TREE MANAGEMENT PLAN

City of Fulton, New York

August 2016

Prepared for:
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Municipal Building
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ACKNOWLEDGMENTS

Fulton’s vision to promote and preserve the urban forest and improve the management of public trees was a fundamental inspiration for this project. This vision will ensure canopy continuity, which will reduce stormwater runoff and improve aesthetic value, air quality, and public health.

Fulton is thankful for the grant funding it received from the New York State Department of Environmental Conservation Urban and Community Forestry Program. The grants are provided to communities through the New York State Environmental Protection Fund (EPF). The Urban Forestry grants are part of New York’s ongoing initiatives to address climate change and environmental justice, and provide funding to expand the number of trees in areas that often have limited space. Projects target local environmental needs and benefit the community.

The city also recognizes the support of its Mayor and Common Council:

Mayor

Ronald L. Woodward Sr.

Ward Councilors

Norman Foster, Thomas Kenyon, Lawrence Macner,
James Myers, Donald Patrick Jr., David Ritchie

EXECUTIVE SUMMARY

This plan was developed for the City of Fulton by Davey Resource Group with a focus on addressing short-term and long-term maintenance needs for inventoried public trees. Davey Resource Group completed a tree inventory to gain an understanding of the needs of the existing urban forest and to project a recommended maintenance schedule for tree care. Analysis of inventory data and information about the city's existing program and vision for the urban forest were utilized to develop this *Tree Management Plan*. This plan includes data from the most recent phase of inventory data collection in 2013 and serves as an extension of the 2013 *Tree Management Plan*. Also included in this plan are economic, environmental, and social benefits provided by the trees in Fulton.

State of the Existing Urban Forest

The May 2016 inventory included trees, stumps, and planting sites along public street rights-of-way (ROW). A total of 722 sites were recorded during the inventory: 462 trees, 12 stumps, and 248 vacant planting sites. Analysis of the tree inventory data found the following:

- Two species, *Acer platanoides* (Norway maple) and *A. rubrum* (red maple), comprise such a large percentage of the street ROW (26% and 17%, respectively) that they threaten biodiversity.
- The diameter size class distribution of the inventoried tree population trends towards the ideal, with a greater number of young trees than established, maturing, or mature trees.
- The overall condition of the inventoried tree population is rated Fair or better.
- Of potential threats from pests, Asian longhorned beetle (*Anoplophora glabripennis*) and granulate ambrosia beetle (*Xylosandrus crassiusculus*) pose the biggest threat to the health of the inventoried population.
- Fulton's trees have an estimated replacement value of $1,199,600.
- Trees provide approximately $67,744 in the following annual benefits:
    - *Aesthetic and other benefits*: valued at $22,048 per year.
    - *Air quality*: 1,139 pounds of pollutants removed valued at $5,814 per year.
    - *Net total carbon sequestered and avoided*: 228,998 pounds valued at $756 per year.
    - *Energy*: 48 megawatt-hours (MWh) and 17,055 therms valued at $30,728 per year.
    - *Stormwater peak flow reductions:* 1,049,837 gallons valued at $8,399 per year.

Tree Maintenance and Planting Needs

Trees provide many environmental and economic benefits that justify the time and money invested in planting and maintenance. Recommended maintenance needs include: Tree Removal (6%); Stump Removal (2%); Tree Clean (Routing Pruning) (48%); Young Tree Train (10%); and Plant Tree (34%). Maintenance should be prioritized by addressing trees with the highest risk first. The inventory noted many Severe and High Risk trees (15% of trees assessed); these trees should be removed or pruned immediately to promote public safety. Low and Moderate Risk trees should be addressed after all elevated risk tree maintenance has been completed. Trees should be planted to mitigate removals and create canopy.

REMOVAL	• Total = 40 trees • Severe and High Risk = 31 trees • Moderate and Low Risk = 9 trees • Stumps = 12
HIGH RISK PRUNING	• Total = 37 trees • Severe Risk = 0 trees • High Risk = 37 trees
ROUTINE PRUNING CYCLE	• Total = 311 trees • Number of trees in cycle each year = approximately 62
YOUNG TREE TRAINING CYCLE	• Total = 74 trees • Number of trees in cycle each year = at least 24
TREE PLANTING	• Number of trees each year = at least 35

Fulton's urban forest will benefit greatly from a three-year young tree training cycle and a five-year routine pruning cycle. Proactive pruning cycles improve the overall health of the tree population and may eventually reduce program costs. In most cases, pruning cycles will correct defects in trees before they worsen, which will avoid costly problems. Based on inventory data, at least 24 young trees should be structurally pruned each year during the young tree training cycle, and approximately 62 trees should be cleaned each year during the routine pruning cycle.

Planting trees is necessary to maintain and increase canopy cover, and to replace trees that have been removed or lost to natural mortality (expected to be 1–3% per year) or other threats (for example, construction, invasive pests, or impacts from weather events such as drought, flooding, ice, snow, storms, and wind). Davey Resource Group recommends planting at least 35 trees of a variety of species each year to offset these losses, increase canopy, maximize benefits, and account for ash tree loss.

Citywide tree planting should focus on replacing tree canopy recommended for removal and establishing new canopy in areas that promote economic growth, such as business districts, recreational areas, trails, parking lots, areas near buildings with insufficient shade, and areas where there are gaps in the existing canopy. Various tree species should be planted; however, the planting of *Acer* (maple) should be limited until the species distribution normalizes. Due to the species distribution and impending threats from emerald ash borer (EAB, *Agrilus planipennis*), all *Fraxinus* spp. (ash) trees should be temporarily removed from the planting list or planted only when a landscape plan is in place.

Urban Forest Program Needs

Adequate funding will be needed for the city to implement an effective management program that will provide short-term and long-term public benefits, ensure that priority maintenance is performed expediently, and establish proactive maintenance cycles. The estimated total cost for the first year of this five-year program is $59,350. This total will decrease to approximately $18,685 by Year 3 of the program. High-priority removal and pruning is costly; since most of this work is scheduled during the first year of the program, the budget is higher for that year. After high-priority work has been completed, the urban forestry program will mostly involve proactive maintenance, which is generally less costly. Budgets for later years are thus projected to be significantly lower.

Over the long term, supporting proactive management of trees through funding will reduce municipal tree care management costs and potentially minimize the costs to build, manage, and support certain city infrastructure.

Fulton has many opportunities to improve its urban forest. Planned tree planting and a systematic approach to tree maintenance will help a reactive operation grow into a cost-effective, proactive program. Investing in this tree management program will promote public safety, improve tree care efficiency, and increase the economic and environmental benefits the community receives from its trees.

Table 1. Estimated Total Cost of Management Program Per Year

Year	Estimated Total Cost
1	$59,350
2	$22,035
3	$18,685
4	$18,715
5	$18,715

TABLE OF CONTENTS

Tables

Figures

Appendices

INTRODUCTION

The City of Fulton is home to approximately 12,000 full-time residents who enjoy the beauty and benefits of their urban forest. The city's forestry program manages and maintains trees on public property, including trees, stumps, and planting sites in specified parks, public facilities, and along the street ROW.

Fulton conducted an inventory of public trees in 2016. The city has a tree ordinance, maintains a budget of more than $2 per capita for tree-related expenses, celebrates Arbor Day, and has been a Tree City USA member for 13 years.

Approach to Tree Management

The best approach to managing an urban forest is to develop an organized, proactive program using tools (such as a tree inventory and tree management plan) to set goals and measure progress. These tools can be utilized to establish tree care priorities, generate strategic planting plans, draft cost-effective budgets based on projected needs, and ultimately minimize the need for costly, reactive solutions to crises or urgent hazards.

In May 2016, Fulton worked with Davey Resource Group to inventory trees and develop a management plan. This plan considers the diversity, distribution, and general condition of the inventoried trees, but also provides a prioritized system for managing public trees. The following tasks were completed:

- Inventory of trees, stumps, and planting sites along the street ROW and within public parks.
- Analysis of tree inventory data.
- Development of a plan that prioritizes the recommended tree maintenance.

This plan is divided into three sections:

- *Section 1: Tree Inventory Analysis* summarizes the tree inventory data and presents trends, results, and observations.
- *Section 2: Benefits of the Urban Forest* summarizes the economic, environmental, and social benefits that trees provide to the community. This section presents statistics of an i-Tree Streets benefits analysis conducted for Fulton.
- *Section 3: Tree Management Program* utilizes the inventory data to develop a prioritized maintenance schedule and projected budget for the recommended tree maintenance over a five-year period.

SECTION 1: TREE INVENTORY ANALYSIS

In May 2016, Davey Resource Group arborists assessed and inventoried trees, stumps, and planting sites along the street ROW. A total of 722 sites were collected during the inventory: 462 trees, 12 stumps, and 248 vacant planting sites. Figure 1 provides a detailed breakdown of the number and type of sites inventoried.

The city's public street rights-of-way were selected by Fulton for the inventory.

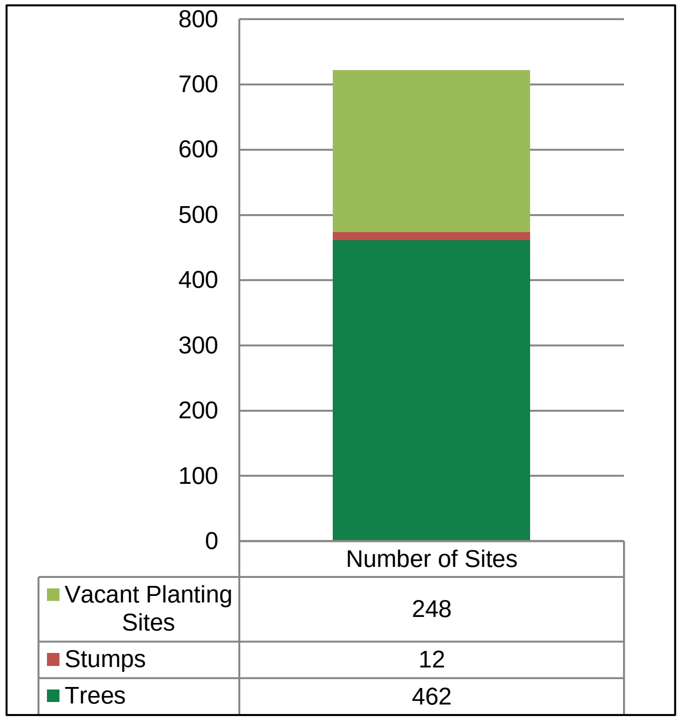


Figure 1. Sites inventoried during the 2016 inventory.

Assessment of Tree Inventory Data

Data analysis and professional judgment are used to make generalizations about the state of the inventoried tree population. Recognizing trends in the data can help guide short-term and long-term management planning. In this plan, the following criteria and indicators of the inventoried tree population were assessed:

- *Species Diversity*, the variety of species in a specific population, affects the population's ability to withstand threats from invasive pests and diseases. Species diversity also impacts tree maintenance needs and costs, tree planting goals, and canopy continuity.
- *Diameter Size Class Distribution Data*, the statistical distribution of a given tree population's trunk-size class, is used to indicate the relative age of a tree population. The diameter size class distribution affects the valuation of tree-related benefits as well as the projection of maintenance needs and costs, planting goals, and canopy continuity.

Photograph 1. *Davey's ISA-Certified Arborists inventoried trees along street ROW and in community parks to collect information about trees that could be used to assess the state of the urban forest.*

- *Condition*, the general health of a tree population, indicates how well trees are performing given their site-specific conditions. General health affects both short-term and long-term maintenance needs and costs as well as canopy continuity. *Street ROW Stocking Level* is the portion of existing street ROW trees compared to the total number of potential street ROW trees (number of inventoried trees plus the number of potential planting spaces); stocking level can help determine tree planting needs and budgets.
- *Other Observations* include inventory data analysis that provides insight into past maintenance practices and growing conditions; such observations may affect future management decisions.

Species Diversity

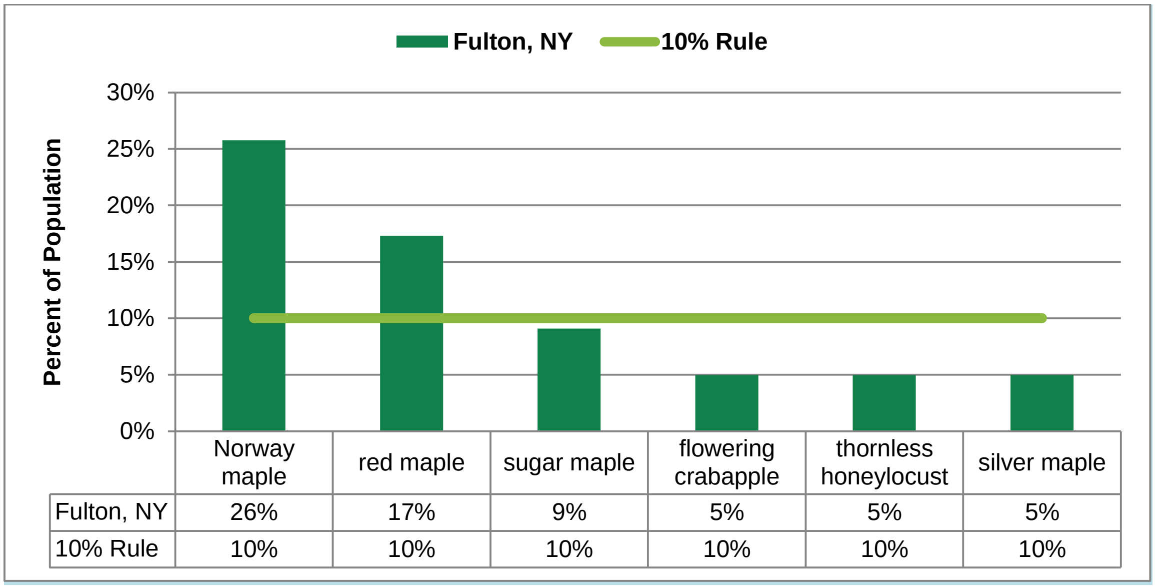
Species diversity affects maintenance costs, planting goals, canopy continuity, and the forestry program's ability to respond to threats from invasive pests or diseases. Low species diversity (large number of trees of the same species) can lead to severe losses in the event of species-specific epidemics such as the devastating results of Dutch elm disease (*Ophiostoma novo-ulmi*) throughout New England and the Midwest. Due to the spread of Dutch elm disease in the 1930s, combined with the disease's prevalence today, massive numbers of *Ulmus americana* (American elm), a popular street tree in Midwestern cities and towns, have perished (Karnosky 1979). Several Midwestern communities were stripped of most of their mature shade trees, creating a drastic void in canopy cover. Many of these communities have replanted to replace the lost elm trees. Ash and maple trees were popular replacements for American elm in the wake of Dutch elm disease. Unfortunately, some of the replacement species for American elm trees are now overabundant, which is a biodiversity concern. EAB and Asian longhorned beetle (ALB, *Anoplophora glabripennis*) are non-native insect pests that attack some of the most prevalent urban shade trees and certain agricultural trees throughout the country.

The composition of a tree population should follow the 10-20-30 Rule for species diversity: a single species should represent no more than 10% of the urban forest, a single genus no more than 20%, and a single family no more than 30%.

Findings

Analysis of Fulton's tree inventory data indicated that the street ROW tree population had relatively good diversity, with 35 genera and 53 species represented.

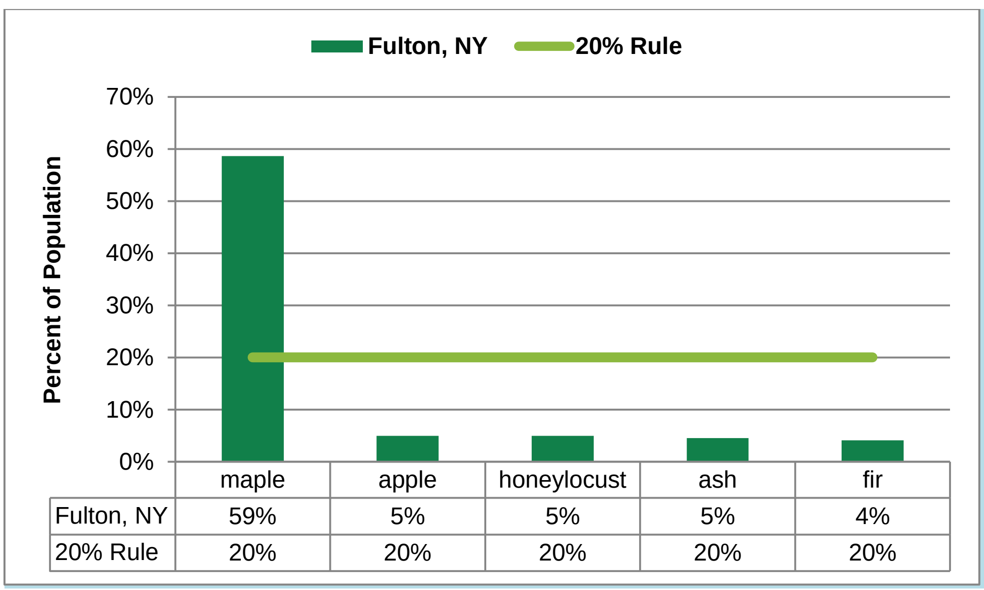
Figure 2 uses the 10% Rule to compare the percentages of the most common species identified during the inventory to the street tree populations. *Acer platanoides* (Norway maple) and *A. rubrum* (red maple) far exceed the recommended 10% maximum for a single species in a population, comprising 26% and 17% of the inventoried tree population, respectively. *A. saccharum* (sugar maple) is approaching the 10% threshold.



	Norway maple	red maple	sugar maple	flowering crabapple	thornless honeylocust	silver maple
Fulton, NY	26%	17%	9%	5%	5%	5%
10% Rule	10%	10%	10%	10%	10%	10%

Figure 2. Five most abundant species of the inventoried population compared to the 10% Rule.

Figure 3 uses the 20% Rule to compare the percentages of the most common genera identified during the inventory to the street tree populations. *Acer* (maple) far exceeds the recommended 20% maximum for a single genus in a population, comprising 59% of the inventoried tree population.



	maple	apple	honeylocust	ash	fir
Fulton, NY	59%	5%	5%	5%	4%
20% Rule	20%	20%	20%	20%	20%

Figure 3. Five most abundant genera of the inventoried population compared to the 20% Rule.

Discussion/Recommendations

Acer (maple) dominates the streets. This is a biodiversity concern because its abundance in the landscape make it a limiting species. Continued diversity of tree species is an important objective that will ensure Fulton's urban forest is sustainable and resilient to future invasive pest infestations.

Considering the large quantity of *Acer* (maple) in the city's population, along with its susceptibility to the Asian longhorned beetle (*Anoplophora glabripennis*), the planting of *Acer* (maple) should be limited to minimize the potential for loss in the event that ALB threatens Fulton's urban tree population. See Appendix C for a recommended tree species list for planting.

Diameter Size Class Distribution

Analyzing the diameter size class distribution provides an estimate of the relative age of a tree population and offers insight into maintenance practices and needs.

The inventoried trees were categorized into the following diameter size classes: young trees (0–8 inches DBH), established (9–17 inches DBH), maturing (18–24 inches DBH), and mature trees (greater than 24 inches DBH). These categories were chosen so that the population could be analyzed according to Richards' ideal distribution (1983). Richards proposed an ideal diameter size class distribution for street trees based on observations of well-adapted trees in Syracuse, New York. Richards' ideal distribution suggests that the largest fraction of trees (approximately 40% of the population) should be young (less than 8 inches DBH), while a smaller fraction (approximately 10%) should be in the large-diameter size class (greater than 24 inches DBH). A tree population with an ideal distribution would have an abundance of newly planted and young trees, and lower numbers of established, maturing, and mature trees.

Findings

Figure 4 compares Fulton's diameter size class distribution of the inventoried tree population to the ideal proposed by Richards (1983). Fulton's distribution trends towards the ideal; however, young trees and mature trees exceed the ideal by over 10%, while established and maturing trees fall short of the ideal.

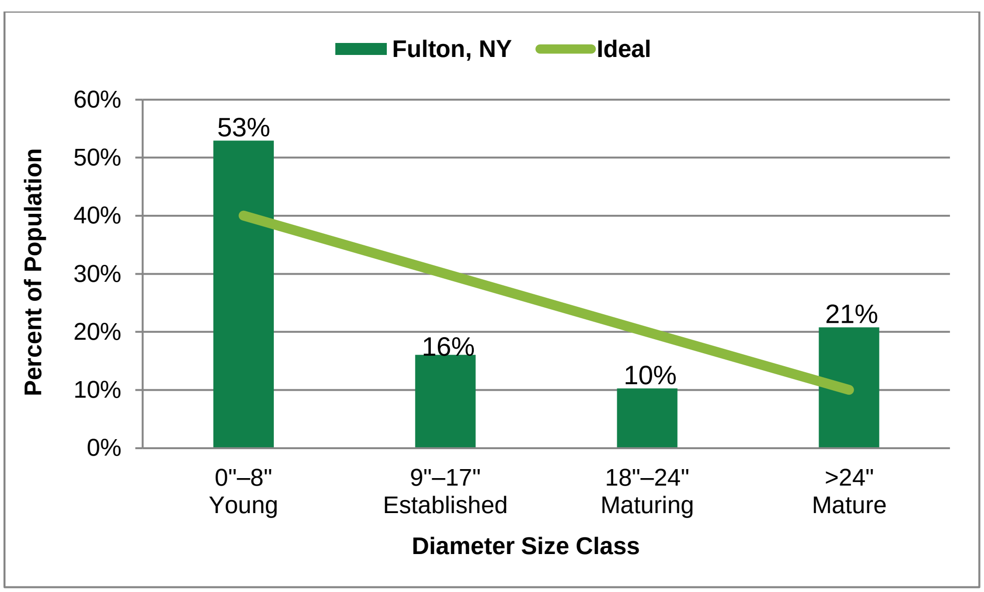


Figure 4. Comparison of diameter size class distribution for inventoried trees to the ideal distribution.

Discussion/Recommendations

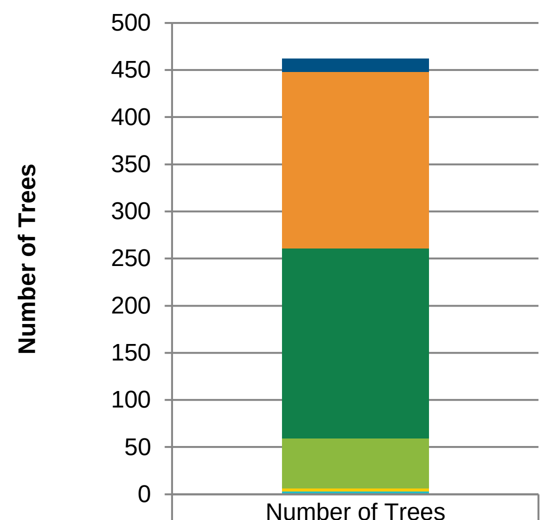
Even though it may appear that Fulton may have too many young trees, this is not the case. Actually, Fulton has too few established and maturing trees and, thus, the distribution is skewed. One of Fulton's objectives is to have an uneven-aged distribution of trees at the street, park, and citywide levels. Davey Resource Group recommends that Fulton support a strong planting and maintenance program to ensure that young, healthy trees are in place to fill in gaps in tree canopy and replace older declining trees. The city must promote tree preservation and proactive tree care to ensure the long-term survival of older trees. Tree planting and tree care will allow the distribution to normalize over time.

Planting trees is necessary to increase canopy cover and replace trees lost to natural mortality (expected to be 1%–3% per year) and other threats (for example, invasive pests or impacts from weather events such as storms, wind, ice, snow, flooding, and drought). Planning for the replacement of existing trees and identifying the best places to create new canopy is critical.

Condition

Davey Resource Group assessed the condition of individual trees based on methods defined by the International Society of Arboriculture (ISA). Several factors were considered for each tree, including: root characteristics; branch structure; trunk; canopy; foliage condition; and the presence of pests. The condition of each inventoried tree was rated Excellent, Very Good, Good, Fair, Poor, Critical, or Dead.

In this plan, the general health of the inventoried tree population was characterized by the most prevalent condition assigned during the inventory.



	Number of Trees
Very Good	14
Good	187
Fair	202
Poor	53
Critical	3
Dead	3

Figure 5. Condition of inventoried trees.

Comparing the condition of the inventoried tree population with relative tree age (or size class distribution) can provide insight into the stability of the population. Since tree species have different lifespans and mature at different diameters, heights, and crown spreads, actual tree age cannot be determined from diameter size class alone. However, general classifications of size can be extrapolated into relative age classes. The following categories are used to describe the relative age of a tree: young (0–8 inches DBH), established (9–17 inches DBH), maturing (18–24 inches DBH), and mature (greater than 24 inches DBH).

Figures 5 and 6 illustrate the general health and distribution of young, established, mature, and maturing trees relative to their condition.

Findings

Most of the inventoried trees were recorded to be in Fair or Good condition, 44% and 40%, respectively (Figure 5). Based on these data, the general health of the overall inventoried tree population is rated Good. Figure 6 illustrates that most of the young and established trees were rated to be in Good to Excellent condition, and that most of the maturing and mature trees were rated to be in Fair condition.

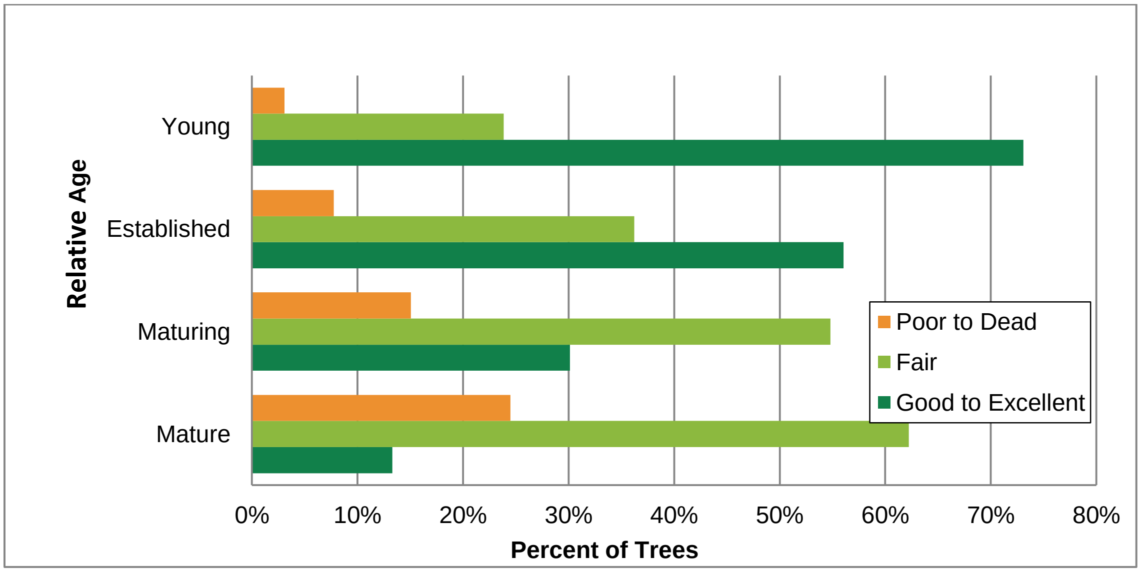


Figure 6. Tree condition by relative age during the 2016 inventory.

Discussion/Recommendations

Even though the condition of Fulton's inventoried tree population is typical, data analysis has provided the following insight into maintenance needs and historical maintenance practices:

- The similar trend in condition across street trees reveals that growing conditions and/or past management of trees were consistent.
- Dead trees and trees in Critical condition should be removed because of their failed health; these trees will likely not recover, even with increased care.
- Younger trees rated in Fair or Poor condition may benefit from improvements in structure that may improve their health over time. Pruning should follow *ANSI A300 (Part 1)* (ANSI 2008).
- Poor condition ratings among mature trees were generally due to visible signs of decline and stress, including decay, dead limbs, sparse branching, or poor structure. These trees will require corrective pruning, regular inspections, and possible intensive plant health care to improve their vigor.
- Proper tree care practices are needed for the long-term general health of the urban forest. Many of the newly planted trees were improperly mulched or had staking hardware attached to them long after they should have been removed. The following guidelines developed by ISA and those recommended by *ANSI A300 (Part 6)* (ANSI 2012) will ensure that tree maintenance practices ultimately improve the health of the urban forest.

Street ROW Stocking Level

Stocking is a traditional forestry term used to measure the density and distribution of trees. For an urban/community forest such as Fulton's, stocking level is used to estimate the total number of sites along the street ROW that could contain trees. Park trees and public property trees are excluded from this measurement.

Stocking level is the ratio of street ROW spaces occupied by trees to the total street ROW spaces suitable for trees. For example, a street ROW tree inventory of 1,000 total sites with 750 existing trees and 250 vacant planting sites would have a stocking level of 75%.

For an urban area, Davey Resource Group recommends that the street ROW stocking level be at least 90% so that no more than 10% of the potential planting sites along the street ROW are vacant.

Street ROW stocking levels may be estimated using information about the community, tree inventory data, and common street tree planting practices. Inventory data that contain the number of existing trees and vacant planting sites along the street ROW will increase the accuracy of the projection. However, street ROW stocking levels can be estimated using only the number of trees present and the number of street miles in the community.

To estimate stocking level based on total street ROW miles and the number of existing trees, it is assumed that any given street ROW should have room for 1 tree for every 50 feet along each side of the street. For example, 10 linear miles of street ROW with spaces for trees to grow at 50-foot intervals along each side of the street account for a potential 2,110 trees. If the inventory found that 1,055 trees were present, the stocking level would be 50%.

The potential stocking level for a community with 10 street miles is as follows:

5,280 feet/mile ÷ 50 feet = 106 trees/mile

106 trees/mile × 2 sides of the street = 212 trees/mile

211 trees per street mile × 10 miles = 2,110 potential sites for trees

1,055 inventoried trees ÷ 2,110 potential sites for trees = 50% stocked

When the estimated stocking level is determined using theoretical assumptions, the actual number of planting sites may be significantly less than estimated due to unknown growing space constraints, including inadequate growing space size, proximity of private trees, and utility conflicts.

Fulton's inventory data set included planting sites. Since the data included vacant planting sites, the stocking level can be more accurately projected and compared to the theoretical stocking level.

Findings

The inventory found 248 vacant planting sites. Of the inventoried sites, 50 were potential planting sites for large-sized trees (8-foot-wide and greater growing space size); 9 were potential sites for medium-sized trees (6- to 7-foot-wide growing space sizes); and 189 were potential sites for small-sized trees (4- to 5-foot-wide growing space sizes). Based on the data collected during this inventory, Fulton's current street ROW tree stocking level is 64%.

Based on a theoretical stocking level, the city has 63.25 linear miles of street ROW and 462 trees, which comes to an average of 7 trees per street mile. In theory, any given street should have growing space for 1 tree every 50 feet along each side of a street, or 211 trees per mile. This suggests that there is room for an additional 12,883 street trees in Fulton to reach full stocking potential.

Discussion/Recommendation

Fully stocking the street ROW with trees is an excellent goal. Inadequate tree planting and maintenance budgets, along with tree mortality, will result in lower stocking levels. Nevertheless, working to attain a fully stocked street ROW is important to promote canopy continuity and environmental sustainability. The city should consider improving its street ROW population's stocking level of 64% and working towards achieving the ideal of 90% or better. Generally, this entails a planned program of planting, care, and maintenance for the city's street ROW trees.

Fulton estimates that it plants 35 trees per year. With a current total of 248 planting sites along the street ROW, it would take approximately 7 years for the city to reach the recommended stocking level of 90%. If budgets allow, Davey Resource Group recommends that the city at least maintain the number of trees planted at 35. If possible, exceed this recommendation to better prepare for impending threats and to increase the benefits provided by the urban forest.

Stocking level can also be used to determine the number of trees per capita. Calculations of trees per capita are important in determining the density of a city's urban forest. The more residents and greater housing density a city possesses, the greater the need for trees to provide benefits.

Fulton's ratio of street trees per capita is 0.04, which falls well below the mean ratio of 0.37 reported for 22 U.S. cities (McPherson and Rowntree 1989). According to the citywide study, there is 1 tree for every 26 residents. Fulton's potential is 1 tree for every 0.9 resident.

Growing Space

Information about the type and size of the growing space was recorded. Growing space size was recorded as the minimum width of the growing space needed for root development. Growing space types are categorized as follows:

- Island—surrounded by pavement or hardscape (for example, parking lot divider).
- Median—located between opposing lanes of traffic.
- Open/Restricted—open sites with restricted growing space on two or three sides.
- Open/Unrestricted—open sites with unrestricted growing space on at least three sides.
- Raised Planter—in an above-grade or elevated planter.
- Tree Lawn/Parkway—located between the street curb and the public sidewalk.
- Unmaintained/Natural Area—located in areas that do not appear to be regularly maintained.
- Well/Pit—at grade level and completely surrounded by sidewalk.

Findings

The majority (60%) of the tree population is located in open/unrestricted areas, with almost all of the rest (39%) in tree lawns. Suggested planting sites are split between tree lawns (40%) and open/unrestricted areas (59%).

Discussion/Recommendations

To prolong the useful life of street trees, small-growing tree species should be planted in tree lawns 4–5 feet wide, medium-sized tree species in tree lawns 6–7 feet wide, and large-growing tree species in tree lawns at least 8 feet wide. The useful life of a public tree ends when the cost of maintenance exceeds the value contributed by the tree. This can be due to increased maintenance required by a tree in decline, or it can be due to the costs of repairing damage caused by the tree's presence in a restricted site.

Further Inspection

This data field indicates whether a particular tree requires further inspection, such as a Level III risk inspection in accordance with ANSI A300, Part 9 (ANSI, 2011), or periodic inspection due to particular conditions that may cause it to be a safety risk and, therefore, hazardous. If a tree was noted for further inspection, city staff should investigate as soon as possible to determine corrective actions.

Findings

Davey Resource Group recommended fourteen (14) trees for further inspection.

Discussion/Recommendations

An ISA-Certified Arborist should perform additional inspections of the 14 trees. If it is determined that these trees exceed the threshold for acceptable risk, the defective part(s) of the trees should be corrected or removed, or the entire tree may need to be removed.

The three inventoried ash trees that showed possible symptoms of EAB should be monitored. If signs of EAB manifest, the tree should be removed and the site should be inspected for potential replacement.

Potential Threats from Pests

Insects and diseases pose serious threats to tree health. Awareness and early diagnosis are essential to ensuring the health and continuity of street and park trees. Appendix C provides information about some of the current potential threats to Fulton's trees and includes websites where more detailed information can be found.

Many pests target a single species or an entire genus. The inventory data were analyzed to provide a general estimate of the percentage of trees susceptible to some of the known pests in New York (Figure 7). It is important to note that the figure only presents data collected from the inventory. Many more trees throughout Fulton, including those on public and private property, may be susceptible to these invasive pests.

Findings

Granulate ambrosia beetle (*Xylosandrus crassiusculus*) and Asian longhorned beetle (ALB or *Anoplophora glabripennis*) are known threats to a large percentage of the inventoried street trees (64% and 60%, respectively). These pests were not detected in Fulton, but if they were identified, the city could see severe losses in its tree population.

There were 21 ash trees inventoried along Fulton's street ROW, but only 3 showed potential symptoms. Private trees that were not part of this inventory also showed symptoms of infestation. The unknown number of private trees that were not part of this inventory may be a future concern.

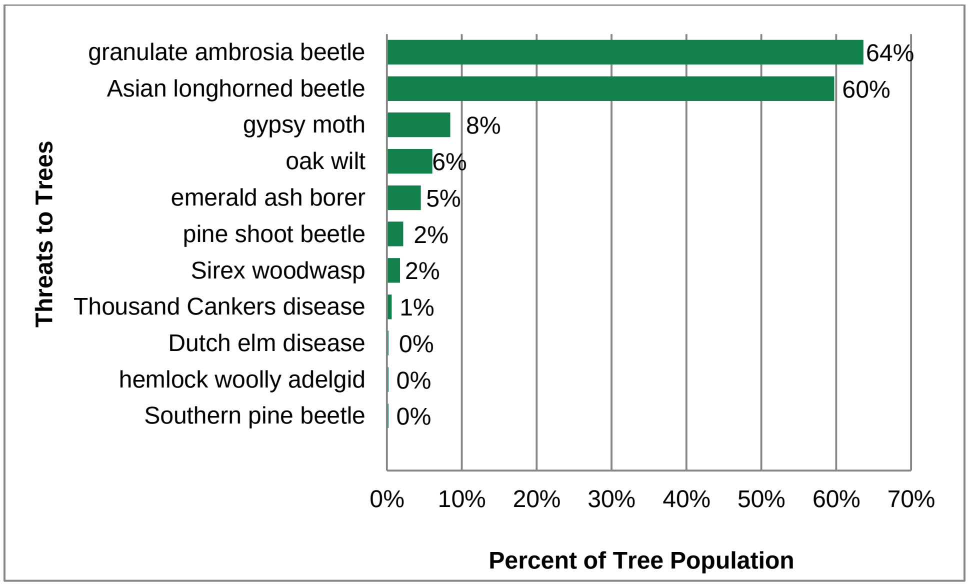


Figure 7. Potential impact of insect and disease threats noted during the 2016 inventory.

Discussion/Recommendations

Fulton should be aware of the signs and symptoms of potential infestations and should be prepared to act if a significant threat is observed in its tree population or a nearby community. An integrated pest management plan should be established. The plan should focus on identifying and monitoring threats, understanding the economic threshold, selecting the correct treatment, properly timing management strategies, recordkeeping, and evaluating results. With signs of EAB already present in the area, quick action is essential. For those trees not currently showing signs or symptoms, a treatment program can be implemented to try and save them. However, a replacement program should be initiated to compensate for the ash trees that are already showing signs of decline.

SECTION 2: BENEFITS OF THE URBAN FOREST

The urban forest plays an important role in supporting and improving the quality of life in urban areas. A tree's shade and beauty contributes to a community's quality of life and softens the often hard appearance of urban landscapes and streetscapes. When properly maintained, trees provide communities abundant environmental, economic, and social benefits that far exceed the time and money invested in planting, pruning, protection, and removal.

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 were 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).

Photograph 2. *Trees provide significant aesthetic value to the community. Additionally, the tangible services of trees provide quantifiable benefits that justify the time and money invested in planting and maintenance.*

The trees growing along the public streets constitute a valuable community resource. They provide numerous tangible and intangible benefits, such as pollution control, energy reduction, stormwater management, property value increases, wildlife habitat, education, and aesthetic value.

The services and benefits of trees in the urban and suburban setting were once considered to be unquantifiable. However, by using extensive scientific studies and practical research, these benefits can now be confidently calculated using tree inventory information. The results of applying a proven, defensible model and method that determine tree benefit values for the City of Fulton's tree inventory data are summarized in this report using the i-Tree's Streets application. The results of Fulton's tree inventory provide insight into the overall health of the city's public trees and the management activities needed to maintain and increase the benefits of trees into the future.

Tree Benefit Analysis

i-Tree Streets

In order to identify the dollar value provided and returned to the community, the city's street tree inventory data were formatted for use in the i-Tree Streets benefit-cost assessment tool.

i-Tree Streets, a component of i-Tree Tools, analyzes an inventoried tree population's structure to estimate the costs and benefits of that tree population. The assessment tool creates an annual benefit report that demonstrates the value street trees provide to a community.

These quantified benefits and the reports generated for this management plan are described below.

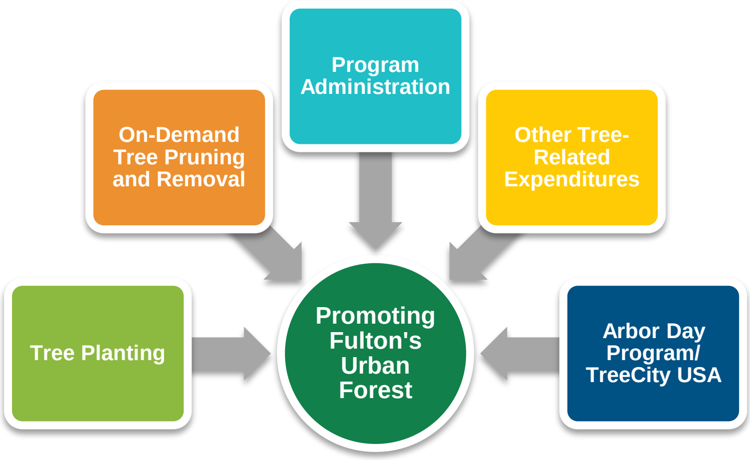
- **Aesthetic/Other Benefits:** Shows the tangible and intangible benefits of trees reflected by increases in property values (in dollars).
- **Stormwater:** Presents reductions in annual stormwater runoff due to rainfall interception by trees measured in gallons.
- **Carbon Stored:** Tallies all of the carbon dioxide (CO_2) stored in the urban forest over the life of its trees as a result of sequestration. Carbon stored is measured in tons.
- **Energy:** Presents the contribution of the urban forest towards conserving energy in terms of reduced natural gas use in the winter (measured in therms [thm]) and reduced electricity use for air conditioning in the summer (measured in Megawatt-hours ([MWh]).
- **Carbon Sequestered:** Presents annual reductions in atmospheric CO_2 due to sequestration by trees and reduced emissions from power plants due to reductions in energy use measured in pounds. The model accounts for CO_2 released as trees die and decompose and CO_2 released during the care and maintenance of trees.
- **Air Quality:** Quantifies the air pollutants (ozone [O_3], nitrogen dioxide [NO_2], sulfur dioxide [SO_2], particulate matter less than 10 micrometers in diameter [PM_{10}]) deposited on tree surfaces, and reduced emissions from power plants (NO_2, PM_{10}, volatile organic compounds [VOCs], SO_2) due to reduced electricity use in pounds. The potential negative effects of trees on air quality due to biogenic volatile organic compounds (BVOC) emissions are also reported.
- **Importance Value (IV):** IVs are calculated for species that comprise more than 1% of the population. The Streets IV is the mean of three relative values (percentage of total trees, percentage of total leaf area, and percentage of canopy cover) and can range from 0 to 100 with an IV of 100 suggesting total reliance on one species. IVs offer valuable information about a community's reliance on certain species to provide functional benefits. For example, a species might represent 10% of a population but have an IV of 25% due to its substantial benefits, indicating that the loss of those trees would be more significant than just their population percentage would suggest.

i-Tree Tools

i-Tree Tools software was developed by the U.S. Department of Agriculture, Forest Service (USDA FS) with the help of several industry partners, including The Davey Tree Expert Company. Learn more at www.itreetools.org.

THE BENEFITS OF FULTON'S URBAN FOREST

i-Tree Streets Inputs



In addition to tree inventory data, i-Tree Streets requires cost-specific information to manage a community's tree management program—including administrative costs and costs for tree pruning, removal, and planting. Regional data, including energy prices, property values, and stormwater costs, are required inputs to generate the environmental and economic benefits trees provide. If community program costs or local economic data are not available, i-Tree Streets uses default economic inputs from a reference city selected by the USDA FS for the climate zone in which your community is located. Any default value can be adjusted for local conditions.

Fulton's Inputs

Since specific local economic data for the city's urban forestry program were not available at the time of this plan, economic data from a Climate Zone 5b reference city were used to help calculate the benefits provided by Fulton's community.

Because unadjusted program economic defaults were used, the reporting function of the i-Tree Streets model is based on estimates of tree benefits. Net Annual Benefits, Cost for Public Trees, and Benefit-Cost Ratio (BCR) will not be calculated.

Table 2 presents results for individual tree species from the i-Tree Streets analysis. Figure 8 summarizes the annual benefits and results for the street tree population.

Table 2. Benefit Data for Common Street Trees by Species

Most Common Trees Collected During Inventory		Number Trees on the ROW	Percent of Total Trees	Benefit Provide By Street Trees						Importance Value (IV)
				Aesthetic/ Other	Stormwater	Carbon Dioxide Stored	Energy	Carbon Sequestered	Air Quality	
Common Name	Botanical Name		(%)	Average/$/Tree						0–100 (higher IV = more important species)
Norway maple	*Acer platanoides*	119	25.67	67.75	14.32	23.33	63.65	2.12	11.82	22.19
red maple	*Acer rubrum*	80	17.32	33.47	24.71	27.29	88.15	1.63	16.96	21.38
sugar maple	*Acer saccharum*	42	9.09	86.18	34.99	69.26	96.22	2.65	17.52	14.77
flowering crabapple	*Malus* spp.	23	4.98	14.85	2.82	2.02	19.6	0.34	3.11	2.2
thornless honeylocust	*Gleditsia tricanthos*	23	4.98	53.03	24.28	22.35	99.1	1.79	18.6	6.73
silver maple	*Acer saccharinum*	23	4.98	45.04	44.07	98.65	123.93	2.8	25.56	9.58
green ash	*Fraxinus pennsylvanica*	16	3.45	49.06	13.38	6.18	66.62	1.31	11.77	2.95
Callery pear	*Pyrus calleryana*	14	3.03	44.92	2.88	1.43	12.61	0.4	2.42	1.32
arborvitae	*Thuja* spp.	8	1.73	26.1	8.61	8.27	40.84	1.16	9.83	1.03
Japanese lilac	*Syringa reticulata*	8	1.73	8.35	0.69	0.17	5.81	0.1	0.84	0.62
Colorado spruce	*Picea pungens*	8	1.73	20.4	15.24	6.3	54.19	1	10.55	1.31
cherry	*Prunus* spp.	7	1.52	10.53	2.11	2.69	15.7	0.34	2.44	0.63
Austrian pine	*Pinus nigra*	7	1.52	23.31	14.44	5.59	51.98	1.01	10.09	1.11
European mountainash	*Sorbus aucuparia*	6	1.3	11.87	3	4.11	21.97	0.5	3.43	0.59
Norway spruce	*Picea abies*	6	1.3	7.31	18.52	9.58	61.81	0.91	12.1	1.1
white ash	*Fraxinus americana*	5	1.08	55.51	19.39	15.06	83.62	1.84	15.74	1.17
other street trees	~28 genera of varying species	67	14.5	47.72	18.18	26.12	66.51	1.64	12.58	11.32
ROW Total	**~35 genera and ~53 species on the ROW**	**462**	**100**	**47.72**	**18.18**	**26.12**	**66.51**	**1.64**	**12.58**	**100**

Annual Benefits

The i-Tree Streets model estimated that the inventoried street trees provide a total annual benefit of $67,745. Essentially, $67,745 was saved to cool buildings, manage stormwater, and clean the air. In addition, community aesthetics were improved and property values increased because of the presence of trees. On average, one of Fulton's trees provides an annual benefit of $146.63.

i-Tree Tools

A common example of a natural BVOC is the gas emitted from pine trees, which creates the distinct smell of a pine forest.

The assessment found that energy conservation was the greatest value to the community. Nearly half of the total annual net benefits were due to energy reductions. It also found that aesthetic value and other tangible and intangible benefits trees provide accounted for another third of the value returned to the community in the form of property value increases. In addition to increasing property values, trees also play a major role in stormwater management. The city's street trees alone intercepted over 1 million gallons of rainfall, which equates to a savings of $8,399 in stormwater management costs. Stormwater management comprises 12% of the annual net benefits street trees provide. Air quality and reductions in CO_2 are important but account for lesser amounts of work performed by community trees. Air quality accounted for 9% of the net annual benefits, while CO_2 reductions accounted for 1%.

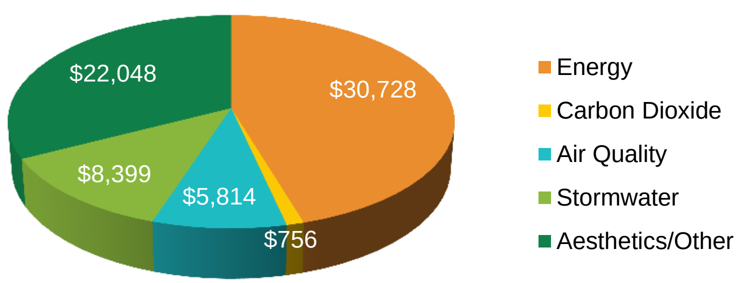


Figure 8. Breakdown of total annual benefits provided to Fulton.

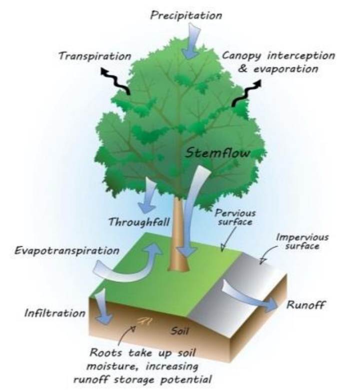
Aesthetic/Other Benefits

The total annual benefit associated with property value increases and other tangible and intangible benefits of street trees was $22,048. The average benefit per tree amounts to an annual value of $47.72.

Stormwater Benefits

Trees intercept rainfall, which helps costs to manage stormwater runoff. The inventoried trees in Fulton intercept 1,049,837 gallons of rainfall annually (Table 3). On average, the estimated annual savings for the city in stormwater runoff management is $8,399.

Of all species inventoried, red maple contributed most of the annual stormwater benefits. The red maple population (17%) intercepted 247,115 gallons of rainfall. The most dominant street tree species, Norway maple (26%), intercepted approximately 212,944 gallons of rainfall. On a per-tree basis, large trees with leafy canopies provided the most value. Silver maple and flowering crabapple each comprised 5% of the inventoried population. The silver maple population intercepted a significant amount of stormwater (126,714 gallons), while flowering crabapple intercepted only 8,119 gallons. Large-sized trees generally offer the greatest benefits.



- *Trees reduce stormwater runoff by capturing and storing rainfall in their canopy and releasing water into the atmosphere.*
- *Tree roots and leaf litter create soil conditions that promote the infiltration of rainwater into the soil.*
- *Trees help slow down and temporarily store runoff and reduce pollutants by absorbing nutrients and other pollutants from soils and water through their roots.*
- *Trees transform pollutants into less harmful substances.*

Table 3. Stormwater Benefits Provided by ROW Trees

Most Common Trees Collected During the Inventory		Number of Trees on the ROW	Percent of Total Trees	Total Rainfall Interception
Common Name	Botanical Name		(%)	(gal.)
Norway maple	*Acer platanoides*	119	25.67	212,944
red maple	*Acer rubrum*	80	17.32	247,115
sugar maple	*Acer saccharum*	42	9.09	183,704
flowering crabapple	*Malus* spp.	23	4.98	8,119
thornless honeylocust	*Gleditsia tricanthos*	23	4.98	69,795
silver maple	*Acer saccharinum*	23	4.98	126,714
green ash	*Fraxinus pennsylvanica*	16	3.45	26,759
Callery pear	*Pyrus calleryana*	14	3.03	5,035
arborvitae	*Thuja* spp.	8	1.73	8,613
Japanese lilac	*Syringa reticulata*	8	1.73	690
Colorado spruce	*Picea pungens*	8	1.73	15,243
cherry	*Prunus* spp.	7	1.52	1,843
Austrian pine	*Pinus nigra*	7	1.52	12,634
European mountainash	*Sorbus aucuparia*	6	1.3	2,247
Norway spruce	*Picea abies*	6	1.3	13,889
white ash	*Fraxinus americana*	5	1.08	12,119
other street trees	~22 genera of varying species	67	14.5	102,374
ROW Total	**~35 genera and ~53 species on the ROW**	**462**	**100**	**1,049,837**

Air Quality Improvements

The inventoried tree population annually removes 603.5 pounds of air pollutants (including ozone, nitrogen dioxide, sulfur dioxide, and particulate matter) through deposition. The population also avoids 657.2 pounds annually.

The i-Tree Streets calculation takes into account the biogenic volatile organic compounds (BVOC's) that are released from trees. The net total value of these benefits is estimated to be $5,814. The inventoried trees removed or avoided more pollutants than they emitted, resulting in a positive economic value. The trees that provided the most value based on an annual per-tree average were *Platanus* × *acerifolia* (London planetree) and *Carya ovata* (shagbark hickory). These species provided benefits of $29.44 and $28.61, respectively.

While trees do a great deal to absorb air pollutants, they also contribute negatively to air pollution. Trees emit various BVOC's such as isoprenes and monoterpenes, which can also contribute to formation of ozone, a harmful gas that pollutes the air and damages vegetation. These BVOC emissions are accounted for in the air quality net benefit.

Carbon Storage and Carbon Sequestration

Trees store some of the carbon dioxide (CO_2) they absorb. This prevents CO_2 from reaching the upper atmosphere, where it can react with other compounds and form harmful gases like ozone, which adversely affects air quality. These trees also sequester some of the CO_2 during growth (Nowak et al. 2013).

The i-Tree Streets calculation takes into account the carbon emissions that are *not* released from power stations due to the heating and cooling effect of trees (i.e., conserved energy in buildings and homes). It also calculates emissions released during tree care and maintenance, such as driving to the site and operating equipment. The net carbon benefit is approximately $756 per year.

The city's street trees store 1,828 tons of carbon (measured in CO_2 equivalents). This amount reflects the amount of carbon they have amassed during their lifetimes. Through sequestration and avoidance, 58 tons of CO_2 are removed each year. Silver maple provided the most carbon benefits, with each tree storing an annual average of $98.65 and sequestering $2.80 worth of carbon.

Photograph 3. *Trees improve quality of life and help enhance the character of a community. Trees filter air, water, and sunlight, moderate local climate, slow wind and stormwater, shade homes, and provide shelter to animals and recreational areas for people.*

Energy Benefits

Acer platanoides (Norway maple)	*Acer rubrum* (red maple)	*Acer saccharum* (sugar maple)	*Acer saccharinum* (silver maple)
26% of ROW	17% of ROW	9% of ROW	5% of ROW
11.5 MWh Electricity	11.1 MWh Electricity	6.2 MWh Electricity	4.7 MWh Electricity
4,236 thm Natural Gas	3,902 thm Natural Gas	2,251 thm Natural Gas	1,561 thm Natural Gas
$63.65 Average $/tree	$88.15 Average $/tree	$96.22 Average $/tree	$123.93 Average $/tree

Public trees conserve energy by shading structures and surfaces, which reduces electricity use for air conditioning in the summer. Trees divert wind in the winter to reduce natural gas use. Based on the inventoried trees, the annual electric and natural gas savings are equivalent to 47.9 MWh of electricity and 17,055 therms of natural gas, which accounts for an annual savings of $30,728 in energy consumption.

On average, red maple contributed $88.15 per tree to the annual energy benefits of the urban forest. Red maple's contribution was mostly due to its dominance on the streets. Other tree species, specifically London planetree and American sycamore, contributed more to conserve energy on a per-tree basis. The annual value these trees provide exceeds $140 per tree, although both species comprise less than 1% of the population. These large leafy canopies are valuable because they provide shade, which reduces energy usage. Smaller species, such as crabapple and cherry, were found to have smaller reductions in energy usage on a per-tree basis. Crabapple, the fourth most common tree along Fulton's ROW, is valued at only $19.60 per tree.

Importance Value (IV)

Understanding the importance of a tree species to the community is based not only on its presence on the ROW, but also its ability to provide environmental and economic benefits to the community. The IV calculated by the street computer model takes into account the total number of trees of a species, its percentage in the population, and its total leaf area and canopy cover. The IV can range from 0 to 100, with an IV of 100 suggesting total reliance on one species. If IV values are greater or less than the percentage of a species on the ROW, it indicates that the loss of that species may be more important or less important than its population percentage implies.

The i-Tree Streets assessment found that Norway maple has the highest IV in the ROW population at 22.2. Norway maple's high IV is likely due to the fact that the species comprises 25% of the ROW. This indicates that the loss of the Norway maple population would be very detrimental to the City of Fulton. Red maple had the second highest IV (21.4), followed by sugar maple (14.8) and silver maple (9.6). Crabapple, silver maple, and thornless honeylocust each represent 5% of the inventoried population. However, silver maple and thornless honeylocust IV's are higher because they are large-sized species; the size and canopy of broadleaf species generally provide more environmental benefits to the community, which all factor into assigning

IV. The IV for crabapple is much less than its percentage of the population, indicating that if it was lost, its economic impact would not be as significant.

Discussion/Recommendations

The i-Tree Streets analysis found that street trees provide environmental and economic benefits to the community by virtue of their mere presence on the streets. The aesthetic/other benefits provided by the inventoried street trees in Fulton were found to return the significant value value to the community. The property value increase provided by trees is important to stimulate economic growth. In addition to increasing aesthetics and property values, trees manage stormwater through rainfall interception, provide shade and windbreaks to reduce energy usage, and store and sequester CO_2. Trees work to intercept rainfall and reduce runoff—in Fulton, as little as 199 street trees absorb nearly half a million gallons of rainfall.

The i-Tree Streets analysis found that Norway maple is the most influential tree along Fulton's ROW. If this species was lost to ALB or other threats, its loss would be felt more than the community may realize.

To increase the benefits the urban forest provides, the city should plant young, large-statured tree species that are low emitters of BVOC's wherever possible. Leafy, large-statured trees consistently return the most environmental and economic benefits. The following list of tree species is used for improving air quality (ICLEI 2006):

- *Betula nigra* (river birch)
- *Celtis laevigata* (sugar hackberry)
- *Fagus grandifolia* (American beech)
- *Metasequoia glyptostroboides* (dawn redwood)
- *Tilia cordata* (littleleaf linden)
- *Tilia europea* (European linden)
- *Tilia tomentosa* (silver linden)
- *Ulmus americana* (American elm)
- *Ulmus procera* (English elm)

SECTION 3: TREE MANAGEMENT PROGRAM

This tree management program was developed to uphold Fulton's comprehensive vision for preserving its urban forest. This five-year program is based on the tree inventory data; the program was designed to reduce risk through prioritized tree removal and pruning, and to improve tree health and structure through proactive pruning cycles. Tree planting to mitigate removals and increase canopy cover and public outreach are important parts of the program as well.

While implementing a tree care program is an ongoing process, tree work must always be prioritized to reduce public safety risks. Davey Resource Group recommends completing the work identified during the inventory based on the assigned risk rating; however, it is also essential to routinely monitor the tree population to identify other Severe or High Risk trees so that they may be systematically addressed. While regular pruning cycles and tree planting is important, priority work (especially for Severe or High Risk trees) must sometimes take precedence to ensure that risk is expediently managed.

Priority and Proactive Maintenance

In this plan, the recommended tree maintenance work was divided into either priority or proactive maintenance. Priority maintenance includes tree removals and pruning of trees with an assessed risk rating of High and Severe Risk. Proactive tree maintenance includes pruning of trees with an assessed risk of Moderate or Low Risk, along with trees that are young. Tree planting, inspections, and community outreach are also considered proactive maintenance.

Severe Risk
- Perform tree maintenance immediately to reduce hazards
- Includes tree removal and pruning
- Mostly high-use areas

High Risk
- Perform tree maintenance immediately to reduce hazards and improve tree health
- Includes tree removal and pruning
- Generally high-use areas

Moderate Risk
- Perform tree maintenance as soon as possible to improve tree health
- Includes tree removal and pruning
- May be high- or low-use areas

Low Risk
- Perform tree maintenance when convenient to improve aesthetics and eliminate nuisance trees and stumps
- Includes tree removals and pruning
- Mostly low-use areas but may be high-use areas as well

Routine Pruning
- Perform tree maintenance when convenient to improve aesthetics and eliminate nuisance trees

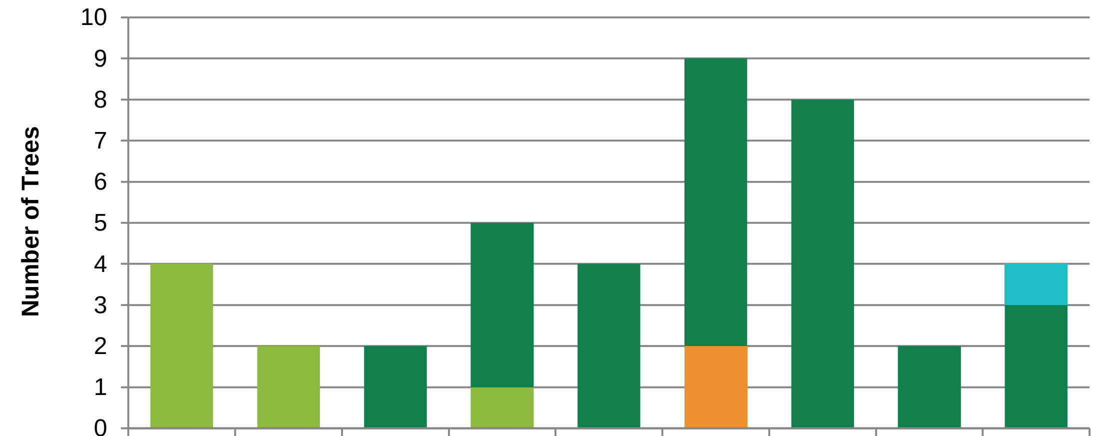
Training Prune
- Perform corrective pruning to young trees to increase structural integrity and develop a strong architecture of branches before serious problems develop

Tree and Stump Removal

Although tree removal is usually considered a last resort and may sometimes create a reaction from the community, there are circumstances in which removal is necessary. Trees fail from natural causes, such as diseases, insects, and weather conditions, and from physical injury due to vehicles, vandalism, and root disturbances. Davey Resource Group recommends that trees be removed when corrective pruning will not adequately eliminate the hazard or when correcting problems would be cost-prohibitive. Trees that cause obstructions or interfere with power lines or other infrastructure should be removed when their defects cannot be corrected through pruning or other maintenance practices. Diseased and nuisance trees also warrant removal.

Even though large short-term expenditures may be required, it is important to secure the funding needed to complete priority tree removals. Expedient removal reduces risk and promotes public safety.

Figure 9 presents tree removals by risk rating and diameter size class. The following sections briefly summarize the recommended removals identified during the inventory.



	1″–3″	4″–6″	7″–12″	13″–18″	19″–24″	25″–30″	31″–36″	37″–42″	≥43″
Severe	0	0	0	0	0	0	0	0	1
High	0	0	2	4	4	7	8	2	3
Moderate	0	0	0	0	0	2	0	0	0
Low	4	2	0	1	0	0	0	0	0

Figure 9. Tree removals by risk rating and diameter size class.

Findings

The inventory identified 31 Severe and High Risk trees and 9 Moderate and Low Risk trees that are recommended for removal.

The diameter size classes for High Risk trees ranged between 7–12 inches diameter at breast height (DBH) and greater than 43 inches DBH. These trees should be removed immediately based on their assigned risk. Severe and High Risk removals and pruning can be performed concurrently.

Most Moderate Risk trees were smaller than 31 inches DBH. These trees should be removed as soon as possible after all Severe and High Risk removals and pruning have been completed.

Low Risk removals pose little threat; these trees are generally small, dead, invasive, or poorly-formed trees that need to be removed. Eliminating these trees will reduce breeding site locations for insects and diseases and will increase the aesthetic value of the area. Healthy trees growing in poor locations or undesirable species are also included in this category. All Low and Moderate Risk trees should be removed when convenient and after all Severe and High Risk removals and pruning have been completed.

The inventory identified 12 stumps recommended for removal. All of these stumps inventoried were 6 inches or larger in diameter. Stump removals should occur when convenient.

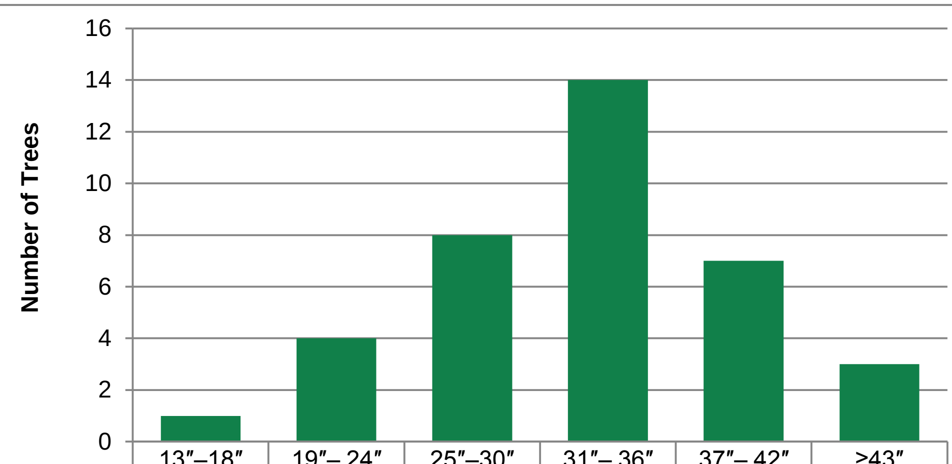
Discussion/Recommendations

Corrective action should be taken when warranted. If their condition worsens, tree removal may be required. Proactive tree maintenance that actively mitigates elevated-risk situations will promote public safety.

Tree Pruning

Severe and High Risk pruning generally require cleaning the canopy of both small and large trees to remove hazardous defects such as dead and/or broken branches that may be present even when the rest of the tree is sound. In these cases, pruning the branch or branches can correct the problem and reduce risk associated with the tree.

Figure 10 presents the number of Severe and High Risk trees recommended for pruning by size class. The following sections briefly summarize the recommended pruning maintenance identified during the inventory.



	13″–18″	19″– 24″	25″–30″	31″– 36″	37″– 42″	≥43″
Severe	0	0	0	0	0	0
High	1	4	8	14	7	3

Figure 10. Severe and High Risk pruning by diameter size class.

Findings

The inventory identified 0 Severe Risk trees, 37 High Risk trees, and 311 Moderate and Low Risk trees recommended for pruning.

High Risk trees ranged in diameter size classes from 13–18 inches in DBH, to greater than 43 inches DBH. High risk pruning should be performed immediately and may be performed concurrently with other Severe and High Risk removals.

Pruning Cycles

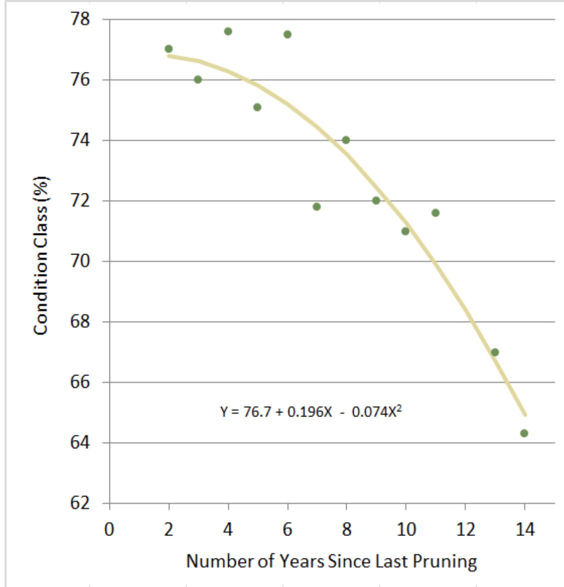


Figure 11. Relationship between average tree condition class and the number of years since the most recent pruning (adapted from Miller and Sylvester 1981).

The goals of pruning cycles are to visit, assess, and prune trees on a regular schedule to improve health and reduce risk. Davey Resource Group recommends that pruning cycles begin after all Severe and High Risk trees are corrected through removal or pruning. However, due to the long-term benefits of pruning cycles, Davey Resource Group recommends that the cycles be implemented as soon as possible. To ensure that all trees receive the type of pruning they need to mature with better structure and fewer hazards, two pruning cycles are recommended: the young tree training cycle (YTT Cycle) and the routine pruning cycle (RP Cycle). The cycles differ in the type of pruning, the general age of the target tree, and length.

The recommended number of trees in the pruning cycles will need to be modified to reflect changes in the tree population as trees are planted, age, and die. Newly planted trees will enter the YTT Cycle once they become established. As young trees reach maturity, they will be shifted from the YTT Cycle into the RP Cycle. When a tree reaches the end of its useful life, it should be removed and eliminated from the RP Cycle.

Why Prune Trees on a Cycle?

Miller and Sylvester (1981) examined the frequency of pruning for 40,000 street and boulevard trees in Milwaukee, Wisconsin. They documented a decline in tree health as the length of the pruning cycle increased. When pruning was not completed for more than 10 years, the average tree condition was rated 10% lower than when trees had been pruned within the last several years. Miller and Sylvester suggested that a pruning cycle of five years is optimal for urban trees.

For many communities, a proactive tree management program is considered unfeasible. An on-demand response to urgent situations is the norm. Research has shown that a proactive program that includes a routine pruning cycle will improve the overall health of a tree population (Miller and Sylvester 1981). Proactive tree maintenance has many advantages over on-demand maintenance, the most significant of which is reduced risk. In a proactive program, trees are regularly assessed and pruned, which helps detect and eliminate most defects before they escalate to a hazardous situation with an unacceptable level of risk. Other advantages of a proactive program include: increased environmental and economic benefits from trees, more predictable budgets and projectable workloads, and reduced long-term tree maintenance costs.

Young Tree Training Cycle

Trees included in the YTT Cycle are generally less than 8 inches DBH. These younger trees sometimes have branch structures that can lead to potential problems as the tree ages. Potential structural problems include codominant leaders, multiple limbs attaching at the same point on the trunk, or crossing/interfering limbs. If these problems are not corrected, they may worsen as the tree grows, increasing risk and creating potential liability.

YTT pruning is performed to improve tree form or structure; the recommended length of a YTT Cycle is three years because young trees tend to grow at faster rates (on average) than more mature trees.

The YTT Cycle differs from the RP Cycle in that these trees generally can be pruned from the ground with a pole pruner or pruning shear. The objective is to increase structural integrity by pruning for one dominant leader. YTT Pruning is species-specific, since many trees such as *Betula nigra* (river birch) may naturally have more than one leader. For such trees, YTT pruning is performed to develop a strong structural architecture of branches so that future growth will lead to a healthy, structurally sound tree.

Recommendations

Davey Resource Group recommends that Fulton implement a three-year YTT Cycle to begin after all Severe and High Risk trees are removed or pruned. The YTT Cycle will include existing young trees. During the inventory, 74 trees smaller than 7 inches DBH were inventoried and recommended for young tree training. Since the number of existing young trees is relatively small, and the benefit of beginning the YTT Cycle is substantial, Davey Resource Group recommends that an average of 25 trees be structurally pruned each year over three years, beginning in Year One of the management program.

If trees are planted, they will need to enter the YTT Cycle after establishment, typically a few years after planting.

In future years, the number of trees in the YTT Cycle will be based on tree planting efforts and growth rates of young trees. The city should strive to prune approximately one-third of its young trees each year (Figure 12).

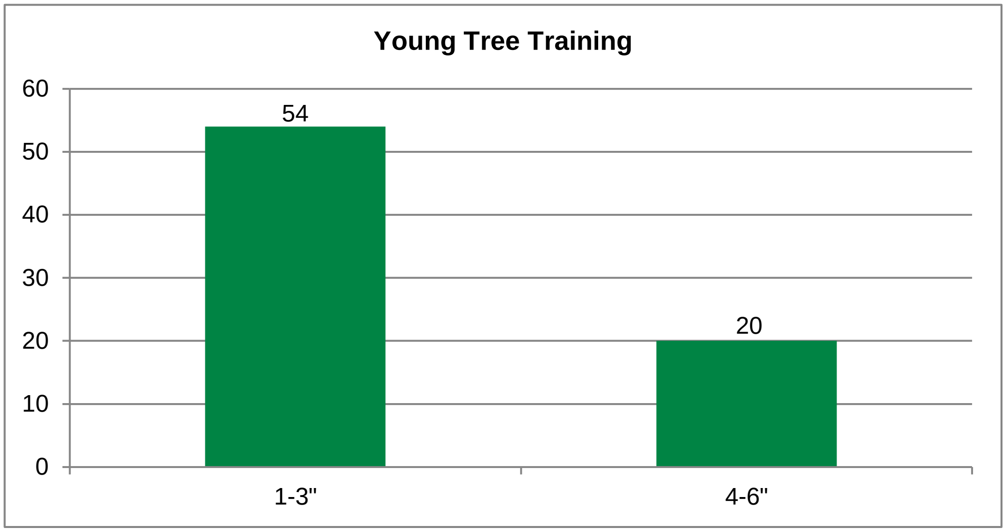


Figure 12. Trees recommended for the YTT Cycle by diameter size class.

Routine Pruning Cycle

The RP Cycle includes established, maturing, and mature trees (mostly greater than 8 inches DBH) that need cleaning, crown raising, and reducing to remove deadwood and improve structure. Over time, routine pruning generally improves health and reduces risk as most problems can be corrected before they escalate into more costly priority tree work. Included in this cycle are Moderate and Low Risk trees that require pruning and pose some risk but have a smaller size of defect and/or less potential for target impact. The hazards found within these trees can usually be remediated during the RP Cycle.

The length of the RP Cycle is based on the size of the tree population and what was assumed to be a reasonable number of trees for a program to prune per year. Generally, the RP Cycle recommended for a tree population is five years but may extend to seven years if the population is large.

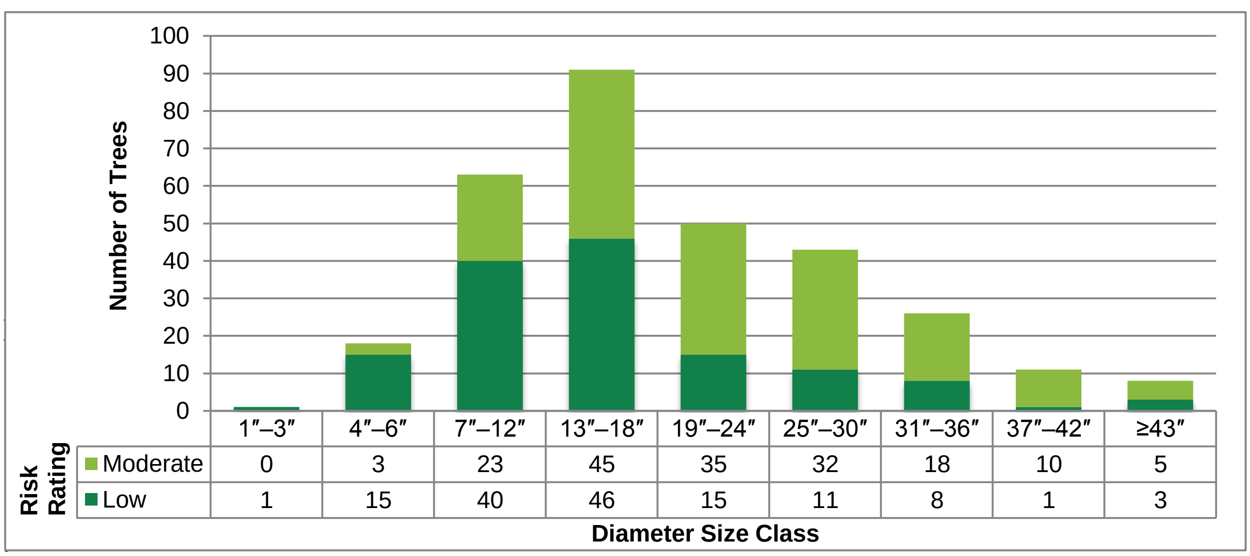


Figure 13. Trees recommended for the RP Cycle by diameter size class.

Recommendations

Davey Resource Group recommends that the city establish a five-year RP Cycle in which approximately one-fifth of the tree population is to be pruned each year. The 2016 tree inventory identified approximately 311 trees that should be pruned over a five-year RP Cycle. An average of 62 trees should be pruned each year over the course of the cycle. Davey Resource Group recommends that the RP Cycle begin in Year One of this five-year plan, after all Severe and High Risk trees are pruned.

The inventory found that a significificate number of trees (43%) on the street ROW needed routine pruning. Figure 13 shows that a variety of tree sizes will require pruning; however, most of the trees that require routine pruning were smaller than 24 inches DBH.

Maintenance Schedule

Utilizing data from the 2016 City of Fulton tree inventory, an annual maintenance schedule was developed that details the number and type of tasks recommended for completion each year. Davey Resource Group made budget projections using industry knowledge and public bid tabulations. Actual costs were not specified by Fulton. A summary of the maintenance schedule is presented (right); a complete table of estimated costs for Fulton's five-year tree management program is presented in Table 4.

FY 2017 **$59,350**

- **31 Severe or High Risk Removals**
- **37 Severe or High Risk Prunes**
- **RP Cycle: 1/5 of Public Trees Cleaned**
- **YTT Cycle: 25 Trees**
- **35 Trees Recommended for Planting and Follow-Up Care**
- **Newly Found Priority Tree Work (Removal or Pruning): Costs TBD**

FY 2018 **$22,035**

- **9 Moderate or Low Risk Removals**
- **12 Stump Removals**
- **RP Cycle: 1/5 of Public Trees Cleaned**
- **YTT Cycle: 25 Trees**
- **35 Trees Recommended for Planting and Follow-Up Care**
- **Newly Found Priority Tree Work (Removal or Pruning): Costs TBD**

FY 2019 **$18,685**

- **RP Cycle: 1/5 of Public Trees Cleaned**
- **YTT Cycle: 25 Trees**
- **35 Trees Recommended for Planting and Follow-Up Care**
- **Newly Found Priority Tree Work (Removal or Pruning): Costs TBD**

FY 2020 **$18,715**

- **RP Cycle: 1/5 of Public Trees Cleaned**
- **YTT Cycle: 25 Trees**
- **35 Trees Recommended for Planting and Follow-Up Care**
- **Newly Found Priority Tree Work (Removal or Pruning): Costs TBD**

FY2021 **$18,715**

- **RP Cycle: 1/5 of Public Trees Cleaned**
- **YTT Cycle: 25 Trees**
- **35 Trees Recommended for Planting and Follow-Up Care**
- **Newly Found Priority Tree Work (Removal or Pruning): Costs TBD**

The schedule provides a framework for completing the inventory maintenance recommendations over the next five years. Following this schedule can shift tree care activities from an on-demand system to a more proactive tree care program.

To implement the maintenance schedule, the city's tree maintenance budget should be no less than $59,350 for the first year of implementation, no less than $22,035 for the second year, and no less than $18,685 for the final three years. Annual budget funds are needed to ensure that hazard trees are remediated and that critical YTT and RP Cycles can begin. With proper professional tree care, the safety, health, and beauty of the urban forest will improve.

If routing efficiencies and/or contract specifications allow for the completion of more tree work, or if the schedule requires modification to meet budgetary or other needs, then the schedule should be modified accordingly. Unforeseen situations such as severe weather events may arise and change the maintenance needs of trees. Should conditions or maintenance needs change, budgets and equipment will need to be adjusted to meet the new demands.

Table 4. Estimated Costs for Five-Year Urban Forestry Management Program

Estimated Costs for Each Activity			2017		2018		2019		2020		2021		Five-Year Cost
Activity	Diameter	Cost/Tree	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	
Severe and High Risk Removal	1-3"	$25	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$105	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	7-12"	$220	2	$440	0	$0	0	$0	0	$0	0	$0	$440
	13-18"	$355	4	$1,420	0	$0	0	$0	0	$0	0	$0	$1,420
	19-24"	$525	4	$2,100	0	$0	0	$0	0	$0	0	$0	$2,100
	25-30"	$845	7	$5,915	0	$0	0	$0	0	$0	0	$0	$5,915
	31-36"	$1,140	8	$9,120	0	$0	0	$0	0	$0	0	$0	$9,120
	37-42"	$1,470	2	$2,940	0	$0	0	$0	0	$0	0	$0	$2,940
	43"+	$1,850	4	$7,400	0	$0	0	$0	0	$0	0	$0	$7,400
Activity Total(s)			**31**	**$29,335**	0	$0	0	$0	0	$0	0	$0	**$29,335**
Moderate and Low Risk Removal	1-3"	$25	0	$0	4	$100	0	$0	0	$0	0	$0	$100
	4-6"	$105	0	$0	2	$210	0	$0	0	$0	0	$0	$210
	7-12"	$220	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	13-18"	$355	0	$0	1	$355	0	$0	0	$0	0	$0	$355
	19-24"	$525	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	25-30"	$845	0	$0	2	$1,690	0	$0	0	$0	0	$0	$1,690
	31-36"	$1,140	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	37-42"	$1,470	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	43"+	$1,850	0	$0	0	$0	0	$0	0	$0	0	$0	$0
Activity Total(s)			0	$0	**9**	**$2,355**	0	$0	0	$0	0	$0	**$2,355**
Stump Removal	1-3"	$25	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$25	0	$0	1	$25	0	$0	0	$0	0	$0	$25
	7-12"	$25	0	$0	3	$75	0	$0	0	$0	0	$0	$75
	13-18"	$40	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	19-24"	$60	0	$0	1	$60	0	$0	0	$0	0	$0	$60
	25-30"	$85	0	$0	3	$255	0	$0	0	$0	0	$0	$255
	31-36"	$110	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	37-42"	$130	0	$0	3	$390	0	$0	0	$0	0	$0	$390
	43"+	$160	0	$0	1	$160	0	$0	0	$0	0	$0	$160
Activity Total(s)			0	$0	**12**	**$965**	0	$0	0	$0	0	$0	**$965**
High Risk Prune	1-3"	$20	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$30	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	7-12"	$75	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	13-18"	$120	1	$120	0	$0	0	$0	0	$0	0	$0	$120
	19-24"	$170	4	$680	0	$0	0	$0	0	$0	0	$0	$680
	25-30"	$225	8	$1,800	0	$0	0	$0	0	$0	0	$0	$1,800
	31-36"	$305	14	$4,270	0	$0	0	$0	0	$0	0	$0	$4,270
	37-42"	$380	7	$2,660	0	$0	0	$0	0	$0	0	$0	$2,660
	43"+	$590	3	$1,770	0	$0	0	$0	0	$0	0	$0	$1,770
Activity Total(s)			**37**	**$11,300**	0	$0	0	$0	0	$0	0	$0	**$11,300**
Routine Pruning	1-3"	$20	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$30	4	$120	4	$120	4	$120	4	$120	4	$120	$600
	7-12"	$75	13	$975	13	$975	13	$975	13	$975	13	$975	$4,875
	13-18"	$120	18	$2,160	18	$2,160	18	$2,160	18	$2,160	18	$2,160	$10,800
	19-24"	$170	10	$1,700	10	$1,700	10	$1,700	10	$1,700	10	$1,700	$8,500
	25-30"	$225	9	$2,025	9	$2,025	9	$2,025	9	$2,025	9	$2,025	$10,125
	31-36"	$305	5	$1,525	5	$1,525	5	$1,525	5	$1,525	5	$1,525	$7,625
	37-42"	$380	2	$760	2	$760	2	$760	2	$760	2	$760	$3,800
	43"+	$590	2	$1,180	2	$1,180	2	$1,180	2	$1,180	2	$1,180	$5,900
Activity Total(s)			**63**	**$10,445**	**62**	**$10,445**	**62**	**$10,445**	**62**	**$10,445**	**62**	**$10,445**	**$52,225**
Young Tree Training Pruning	1-3"	$20	18	$360	18	$360	18	$360	18	$360	18	$360	$1,800
	4-6"	$30	7	$210	7	$210	6	$180	7	$210	7	$210	$1,020
	7-12"	$75	0	$0	0	$0	0	$0	0	$0	0	$0	$0
Activity Total(s)			**25**	**$1,065**	**25**	**$1,065**	**24**	**$1,065**	**25**	**$1,065**	**25**	**$1,065**	**$2,820**
Tree Planting	Purchasing	$110	35	$3,850	35	$3,850	35	$3,850	35	$3,850	35	$3,850	$19,250
	Planting	$110	35	$3,850	35	$3,850	35	$3,850	35	$3,850	35	$3,850	$19,250
Activity Total(s)			**70**	**$7,700**	**70**	**$7,700**	**70**	**$7,700**	**70**	**$7,700**	**70**	**$7,700**	**$38,500**
Activity Grand Total			**226**		**178**		**156**		**157**		**157**		**874**
Cost Grand Total				**$59,350**		**$22,035**		**$18,685**		**$18,715**		**$18,715**	**$137,500**

Community Outreach

The data collected and analyzed to develop this plan contribute significant information about the tree population and can be utilized to guide the proactive management of that resource. These data can also be utilized to promote the value of the urban forest and the tree management program in the following ways:

- Tree inventory data can be used to justify necessary priority and proactive tree maintenance activities as well as tree planting and preservation initiatives.
- Species data can be used to guide tree species selection for planting projects with the goals of improving species diversity and limiting the introduction of invasive pests and diseases.
- Information in this plan can be used to advise citizens about threats to urban trees (such as granulate ambrosia beetle, emerald ash borer, and gypsy moth).

There are various avenues for outreach. Maps can be created and posted on websites, in parks, or in business areas. Public service announcements can be developed. Articles can be written and programs about trees and the benefits they provide can be developed. Arbor Day and Earth Day celebrations can become community traditions. Signs can be hung from trees to highlight the contributions trees provide to the community. Community contests or challenges can be created to increase awareness of the importance of trees. Trees provide oxygen we need to breathe, shade to cool our neighborhoods, and canopies to stand under when it rains.

Fulton's data are instrumental in helping to provide tangible and meaningful outreach about the urban forest.

Photograph 4. Community volunteer work can complement Fulton's tree urban forestry program. Public involvement contributes to helping plant and prune more young trees.

Inspections

Inspections are essential to uncovering potential problems with trees. They should be performed by a qualified arborist who is trained in the art and science of planting, caring for, and maintaining individual trees. Arborists are knowledgeable about the needs of trees and are trained and equipped to provide proper care.

Trees along the street ROW should be regularly inspected and attended to as needed based on the inspection findings. When trees need additional or new work, they should be added to the maintenance schedule and budgeted as appropriate. In addition to locating potential new hazards, inspections are an opportunity to look for signs and symptoms of pests and diseases. Fulton has a large population of trees that are susceptible to pests and diseases, such as ash, oak, and maple.

Inventory and Plan Updates

Davey Resource Group recommends that the inventory and management plan be updated so that the city can sustain its program and accurately project future program and budget needs:

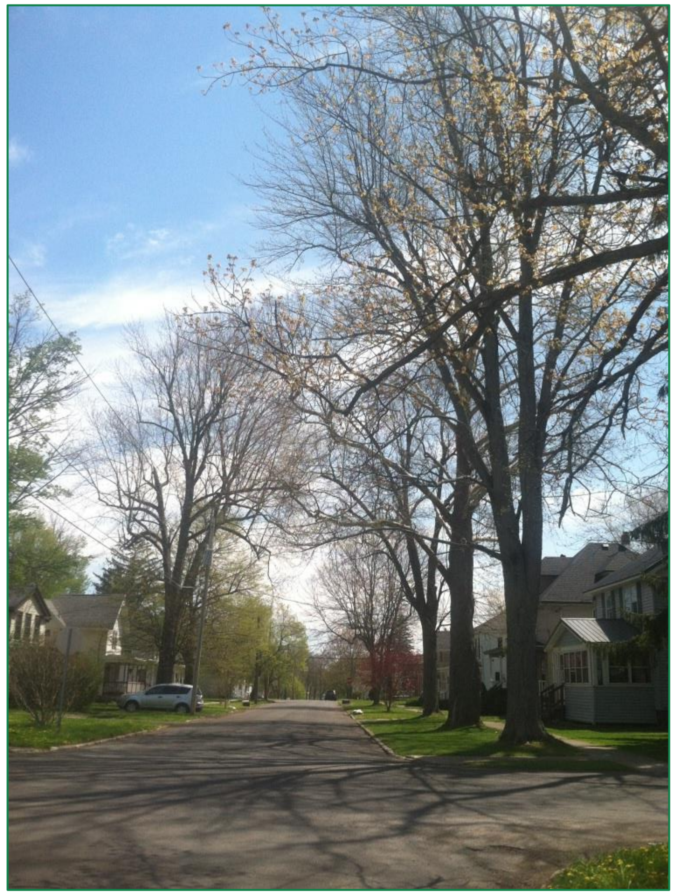
- Conduct inspections of trees after all severe weather events. Record changes in tree condition, maintenance needs, and risk rating in the inventory database. Update the tree maintenance schedule and acquire the funds needed to promote public safety. Schedule and prioritize work based on risk.
- Perform routine inspections of public trees as needed. Windshield surveys (inspections performed from a vehicle) in line with *ANSI A300 (Part 9)* (ANSI 2011) will help city staff stay apprised of changing conditions. Update the tree maintenance schedule and the budget as needed so that identified tree work may be efficiently performed. Schedule and prioritize work based on risk.
- If the recommended work cannot be completed as suggested in this plan, modify maintenance schedules and budgets accordingly.
- Update the inventory database as work is performed. Add new tree work to the schedule when work is identified through inspections or a citizen call process.
- Re-inventory the street ROW and update all data fields in five years.
- Revise the *Tree Management Plan* after five years when the re-inventory has been completed.

CONCLUSIONS

Every hour of every day, public trees in Fulton are supporting and improving quality of life. The city's street trees provide a total annual benefit of $67,744. When properly maintained, trees provide numerous environmental, economic, and social benefits that far exceed the time and money invested in planting, pruning, protection, and removal.

Managing trees in urban areas is often complicated. Navigating the recommendations of experts, the needs of residents, the pressures of local economics and politics, concerns for public safety and liability, physical components of trees, forces of nature and severe weather events, and the expectation that these issues are resolved all at once is a considerable challenge. The city should prepare and implement an EAB Management Plan as soon as possible.

The city must carefully consider these challenges to fully understand the needs of maintaining an urban forest. With the knowledge and wherewithal to address the needs of the city's trees, Fulton is well positioned to thrive. If the management program is successfully implemented, the health and safety of Fulton's trees and citizens will be maintained for years to come.



Photograph 5. *A street well stocked with trees provides economic, environmental, and social benefits, including temperature moderation, reduction of air pollutants, energy conservation, and increased property values.*

GLOSSARY

aboveground utilities (data field): Shows the presence or absence of overhead utilities at the tree site.

address number (data field): The address number was recorded based on the visual observation by the Davey Resource Group arborist at the time of the inventory of the actual address number posted on a building at the inventoried site. In instances where there was no posted address number on a building or sites were located by vacant lots with no GIS parcel addressing data available, the address number assigned was matched as closely as possible to opposite or adjacent addresses by the arborist(s) and an "X" was added to the number in the database to indicate that the address number was assigned.

Aesthetic/Other Report: The i-Tree Streets Aesthetic/Other Report presents the tangible and intangible benefits of trees reflected by increases in property values in dollars ($).

Air Quality Report: The i-Tree Streets Air Quality Report quantifies the air pollutants (ozone [O_3], nitrogen dioxide [NO_2], sulfur dioxide [SO_2], coarse particulate matter less than 10 micrometers in diameter [PM_{10}]) deposited on tree surfaces and reduced emissions from power plants (NO_2, PM_{10}, Volatile Oxygen Compounds [VOCs], SO_2) due to reduced electricity use measured in pounds (lbs.). Also reported are the potential negative effects of trees on air quality due to Biogenic Volatile Organic Compounds (BVOC) emissions.

American National Standards Institute (ANSI): ANSI is a private, nonprofit organization that facilitates the standardization work of its members in the United States. ANSI's goals are to promote and facilitate voluntary consensus standards and conformity assessment systems, and to maintain their integrity.

ANSI A300**:** Tree care performance parameters established by ANSI that can be used to develop specifications for tree maintenance.

arboriculture: The art, science, technology, and business of commercial, public, and utility tree care.

area (data fields): A collection of data fields collected during the inventory to aid in finding trees, including park section number.

Benefit-Cost Ratio (BCR): The i-Tree Streets (BCR) is the ratio of the cumulative benefits provided by the landscape trees, expressed in monetary terms, compared to the costs associated with their management, also expressed in monetary terms.

biogenic volatile organic compounds (BVOC): Gases emitted from trees, like pine trees, which create the distinct smell of a pine forest. When exposed to sunlight in the air, BVOCs react to form tropospheric ozone, a harmful gas that pollutes the air and damages vegetation.

block side (data field): Address information for a site that includes the *on street*, *from street*, and *to street*. The *on street* is the street on which the site is actually located. The *from street* is the cross street from which one moves away when heading in the direction of traffic flow. The *to street* is the cross street from which one moves towards when heading in the direction of traffic flow.

canopy: Branches and foliage that make up a tree's crown.

canopy cover: As seen from above, it is the area of land surface that is covered by tree canopy.

Carbon Dioxide Report: The i-Tree Streets Carbon Dioxide Report presents annual reductions in atmospheric CO_2 due to sequestration by trees and reduced emissions from power plants due to reduced energy use in pounds. The model accounts for CO_2 released as trees die and decompose and CO_2 released during the care and maintenance of trees.

community forest: see **urban forest**.

condition (data field): The general condition of each tree rated during the inventory according to the following categories adapted from the International Society of Arboriculture's rating system: Excellent (100%), Very Good (90%), Good (80%), Fair (60%), Poor, (40%), Critical (20%), Dead (0%).

cycle: Planned length of time between vegetation maintenance activities.

defect: See **structural defect**.

diameter: See **tree size**.

diameter at breast height (DBH): See **tree size**.

Energy Report: The i-Tree Streets Energy Report presents the contribution of the urban forest toward conserving energy in terms of reduced natural gas use in winter measured in therms (th) and reduced electricity use for air conditioning in summer measured in megawatt-hours (MWh).

failure: In terms of tree management, failure is the breakage of stem or branches, or loss of mechanical support of the tree's root system.

further inspection (data field): Notes that a specific tree may require an annual inspection for several years to make certain of its maintenance needs. A healthy tree obviously impacted by recent construction serves as a prime example. This tree will need annual evaluations to assess the impact of construction on its root system. Another example would be a tree with a defect requiring additional equipment for investigation.

genus: A taxonomic category ranking below a family and above a species and generally consisting of a group of species exhibiting similar characteristics. In taxonomic nomenclature, the genus name is used, either alone or followed by a Latin adjective or epithet, to form the name of a species.

geographic information system (GIS): A technology that is used to view and analyze data from a geographic perspective. The technology is a piece of an organization's overall information system framework. GIS links location to information (such as people to addresses, buildings to parcels, or streets within a network) and layers that information to provide a better understanding of how it all interrelates.

global positioning system (GPS): GPS is a system of earth-orbiting satellites that make it possible for people with ground receivers to pinpoint their geographic location.

grow space size (data field): Identifies the minimum width of the tree grow space for root development.

grow space type (data field): Best identifies the type of location where a tree is growing. During the inventory, grow space types were categorized as island, median, open/restricted, open/unrestricted, raised planter, tree lawn/parkway, unmaintained/natural area, or well/pit.

hardscape damage (data field): Indicates trees damaged by hardscape or hardscape damaged by trees (for example, damage to curbs, cracking, lifting of sidewalk pavement 1 inch or more).

High Risk tree: Tree that cannot be cost-effectively or practically treated. Most High Risk trees have multiple or significant defects affecting more than 40% of the trunk, crown, or critical root zone.

Defective trees and/or tree parts are most likely between 4–20 inches in diameter and can be found in areas of frequent occupation, such as a main thoroughfare, congested streets, and/or near schools.

importance value (IV): A calculation in i-Tree Streets displayed in table form for all species that make up more than 1% of the population. The i-Tree Streets IV is the mean of three relative values (percentage of total trees, percentage of total leaf area, and percentage of canopy cover) and can range from 0 to 100, with an IV of 100 suggesting total reliance on one species. IVs offer valuable information about a community's reliance on certain species to provide functional benefits. For example, a species might represent 10% of a population, but have an IV of 25% because of its great size, indicating that the loss of those trees due to pests or disease would be more significant than their numbers suggest.

invasive, exotic tree: A tree species that is out of its original biological community. Its introduction into an area causes or is likely to cause economic or environmental harm, or harm to human health. An invasive, exotic tree has the ability to thrive and spread aggressively outside its natural range. An invasive species that colonizes a new area may gain an ecological edge since the insects, diseases, and foraging animals that naturally keep its growth in check in its native range are not present in its new habitat.

inventory: See **tree inventory**.

IPED (data field): Invasive pest detection protocol— a standardized method for evaluating a tree for possible insect or disease.

i-Tree Streets: i-Tree Streets is a street tree management and analysis tool that uses tree inventory data to quantify the dollar value of annual environmental and aesthetic benefits: energy conservation, air quality improvement, CO_2 reduction, stormwater control, and property value increase.

i-Tree Tools: State-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban forestry analysis and benefits assessment tools. The i-Tree Tools help communities of all sizes to strengthen their urban forest management and advocacy efforts by quantifying the structure of community trees and the environmental services that trees provide.

location (data fields): A collection of data fields collected during the inventory to aid in finding trees, including address number, street name, site number, side, and block side.

Low Risk tree: Tree with minor visible structural defects or wounds in areas with moderate to low public access.

Management Costs: Used in i-Tree Streets, they are the expenditures associated with street tree management presented in total dollars, dollars per tree, and dollars per capita.

mapping coordinates (data field): Helps to locate a tree; X and Y coordinates were generated for each tree using GPS.

Moderate Risk tree: Tree with defects that may be cost-effectively or practically treated. Most of the trees in this category exhibit several moderate defects affecting less than 40% of a tree's trunk, crown, or critical root zone. These trees may be in high-, moderate-, or low-use areas.

monoculture: A population dominated by one single species or very few species.

Net Annual Benefits: Specific data field for i-Tree Streets. Citywide benefits and costs are calculated according to category and summed. Net benefits are calculated as benefits minus costs.

Nitrogen Dioxide (NO_2): Nitrogen dioxide is a compound typically created during the combustion processes and is a major contributor to smog formation and acid deposition.

None (risk rating): Equal to zero. It is used only for planting sites and stumps.

notes (data field): Describes additional pertinent information.

ordinance: See **tree ordinance**.

overhead utilities (data field): The presence of overhead utility lines above a tree or planting site.

Ozone (O_3): A strong-smelling, pale blue, reactive toxic chemical gas with molecules of three oxygen atoms. It is a product of the photochemical process involving the Sun's energy. Ozone exists in the upper layer of the atmosphere as well as at the Earth's surface. Ozone at the Earth's surface can cause numerous adverse human health effects. It is a major component of smog.

Particulate Matter (PM_{10}): A major class of air pollutants consisting of tiny solid or liquid particles of soot, dust, smoke, fumes, and mists.

Plant Tree (Primary Maintenance Need): If collected during an inventory, this data field identifies planting sites as small, medium, or large (indicating the ultimate size that the tree will attain), depending on the growspace available and the presence of overhead wires.

primary maintenance needs (data field): The type of tree work needed to reduce immediate risk.

pruning: The selective removal of plant parts to meet specific goals and objectives.

Removal (Primary Maintenance Need): Data field collected during the inventory identifying the need to remove a tree. Trees designated for removal have defects that cannot be cost-effectively or practically treated. Most of the trees in this category have a large percentage of dead crown.

right-of-way (ROW): See **street right-of-way**.

risk: Combination of the probability of an event occurring and its consequence.

risk assessment (data fields): The risk assessment is a point-based assessment of each tree by an arborist using a protocol based on the U.S. Forest Service Community Tree Risk Rating System. In the field, the probability of tree or tree part failure is assigned 1–4 points (identifies the most likely failure and rates the likelihood that the structural defect(s) will result in failure based on observed, current conditions), the size of the defective tree part is assigned 1–3 points (rates the size of the part most likely to fail), the probability of target impact by the tree or tree part is assigned 1–3 points (rates the use and occupancy of the area that would be struck by the defective part), and other risk factors are assigned 0–2 points (used if professional judgment suggests the need to increase the risk rating). The data from the risk assessment is used to calculate the risk rating that is ultimately assigned to the tree.

Severe Risk tree: Tree rated to be Severe Risk cannot be cost-effectively or practically treated. Most Severe Risk trees have multiple and significant defects present in the trunk, crown, or critical root zone. Defective trees and/or tree parts are most likely larger than 20 inches in diameter and can be found in areas of frequent occupation, such as a main thoroughfare, congested streets, and/or near schools.

side value (data field): Each site is assigned a side value to aid in locating the site. Side values include: *front*, *side to*, *side away*, *median* (includes islands), and *rear* based on the site's location in relation to the lot's street frontage. The *front* side is the side that faces the address street. *Side to* is the name of the street the arborist is walking towards as data are being collected. The *side from* is the name of the street the arborist is walking away from while collecting data. *Median* indicates a median or island. The *rear* is the side of the lot opposite the front.

site number (data field): All sites at an address are assigned a *site number*. Sites numbers are not unique; they are sequential to the side of the address only (the only unique number is the tree identification number assigned to each site). Site numbers are collected in the direction of vehicular traffic flow. The only exception is a one-way street. Site numbers along a one-way street are collected as if the street were actually a two-way street, so some site numbers will oppose traffic.

species: Fundamental category of taxonomic classification, ranking below a genus or subgenus, and consisting of related organisms capable of interbreeding.

stem: A woody structure bearing buds and foliage, and giving rise to other stems.

stems (data field): Identifies the number of stems or trunks splitting less than 1 foot above ground level.

Stored Carbon Report: While the i-Tree Streets Carbon Dioxide Report quantifies annual CO_2 reductions, the i-Tree Streets Stored Carbon Report tallies all of the Carbon (C) stored in the urban forest over the life of the trees as a result of sequestration measured in pounds as the CO_2 equivalent.

Stormwater Report: A report generated by i-Tree Streets that presents the reductions in annual stormwater runoff due to rainfall interception by trees measured in gallons (gals.).

street name (data field): The name of a street right-of-way or road identified using posted signage or parcel information.

street right-of-way (ROW): A strip of land generally owned by a public entity over which facilities, such as highways, railroads, or power lines, are built.

street tree: A street tree is defined as a tree within the right-of-way.

structural defect: A feature, condition, or deformity of a tree or tree part that indicates weak structure and contributes to the likelihood of failure.

Stump Removal (Primary Maintenance Need): Indicates a stump that should be removed.

Sulfur Dioxide (SO_2): A strong-smelling, colorless gas that is formed by the combustion of fossil fuels. Sulfur oxides contribute to the problem of acid rain.

Summary Report: A report generated by i-Tree Streets that presents the annual total of energy, stormwater, air quality, carbon dioxide, and aesthetic/other benefits. Values are reflected in dollars per tree or total dollars.

topping: Characterized by reducing tree size using internodal cuts without regard to tree health or structural integrity; this is not an acceptable pruning practice.

tree: A tree is defined as a perennial woody plant that may grow more than 20 feet tall. Characteristically, it has one main stem, although many species may grow as multi-stemmed forms.

tree benefit: An economic, environmental, or social improvement that benefits the community and results mainly from the presence of a tree. The benefit received has real or intrinsic value associated with it.

Tree Clean (Primary Maintenance Need): Based on *ANSI A300 Standards*, these trees require selective removal of dead, dying, broken, and/or diseased wood to minimize potential risk.

tree height (data field): If collected during the inventory, the height of the tree is estimated by the arborist and recorded in 10-foot increments.

tree inventory: Comprehensive database containing information or records about individual trees typically collected by an arborist.

tree ordinance: Tree ordinances are policy tools used by communities striving to attain a healthy, vigorous, and well-managed urban forest. Tree ordinances simply provide the authorization and standards for management activities.

tree size (data field): A tree's diameter measured to the nearest inch in one-inch size classes at 4.5 feet above ground, also known as diameter at breast height (DBH) or diameter.

urban forest: All of the trees within a municipality or a community. This can include the trees along streets or rights-of-way, in parks and greenspaces, in forests, and on private property.

urban tree canopy (UTC) assessment: A study performed of land cover classes to gain an understanding of the tree canopy coverage, particularly as it relates to the amount of tree canopy that currently exists and the amount of tree canopy that could exist. Typically performed using aerial photographs, GIS data, or Lidar.

Volatile Organic Compounds (VOCs): Hydrocarbon compounds that exist in the ambient air and are by-products of energy used to heat and cool buildings. Volatile organic compounds contribute to the formation of smog and/or are toxic. Examples of VOCs are gasoline, alcohol, and solvents used in paints.

Young Tree Train (Primary Maintenance Need): Data field based on *ANSI A300* standards, this maintenance activity is characterized by pruning of young trees to correct or eliminate weak, interfering, or objectionable branches to improve structure. These trees can be up to 20 feet tall and can be worked with a pole pruner by a person standing on the ground.

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APPENDIX A
DATA COLLECTION AND SITE LOCATION METHODS

Data Collection Methods

Davey Resource Group collected tree inventory data using a system that utilizes a customized ArcPad program loaded onto pen-based field computers equipped with geographic information system (GIS) and global positioning system (GPS) receivers. The knowledge and professional judgment of Davey Resource Group's arborists ensure the high quality of inventory data.

Data fields are defined in the glossary of the management plan. At each site, the following data fields were collected:

- aboveground utilities
- block side
- condition
- grow space size
- grow space type
- further inspection
- hardscape damage
- IPED
- location
- mapping coordinates
- notes
- observations
- primary maintenance needs
- risk assessment
- risk rating
- species
- stems
- tree size*

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

Maintenance needs are based on *ANSI A300 (Part 1)* (ANSI 2008). Risk assessment and risk rating are based on *Urban Tree Risk Management* (Pokorny et al. 1992).

The data collected were provided in an ESRI® shapefile, Access™ database, and Microsoft Excel™ spreadsheet on a CD-ROM that accompanies this plan.

Site Location Methods

Equipment and Base Maps

Inventory arborists use CF-19 Panasonic Toughbook® unit(s).

Base map layers were loaded onto these unit(s) to help locate sites during the inventory. Table 1 lists the base map layers, utilized along with source and format information for each layer.

Table 1. Base Map Layers Utilized for Inventory

Imagery/Data Source	Date	Projection
New York GIS Clearinghouse http://gis.ny.gov/	2013-Current	NAD 1983 State Plane New York Central Feet

Street ROW Site Location

Individual street ROW sites (trees, stumps, or planting sites) were located using a methodology that identifies sites by *address number, street name, side, site number*, or *block side*. This methodology was developed by Davey Resource Group to help ensure consistent assignment of location.

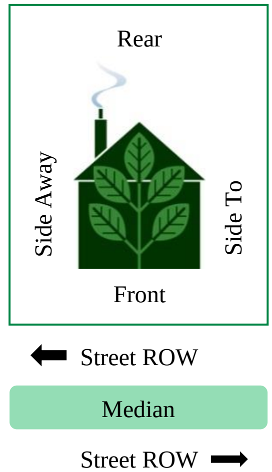


Figure 1. Side values for street ROW sites.

Address Number and Street Name

The *address number* was recorded based on visual observation by the arborist at the time of the inventory (the address number was posted on a building at the inventoried site). Where there was no posted address number on a building or where the site was located by a vacant lot with no GIS parcel addressing data available, the assigned address number was matched as closely as possible to opposite or adjacent addresses by the arborist. An "X" was then added to the number in the database to indicate that it was assigned (for example, "37X Choice Avenue").

Sites in medians or islands were assigned an address number using the address on the right side of the street in the direction of collection closest to the site. Each segment was numbered with an assigned address that was interpolated from addresses facing that median/island. If there were multiple median/islands between cross streets, each segment was assigned its own address.

The *street name* assigned to a site was determined by street ROW parcel information and posted street name signage.

Side Value and Site Number

Each site was assigned a *side value* and *site number*. Side values include: *front*, *side to*, *side away*, *median* (includes islands), or *rear* based on the site's location in relation to the lot's street frontage (Figure 1). The *front side* is the side that faces the address street. *Side to* is the name of the street the arborist walks towards as data are being collected. *Side from* is the name of the street the arborist walks away from while collecting data. *Median* indicates a median or island. The *rear* is the side of the lot opposite the front.

All sites at an address are assigned a *site number*. Site numbers are not unique; they are sequential to the side of the address only. The only unique number is the tree identification number assigned to each site. Site numbers are collected in the direction of vehicular traffic flow. The only exception is a one-way street. Site numbers along a one-way street are collected as if the street was a two-way street; therefore, some site numbers will oppose traffic.

A separate site number sequence is used for each side value of the address (*front*, *side to*, *side away*, *median*, or *rear*). For example, trees at the front of an address may have site numbers from 1 through 999; if trees are located on the *side to*, *side away*, *median*, or *rear* of that same address, each side will also be numbered consecutively beginning with the number 1.

Block Side

Block side information for a site includes the *on street*, *from street*, and *to street*.

- The *on street* is the street on which the site is located. The *on street* may not match the address street. A site may be physically located on a street that is different from its street address (i.e., a site located on a side street).
- The *from street* is the first cross street encountered when proceeding along the street in the direction of traffic flow.
- The *to street* is the second cross street encountered when moving in the direction of traffic flow.

Park and/or Public Space Site Location

Park and/or public space site locations were collected using the same methodology as street ROW sites; however, the *on street*, *from street*, and *to street* would be the park and/or public space's name (not street names).

Site Location Examples

Figure 2. The tree trimming crew in the truck traveling westbound on E. Mac Arthur Street is trying to locate an inventoried tree with the following location information:

Address/Street Name:	226 E. Mac Arthur Street
Side:	Side To
Site Number:	1
On Street:	Davis Street
From Street:	Taft Street
To Street:	E. Mac Arthur Street

The tree site circled in red signifies the crew's target site. Because the tree is located on the side of the lot, the *on* street is Davis Street, even though it is addressed as 226 East Mac Arthur Street. Moving with the flow of traffic, the *from* street is Taft Street, and the *to* street is East Mac Arthur Street.

Figure 3. Location information collected for inventoried trees at Corner Lots A and B.

<u>Corner Lot A</u>

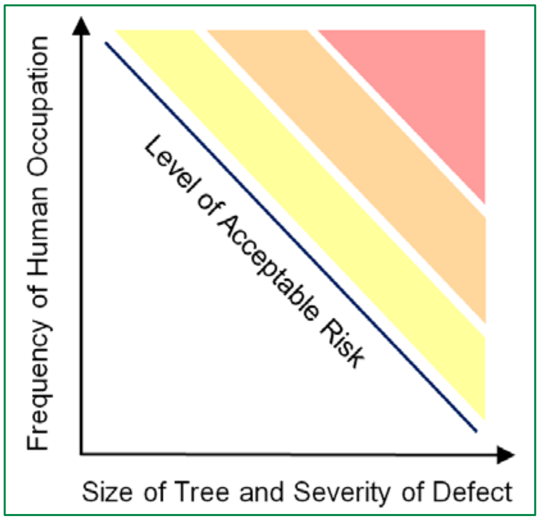
Address/Street Name:	205 Hoover St.
Side/Site Number:	Side To / 1
On Street:	Taft St.
From Street:	E Mac Arthur St.
To Street:	Hoover St.
Address/Street Name:	205 Hoover St.
Side/Site Number:	Side To / 2
On Street:	Taft St.
From Street:	E Mac Arthur St.
To Street:	Hoover St.
Address/Street Name:	205 Hoover St.
Side/Site Number:	Side To / 3
On Street:	Taft St.
From Street:	19th St.
To Street:	Hoover St.
Address/Street Name:	205 Hoover St.
Side/Site Number:	Front / 1
On Street:	Hoover St.
From Street:	Taft St.
To Street:	Davis St.

<u>Corner Lot B</u>

Address/Street Name:	226 E Mac Arthur St.
Side/Site Number:	Side To / 1
On Street:	Davis St.
From Street:	Hoover St.
To Street:	E Mac Arthur St.
Address/Street Name:	226 E Mac Arthur St.
Side/Site Number:	Front / 1
On Street:	E Mac Arthur St.
From Street:	Davis St.
To Street:	Taft St.
Address/Street Name:	226 E Mac Arthur St.
Side/Site Number:	Front / 2
On Street:	E Mac Arthur St.
From Street:	Davis St.
To Street:	Taft St.

APPENDIX B
RISK ASSESSMENT / PRIORITY AND PROACTIVE MAINTENANCE

Risk Assessment



Every tree has an inherent risk of tree failure or defective tree part failure. During the inventory, Davey Resource Group performed a risk assessment for each tree and assigned a risk rating following protocol based on *Urban Tree Risk Management* (Pokorny et al. 1992). The probability of failure, size of defective part, probability of target impact, and other risk factors were evaluated for each tree inventoried tree. Independent point values were assigned and summed to generate the risk rating.

- *Probability of Failure* (1–4 points)—Identifies the most likely failure and rates the likelihood that the structural defect(s) will result in failure based on observed, current conditions.
- *Size of Defective Part* (1–3 points)—Rates the size of the part most likely to fail.
- *Probability of Target Impact* (1–3 points)—Rates the use and occupancy of the area that would be struck by the defective part.
- *Other Risk Factors* (0–2 points)—This category is used if professional judgment suggests the need to increase the risk rating. It is especially helpful when growth characteristics become a factor in risk rating. For example, some tree species have growth patterns that make them more vulnerable to certain defects such as weak branch unions and branching shedding.

Once risk rating is calculated, a level of risk is assigned to each tree. The assigned risk rating allows for effective prioritization of tree maintenance work.

- *Severe Risk* (rating of 9 or 10)—Trees described as Severe Risk have defects that cannot be cost-effectively or practically treated. Most of the trees in this category have multiple or significant defects in the trunk, crown, or critical root zone. Defective trees and/or tree parts are generally larger than 20 inches in diameter and are found in areas of frequent occupation, such as a congested street, a main thoroughfare, and/or near a school.
- *High Risk* (rating of 7 or 8)—Trees designated as High Risk have defects that may or may not be cost-effectively or practically treated. Most of the trees in this category have multiple or significant defects that affect more than 40% of the trunk, crown, or critical root zone. Defective trees and/or tree parts are generally 4–20 inches in diameter and are found in areas of frequent occupation, such as a congested street, main thoroughfare, and/or near a school.

- *Moderate Risk* (rating of 5 or 6)—Trees described as Moderate Risk have defects that may be cost-effectively or practically treated. Most of the trees in this category exhibit several moderate defects that affect less than 40% of a tree's trunk, crown, or critical root zone. These trees may be in high-, moderate-, or low-use areas.
- *Low Risk* (rating of 3 or 4)—Trees designated as Low Risk have minor visible structural defects or wounds and are typically found in areas with moderate- to low-use areas.
- *None* (rating of 0)—Used for planting sites and stumps.

Trees with elevated (Severe or High) risk levels are usually recommended for removal or for pruning to eliminate the defects that warranted their risk rating. However, in some situations, risk may be reduced by adding support (cabling or bracing) or by moving the target away from the tree. Davey Resource Group recommends only removal or pruning to alleviate risk. But in special situations, such as a significant or memorial tree or a tree in an historic area, Fulton may decide that cabling, bracing, or moving the target may be the best option for alleviating risk.

Determination of acceptable risk ultimately lies with city managers. Since there are inherent risks associated with trees, the location of a tree is an important factor in the determination and acceptability of risk for any given tree. The level of risk associated with a tree increases as the frequency of human occupation increases in the vicinity of the tree. For example, a tree located next to a heavily traveled street will have a higher level of risk than a similar tree in an open field.

Priority Maintenance

Identifying and ranking the maintenance needs of a tree population enable tree work to be assigned priority based on observed risk. Once prioritized, tree work can be systematically addressed to eliminate the greatest risk and liability first (Stamen 2011).

Risk is a graduated scale that measures potential tree-related hazardous conditions. A tree is considered hazardous when its potential risks exceed an acceptable level. Managing trees for risk reduction provides many benefits, including:

- Lower frequency and severity of accidents, damage, and injury
- Less expenditure for claims and legal expenses
- Healthier, long-lived trees
- Fewer tree removals over time
- Lower tree maintenance costs over time

Regularly inspecting trees and establishing tree maintenance cycles generally reduce the risk of failure, as problems can be found and addressed before they escalate.

In this plan, all tree removals and Severe and High Risk prunes are included in the priority maintenance program.

Proactive Maintenance

Proactive tree maintenance requires that trees are managed and maintained under the responsibility of an individual, department, or agency. Tree work is typically performed during a cycle. Individual tree health and form are routinely addressed during the cycle. When trees are planted, they are planted selectively and with purpose. Ultimately, proactive tree maintenance should reduce crisis situations in the urban forest, as every tree in the inventoried population is regularly visited, assessed, and maintained. Davey Resource Group recommends proactive tree maintenance that includes pruning cycles, inspections, and planned tree planting.

APPENDIX C
SUGGESTED TREE SPECIES

Proper landscaping and tree planting are critical components of the atmosphere, livability, and ecological quality of a community's urban forest. The tree species listed below have been evaluated for factors such as size, disease and pest resistance, seed or fruit set, and availability. The following list is offered to assist city personnel in selecting appropriate tree species. These trees have been selected because of their aesthetic and functional characteristics and their ability to thrive in the majority of soil and climate conditions throughout Zone 5b on the USDA Plant Hardiness Zone Map.

Deciduous Trees

Large Trees: Greater than 45 Feet in Height at Maturity

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

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

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

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Aesculus × carnea	red horsechestnut	
Cladrastis kentukea	American yellowwood	'Rosea'
Eucommia ulmoides	hardy rubbertree	
Koelreuteria paniculata	goldenraintree	
Ostrya virginiana	eastern hophornbeam	
Parrotia persica	Persian parrotia	'Vanessa'
Phellodendron amurense	amur corktree	'Macho'
Prunus maackii	amur chokecherry	'Amber Beauty'
Prunus sargentii	Sargent cherry	
Quercus acutissima	sawtooth oak	
Quercus cerris	European turkey oak	
Sorbus alnifolia	Korean mountainash	'Redbird'

Small Trees: 15 to 30 Feet in Height at Maturity

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

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

Coniferous and Evergreen Trees

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Abies balsamea	balsam fir	
Abies concolor	white fir	'Violacea'
Chamaecyparis nootkatensis	Nootka falsecypress	'Pendula'
Cryptomeria japonica	Japanese cryptomeria	'Sekkan-sugi'
Ilex opaca	American holly	
Picea omorika	Serbian spruce	
Picea orientalis	Oriental spruce	
Pinus densiflora	Japanese red pine	
Pinus strobus	eastern white pine	
Pinus sylvestris	Scotch pine	
Psedotsuga menziesii	Douglasfir	
Thuja plicata	western arborvitae	(numerous exist)
Tsuga canadensis	eastern hemlock	

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Chamaecyparis thyoides	Atlantic whitecedar	(numerous exist)
Juniperus virginiana	eastern redcedar	
Pinus bungeana	lacebark pine	
Pinus flexilis	limber pine	
Thuja occidentalis	eastern arborvitae	(numerous exist)

Small Trees: 15 to 30 Feet in Height at Maturity

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

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

APPENDIX D
TREE PLANTING

Tree Planting

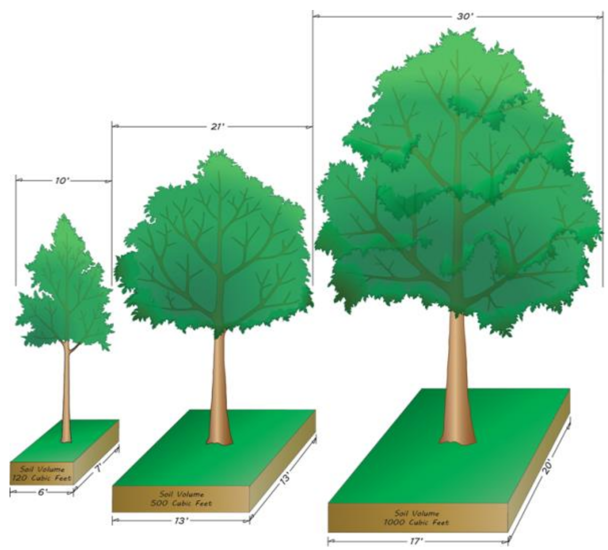
Planting trees is a valuable goal as long as tree species are carefully selected and correctly planted. When trees are planted, they are planted selectively and with purpose. Without proactive planning and follow-up tree care, a newly planted tree may become a future problem instead of a benefit to the community.

When planting trees, it is important to be cognizant of the following:

- Consider the specific purpose of the tree planting.
- Assess the site and know its limitations (i.e., confined spaces, overhead wires, and/or soil type).
- Select the species or cultivar best suited for the site conditions.
- Examine trees before buying them, and buy for quality.

Inventoried Street ROW Planting Space

The goal of tree planting is to have a vigorous, healthy tree that lives to the limits of its natural longevity. That can be difficult to achieve in an urban growing environment because irrigation is limited and the soils are typically poor quality. However, proper planning, species selection, tree planting techniques, and follow-up tree maintenance will improve the chance of tree planting success.



Minimum recommended requirements for tree sites is based on tree size/dimensions. This illustration is based on the work of Casey Trees (2008).

Findings

The inventory found 248 planting sites, of which 76% are designated for small-sized mature trees, 4% for medium-sized trees, and 20% for large-sized trees. Plant small-sized trees where the growing space is either too small for a medium- or large-sized species or where overhead utilities are present.

Tree Species Selection

Selecting a limited number of species could simplify decision-making processes; however, careful deliberation and selection of a wide variety of species is more beneficial and can save money. Planting a variety of species can decrease the impact of species-specific pests and diseases by limiting the number of susceptible trees in a population. This reduces time and money spent to mitigate pest- or disease-related problems. A wide variety of tree species can help limit the impacts from physical events, as different tree species react differently to stress. Species diversity helps withstand drought, ice, flooding, strong storms, and wind.

Fulton is located in USDA Hardiness Zone 5b, which is identified as a climatic region with average annual minimum temperatures between −15°F and −10°F. Tree species selected for planting in Fulton should be appropriate for this zone.

Tree species should be selected for their durability and low-maintenance characteristics. These attributes are highly dependent on site characteristics below ground (soil texture, soil structure, drainage, soil pH, nutrients, road salt, and root spacing). Matching a species to its favored soil conditions is the most important task when planning for a low-maintenance landscape. Plants that are well matched to their environmental site conditions are much more likely to resist pathogens and insect pests and will, therefore, require less maintenance overall.

The Right Tree in the Right Place is a mantra for tree planting used by the Arbor Day Foundation and many utility companies nationwide. Trees come in many different shapes and sizes, and often change dramatically over their lifetimes. Some grow tall, some grow wide, and some have extensive root systems. Before selecting a tree for planting, make sure it is the right tree—know how tall, wide, and deep it will be at maturity. Equally important to selecting the right tree is choosing the right spot to plant it. Blocking an unsightly view or creating some shade may be a priority, but it is important to consider how a tree may impact existing utility lines as it grows taller, wider, and deeper. If the tree's canopy, at maturity, will reach overhead lines, it is best to choose another tree or a different location. Taking the time to consider location before planting can prevent power disturbances and improper utility pruning practices.

A major consideration for street trees is the amount of litter dropped by mature trees. Trees such as *Acer saccharinum* (silver maple) have weak wood and typically drop many small branches during a growing season. Others, such as *Liquidambar styraciflua* (American sweetgum), drop high volumes of fruit. In certain species, such as *Ginkgo biloba* (ginkgo), female trees produce large odorous fruit; male ginkgo trees, however, do not produce fruit. Furthermore, a few species of trees, including *Crataegus* spp. (hawthorn) and *Gleditsia triacanthos* (honeylocust), may have substantial thorns. These species should be avoided in high-traffic areas.

Seasonal color should also be considered when planning tree plantings. Flowering varieties are particularly welcome in the spring, and deciduous trees that display bright colors in autumn can add a great deal of appeal to surrounding landscapes.

Davey Resource Group recommends limiting the planting of all *Acer* (maple) until the species distribution normalizes. Of the inventoried population, the genus *Acer* comprises nearly 59%, which far exceeds the recommended 20% genus maximum.

Photograph 1. *When planting a tree, it is important to cut and remove all rope/twine from around the base of the tree. If the twine is left while the tree grows, it will girdle the tree, essentially choking the flow of nutrients and water from the roots to the rest of the tree.*

Tips for Planting Trees

To ensure a successful tree planting effort, the following measures should be taken:

- Handle trees with care. Trees are living organisms and are perishable. Protect trees from damage during transport and when loading and unloading. Use care not to break branches, and do not lift trees by the trunk.
- If trees are stored prior to planting, keep the roots moist.
- Dig the planting hole according to the climate. Generally, the planting hole is two to three times wider and not quite as deep as the root ball. The root flair is at or just above ground level.
- Fill the hole with native soil unless it is undesirable, in which case soil amendments should be added as appropriate for local conditions. Gently tamp and add water during filling to reduce large air pockets and ensure a consistent medium of soil, oxygen, and water.
- Stake the tree as necessary to prevent it from shifting too much in the wind.
- Add a thin layer (1–2 inches) of mulch to help prevent weeds and keep the soil moist around the tree. Do not allow mulch to touch the trunk.

Newly Planted and Young Tree Maintenance

Caring for trees is just as important as planting them. Once a tree is planted, it must receive maintenance for several years.

Watering

Initially, watering is the key to survival; new trees typically require at least 60 days of watering to establish. Determine how often trees should be irrigated based on time of planting, drought status, species selection, and site condition.

Mulching

Mulch can be applied to the growspace around a newly planted tree (or even a more mature tree) to ensure that no weeds grow, that the tree is protected from mechanical damage, and that the growspace is moist. Mulch should be applied in a thin layer, generally 1 to 2 inches, and the growing area should be covered. Mulch should not touch the tree trunk or be piled up around the tree.

Lifelong Tree Care

After the tree is established, it will require routine tree care, which includes inspections, routine pruning, watering, plant health care, and integrated pest management as needed.

The city should employ qualified arborists to provide most of the routine tree care. An arborist can determine the type of pruning necessary to maintain or improve the health, appearance, and safety of trees. These techniques may include: eliminating branches that rub against each other; removing limbs that interfere with wires and buildings or that obstruct streets, sidewalks, or signage; removing dead, damaged, or weak limbs that pose a hazard or may lead to decay; removing diseased or insect-infested limbs; creating better structure to reduce wind resistance and minimize the potential for storm damage; and removing branches—or thinning—to increase light penetration.

An arborist can help decide whether a tree should be removed and, if so, to what extent removal is needed. Additionally, an arborist can perform—and provide advice on—tree maintenance when disasters such as storms or droughts occur. Storm-damaged trees can often be dangerous to remove or trim. An arborist can assist in advising or performing the job in a safe manner while reducing further risk of damage to property.

Plant Health Care, a preventive maintenance process that keeps trees in good health, helps a tree better defend itself against insects, disease, and site problems. Arborists can help determine proper plant health so that the city’s tree population will remain healthy and provide benefits to the community for as long as possible.

Integrated Pest Management is a process that involves common sense and sound solutions for treating and controlling pests. These solutions incorporate basic steps: identifying the problem, understanding pest biology, monitoring trees, and determining action thresholds. The practice of Integrated Pest Management can vary depending on the site and based on each individual tree. A qualified arborist will be able to make sure that the city’s trees are properly diagnosed and that a beneficial and realistic action plan is developed.

The arborist can also help with cabling or bracing for added support to branches with weak attachment, aeration to improve root growth, and installation of lightning protection systems.

Educating the community on basic tree care is a good way to promote the city’s urban forestry program and encourage tree planting on private property. The city should encourage citizens to water trees on the ROW adjacent to their homes and to reach out to the city if they notice any changes in the trees, such as signs or symptoms of pests, early fall foliage, or new mechanical or vehicle damage.

APPENDIX E
INVASIVE PESTS AND DISEASES

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

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

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

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

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

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

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

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

Asian Longhorned Beetle

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

Adult Asian longhorned beetle

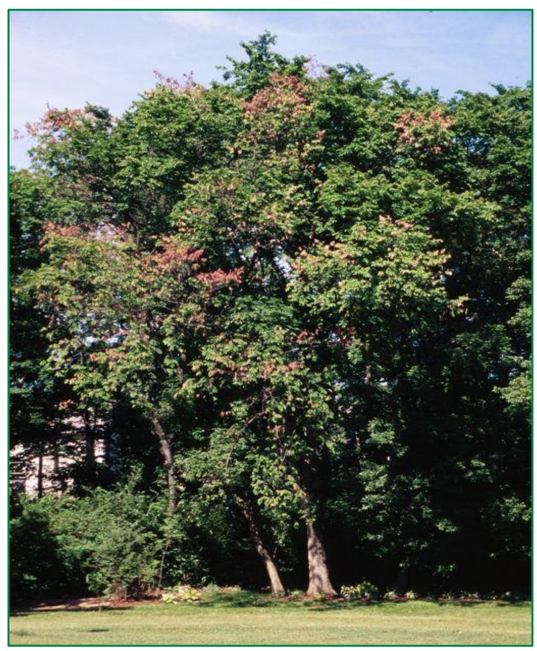
Photograph courtesy of New Bedford Guide 2011

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

Dutch Elm Disease

Considered by many to be one of the most destructive, invasive diseases of shade trees in the United States, Dutch elm disease (DED) was first found in Ohio in 1930; by 1933, the disease was present in several East Coast cities. By 1959, it had killed thousands of elms. Today, DED covers about two-thirds of the eastern United States, including Illinois, and annually kills many of the remaining and newly planted elms. The disease is caused by a fungus that attacks the vascular system of elm trees blocking the flow of water and nutrients, resulting in rapid leaf yellowing, tree decline, and death.

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 elms by elm bark beetles. Two species carry the fungus: native elm bark beetle (*Hylurgopinus rufipes*) and European elm bark beetle (*Scolytus multistriatus).*



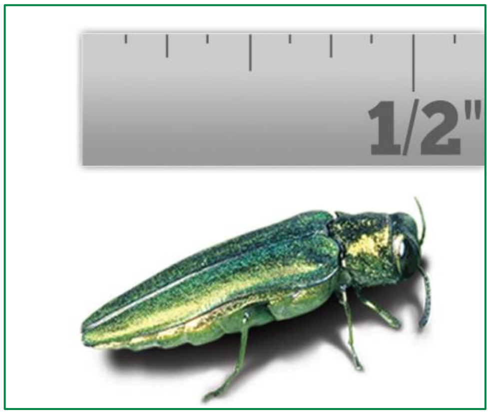
Branch death, or flagging, at multiple locations in the crown of a diseased elm

Photograph courtesy of Steven Katovich, USDA Forest Service, Bugwood.org (2011)

The species most affected by DED is the *Ulmus americana* (American elm).

Emerald Ash Borer

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



Close-up of the emerald ash borer

Photograph courtesy of APHIS (2011)

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

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

Gypsy Moth

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

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

Photograph courtesy of APHIS (2011b)

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

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

Granulate Ambrosia Beetle

Adult granulate ambrosia beetle

Photograph courtesy of Paul M. Choate, University of Florida (Atkinson et al. 2011)

The granulate ambrosia beetle (*Xylosandrus crassiusculus*), formerly the Asian ambrosia beetle, was first found in the United States in 1974 on peach trees near Charleston, South Carolina. The native range of the granulate ambrosia beetle is probably tropical and subtropical Asia. The beetle is globally present in countries such as equatorial Africa, Asia, China, Guinea, Hawaii, India, Japan, New South Pacific, Southeast Indonesia, Sri Lanka, and the United States. In the United States, this species has spread along the lower Piedmont region and coastal plain to East Texas, Florida, Louisiana, and North Carolina. Populations were found in Oregon and Virginia in 1992, and in Indiana in 2002.

Adults are small and have a reddish-brown appearance with a downward facing head. Most individuals have a reddish head region and a dark-brown to black elytra (hard casings protecting the wings). Light-colored forms that appear almost yellow have also been trapped. A granulated (rough) region is located on the front portion of the head and long setae (hairs) can be observed on the back end of the wing covers. Females are 2–2.5mm and males are 1.5mm long. Larvae are C-shaped with a defined head capsule.

The granulate ambrosia beetle is considered an aggressive species and can attack trees that are not highly stressed. It is a potentially serious pest of ornamentals and fruit trees and is reported to be able to infest most trees and some shrubs (azalea, rhododendron) but not conifers. Known hosts in the United States include: *Acer* (maple); *Albizia* (albizia); *Carya* (hickory); *Cercis canadensis* (eastern redbud); *Cornus* (dogwood); *Diospyros* (persimmon); *Fagus* (beech); *Gleditsia* or *Robinia* (locust); *Juglans* (walnut); *Koelreuteria* (goldenrain tree); *Lagerstroemia* (crapemyrtle); *Liquidambar styraciflua* (sweetgum); *Liriodendron tulipifera* (tulip poplar); *Magnolia* (magnolia); *Populus* (aspen); *Prunus* (cherry); *Quercus* (oak); and *Ulmus parvifolia* (Chinese elm). *Carya illinoinensis* (pecan) and *Pyrus calleryana* (Bradford pear) are commonly attacked in Florida and in the southeastern United States.

Hemlock Woolly Adelgid

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

Hemlock woolly adelgids on a branch

Photograph courtesy of USDA Forest Service (2011a)

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

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

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. This disease affects the oak genus and is most devastating to those in the red oak subgenus, such as *Quercus coccinea* (scarlet oak), *Q. imbricaria* (shingle oak), *Q. palustris* (pin oak), *Q. phellos* (willow oak), and *Q. rubra* (red oak). It also attacks trees in the white oak subgenus, although it is not as prevalent and spreads at a much slower pace in these trees.

Oak wilt symptoms on red and white oak leaves

Photograph courtesy of USDA Forest Service (2011a)

Just as with DED, oak wilt disease is caused by a fungus that clogs the vascular system of oaks and results in decline and death of the tree. The fungus is carried from tree to tree by several borers common to oaks, 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.

Pine Shoot Beetle

The pine shoot beetle (*Tomicus piniperda L.*), a native of Europe, is an introduced pest of *Pinus* (pine) in the United States. It was first discovered in the United States at a Christmas tree farm near Cleveland, Ohio in 1992. Following the first detection in Ohio, the beetle has been detected in parts of 19 states (Connecticut, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia, and Wisconsin).

Mined shoots on a Scotch pine

Photograph courtesy of USDA Forest Service (1993)

The beetle attacks new shoots of pine trees, stunting the growth of the trees. The pine shoot beetle may also attack stressed pine trees by breeding under the bark at the base of the trees. The beetles can cause severe decline in the health of the trees and, in some cases, kill the trees when high populations exist.

Adult pine shoot beetles range from 3 to 5 millimeters long, or about the size of a match head. They are brown or black and cylindrical. The legless larvae are about 5 millimeters long with a white body and brown head. Egg galleries are 10–25 centimeters long. From April to June, larvae feed and mature under the pine bark in separate feeding galleries that are 4–9 centimeters long. When mature, the larvae stop feeding, pupate, and then emerge as adults. From July through October, adults tunnel out through the bark and fly to new or 1-year-old pine shoots to begin maturation feeding. The beetles enter the shoot 15 centimeters or less from the shoot tip and move upwards by hollowing out the center of the shoot for a distance of 2.5–10 centimeters. Affected shoots droop, turn yellow, and eventually fall off during the summer and fall.

P. sylvestris (Scots pine) is preferred, but other pine species, including *P. banksiana* (jack pine), *P. nigra* (Austrian pine), *P. resinosa* (red pine), and *P. strobus* (eastern white pine), have been infested in the Great Lakes region.

Sirex Woodwasp

Close-up of female Sirex Woodwasp

Photograph courtesy of USDA (2005)

Sirex woodwasp (*Sirex noctillio*) has been the most common species of exotic woodwasp detected at United States ports-of-entry associated with solid wood-packing materials. Recent detections of sirex woodwasp outside of port areas in the United States have raised concerns because this insect has the potential to cause significant mortality of pines. Awareness of the symptoms and signs of a sirex woodwasp infestation increases the chance of early detection, thus increasing the rapid response needed to contain and manage this exotic forest pest.

Woodwasps (or horntails) are large robust insects, usually 1.0 to 1.5 inches long. Adults have a spear-shaped plate (cornus) at the tail end; in addition, females have a long ovipositor under this plate. Larvae are creamy white, legless, and have a distinctive dark spine at the rear of the abdomen. More than a dozen species of native horntails occur in North America.

Sirex woodwasps can attack living pines, while native woodwasps attack only dead and dying trees. At low populations, sirex woodwasp selects suppressed, stressed, and injured trees for egg laying. Foliage of infested trees initially wilts, and then changes color from dark green to light green, to yellow, and finally to red, during the three to six months following attack. Infested trees may have resin beads or dribbles at the egg laying sites, but this is more common at the mid-bole level. Larval galleries are tightly packed with very fine sawdust. As adults emerge, they chew round exit holes that vary from 1/8 to 3/8 inch in diameter.

Southern Pine Beetle

Adult southern pine beetles

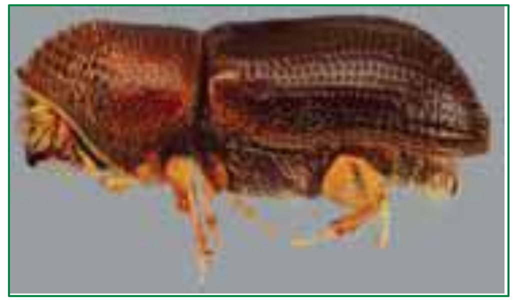
Photograph courtesy of Forest Encyclopedia Network (2012)

The southern pine beetle (SPB, *Dendroctonus frontalis*) is the most destructive insect pest of pine in the southern United States. It attacks and kills all species of southern yellow pines including *P. strobus* (eastern white pine). Trees are killed when beetles construct winding, S-shaped egg galleries underneath the bark. These galleries effectively girdle the tree and destroy the conductive tissues that transport food throughout the tree. Furthermore, the beetles carry blue staining fungi on their bodies that clog the water conductive tissues (wood), which transport water within the tree. Signs of attack on the outside of the tree are pitch tubes and boring dust, known as frass, caused by beetles entering the tree.

Adult SPBs reach an ultimate length of only 1/8 inch, similar in size to a grain of rice. They are short-legged, cylindrical, and brown to black in color. Eggs are small, oval-shaped, shiny, opaque, and pearly white.

Thousand Cankers Disease

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



Walnut twig beetle, side view

Photograph courtesy of USDA Forest Service (2011b)

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

The tree species preferred as hosts for TCD are walnuts.

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