		$0		$0	$9,495
	>35"	$450	23	$10,764		$0		$0		$0		$0	$10,764
Activity Total(s)			**90**	**$34,091**	**126**	**$32,368**	**138**	**$31,331**	**146**	**$31,260**	**199**	**$32,591**	**$161,641**
Stump Removals	1-5"	$50	5	$260	5	$270	4	$224	4	$234	4	$244	$1,232
	6-10"	$100	8	$832	8	$864	8	$896	8	$936	8	$976	$4,504
	11-15"	$125	11	$1,430	10	$1,350	10	$1,400	10	$1,463	10	$1,525	$7,168
	16-20"	$195	13	$2,636	12	$2,527	12	$2,621	12	$2,738	12	$2,855	$13,377
	21-25"	$250	6	$1,560	6	$1,620	5	$1,400	5	$1,463	5	$1,525	$7,568
	26-30"	$310	4	$1,290	4	$1,339	3	$1,042	3	$1,088	3	$1,135	$5,893
	31-35"	$375	2	$780	2	$810	2	$840	1	$439	1	$458	$3,326
	>35"	$425	2	$884	2	$918	2	$952	1	$497	1	$519	$3,770
Activity Total(s)			**51**	**$9,672**	**49**	**$9,698**	**46**	**$9,374**	**44**	**$8,857**	**44**	**$9,235**	**$46,837**
Inventory Updates	20% of inventory annually	$8	766	$6,373	767	$6,627	766	$6,863	767	$7,179	766	$7,476	$34,519
Activity Total(s)			**766**	**$6,373**	**767**	**$6,627**	**766**	**$6,863**	**767**	**$7,179**	**766**	**$7,476**	**$34,519**
Routine Pruning (5-year cycle)	1-5"	$62	18	$1,161	19	$1,272	18	$1,250	19	$1,378	18	$1,362	$6,423
	6-10"	$126	94	$12,318	93	$12,655	93	$13,124	93	$13,710	93	$14,296	$66,103
	11-15"	$183	119	$22,648	119	$23,519	119	$24,390	119	$25,479	118	$26,345	$122,381
	16-20"	$223	52	$12,060	53	$12,765	52	$12,988	53	$13,828	52	$14,147	$65,787
	21-25"	$275	17	$4,862	18	$5,346	17	$5,236	18	$5,792	17	$5,704	$26,939
	26-30"	$312	7	$2,271	7	$2,359	7	$2,446	7	$2,555	6	$2,284	$11,915
	31-35"	$415	3	$1,295	3	$1,345	3	$1,394	3	$1,457	3	$1,519	$7,009
	>35"	$450	3	$1,404	3	$1,458	3	$1,512	3	$1,580	3	$1,647	$7,601
Activity Total(s)			**313**	**$58,018**	**315**	**$60,719**	**312**	**$62,340**	**315**	**$65,779**	**310**	**$67,303**	**$314,159**
Young Tree Training (3-year cycle)	all sizes	$45	523	$24,476	522	$25,369	523	$26,359	522	$27,483	523	$28,713	$132,401
Activity Total(s)			**523**	**$24,476**	**522**	**$25,369**	**523**	**$26,359**	**522**	**$27,483**	**523**	**$28,713**	**$132,401**
Replacement Tree Planting and Maintenance	Purchasing & Planting	$550	9	$5,148	12	$7,128	20	$12,320	21	$13,514	57	$38,247	$76,357
	Watering	$80	9	$749	12	$1,037	20	$1,792	21	$1,966	57	$5,563	$11,106
Activity Total(s)			**9**	**$5,897**	**12**	**$8,165**	**20**	**$14,112**	**21**	**$15,479**	**57**	**$43,810**	**$87,463**
New Tree Planting and Maintenance	Tree Pit Cutting (50%)	$260	38	$10,140	40	$11,232	43	$12,376	45	$13,689	48	$15,067	$62,504.00
	Purchasing & Planting	$550	75	$42,900	80	$47,520	85	$52,360	90	$57,915	95	$63,745	$264,440.00
	Watering	$80	75	$6,240	80	$6,912	85	$7,616	90	$8,424	95	$9,272	$38,464.00
Activity Total(s)			**75**	**$59,280**	**80**	**$65,664**	**85**	**$72,352**	**90**	**$80,028**	**95**	**$88,084**	**$365,408**
Natural Mortality (2%)	Tree & Stump Removal	$800	79	$65,728	79	$68,256	79	$70,784	79	$73,944	79	$77,104	$355,816.00
	Replacement Tree	$630	79	$51,761	79	$53,752	79	$55,742	79	$58,231	79	$60,719	$280,205.10
Activity Total(s)			**79**	**$117,489**	**79**	**$122,008**	**79**	**$126,526**	**79**	**$132,175**	**79**	**$137,823**	**$636,021**
Activity Grand Total			**1,915**		**1,962**		**1,989**		**2,005**		**2,130**		**10,001**
Cost Grand Total				**$345,134**		**$354,442**		**$367,795**		**$382,368**		**$424,917**	**$1,874,656**
Cost Without Planting				**$162,469**		**$158,606**		**$154,804**		**$154,686**		**$155,200**	**$785,764**

*Activity costs are based on price of contracted work.

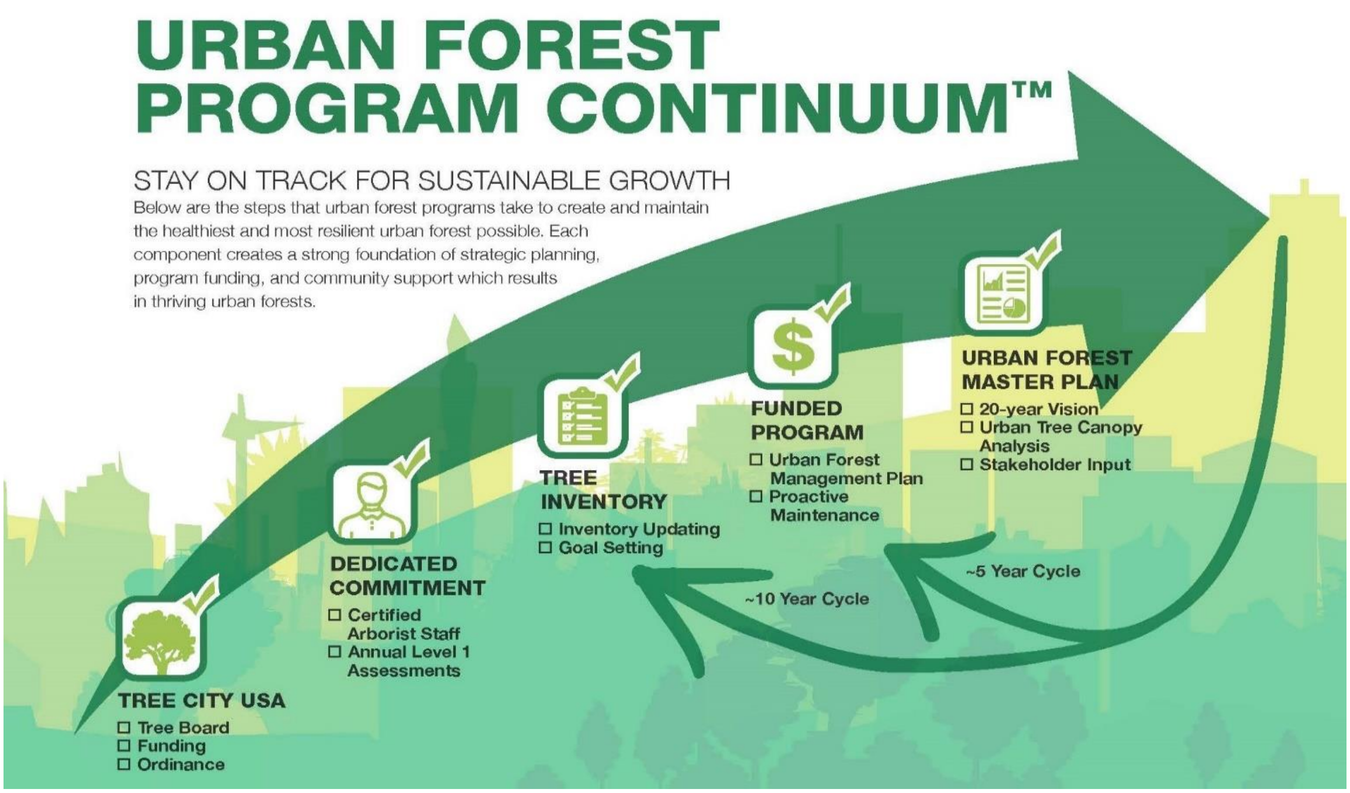
**Annual costs include 4% annual inflation over 2023 contractor estimates.

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 3,951 public trees inventoried provide at least $24,930 in estimated annual stormwater runoff reduction, carbon sequestration, and air pollutant removal benefits.** The full suite of benefits provided by Revere's public trees is certainly much more valuable than can be estimated using inventory data and i-Tree Eco modeling alone. **Successfully implementing the five-year maintenance program is likely to increase the benefits the city receives from its public trees over time.**

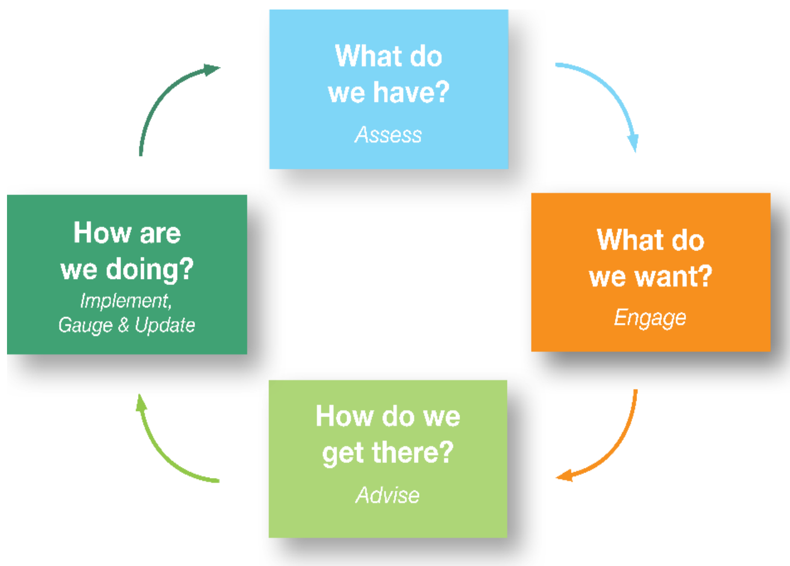
The five-year maintenance program outlined here is ambitious. Tree removal and priority pruning can be costly but are necessary for the health and safety of both the human and arboreal residents of Revere. After this priority work is completed, the remainder of the work can be done over a longer period, if budgets, staffing, or equipment render it necessary. Tree planting is particularly expensive and will require significant additional funding to ensure that at least a one-for-one removal to replacement ratio is maintained in Revere. **This *Public Tree Resource Analysis and Maintenance Schedule* could potentially help the city tree care staff advocate for an increased urban forestry budget to fund the recommended maintenance activities**.

As the urban forest grows, the benefits enjoyed by Revere will increase as well. The city's forestry program is on its way to creating a sustainable and resilient tree resource, and can stay on track by setting goals, taking action to reach those goals, updating inventory data to check progress, and revising the original goals in an iterative manner (see flow chart, next page). The Urban Forest



Program Continuum, created by DRG and shown in the graphic on page 42, can provide guidance on the next steps for Revere to take in their ongoing mission to provide higher levels of care for the city's public trees – a mission that will enrich the lives of all who live, work, and recreate in the City of Revere.

EVALUATING AND UPDATING THIS PLAN



This *Public Tree Inventory Analysis and Maintenance Schedule* provides management priorities for the next five years. To ensure the maintenance schedule and budget remain accurate, it is important to update the tree inventory using TreeKeeper® or other asset management software as work is completed, so the software can provide updated species distribution, maintenance needs, and benefit estimates. Keeping the inventory up to date empowers the city to assess its progress over time and set goals to strive toward by following the adaptive management cycle (flow chart, above). Below are some examples of implementing the steps of this cycle:

- Preparing planting plans far 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 species and genera abundance.
- Scheduling and assigning 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.
- Including 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
STUDY AREA AND DATA COLLECTION

STUDY AREA

The City of Revere covers an area of only 5.7 square miles but has a population of over 58,000, making it a densely populated urban area. The city is located slightly north of Boston along the Atlantic coast, with a long swath of beach along the waterfront. The 2023 public tree inventory focused data collection on the populated areas of the city, excluding the large Rumney Marsh Reservation and Sea Plane Basin to the north.

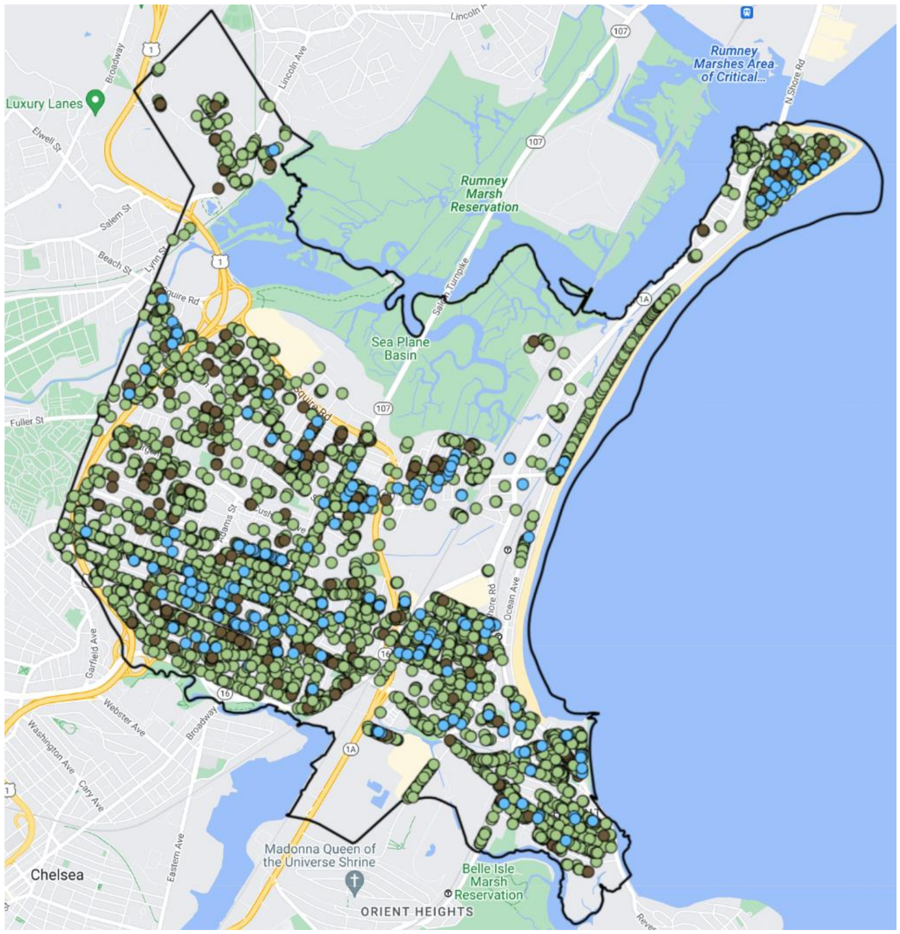


Image 1. Screenshot of inventoried points taken from Revere's TreeKeeper program. Each dot represents an inventoried site.

DATA COLLECTION

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
- Comments
- Condition
- Defect
- Hardscape Damage
- Inventory Date
- Multi-Stem
- Overhead Utilities
- Park Name
- Primary Maintenance Need
- Size
- Species

Tree size was measured as diameter at breast height (DBH), or 4.5 feet above ground level. Where a tree had more than one stem at DBH height, the DBH of largest stem was recorded. 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.

Equipment and Base Maps

Inventory arborists used FZ-G1 Panasonic Toughbook® units with internal GPS receivers. Geographic information system (GIS) map layers were loaded onto these units to help locate sites during the inventory. Arborists used a combination of GPS location data and aerial background imagery to locate and place each site.

Addressing

In addition to XY geographic coordinates for each inventoried site, addressing information was also collected during the inventory. While geographic coordinates allow spatial representation of the data within a geographic information system, such as TreeKeeper or ArcMap, addressing information allows each site to be located in the field without use of a GPS. The following fields were collected as part of the addressing of each site:

- **Address:** The numeric address of the parcel nearest to the site. This field is automatically filled by the data collection program where parcel addressing is available. When parcel addressing was not available, the arborist used their best judgement to assign a logical address number to the site.
- **Suffix:** Indicates whether the arborist needed to manually assign an address number to the site. If the arborist added the address number manually, this field reads "X". If the data collection program assigned an address number, this field is left blank.
- **Street:** The street which the assigned parcel is addressed to. The Address and Street fields, together, provide the street address of the site (e.g. 111 Example Rd.). The street is usually assigned by the data collection program based on parcel data included in the program.
- **On Street:** The street on which the site is physically located. Assigned by the data collection program.
- **Side:** Indicates what side of the parcel a site is physically located on. Assigned by the arborist, this field can read front, side, rear, median, or N/A.
    - **Front –** The site is located on the front side of the parcel. The Street and On Street names should match.
    - **Side –** The site is located on the side of the parcel. The Street and On Street names will likely not match.
    - **Rear –** The site is located on the rear side of the parcel, which only happens when a parcel occupies the full space between two roads. The Street and On Street names will not match.
    - **Median –** The site is located in a median. Technically, sites located in medians do not have addresses, but are assigned to the closest parcel address to aid in finding them in the field. All median sites will have Suffix = X.
    - **N/A –** The site is located in a park or other public grounds rather than along the street ROW. Since these sites may be anywhere within a public grounds parcel, a side designation is not useful and is omitted.

I-TREE ECO METHODOLOGY

Replacement 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 replacement value of an urban forest is the sum of the replacement 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.

Carbon sequestration refers to the capture and storage of carbon from the earth's atmosphere. i-Tree Eco 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 $170.55 per ton.

Air pollution removal refers to the removal of ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter less than 2.5 microns ($PM_{2.5}$), and particulate matter less than 10 microns (PM_{10}). For this analysis, the pollution removal value is calculated based on the prices of $0.70 per pound of carbon monoxide, $6.59 per pound of ozone, $0.92 per pound of nitrogen dioxide, $0.30 per pound of sulfur dioxide, $261.99 per pound of particulate matter less than 2.5 microns, and $3.28 per pound of particulate matter less than 10 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 at the Logan International Airport in Boston, where annual precipitation in 2020 was 37.4 inches. This weather station was chosen to represent Revere as the closest weather station available within iTree-Eco. The monetary value of avoided runoff is based on the U.S. Forest Service's Community Tree Guide Series at a rate of $0.067 per cubic foot.

APPENDIX B
INVASIVE PESTS AND DISEASES

In today's worldwide marketplace, the volume of international trade brings increased potential for pests and diseases to be introduced into new habitats. 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 such as plant cultivation, commerce, tourism, and travel.

Once they arrive, invasive pests often grow and spread rapidly because controls, such as native predators, are lacking. Invasive pests can disrupt the landscape by pushing out native species, reducing biological diversity, killing trees, altering wildfire intensity and frequency, and damaging crops, among other actions. Some pests may even push native species to extinction.

Invasive pests and diseases have seriously harmed both 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 U.S. is the number one priority of the USDA's Animal and Plant Inspection Service (APHIS). 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 so that you can be prepared to identify infestations quickly and manage their spread effectively. Early detection of threats can significantly reduce both the damage caused and the costs associated with management of the invasive species.

The following appendix includes key pests and diseases that are of concern for Massachusetts at the time of this plan's development. This list is not comprehensive and may not include all threats.

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
- https://www.invasivespeciesinfo.gov/terrestrial/pathogens-and-diseases

USDA Forest Service Eastern Region
- https://www.fs.usda.gov/r9

ASIAN LONGHORNED BEETLE

Adult Asian longhorned beetles and egg sites.

Kenneth R. Law, USDA APHIS PPQ, Bugwood.org

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 arrived in the U.S. in wood pallets and other wood-packing material accompanying cargo shipments from Asia.

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, although it is more common to spot damage caused by the beetle than the beetle itself. Common signs of ALB include sunken, softball-sized galleries; circular pencil-sized exit holes; egg sites; and frass. Boring damage from the beetle can eventually cause crown dieback and tree death and predisposes the tree to mechanical damage from snow, ice, or wind.

ALB has a long list of host species, including box elder, Norway maple, red maple, silver maple, sugar maple, buckeye, horsechestnut, birch, London planetree, willow, and elm.

BEECH BARK DISEASE

Cankers on a beech caused by beech bark disease.

Linda Haugen, USDA Forest Service, Bugwood.org

Beech bark disease is the result of an insect-fugus complex which begins when a non-native beech scale insect, *Cryptococcus fagisuga*, feeds on the bark of beech trees, creating lesions through which a native canker fungi, *Neonectria* spp., can enter the tree. The scale insect, which is native to Europe, was first introduced to Nova Scotia in the 1890s and has since spread west and south across Canada and the U.S.

Cryptococcus fagisuga is a soft-bodied scale insect which secretes a white wooly wax during the nymph stage which can make infested trees appear to be covered in wool. The insects feed on the bark, leaving punctures through which the nectria canker fungi can enter. 50–85% of infected beech trees will die within 10 years of infestation. Even trees that do not succumb to the disease may be significantly structurally weakened by the nectria cankers and are prone to “beech snap”, or trunk failure. Such trees pose a safety hazard within the urban environment.

The beech scale and resulting beech bark disease is found on both American beech and on European beech.

BEECH LEAF DISEASE

Beech leaf disease (BLD) was first identified in Ohio in 2012. Since then, it has been found in Pennsylvania, New York, Rhode Island, Connecticut, and Massachusetts and is spreading rapidly.

Dark stripes between leaf veins are a clear symptom of BLD.

Tom Macy, Ohio DNR Division of Forestry

The disease is caused by a nematode, *Litylenchas crenatae*, which lives within leaf tissue. Early signs of the disease include dark stripes between the veins of leaves, most noticeable when looking up through the canopy on sunny days. As the disease progresses, leaves become withered, curled, or develop a leathery texture and sections of canopy may die back. Infected trees often appear to have a thin canopy, and the disease can lead to tree mortality. Research into this disease is ongoing, and the method of spread and infection, as well as potential treatments, are not yet known. BLD affects all species of beech.

DUTCH ELM DISEASE

Dutch elm disease (DED) was first found in Ohio in 1930. By 1959 it had killed thousands of elms. Today, DED is present in about two-thirds of the eastern U.S. and kills many of the remaining and newly planted elms annually. The disease is caused by a fungus that attacks the vascular system of elm trees, blocking the flow of water and nutrients and resulting in rapid leaf yellowing, tree decline, and death.

Elm exhibiting leaf yellowing and branch dieback due to DED.

Ward Upham, Kansas State University, Bugwood.org

There are two closely related fungi that are collectively referred to as DED. The most common is *Ophiostoma novo-ulmi*, which is thought to be responsible for most of the elm deaths since the 1970s. The fungus is transmitted to healthy elm by elm bark beetles. Two species of beetle carry the fungus: native elm bark beetle (*Hylurgopinus rufipes*) and European elm bark beetle (*Scolytus multistriatus)*.

The species most affected by DED is American elm, although other elms may get the disease and survive. Recent genetic manipulation has resulted in many DED-resistant American elm cultivars, such as ‘Princeton’, ‘Valley Forge’, and ‘Jefferson’.

ELONGATE HEMLOCK SCALE

EHS covering the undersides of hemlock needles.

Eric R. Day, Virginia Polytechnic Institute and State University, bugwood.org

The elongate hemlock scale (EHS, *Fiorina externa*) was introduced from Japan and was first observed in Queens, NY as early as 1908. This invasive scale insect has been found in 16 states to date, mainly along the east coast of the U.S. It is thought to have been spread widely on infested conifer products, including holiday wreaths and Christmas trees.

Adult EHS are encased in white or brown waxy scales. The scales are a visible sign that a tree is infested with EHS, and needle yellowing, especially on lower branches, premature needle drop, and branch dieback are all common symptoms of EHS infestation. While these insects can kill trees outright by siphoning away nutrients and water from the tree, more commonly they weaken hosts, leaving them susceptible to other pests or environmental conditions.

EHS, despite the name, can affect spruce and fir species as well as hemlocks.

EMERALD ASH BORER

Blonding and damage from woodpeckers going after EAB.

David Cappaert, Bugwood.org

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, It likely arrived in the U.S. hidden in wood-packing materials commonly used to ship consumer goods, auto parts, and other products. The first official U.S. identification of EAB was in southeastern Michigan in 2002.

Adult beetles are slender and 1/2-inch long. Color varies but adults are usually bronze or golden green overall with metallic, emerald-green wing covers. Common signs and symptoms of EAB infestation include excessive woodpecker activity, 'blonding' (striping of outer bark by woodpeckers), stunted foliage and branch dieback, and characteristic D-shaped exit holes.

The EAB-preferred host tree species are ashes, although white fringetree is also susceptible to EAB.

HEMLOCK WOOLY ADELGID

The hemlock woolly adelgid (HWA, *Adelges tsugae*) was first described in western North America in 1924 and first reported in the eastern U.S. in 1951 near Richmond, Virginia. It is now established from northeastern Georgia to southeastern Maine and as far west as eastern Kentucky and Tennessee.

Wooly adelgid casings on a hemlock twig.

Bruce Watt, University of Maine, Bugwood.org

In their native range in eastern Asia, populations of HWA cause little damage to hemlock trees, as they are preyed on by on natural enemies and some tree resistance has evolved with this insect. In eastern North America and in the absence of natural control elements, HWA often causes serious damage and death to trees. Affected trees may have grey or discolored needles, needle loss and branch dieback, and “wooly” tufts of adelgid casing present along the underside of branches near the base of the needles.

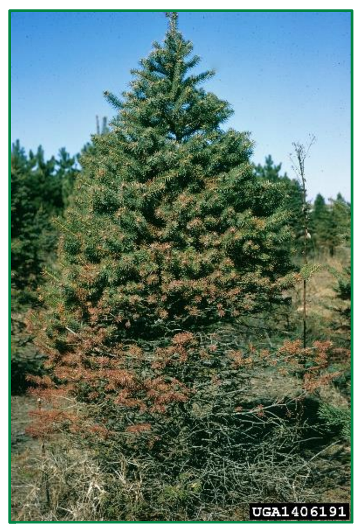
All species of hemlock are affected by HWA, but Carolina hemlock and eastern hemlock tend to sustain the most damage.

NEEDLECAST DISEASES

Various fungi, including *Rhizosphaera*, *Lophodermium*, and *Rhadocline* can cause needlecast diseases. Various species of these fungi are present in locations across the globe and attack many needle-bearing species of tree, causing premature needle drop.

As trees drop infected needles, they may look sparse or thin and branch dieback will occur. Severe and prolonged infections can cause tree death and predispose the tree to other pests and diseases. Fungicide applications can help protect high-value landscape trees, but often trees which succumb to needlecast diseases are already stressed by environmental factors such as drought, heat, or poor planting locations. Improving overall tree health by selecting proper planting sites and keeping trees watered during periods of heat and drought can do much to help prevent needlecast diseases.

Needlecast diseases often affect spruces, pines, firs, and douglas-fir.



Needle browning and loss caused by a needlecast disease.

USDA Forest Service - North Central Research Station, USDA Forest Service, Bugwood.org

OAK WILT

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.

Browning of leaves due to oak wilt.

Paul A. Mistretta, USDA Forest Service, Bugwood.org

Oak wilt 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.

This disease affects all oaks but is most devastating to those in the red oak subgenus, such as scarlet oak, pin oak, and red oak. It may also attack oaks in the white oak subgenus, but spreads at a much slower pace in these trees.

RED PINE SCALE

Red pine scale (*Matsucoccus matsumarae*) is a non-native pest species of red pine (*Pinus resinosa*) which was likely introduced to the U.S. on exotic pines brought in for the 1939 New York World's Fair. Today it is distributed throughout southern New England, New York, New Jersey, and eastern Pennsylvania.

Cottony white masses wedged in the bark is a sign of red pine scale.

Allison Kanoti, Maine Forest Service, Bugwood.org

This scale insect feeds through the bark, leeching nutrients and water from the tree and leading to foliage changing slowly from light green to yellow to red. Symptoms generally appear on individual branches first and gradually spread to the entire crown. Cottony white filaments may be easily visible on branches when infestations are heavy. The feeding of the insects weakens host trees, predisposing them to attack by bark beetles and other pests which, in conjunction with red pine scale, may kill the tree.

As the name suggests, red pine scale affects red pine, Japanese red pine, Japanese black pine, and Chinese pine.

SPONGY MOTH

Spongy moth caterpillars can be identified by the blue and red dots along their backs.

John Ghent, John Ghent, Bugwood.org

Spongy moth (*Lymantria dispar,* formerly called European gypsy moth) is native to Europe and first arrived in the United States in Massachusetts in 1869. This moth is a significant pest because its caterpillars will devour the leaves or needles of more than 300 species of trees and shrubs. Spongy moth caterpillars defoliate trees, which makes the host trees vulnerable to diseases and other pests that can eventually kill the tree.

Males 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 of the species cannot fly. Spongy moth is named for the fuzzy, light-brown, spongy-looking egg masses laid by females and easily spotted on tree bark during the winter.

Spongy moth prefers approximately 150 primary hosts but feeds on more than 300 species of trees and shrubs. Many preferred hosts are found among the birches, cedars, larches, poplars, oaks, and willows.

SOUTHERN PINE BEETLE

Pitch tube with expelled SPB.

Erich G. Vallery, USDA Forest Service - SRS-4552, Bugwood.org

The southern pine beetle (SPB, *Dendroctonus frontalis*) is the most destructive insect pest of pine in the southern U.S. Trees are killed when beetles construct winding egg galleries underneath the bark. These galleries effectively girdle the tree and destroy the conductive tissues that transport nutrients and water throughout the tree. The beetles also carry blue staining fungi on their bodies that clog the water conductive tissues which transport water within the tree. Signs of attack on the outside of the tree include pitch tubes and boring dust, known as frass, caused by beetles entering the tree.

Infested trees have only recently been found in Massachusetts, but this insect could have significant impacts on pitch pine forests in the state. Other species at risk from SPB include Norway spruce and eastern white pine.

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.

SLF congregating on a branch to feed.

Lawrence Barringer, Pennsylvania Department of Agriculture, Bugwood.org

Symptoms of SLF include 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 insects themselves are often easy to spot as well, congregating in large groups on the same tree. Adults have grey upper wings which, when spread, reveal bright red and black lower wings.

Among the many trees impacted by SLF are almonds, apricots, cherries, nectarines, peaches, plums, apples, maples, oaks, pines, poplars, sycamores, walnuts, and willows, as well as grape vines and hop plants.

WHITE PINE DECLINE

White pine decline is believed to have developed around 2009 and is affecting eastern white pine throughout the east coast of the U.S. White pine decline is characterized by yellowing or browning needles, premature needle drop, thinning canopies, undersized shoots and needles, resinosis, branch dieback, and whole tree death. However, white pine decline is not the result of a single pest or disease, but rather, a complex of multiple native pests and diseases, spurred on by changing climate.

Eastern white pine exhibiting signs of white pine decline.

UMass Amherst.

White pine needle disease is the primary cause of many of the observed symptoms of white pine decline and is caused by several different fungal pathogens, including *Lecanostica acicula*, *Septorioides strobi*, *Bifusella linearis*, and *Lophophacidium dooksii*. Caliciopsis canker, another component of white pine decline, is facilitated by white pine bast scale. It is believed that increased temperatures and precipitation from May through July, caused by climate change, are boosting the concentration of these pests and contributing to white pine decline. Currently, the best management method for combating this disease complex is to improve white pine vigor through stand thinning, fertilization, and generally reducing stressors on white pines.

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APPENDIX C
SUGGESTED TREE SPECIES

Diverse trees planted in appropriate locations are a critical component 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, tolerance to urban conditions, and suitability for planting in USDA Plant Hardiness Zones 6 and 7. The following list is offered to assist all relevant community personnel in selecting appropriate tree species for a variety of sites.

LARGE TREES

DRG defines a "large" tree as one which typically grows taller than 45 feet at maturity. Large trees should be planted in locations with a minimum growing space dimension of at least 8 feet between hardscape features. This allows sufficient soil volume for the tree to develop a robust root system and ample space for large structural roots to grow without damaging hardscape features.

Botanical Name	Common Name	Example Cultivars	Street Tree
Abies concolor	white fir	'Candicans'	No
Abies fraseri	Fraser fir		No
Acer saccharinum	silver maple	'Silver Queen', 'Skinner'	No
Acer saccharum	sugar maple	Apollo®, Commemoration®, 'Green Mountain', Legacy®	Potential
Acer x freemanii	Freeman maple	Autumn Blaze®, Celebration®, 'Marmo', Scarlet Sentinel®	Yes
Aesculus flava	yellow buckeye	'Homestead'	No
Aesculus hippocastanum	horsechestnut	'Baumanii'	No
Betula alleghaniensis	yellow birch		Potential
Betula lenta	sweet birch	subspecies *uber*	Potential
Betula nigra	river birch	City Slicker®, Heritage®	Potential
Carya illinoinensis	pecan	'Green River', 'Major'	No
Carya ovata	shagbark hickory		No
Catalpa speciosa	northern catalpa	Heartland®	No
Cedrus libani	cedar-of-Lebanon		No
Celtis occidentalis	hackberry	'Chicagoland', Prarie Sentinel®	Yes
Cercidiphyllum japonicum	katsura tree	'Morioka Weeping'	No
Cryptomeria japonica	Japanese cedar	'Yoshino', 'Sekkan'	Potential
Ginkgo biloba	ginkgo	'Autumn Gold', Princeton Sentry®	Yes
Gymnocladus dioicus	Kentucky coffeetree	Espresso®, True North®	Yes
Ilex opaca	American holly	'Canary', 'Jersey Princess', 'Miss Helen'	Potential
Juglans nigra	black walnut		No

Botanical Name	Common Name	Example Cultivars	Street Tree
Liquidambar styraciflua	American sweetgum	'Cherokee', Emerald Sentinel®, 'Rotundiloba', 'Slender Silhouette'	Yes
Liriodendron tulipifera	tuliptree	Emerald City®, 'Fastigiatum'	Potential
Magnolia acuminata	cucumber magnolia	hybrids, 'Fertile Myrtle', 'Urbana'	Potential
Metasequoia glyptostroboides	dawn redwood	Jade Prince®, 'National', 'Urban Spire'	Potential
Picea orientalis	Oriental spruce	'Aureospicata', 'Skylands'	No
Pinus densiflora	Japanese red pine		No
Pinus nigra	Austrian pine	'Arnold Sentinel'	No
Pinus strobus	eastern white pine	'Fastigiata', 'Glauca'	Potential
Pinus sylvestris	Scotch pine	'Gold Coin'	No
Pinus taeda	loblolly pine		No
Platanus occidentalis	American sycamore		No
Platanus x acerifolia	London planetree	'Bloodgood', Exclamation!®, 'Liberty'	Yes
Quercus acutissima	sawtooth oak		No
Quercus alba	white oak		Potential
Quercus bicolor	swamp white oak	American Dream®, Beacon®	Yes
Quercus cerris	turkey oak		Potential
Quercus coccinea	scarlet oak		Yes
Quercus imbricaria	shingle oak		Yes
Quercus lyrata	overcup oak	Marquee®, Resilience®, Streamline®	Yes
Quercus macrocarpa	bur oak	Urban Pinnacle®	Yes
Quercus michauxii	swamp chestnut oak		Yes
Quercus nuttallii	Nuttall oak	Esplanade®, Sangria®, Solshine®	Yes
Quercus palustris	northern pin oak	Green Pillar®, Promenade®	Yes
Quercus phellos	willow oak	Ascendor®, Kingpin®	Yes
Quercus robur	English oak	Heritage®, Regal Prince®, Skymaster®	Yes
Quercus rubra	northern red oak		Yes
Quercus shumardii	Shumard oak	Madison®, Prominence®	Yes
Quercus velutina	black oak		Potential
Taxodium distichum	bald cypress	'Prairie Sentinel', Shawnee Brave®	Yes
Thuja occidentalis	eastern arborvitae		Yes
Tilia americana	basswood	'Redmond'	Yes
Tilia cordata	littleleaf linden	Greenspire®, Summer Sprite®	Yes
Tilia tomentosa	silver linden	Green Mountain®, 'Silver Lining', 'Sterling'	Yes
Ulmus americana	American elm	Colonial Spirit®, 'Jefferson', 'New Harmony', Prairie Expedition®	Yes

Botanical Name	Common Name	Example Cultivars	Street Tree
Ulmus davidiana	David elm	Accolade®, 'Patriot', Triumph®	Yes
Ulmus parviflora	Chinese lacebark elm	'Allee', Emerald Flair®, Everclear®	Yes
Zelkova serrata	Japanese zelkova	City Sprite®, Green Vase®, 'Halka', 'Musashino', Wireless®	Yes

MEDIUM TREES

DRG defines a "medium" tree as one which is typically 30 to 45 feet tall at maturity. Medium trees should be planted in locations with a minimum growing space dimension of at least 6 feet between hardscape features.

Botanical Name	Common Name	Example Cultivars	Street Tree
Acer miyabei	miyabei maple	Rugged Ridge®, State Street®	Yes
Acer rubrum	red maple	Armstrong Gold®, 'Brandywine', 'Columnare', 'Morgan', 'New World', Redpointe®, Summer Sensation®	Yes
Aesculus x carnea	red horsechestnut	'Briotii', 'Fort McNair'	No
Callitropsis nootkatensis	Nootka false cypress	'Pendula', 'Green Arrow'	No
Carpinus betulus	European hornbeam	Emerald Avenue®, 'Fastigiata'	Yes
Chamaecyparis thyoides	Atlantic whitecedar		No
Cladrastis kentukea	American yellowwood	'Perkins Pink'	No
Corylus colurna	Turkish filbert		Yes
Diospyros virginiana	persimmon	John Rick', 'Killen'	No
Eucommia ulmoides	hardy rubber tree	Emerald Pointe®	Potential
Gleditsia triacanthos	honeylocust	'Moraine', 'Shademaster', Skyline®, StreetKeeper®	Yes
Ilex x attenuata	topal holly	'Foster No. 2', 'Savannah'	Yes
Juniperus virginiana	eastern red cedar	'Burkii', 'Providence'	Potential
Koelreuteria paniculata	golden rain tree	'Coral Sun', 'Fastigiata', 'Summerburst'	Potential
Maclura pomifera	osage-orange	'White Shield', 'Wichita'	Yes
Magnolia grandiflora	southern magnolia	'Edith Bogue', 'Little Gem', 'Victoria'	Potential
Magnolia macrophylla	big leaf magnolia	subspecies *ashei* , 'Julian Hill'	No
Morus rubra	red mulberry		Potential
Nyssa sylvatica	black gum	Afterburner®, Firestarter®, White Chapel®	Yes
Picea omorika	Serbian spruce	'Bruns', 'Silberblau'	Yes
Pinus flexilis	limber pine	'Vanderwolf's Pyramid'	Potential
Pistachia chinensis	Chinese pistache	'Keith Davey', 'Sarah's Radiance'	Yes
Quercus stellata	post oak		Potential

SMALL TREES

DRG defines a "small" tree as one which is typically 30 feet tall or smaller at maturity. Small trees should be planted in locations with a minimum growing space dimension of at least 4 feet between hardscape features, although 3 feet may be workable where wider spaces are not possible. Small trees are good candidates for planting under utility lines. In some cases, small cultivars of large or medium trees are available, such as the City Sprite® and Wireless® zelkovas or the Summer Sprite® littleleaf linden.

Botanical Name	Common Name	Example Cultivars	Street Tree
Acer buergeranium	trident maple	Aeryn®, Blood Moon®, Valynor®	Yes
Acer campestre	hedge maple	Jade Patina®, Metro Gold®, Streetside®	Yes
Acer griseum	paperbark maple	Cinnamon Girl®, Fireburst®	Yes
Aesculus pavia	red buckeye	'Humilis', 'Splendens'	No
Amelanchier arborea	downy serviceberry	Pink Damsel®	Yes
Amelanchier laevis	allegheny serviceberry	Cumulus', 'Snowcloud', Spring Flurry®	Yes
Amelanchier x grandiflora	hybrid serviceberry	Princess Diana', 'Robin Hill'	No
Asimina triloba	paw paw	Potomac®, Wabash®	No
Carpinus caroliniana	American hornbeam	Native Flame®, Rising Fire®	Yes
Cercis canadensis	redbud	Pink Pom Poms', 'Merlot'	Yes
Cornus florida	flowering dogwood	'Appalachian Joy', Cherokee Brave®, 'Rubra'	Potential
Cornus kousa	Kousa dogwood	Prophet®, Scarlet Fire®	No
Cornus mas	Cornelian cherry	'Golden Glory'	No
Cornus x rutgersensis	hybrid dogwood	Aurora®, Celestial®, Stellar Pink®	No
Cotinus obovatus	American smoketree	Cotton Candy®, 'Grace'	No
Crataegus crus-galli	cockspur hawthorn	'Inermis'	No
Crataegus phaenopyrum	Washington hawthorn	'Washington Tree'	Potential
Crataegus viridis	green hawthorn	'Winter King'	No
Halesia carolina	Carolina silverbell	'Rosea'	No
Hamamelis virginiana	common witchhazel	'Harvest Moon'	No
Hamamelis x intermedia	hybrid witchhazel	'Diane', 'Jelena', 'Sunburst'	No
Heptacodium miconioides	Seven-son flower		Potential
Ilex 'Nellie R. Stevens'	Nellie R. Stevens holly	'Golden Nellie'	Potential
Maackia amurensis	Amur maackia	Maacnificent®, 'Starburst'	Yes
Magnolia stellata	star magnolia	'Centennial', 'Royal Star', 'Waterlily'	Potential
Magnolia tripetala	umbrella magnolia		No
Magnolia virginiana	sweetbay magnolia	Emerald Tower®, 'Keltyk'	Potential
Magnolia x soulangeana	saucer magnolia	'Alexandrina', 'Amabilis', 'Rustica Rubra'	Potential

Botanical Name	Common Name	Example Cultivars	Street Tree
Malus x	crabapple	'Adirondack', Golden Raindrops®, Red Jewel®, 'Prairifire', 'Purple Prince', Royal Raindrops®, Raspberry Spear®, 'Prairie Rose'	Potential
Ostrya virginiana	hohormbeam	Autumn Treasure®, Sun Beam®	Yes
Oxydendrum arboreum	sourwood		No
Parrotia persica	Persian parrotia	Golden Belltower®, 'Vanessa'	Yes
Pinus cembra	Swiss stone pine	'Chalet', 'Stricta'	No
Pinus parviflora	Japanese white pine	'Aoi', 'Glauca'	No
Prunus sargentii	Sargent cherry	'Accolade', 'Columnaris', Pink Flair®	Yes
Prunus serrulata	Japanese flowering cherry	'Amanogawa', 'Kanzan', 'Sunset Boulevard', 'Ukon'	Yes
Prunus subhirtella	Higan cherry	'Pendula Plena Rosea'	No
Prunus virginiana	chokecherry	Canada Red Improved', Sucker Punch®	Potential
Prunus x yedoensis	Yoshino cherry	'Akebono'	Potential
Sciadoptiys verticillata	umbrella pine	'Wintergreen'	No
Stewartia pseudocamellia	Japanese stewartia		No
Styrax japonicus	Japanese snowbell	Prystine Spire®, Snowcone®	Potential
Syringa reticulata	Japanese tree lilac	Ivory Pillar®, 'Ivory Silk', 'Summer Storm'	Yes

The Tree Book by Michael A. Dirr & Keith S. Warren was consulted to compile this suggested species list. Cultivar selections are recommendations only – many other suitable cultivars may be available. DRG recommends building flexibility into planting plans as desired trees may or may not be available in local trade at the time of planting.