TREE MANAGEMENT PLAN

Prospect Park

July 2018

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ACKNOWLEDGMENTS

Prospect Park Alliance's vision to promote and preserve the urban forest and improve the management of park 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.

Prospect Park Alliance is thankful for the urban forestry grant funding they received from the New York State Department of Environmental Conservation. Provided through the Environmental Protection Fund this grant is designed to encourage communities to create and support long-term and sustained urban and community forestry programs throughout New York.

Prospect Park Alliance

NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

EXECUTIVE SUMMARY

This plan was developed for Prospect Park Alliance by DRG with a focus on addressing short-term and long-term maintenance needs for inventoried trees of Prospect Park. DRG 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 Prospect Park Alliance's vision for the urban forest were utilized to develop this *Tree Management Plan*. Also included in this plan are economic, environmental, and social benefits provided by the trees in Prospect Park.

State of the Existing Urban Forest

The May 2018 inventory included all trees greater than 6 inches in DBH in woodlots and all trees and stumps in horticultural and lawn areas. The zones selected for the inventory include: Zone 1, Zone 2, and a portion of Zone 3. A total of 12,413 sites were recorded during the inventory: 12,268 trees and 145 stumps. Analysis of the tree inventory data found the following:

- One species, *Prunus serotina* (black cherry), was found in abundance (13%), which is a concern for Prospect Park's biodiversity.
- The diameter size class distribution of the inventoried tree population trends well towards the ideal.
- The overall condition of the inventoried tree population is rated Fair.
- Approximately 15% of the inventoried trees had decay, 21% of the inventoried trees had broken branches, 8% of the inventoried trees had stress caused by humans, and 3% of the inventoried trees had observed dieback.
- Gypsy moth (*Lymantria dispar dispar*) and Asian longhorned beetle (*Anoplophora glabripennis*) pose the biggest threats to the health of the inventoried population.
- *Fraxinus* (ash) trees could be infested with emerald ash borer (EAB or *Agrilus planipennis*), 7 of them were identified as having D-shaped exit holes and 13% were growing epicormics sprouts.
- Prospect Park's trees have an estimated replacement value of $59,463,000.
- Trees provide approximately $1,596,472 in the following annual benefits:
  - *Aesthetic and other benefits*: valued at $589,254 per year.
  - *Net Air quality*: 24,181 pounds of pollutants removed and avoided valued at $125,098 per year.
  - *Net Carbon*: 2,9611 tons valued at $17,233 per year.
  - *Energy*: 1,064 megawatt-hours (MWh) and 386,499 therms valued at $693,263 per year.
  - *Stormwater:* 21,452,985 gallons valued at $ 171,624 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 and stump removal (4%); priority pruning (37%); routinely monitoring (58%); and planting (less than 1%). Maintenance should be prioritized by addressing trees highest priority first. The inventory noted 4,160 Priority 1 trees for removal and pruning based on a Level 1 risk assessment. All of these trees should be removed or pruned immediately to promote public safety. The inventory noted 798 Priority 2 trees for re-inspection and pruning based on a Level 1 risk assessment. All of these trees should be re-inspected or pruned after Priority 1 trees to promote public safety. Due to the nature of a Level 1 assessment, if upon re-inspection or pruning of a tree, tree conditions are worse than observed during the inventory, the entire tree may need to be removed. Trees should be planted to mitigate removals and create canopy.

REMOVAL	• Total = 602 • Trees= 457 trees • Stumps = 145 stumps
PRIORITY PRUNING	• Total = 4,265 trees • Priority 1 = 3,703 trees • Priority 2 = 798 trees
ROUTINE MAINTENANCE CYCLE	• Total = 7,310 trees • Number of trees in cycle each year = approximately 1,044
TREE PLANTING	• Number of trees each year = at least 188

Prospect Park's urban forest will benefit greatly from a five-year routine maintenance cycle. A proactive maintenance cycle will improve the overall health of the tree population and may eventually reduce program costs. In most cases, maintenance cycles will correct defects in trees before they worsen, which will avoid costly problems. Based on inventory data, approximately 1,044 trees should be visited, assessed, and pruned each year during the routine maintenance 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). DRG recommends planting at least 188 trees of a variety of species each year to replace inventory recommend tree and stump removals in 5 years and offset natural mortality losses, increase canopy, and maximize benefits.

Prospect Park Alliance's tree planting should focus on replacing tree canopy recommended for removal and establishing new canopy in areas that promote economic growth, such as 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 *Prunus serotina* (black cherry) should be limited until the species distribution normalizes. Additionally, due to the species distribution and impending threats from emerald ash borer (EAB, *Agrilus planipennis*), all *Fraxinus* spp. (ash) should be temporarily removed from the planting list.

Urban Forest Program Need

Adequate funding will be needed for the Prospect Park Alliance 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 $518,015. This total will decrease to approximately $170,937 per year by Year 5 of the program. High-priority removal and pruning are 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 lower.

Over the long term, supporting proactive management of trees through funding will reduce park tree care management costs and potentially minimize the costs to build, manage, and support certain Prospect Park infrastructure. Keeping the inventory up-to-date using TreeKeeper® or similar software is crucial for making informed management decisions and projecting accurate maintenance budgets.

Prospect Park Alliance has many opportunities to improve its urban forest. Planned tree planting and a systematic approach to tree maintenance will help ensure 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.

FY 2019 **$518,015**

- 87 Dead and Poor Condition Tree and Stump Removals
- 1,102 Priority 1 Prunes
- 526 Reinspections
- 121 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2020 **$491,916**

- 67 Dead and Poor Condition Tree and Stump Removals
- 2,601 Priority 1 Prunes
- 121 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2021 **$378,312**

- 262 Dead and Poor Condition Tree and Stump Removals
- 236 Priority 2 Prunes
- RM Cycle: 1,044 Trees
- 121 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2022 **$241,913**

- 41 Fair and Good Condition Tree and Stump Removals
- RM Cycle: 1,044 Trees
- 121 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY2023 **$234,476**

- RP Cycle: 1,044 Trees
- 145 Stump Removals
- 121 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

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INTRODUCTION

Designed by James T. Stranahan in 1858, Prospect Park has been Brooklyn's beloved greenspace where city residents and visitors could get away for some much-needed pure air and healthy exercise any time of the year. Prospect Park Alliance employs a professional staff of horticulturalists, maintenance workers, arborists, ecologists, educators, volunteer coordinators, visitor services representatives, and many others who ensure the day-to-day operation of Prospect Park. Prospect Park Alliance manages and maintains the park's urban forest, including trees, stumps, and planting sites

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, tree management plan, and inventory management software) to set goals and measure progress. These tools can be utilized to establish tree care priorities, build 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.

From April to May 2018, Prospect Park Alliance worked with DRG 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 park trees. The following tasks were completed:

- Inventory of trees and stumps in horticultural areas, lawns, playgrounds, streets, and wooded areas of the park.
- 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 Prospect Park.
- *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

From April to May 2018, DRG arborists certified by the International Society of Arboriculture (ISA) and Qualified to preform Tree Risk Assessments (TRAQ) completed a Level 1 assessment and inventory of all trees and stumps in Prospect Park. In maintained areas (including horticultural areas, lawns, playgrounds, and streets) all trees were assessed and inventoried regardless of tree size. In woodland areas, only trees over 6 inches in diameter at breast height (DBH) were inspected and inventoried. A total of 12,413 sites were collected during the inventory: 12,268 trees and 145 stumps. Table 1 provides a detailed breakdown of the number and type of sites inventoried in each landscape type.

Table 1. Sites Collected by Landscape Type During the 2018 Inventory

Site Type	Number of Sites
Horticulture Area	823
Lawn	3,380
Playground	149
Street	93
Woodland	7,968
Grand Total	12,413

Prospect Park was divided into three zones for the purposes of the inventory. These included Zone1, Zone 2, and Zone 3. All of Zones 1 and 2 were inventoried and only a portion of Zone 3 was inventoried. Figure 1 provides a detailed breakdown of the number and type of sites inventoried in each park zone.

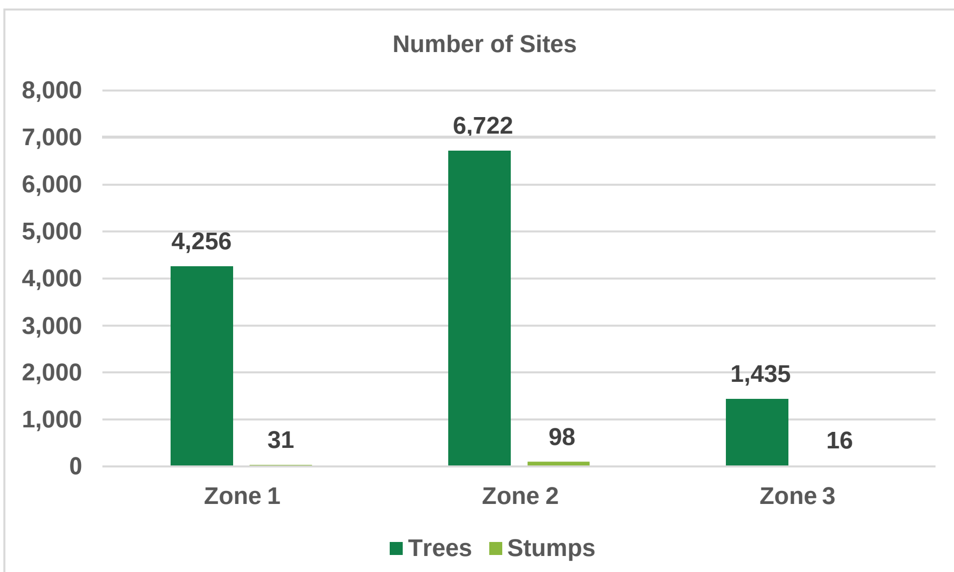


Figure 1. Sites collected by zone during the 2018 inventory.

Assessment of Tree Inventory Data

Photograph 1. *Davey's Tree Risk Assessment* **Qualified and ISA Certified Arborists inventoried the urban forest of Prospect Park by collecting information about trees that could be used to assess the state of the urban forest.**

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. See Appendix A for more information on data collection and site location methods. 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*, 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.
- *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.
- *Other Observations* include such observations that 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

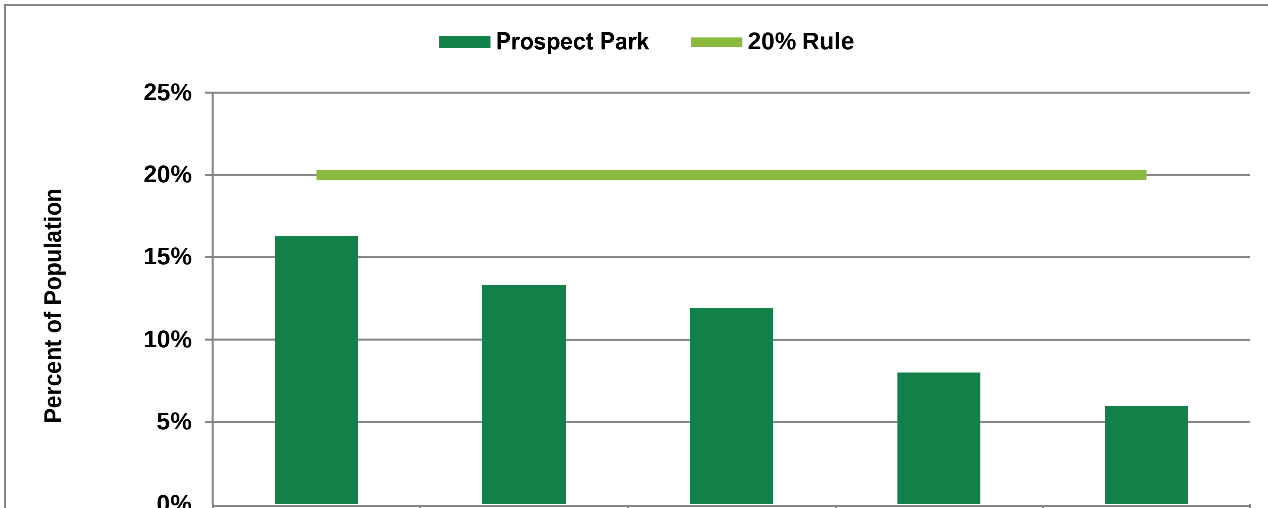
Analysis of Prospect Park's tree inventory data indicated that the park tree population had 84 genera and 193 species represented.

Figure 2 uses the 10% Rule to compare the percentages of the most common species identified during the inventory to the park populations. *Prunus serotina* (black cherry) exceeds the recommended 10% maximum for a single species in a population, comprising 13% of the inventoried tree population. The two next most common species were *Quercus rubra* (northern red oak) and *Fraxinus americana* (white ash) which both comprised 5% of the total tree population.

	black cherry	northern red oak	white ash	slippery elm	American linden
Prospect Park	13%	5%	5%	4%	4%
10% Rule	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 park tree population. Cherry (*Prunus*) is the only genera that is approaching the 20% threshold and comprises 16% of the total park tree population. From the genus distribution level no single genera is a threat to the diversity of the park.



	cherry	maple	oak	elm	ash
Prospect Park	16%	13%	12%	8%	6%
20% Rule	20%	20%	20%	20%	20%

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

Discussion/Recommendations

Black cherry is the most dominant species in the park. This is a biodiversity concern because its abundance in the landscape makes it a limiting species. Continued diversity of tree species is an important objective that will ensure Prospect Park's urban forest is sustainable and resilient to future invasive pest infestations.

Considering the large quantity of black cherry in Prospect Park's tree population, along with its susceptibility to many insects and diseases, the planting of black cherry should be limited to minimize the potential for loss in the event that insects like the eastern tent caterpillar (*Malacosoma americanum*) threaten Prospect Park's urban tree population. See Appendix B 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.

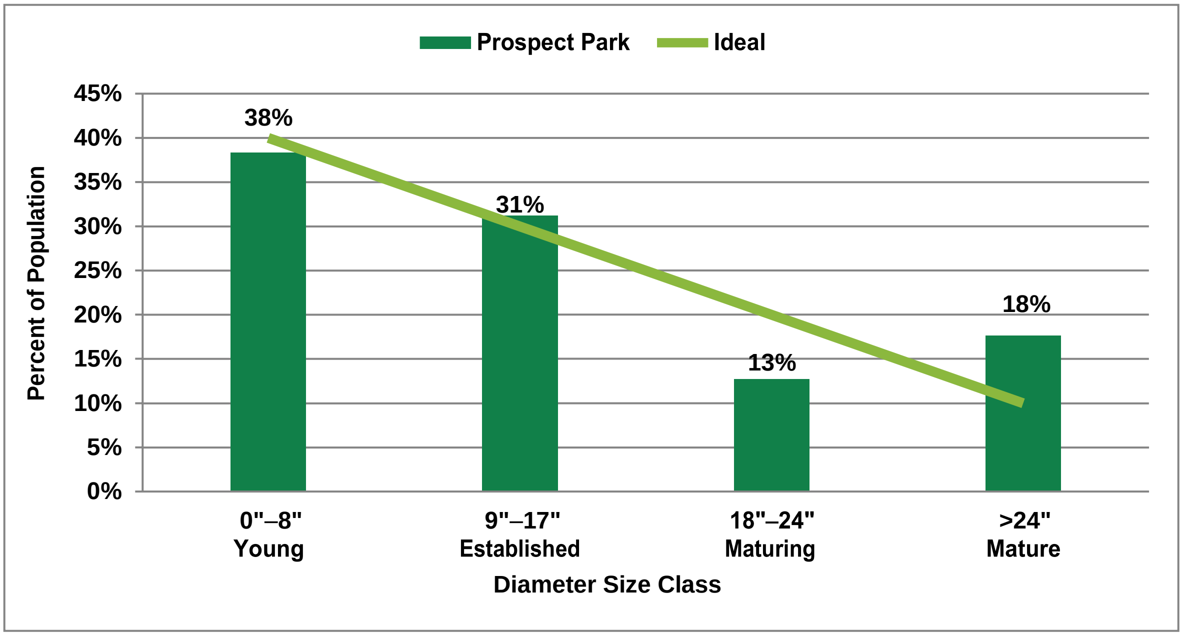


Figure 4. Comparison of diameter size class distribution for inventoried trees to the ideal distribution.

Findings

Figure 4 compares Prospect Park's diameter size class distribution of the inventoried tree population to the ideal proposed by Richards (1983). Prospect Park's distribution trends towards the ideal. The young size class of trees do not deviate from the ideal more than 2%. However, the maturing size class falls short of the ideal by 7% while the mature size classes exceeds the ideal by 8%.

Discussion/Recommendations

The large presence of mature trees in Prospect Park is a reflection of how long Brooklyn has enjoyed and celebrated public green spaces. The diameter size class distribution of the inventoried tree population trends towards the ideal. DRG recommends that Prospect Park Alliance develop/review and implement a planting and young tree maintenance program to ensure that young, healthy trees are in place to fill in gaps in tree canopy and replace older declining Prospect Park trees. DRG also recommends Prospect Park Alliance develop/review and implement a tree preservation and proactive tree care program to ensure the long-term survival Prospect Park's older trees. Tree planting and young and mature proactive tree care will allow the distribution to normalize over time. See Appendix C for planting suggestions and information on species selection.

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

DRG 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 Good, Fair, Poor, or Dead.

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

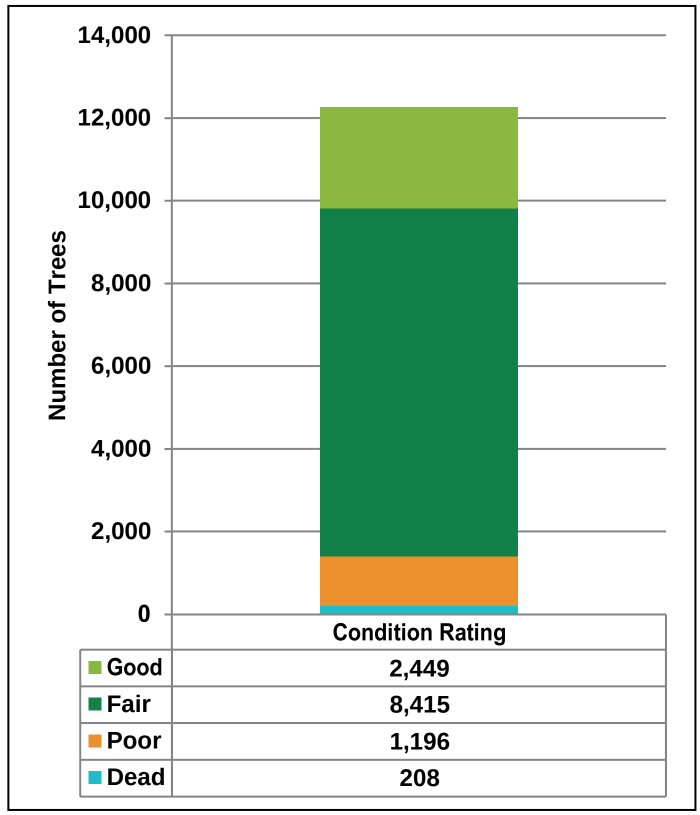


Figure 5. Conditions of inventoried trees.

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 condition (69%, Figure 5). Based on these data, the general health of the overall inventoried tree population is Fair. Figure 6 illustrates that most of the maturing and mature trees were rated to be in Fair to Good condition while most of the young and established trees were rated to be in Fair to Poor condition.

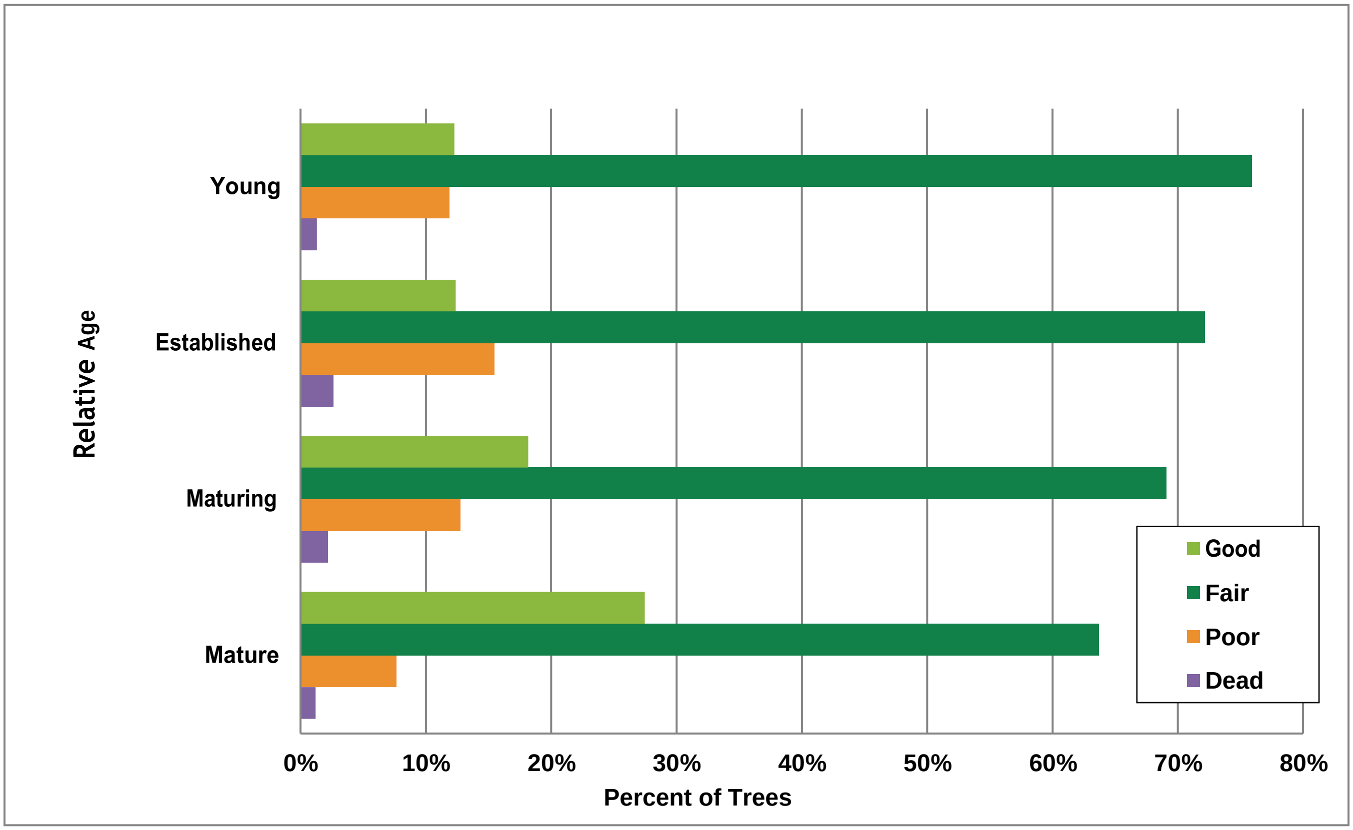


Figure 6. Tree condition by relative age during the 2018 inventory.

Discussion/Recommendations

Even though the condition of Prospect Park'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 the park trees reveals that growing conditions and/or past management of trees were inconsistent.
- Dead trees should be removed because of their failed health; these trees will likely not recover, even with increased care.
- Poor condition ratings 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.

- Younger trees rated in Fair condition may benefit from improvements in structure that may improve their health over time. Pruning should follow *ANSI A300 (Part 1)* (ANSI 2008).
- Proper tree care practices are needed for the long-term general health of the urban forest. 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.

Other Observations

Inventory Pest Evaluation Detection (IPED)

The Inventory Pest Evaluation Protocol (IPED) was designed by the United States Department of Agriculture, the U.S. Forest Service, and supported by several universities, professional forestry companies, and tree care industry associations. The protocol was developed to better track and detect exotic pest species that tend to be introduced and first detected in urban areas. IPED is a standardized method for observing trees for signs and symptoms of exotic pests and diseases during a tree inventory. Collecting this information during inventories enables urban forestry managers to make informed and systematic decisions regarding the long-term management of their urban forests. Prospect Park Alliance incorporated the IPED protocol into the park tree inventory. The inventory was conducted April to May 2018.

Findings

1) *Signs and Symptoms of Branches and Bole*

Disease signs were the most frequently observed signs recorded and comprised 17% of all the trees inventoried. Decay was the most common type of Disease Signs and accounted for 15% of all the trees inventoried.

Abnormal Growth was observed in 2% of the trees inventoried. Loose bark was the most frequently observed sign or symptom of Abnormal Growth and accounted for 1% of all the trees inventoried.

Insects Signs were observed in 1% of the trees inventoried, and Insect Presence was observed in less than 1% of the trees inventoried.

Table 2. Signs and Symptoms of Branches and Bole

Signs and Symptoms	Number	Percent
Problem Location	**12,268**	**100%**
Bole and/or root collar	897	7%
Both	507	4%
Branches	655	5%
None	10,209	83%
Abnormal Growth	**12,268**	**100%**
Insect boring or galleries causing loose bark	22	0%
Loose bark only	137	1%
Mycelial fans or pads present	25	0%
Other	8	0%
Rhizomorphs present	1	0%
None	12,075	98%
Disease Signs	**12,268**	**100%**
Bleeding/slime flux	70	1%
Cankers	69	1%
Conks	35	0%
Decay	1,788	15%
Fleshy mushrooms	37	0%
Other	7	0%
Resinosis/gummosis	24	0%
Woody galls or burls	66	1%
None	10,172	83%
Insect Signs	**12,268**	**100%**
D-shaped exit holes	7	0%
Frass only	2	0%
Other holes	57	0%
Pencil round or oval exit holes (2mm or more)	1	0%
Pitch/resin exudation	1	0%
Sawdust	2	0%
Short holes (less than 2mm)	23	0%
None	12,175	99%
Insect Presence	**12,268**	**100%**
Carpenter ants	1	0%
Other insects	9	0%
Scale	6	0%
None	12,252	100%

2) Signs and Symptoms of Foliage and Twigs

Table 3 summarizes signs and symptoms of foliage and twigs problems observed during the inventory. The inventory was conducted April to May 2018. Most trees did not have foliage present during that time.

Table 3. Signs and Symptoms of Foliage and Twigs

Signs and Symptoms	Number	Percent
Abnormal Foliage	**12,268**	**100%**
Foliage/twigs distorted (including galls)	**12**	**0%**
Witches' brooms present	**13**	**0%**
None	**12,243**	**100%**
Chewed Foliage	**12,268**	**100%**
None	**12,268**	**100%**
Discolored Foliage	**12,268**	**100%**
Complete yellowing of leaves or needles	**4**	**0%**
Marginal scorching (browning) of leaves	**3**	**0%**
Mottling, spots, or blotches (any color)	**23**	**0%**
None	**12,238**	**100%**
Percent of Foliage Affected	**12,268**	**100%**
30% but not the whole crown	**19**	**0%**
More than 10%, less than 30%	**5**	**0%**
Whole crown affected	**16**	**0%**
None	**12,228**	**100%**
Insect Signs	**12,268**	**100%**
Aphids/white cotton pervasive in crown	**22**	**0%**
Other	**1**	**0%**
None	**12,245**	**100%**
Species Identified	**12,268**	**100%**
Unknown (Unknown)	**1**	**0%**
None (None)	**12,267**	**100%**

3) General Tree Stress

Environmental Stress was the most frequent type of Tree Stress observed and accounted for 24% of all trees inventoried. Broken Branches were the most common type of Environmental Stress and comprised 21% of all the trees inventoried.

Epicormic sprouting was the second most common Tree Stress type observed and was present in 13% of all the trees inventoried.

Human Stress accounted for 8% of the trees inventoried. Poor or Restricted Planting/Mulching comprised 5% of all the trees inventoried.

Dieback was observed in 3% of the trees inventoried, and approximately 1% of the dieback observed was found to be pervasive throughout the crown.

Table 4. General Tree Stress

Tree Stress	Number	Percent
Dieback	**12,268**	**100%**
Pervasive twig dieback throughout the crown	112	1%
Twig dieback upper/outer crown, more than 10% but not pervasive	309	3%
None	11,847	97%
Environmental Stress	**12,268**	**100%**
Broken branches	2,554	21%
Drought/poor soil	5	0%
Flooding	6	0%
Frost cracks	74	1%
Lightning strike	7	0%
Other	235	2%
Sunscald	4	0%
None	9,383	76%
Epicormic Sprouts	**12,268**	**100%**
No	10,720	87%
Yes	1,548	13%
Human Stress	**12,268**	**100%**
Other	11	0%
Poor or restricted planting/mulching	621	5%
Salt/chemicals	4	0%
Topping/poor pruning	137	1%
Wounding of woody tissues	234	2%
None	11,261	92%
Wilted Foliage	**12,268**	**100%**
None	12,268	100%

Discussion/Recommendations

Decay and broken branches were the most common signs identified during the inventory. Unless slated for removal or cleaning, trees noted as having decay (1,788 trees) or broken branches (2,554 trees) should be regularly inspected. Corrective actions should be taken when warranted. If their condition worsens, removal may be required. Of the 1,788 trees noted with decay, 218 were recommended for removal, 628 were recommended for cleaning, and 255 were recommended for re-inspection. Of the 2,554 trees noted with broken branches, 54 were recommended for removal, 1,726 were recommended for cleaning, and 132 were recommended for re-inspection.

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 park trees. Appendix D provides information about some of the current potential threats to Prospect Park'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 State (see Figure 7). It is important to note that the figure only presents data collected from the inventory. Many more trees throughout Prospect Park may be susceptible to these invasive pests.

Findings

Gypsy moth (*Lymantria dispar dispar*) and Asian longhorned beetle (ALB or *Anoplophora glabripennis*) are known threats to a large percentage of the inventoried park trees (26% and 25%, respectively). These pests were not detected in Prospect Park, but if they were detected Prospect Park Alliance could see severe losses in its tree population.

European oak borer (*Agrilus sulcicollis*), oak wilt (*Ceratocystis fagacearum*), and oak splendor beetle (*Agrilus biguttatus*) present threats to a lesser percentage of the inventoried park trees (13%, 12%, and 12%, respectively).

There were 729 ash trees inventoried in Prospect Park, and 7 of them were identified as having D-shaped exit holes. Additionally, 17% of the ash trees inspected showed signs of decay, 13% were growing epicormics sprouts, and 3% were observed to have significant dieback. Data suggests that nearly 11% of Prospect Park's ash trees could be infested with emerald ash borer (EAB or *Agrilus planipennis*).

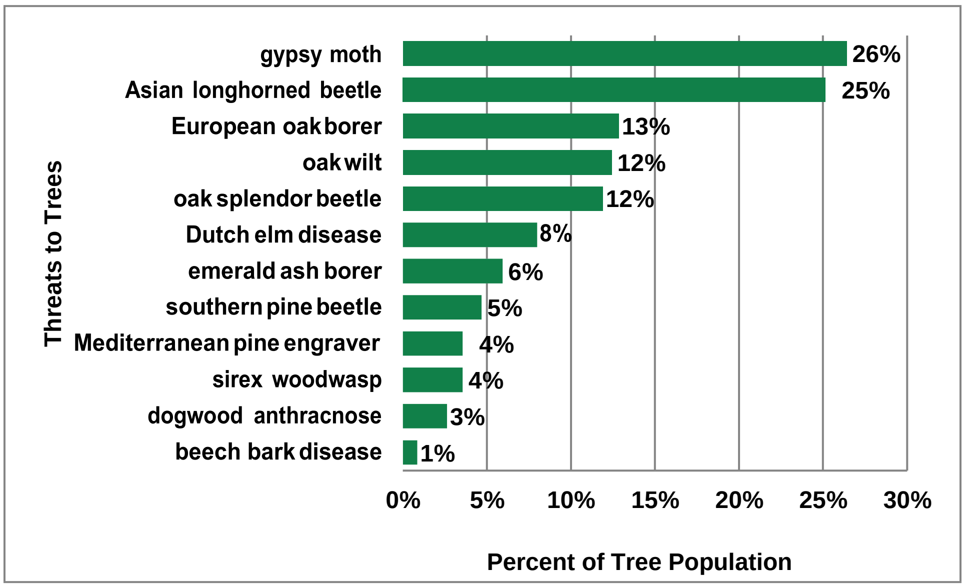


Figure 7. Potential impact of insect and disease threats noted during the 2018 inventory.

Discussion/Recommendations

Prospect Park Alliance 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.

DRG recommends Prospect Park Alliance develop an EAB mitigation plan. The 7 inventoried ash trees that showed possible signs of EAB (D-shaped exit holes) should be treated or removed and all other ash trees should be routinely monitored. All areas where trees are removed should be inspected for potential replacement.

Replacement Value

Replacement value describes the historical investment in trees over time. Replacement value on a species level gives urban forest managers a look into the landscape value of their species populations. Values will reflect species population, stature, and condition.

Findings

Prospect Park's trees are an important community asset valued at $59,463,000. Over time, this value could increase as trees mature, provided the trees are properly maintained. The average replacement value is approximately $4,700 per tree. Northern red oak is shown to have the highest replacement value of all inventoried species at $11,711,000, or 20% of Prospect Park's historical investment.

Discussion/Recommendations

A healthy, well-placed tree will become more valuable over time as is grows from a young tree to a mature tree. DRG recommends that Prospect Park Alliance focus on tree care practices that will improve upon species diversity, size distribution, and health of the urban forest. Focusing on these things can promote higher valued investments.

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

Social Benefits

- **Tree-lined streets are safer; traffic speeds and the amount of stress drivers feel are reduced, which likely reduces road rage/aggressive driving (Wolf 1998a, Kuo and Sullivan 2001a).**
- **Chicago apartment buildings with medium amounts of greenery had 42% fewer crimes than those without any trees (Kuo and Sullivan 2001b).**
- **Chicago apartment buildings with high levels of greenery had 52% fewer crimes than those without any trees (Kuo and Sullivan 2001a).**
- **Employees who see trees from their desks experience 23% less sick time and report greater job satisfaction than those who do not (Wolf 1998a).**
- **Hospital patients recovering from surgery who had a view of a grove of trees through their windows required fewer pain relievers, experienced fewer complications, and left the hospital sooner than similar patients who had a view of a brick wall (Ulrich 1984, 1986).**
- **When surrounded by trees, physical signs of personal stress, such as muscle tension and pulse rate, were measurably reduced within three to four minutes (Ulrich 1991).**

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 determines tree benefit values for Prospect Park's tree inventory data are summarized in this report using the i-Tree's Streets application. The results of Prospect Park's tree inventory provide insight into the overall health of park 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 park's 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 trees provide to a community:

These quantified benefits and the reports generated 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 pounds and has been translated to tons for this report.
- **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. This is measured pounds and has been translated to tons for this report. 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 is 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.

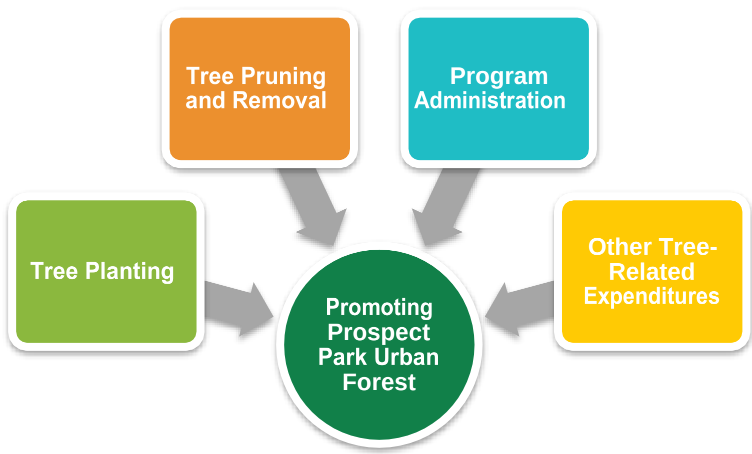
i-Tree Tools

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 Prospect Park'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 local economic data are not available, i-Tree Streets uses default economic inputs from a reference city selected by USDA FS for the climate zone in which your community is located. Any default value can be adjusted for local conditions. If local community program costs are not available, i-Tree Streets will not compute net benefit or cost-benefit ratio values.



Prospect Park's Inputs

Specific local economic data and Prospect Park's urban forestry program annual budget were not available at the time of this plan. Economic data from New York, New York were used to help calculate the benefits provided by Prospect Park trees. Net Annual Benefits, Cost for Public Trees, and Benefit-Cost Ratio (BCR) will not be calculated.

Annual Benefits

The i-Tree Streets model estimated that the inventoried trees provide a total annual benefit of $1,596,472. Essentially, $1,596,472 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 Prospect Park's trees provides an annual benefit of $130.13.

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 and aesthetics and other tangible and intangible benefits trees provide were the greatest values to the community. In addition to saved energy usage and increasing property values, trees also play a major role in stormwater management. The park's trees alone intercepted over 21 million gallons of rainfall, which equates to a savings of $171,624 in stormwater management costs. Stormwater management comprises 11% of the annual benefits park trees provide. Reductions in CO_2 and air quality improvement are important but account for lesser amounts of work performed by park trees, 9% of the annual benefits.

Figure 8 summarizes the annual benefits and results for the park tree population. Table 5 presents results for individual tree species from the i-Tree Streets analysis.

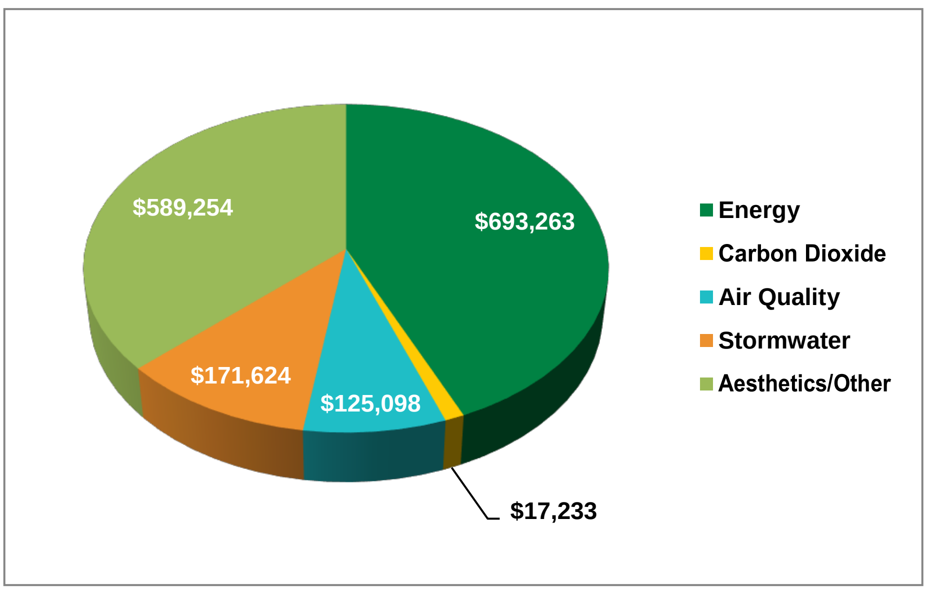


Figure 8. Breakdown of total annual benefits provided to Prospect Park.

Table 5. Benefit Data for Common Park Trees by Species

Most Common Trees Collected During Inventory		Number Trees	Percent of Total Trees	Canopy Cover	Benefit Provide By Park Trees					Importance Value (IV)
					Aesthetic/ Other	Stormwater	Energy	Carbon Sequestered	Air Quality	
Common Name	Botanical Name		(%)	(ft^2)	Average/$/Tree					0–100 (higher IV = more important species)
black cherry	Prunus serotina	1,656	13%	636,896	13.49	4.68	31.56	0.54	5.02	7.57
northern red oak	Quercus rubra	674	5%	1,505,813	64.37	33.91	113.21	1.77	21.74	10.51
white ash	Fraxinus americana	570	5%	770,967	55.58	20.06	79.22	0.78	15.35	6.09
slippery elm	Ulmus rubra	525	4%	513,436	83.28	14.69	59.70	0.84	10.96	4.69
American basswood	Tilia americana	508	4%	466,318	58.10	15.71	58.09	0.55	10.32	4.52
tulip tree	Liriodendron tulipifera	456	4%	459,116	77.97	15.62	73.05	0.46	12.67	4.08
sycamore maple	Acer pseudoplatanus	446	4%	414,109	59.46	12.92	61.21	1.21	11.14	3.41
Norway maple	Acer platanoides	443	4%	399,492	59.37	12.94	58.14	1.24	10.68	3.38
sweetgum	Liquidambar styraciflua	350	3%	334,830	43.70	13.96	60.84	0.26	7.16	3.01
pin oak	Quercus palustris	342	3%	533,083	76.35	23.53	77.31	1.68	15.22	4.04
eastern white pine	Pinus strobus	332	3%	223,407	19.09	12.70	43.23	0.15	8.31	2.10
American elm	Ulmus americana	299	2%	328,579	86.31	16.47	64.81	0.94	12.19	2.90
white mulberry	Morus alba	248	2%	152,084	45.39	10.53	44.48	0.34	7.40	1.66
sugar maple	Acer saccharum	231	2%	193,219	52.30	15.20	57.75	0.72	9.78	1.97
red maple	Acer rubrum	219	2%	172,763	43.18	13.17	53.32	0.37	9.31	1.68
London planetree	Platanus × acerifolia	194	2%	429,187	78.08	34.65	112.71	1.38	20.47	3.16
black locust	Robinia pseudoacacia	181	1%	201,521	88.06	17.07	77.98	0.60	13.77	1.72
boxelder	Acer negundo	170	1%	79,297	31.04	5.68	35.81	0.47	5.91	0.84
white oak	Quercus alba	144	1%	345,798	92.57	36.36	103.54	2.58	22.27	2.41
plum	Prunus domestica	143	1%	42,574	12.27	3.45	24.96	0.38	3.90	0.59
Siberian elm	Ulmus pumila	138	1%	191,837	93.09	20.68	75.54	1.19	14.92	1.58
serviceberry	Amelanchier spp.	136	1%	6,674	8.14	0.56	4.70	0.04	0.67	0.40
Japanese pagodatree	Styphnolobium japonicum	133	1%	131,646	40.53	16.38	63.18	0.41	11.37	1.18
littleleaf linden	Tilia cordata	124	1%	120,488	17.43	13.39	65.30	0.28	11.03	0.99
other trees	~169 varying species	3,606	29%	174,826	37.33	9.98	41.10	6.57	7.65	25.51
Total	~84 genera and ~193 species	12,268	100%	1,122,456	48.03	13.99	56.51	0.73	10.20	100.00

Aesthetic/Other Benefits

The total annual benefit associated with property value increases and other tangible and intangible benefits of park trees was $589,254. The average benefit per tree equaled $48.03 per year.

Energy Benefits

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 1,064 MWh of electricity and 386,499 therms of natural gas, which accounts for an annual savings of $693,263 in energy consumption. One of Prospect Park's trees provides an average of $56.51 in energy benefits each year.

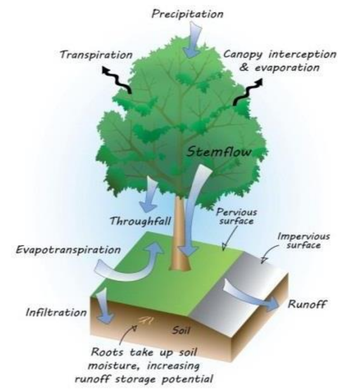
Prunus serotina (black cherry)	*Prunus* spp. (plum)	*Platanus × acerifolia* (London planetree)	*Quercus rubra* (northern red oak)
13% of Trees	1% of Trees	2% of Trees	5% of Trees
67 MWh Electricity	5 MWh Electricity	36 MWh Electricity	127 MWh Electricity
30,429 thm Natural Gas	2,091 thm Natural Gas	11,925 thm Natural Gas	41,590 thm Natural Gas
$31.56 Average $/Tree	$24.96 Average $/Tree	$112.71 Average $/Tree	$113.21 Average $Tree

Northern red oak contributes $113.21 per tree to the annual energy benefits of the urban forest and comprises 11% of the population's total annual benefit. London planetree contributes $112.71 per tree to the annual energy benefits and comprises 3% of the population's total annual benefit. Both species provide more benefit than their population would lead to believe. Large leafy canopies are valuable because they provide shade, which reduces energy usage. Smaller trees inventoried such as black cherry were found to have smaller reductions in energy usage on a per-tree basis. Black cherry is valued at only $31.56 per tree and only comprises 8% of the population's total annual benefit.

Stormwater Benefits

Trees intercept rainfall, which helps lower costs to manage stormwater runoff. The inventoried trees in Prospect Park intercept 21,452,985 gallons of rainfall annually (Table 6). The estimated annual savings from Prospect Park trees in stormwater runoff management is $171,624.

Of all species inventoried, northern red oak contributed most of the annual stormwater benefits. The population of northern red oak intercepted approximately 2.9 million gallons of rainfall. The most dominant species in the park, black cherry, only intercepted approximately 968,050 gallons of rainfall. Northern red oak absorbed 3 times more gallons of rainfall than black cherry. Large-statured trees with big canopies offered 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 6. Stormwater Benefits Provided by Park Trees

Most Common Trees Collected During Inventory		Number of Trees	Percent of Total Trees	Total Rainfall Interception
Common Name	Botanical Name		(%)	(gal.)
black cherry	Prunus serotina	1,656	13%	968,050
northern red oak	Quercus rubra	674	5%	2,856,616
white ash	Fraxinus americana	570	5%	1,429,626
slippery elm	Ulmus rubra	525	4%	964,333
American basswood	Tilia americana	508	4%	997,677
tulip tree	Liriodendron tulipifera	456	4%	890,596
sycamore maple	Acer pseudoplatanus	446	4%	720,375
Norway maple	Acer platanoides	443	4%	716,531
sweetgum	Liquidambar styraciflua	350	3%	610,744
pin oak	Quercus palustris	342	3%	1,006,083
eastern white pine	Pinus strobus	332	3%	527,105
American elm	Ulmus americana	299	2%	615,728
white mulberry	Morus alba	248	2%	326,295
sugar maple	Acer saccharum	231	2%	438,997
red maple	Acer rubrum	219	2%	360,615

Most Common Trees Collected During Inventory		Number of Trees	Percent of Total Trees	Total Rainfall Interception
Common Name	Botanical Name		(%)	(gal.)
London planetree	Platanus × acerifolia	194	2%	840,217
black locust	Robinia pseudoacacia	181	1%	386,096
boxelder	Acer negundo	170	1%	120,740
white oak	Quercus alba	144	1%	654,568
plum	Prunus domestica	143	1%	61,752
Siberian elm	Ulmus pumila	138	1%	356,762
serviceberry	Amelanchier spp.	136	1%	9,520
Japanese pagodatree	Styphnolobium japonicum	133	1%	272,252
littleleaf linden	Tilia cordata	124	1%	207,560
other trees	~169 varying species	3606	29%	5,114,148
Total	~84 genera and ~193 species	12,268	100%	21,452,985

Air Quality Improvements

The inventoried tree population annually removes 12,864 pounds of air pollutants (including ozone, nitrogen dioxide, sulfur dioxide, and particulate matter) through deposition. The population also avoids 14,682 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 $125,098. The inventoried trees removed or avoided more pollutants than they emitted, resulting in a positive economic value.

The trees that provided the most benefits based on an annual per-tree average value were northern red oak and white ash ($14,650 and $ 8,750), respectively. Using the annual per-tree values in Table 5, the trees that provided the most benefits based on the annual per-tree average value were white oak and northern red oak, providing $22.27 and $21.74, respectively. On a per-tree basis, large trees with leafy canopies provided the most value.

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 $17,233 per year.

Prospect park's trees store 32,795 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, 2,611 tons of CO_2 are removed each year. White oak provided the most carbon benefits per tree, with each tree storing an average of $74.38 per tree and annually sequestering $2.58 worth of carbon.

Importance Value (IV)

Understanding the importance of a tree species to the community is based on its presence in the park, but also its ability to provide environmental and economic benefits to the community. The IV calculated by the 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 in the park, 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 northern red oak has the greatest IV in the park population at 10.51, even though it comprises only 5% of the park tree population. This indicates that the loss of the northern red oak population would be more economically detrimental than its percentage of the population leads us to believe. The second highest IV was black cherry (7.57), followed by white ash (6.09) and slippery elm (4.69). The abundances of white ash (5%) and slippery elm (4%) in the park are not as great as black cherry (13%), but their IVs are not much lower. Because they are large growing, the size and canopy of broadleaf species by nature provide more environmental benefits to the community, which all factor into assigning IV. The IV for black cherry is much less than its percentage of the population, indicating that if black cherry was lost, its economic impact would not be as significant.

Discussion/Recommendations

The i-Tree Streets analysis found that park trees provide environmental and economic benefits to the community by virtue of their mere presence in Prospect Park. Currently, energy conservation and aesthetics and other tangible and intangible benefits provided by park trees were rated as having the greatest value to the community. The large population of trees in Prospect Park provides shade and windbreaks to reduce energy usage and the property value increase provided by the park trees is important to stimulate economic growth. In addition to increasing energy benefits and aesthetics and property values, trees manage stormwater through rainfall interception, and store and sequester CO_2, and improve air quality. Even though these benefits were not found to be as great as both the energy and aesthetic/other benefits, they are noteworthy.

i-Tree Streets analysis found that the northern red oak is the most influential tree in Prospect Park. If this species was lost to oak wilt or other threats, its loss would be felt more than the community may realize.

To increase the benefits the urban forest provides, Prospect Park Alliance should plant young, large-statured tree species that manage the most stormwater, absorb the most CO_2, and remove the most air pollutants. Leafy, large-stature trees consistently created the most environmental and economic benefits. The following list of tree species is used for improving environmental benefits (iTree Species 2018):

Pollutant Removal

- *Ulmus americana* (American elm)
- *Liriodendron tulipifera* (tuliptree)
- *Tsuga canadensis* (eastern hemlock)
- *Betula alleghaniensis* (yellow birch)
- *Tilia americana* (American linden)

Carbon Storage

- *Quercus falcata* (southern red oak)
- *Quercus shumardii* (shumard oak)
- *Platanus occidentalis* (American sycamore)
- *Zelkova serrata* (Japanese zelkova)
- *Ulmus americana* (American elm))

Stormwater Reduction

- *Liriodendron tulipifera* (tuliptree)
- *Ulmus americana* (American elm)
- *Magnolia grandiflora* (southern magnolia)
- *Tilia americana* (American linden)
- *Betula alleghaniensis* (yellow birch)

Energy Reduction

- *Liriodendron tulipifera* (tuliptree)
- *Ulmus americana* (American elm)
- *Tilia americana* (American linden)
- *Betula alleghaniensis* (yellow birch)
- *Platanus occidentalis* (American sycamore)

SECTION 3: TREE MANAGEMENT PROGRAM

This tree management program was developed to uphold Prospect Park Alliance's comprehensive vision for preserving Prospect Park's 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. DRG recommends completing the work identified during the inventory based on the condition rating; however, routinely monitoring the tree population is essential so that other declining trees can be identified and systematically addressed. While regular pruning cycles and tree planting are important, priority work 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 cleaning, raising, or reducing tree canopy and re-inspecting the tree at a higher level of assessment (Level 2). Routine tree maintenance is considered proactive and includes structural pruning, thinning, and restoring tree canopy. Tree planting and community outreach are also considered routine activities of a proactive urban forestry program. See Appendix E for more information on priority maintenance and proactive maintenance.

Removals

- **Tree removal - Trees designated for removal have defects that cannot be cost-effectively or practically treated.**
- **Stump removal - Stump that should be removed.**

Priority Pruning

- **Clean - These trees require selective removal of dead, diseased, dying, and/or broken wood to minimize potential risk.**
- **Raise - Trees requiring pruning to provide vertical clearance by removing low branches that interfere with sight and/or traffic.**
- **Reduce - Selective pruning to decrease height and/or spread of the crown in order to provide clearance for electric utilities and lighting.**
- **Re-inspect - Indicates that a particular tree will require further or periodic inspection due to particular conditions with the tree that could cause it to be a safety risk and, therefore, potentially hazardous to the public.**

Routine Pruning

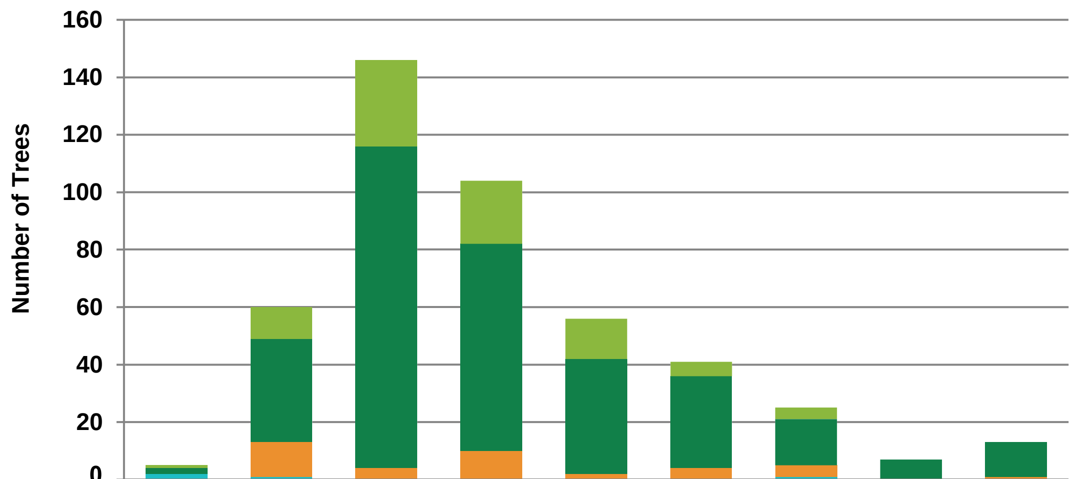
- **Structural - Selective pruning to correct or eliminate weak, interfering, or objectionable branches in order to minimize future maintenance requirements.**
- **Thin - The selective removal of water sprouts, epicormic branches, and live branches to reduce density.**
- **Restore - Selective pruning to improve the structure, form, and appearance of trees that have been severely headed, vandalized, or damaged.**

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. DRG 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 condition and diameter size class. The following sections briefly summarize the recommended removals identified during the inventory.



Condition	1 –3	4 –6	7 –12	13 –18	19 –24	25 –30	31 –36	37 –42	43
Dead	1	11	30	22	14	5	4	0	0
Poor	2	36	112	72	40	32	16	7	12
Fair	0	12	4	10	2	4	4	0	1
Good	2	1	0	0	0	0	1	0	0

Diameter Size Class

Figure 9. Tree removals by condition and diameter size class.

Findings

The inventory identified 87 Dead trees, 329 Poor condition trees, 37 Fair condition trees, and 4 Good condition trees recommended for removal based on a Level 1 assessment. Trees should be removed based on their condition, size, and location. Generally, Dead and Poor condition trees are higher priority than Fair and Good condition trees. Dead and Poor condition trees should be removed as soon as possible. Fair and Good condition trees should be removed after Dead and Poor condition trees.

The inventory identified 44 ash trees recommended for removal.

The inventory identified 145 stumps recommended for removal. Almost all of these stumps were larger than 10 inches in diameter. Stump removals should occur when convenient.

Discussion/Recommendations

Unless already slated for removal, trees noted as having decay (1,788 trees) should be inspected on a regular basis. 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.

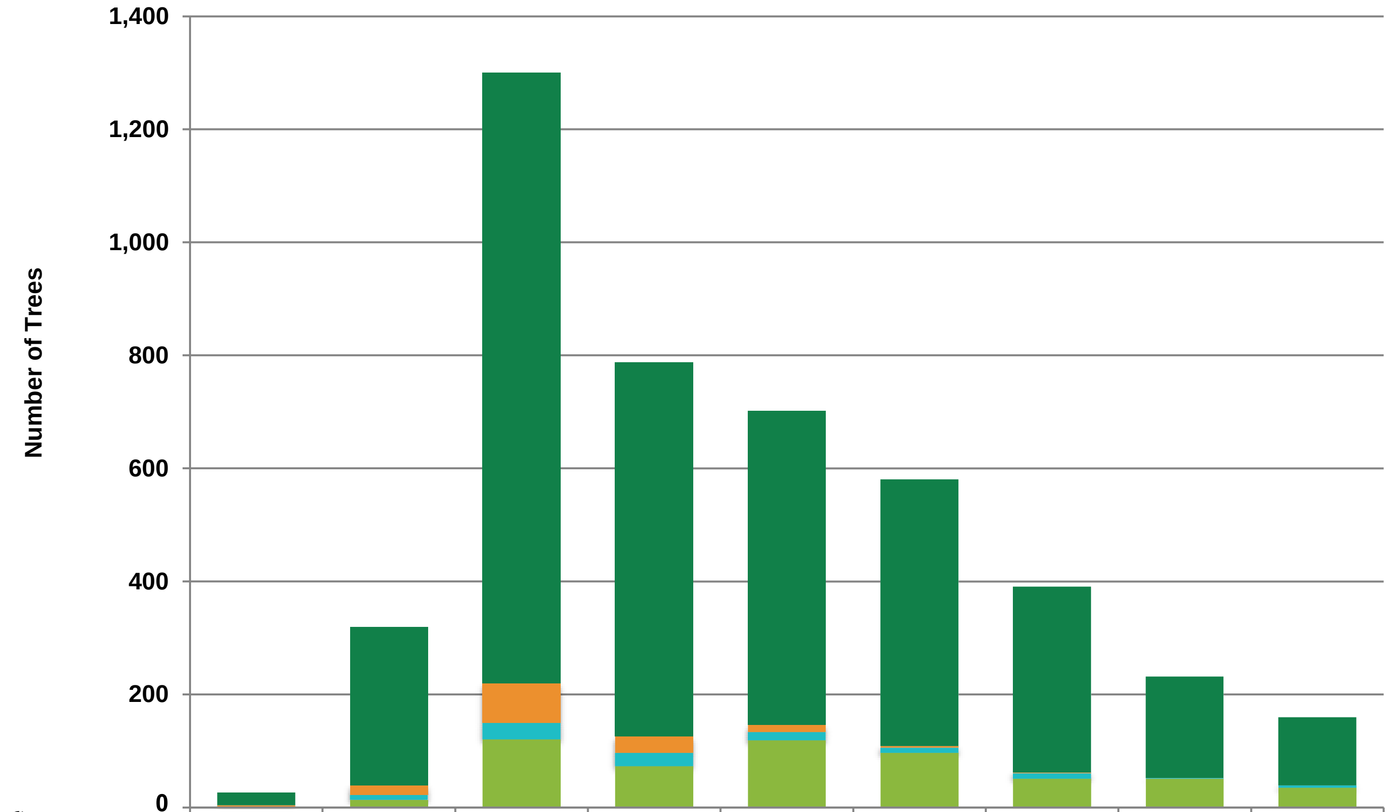
Updating the tree inventory data can streamline workload management and lend insight into setting accurate budgets and staffing levels. Inventory updates should be made electronically and can be implemented using TreeKeeper™ or similar computer software.

Priority Pruning

Cleaning generally requires removal of both small and large dead, diseased, 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. The primary maintenance category Clean should be considered Priority 1 and be completed as soon as possible

Priority 2 pruning includes raising to provide better clearance to pedestrian and vehicular traffic, reduction pruning to provide clearance for infrastructure or heavily trafficked rights-of-way, and re-inspect to determine particular conditions with the tree that could cause it to be a safety risk and, therefore, potentially hazardous to the public.

Figure 10 presents the number of Priority 1 and Priority 2 trees recommended for pruning by size class and pruning type. The following sections briefly summarize the recommended pruning maintenance identified during the inventory.



Maintenance Type	1 –3	4 –6"	7 – 12	13 –18	19 – 24	25 –30	31 – 36	37 – 42	43
Clean	23	280	1,080	662	556	472	329	180	121
Raise	3	17	70	29	13	3	1	0	0
Reduce	0	8	29	24	15	9	10	1	4
Re-inspect	1	14	121	73	119	97	51	51	35

Diameter Size Class (inches)

Figure 10. Priority pruning by maintenance type and diameter size class.

Findings

The inventory identified 3,703 trees needing canopy cleaning. These trees should be Priority 1 and pruned based on their condition, size, and location.

The inventory identified 562 trees needing re-inspected, 136 trees needing canopy raised, and 100 trees needing canopy reduced. These trees should be Priority 2 and pruned based on their condition, size, and location.

This inventory was a Level 1 assessment of all trees inspected. A recommendation to re-inspect a tree was used to designate trees that we were determined to need a Level 2 or Level 3 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, Prospect Park Alliance staff should investigate as soon as possible to determine corrective actions.

Discussion/Recommendations

An ISA Certified Arborist should perform all pruning activities and re-inspections should be performed by an ISA Tree Risk Assessment Qualified Arborist. Due to the nature of a Level 1 assessment, if upon re-inspection or pruning of a tree, tree conditions are worse than observed during the inventory the entire tree may need to be removed.

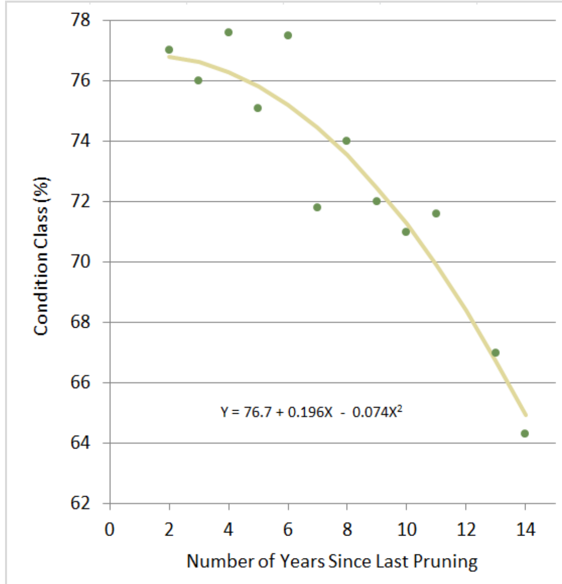


Figure 11. Relationship between average tree condition class and the number of years since the most recent pruning (adapted from Miller and Sylvester 1981).

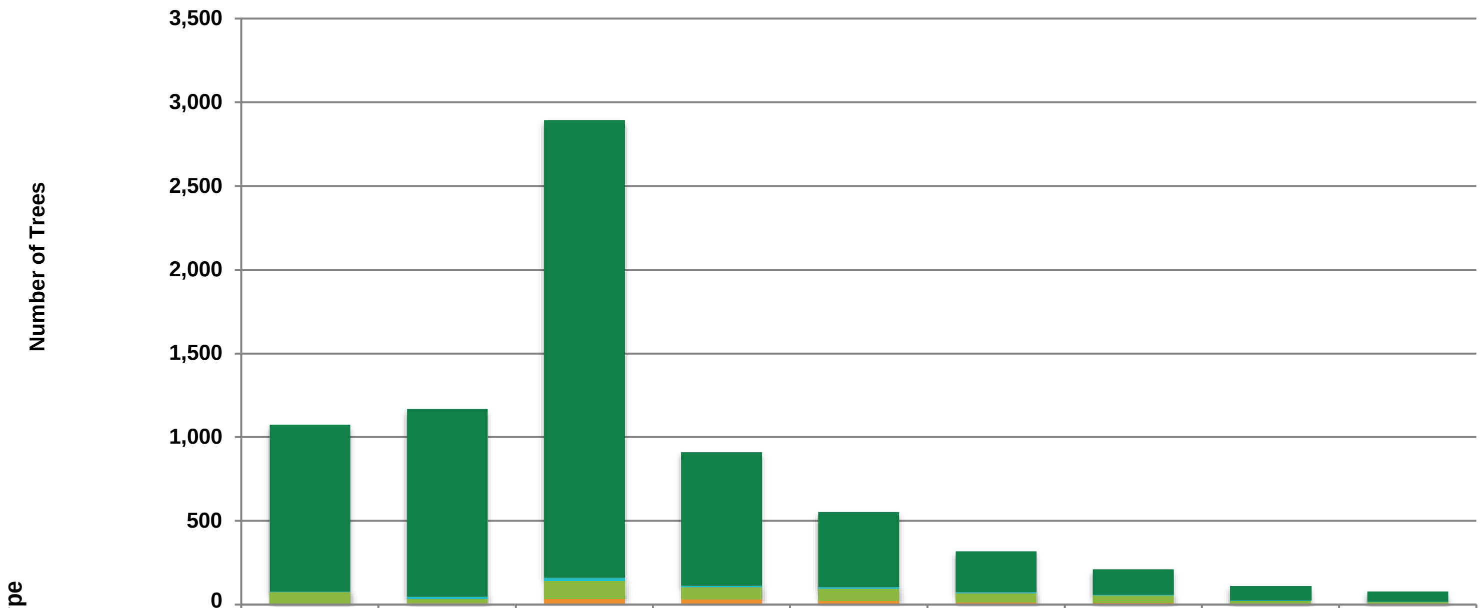
Routine Maintenance

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.

The goals of a maintenance cycle are to visit, assess, and prune trees on a regular schedule to improve health and reduce risk. DRG recommends that a Routine Maintenance (RM) Cycle begin after all Priority 1 and Priority 2 trees are corrected through pruning and re-inspection.

For this maintenance program, the RM Cycle includes young, established, maturing, and mature trees that need structural pruning, thinning, and restoration to remove improve structure. Over time, routine maintenance can reduce reactive maintenance, minimize instances of elevated risk, and provide the basis for a more defensible risk management program.

The length of the RM 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 visit, assess, and prune per year. Generally, the RM Cycle recommended for a tree population is five years but may extend to seven years if the population is large.



Maintenance Type	1 –3	4 –6	7 –12	13 –18	19 –24	25 –30	31 –36	37 –42	43
Discretionary (N/A)	996	1,121	2,735	799	449	245	154	85	60
Restore	3	12	14	6	10	6	4	4	2
Structural	69	26	110	73	71	55	43	16	12
Thin	5	7	34	31	22	12	10	5	4

Diameter Size Class

Figure 12. Trees recommended for the RM cycle by maintenance type and diameter size class.

Recommendations

DRG recommends that the Prospect Park Alliance establish a five-year RM Cycle in which approximately one-fifth of the tree population is to be pruned each year. The 2018 tree inventory identified approximately 7,310 trees that should be visited, assessed, and pruned over a five-year RM Cycle. An average of 1,044 trees should be pruned each year over the course of the cycle. DRG recommends that the RM Cycle begin after all Priority 1 and Priority 2 trees are pruned and re-inspected.

Figure 12 shows that a variety of trees of varying sizes will pruned (structural, thin, and restore) to improve tree health or need routinely visited, assessed, and pruned as needed (discretionary).

Maintenance Schedule

Utilizing data from the 2018 Prospect Park tree inventory, an annual maintenance schedule was developed that details the number and type of tasks recommended for completion each year. DRG made budget projections using industry knowledge and public bid tabulations. Actual costs were not specified by the Prospect Park Alliance. A complete table of estimated costs for Prospect Park Alliance's five-year tree management program is presented in Table 7.

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 Prospect Park Alliance's tree maintenance budget should be no less than $518,015 for the first year of implementation, no less than $491,916 for the second year, $378,312 for the third year, no less than $241,913 for the fourth year, and $234,476 for the final year of the maintenance schedule. Annual budget funds are needed to ensure that priority maintenance and re-inspection trees are remediated and that the RM Cycle 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.

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.

Table 7. Estimated Costs for Five-Year Urban Forestry Management Program

Estimated Costs for Each Activity			Year 1		Year 2		Year 3		Year 4		Year 5		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	
Dead and Poor Condition Removals	1-3"	$63	1	$63	0	$0	2	$126	0	$0	0	$0	$189
	4-6"	$140	11	$1,540	0	$0	36	$5,040	0	$0	0	$0	$6,580
	7-12"	$260	30	$7,800	0	$0	112	$29,120	0	$0	0	$0	$36,920
	13-18"	$603	22	$13,266	0	$0	72	$43,416	0	$0	0	$0	$56,682
	19-24"	$900	14	$12,600	0	$0	40	$36,000	0	$0	0	$0	$48,600
	25-30"	$1,198	5	$5,990	32	$38,336	0	$0	0	$0	0	$0	$44,326
	31-36"	$1,518	4	$6,072	16	$24,288	0	$0	0	$0	0	$0	$30,360
	37-42"	$1,735	0	$0	7	$12,145	0	$0	0	$0	0	$0	$12,145
	43"+	$2,125	0	$0	12	$25,500	0	$0	0	$0	0	$0	$25,500
Activity Total(s)			87	$47,331	67	$100,269	262	$113,702	0	$0	0	$0	$261,302
Fair and Good Condition Removals	1-3"	$63	0	$0	0	$0	0	$0	2	$126	0	$0	$126
	4-6"	$140	0	$0	0	$0	0	$0	13	$1,820	0	$0	$1,820
	7-12"	$260	0	$0	0	$0	0	$0	4	$1,040	0	$0	$1,040
	13-18"	$603	0	$0	0	$0	0	$0	10	$6,030	0	$0	$6,030
	19-24"	$900	0	$0	0	$0	0	$0	2	$1,800	0	$0	$1,800
	25-30"	$1,198	0	$0	0	$0	0	$0	4	$4,792	0	$0	$4,792
	31-36"	$1,518	0	$0	0	$0	0	$0	5	$7,590	0	$0	$7,590
	37-42"	$1,735	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	43"+	$2,125	0	$0	0	$0	0	$0	1	$2,125	0	$0	$2,125
Activity Total(s)			0	$0	0	$0	0	$0	41	$25,323	0	$0	$25,323
Stump Removals	1-3"	$33	1	$33	0	$0	2	$66	2	$66	6	$198	$363
	4-6"	$33	11	$363	0	$0	36	$1,188	13	$429	3	$99	$2,079
	7-12"	$68	30	$2,040	0	$0	112	$7,616	4	$272	21	$1,428	$11,356
	13-18"	$113	22	$2,486	0	$0	72	$8,136	10	$1,130	32	$3,616	$15,368
	19-24"	$155	14	$2,170	0	$0	40	$6,200	2	$310	30	$4,650	$13,330
	25-30"	$193	5	$965	32	$6,176	0	$0	4	$772	18	$3,474	$11,387
	31-36"	$230	4	$920	16	$3,680	0	$0	5	$1,150	20	$4,600	$10,350
	37-42"	$265	0	$0	7	$1,855	0	$0	0	$0	10	$2,650	$4,505
	43"+	$325	0	$0	12	$3,900	0	$0	1	$325	5	$1,625	$5,850
Activity Total(s)			87	$8,977	67	$15,611	262	$23,206	41	$4,454	145	$22,340	$74,588
Priority 1 Maintenance	1-3"	$20	0	$0	23	$460	0	$0	0	$0	0	$0	$460
	4-6"	$30	0	$0	280	$8,400	0	$0	0	$0	0	$0	$8,400
	7-12"	$75	0	$0	1,080	$81,000	0	$0	0	$0	0	$0	$81,000
	13-18"	$120	0	$0	662	$79,440	0	$0	0	$0	0	$0	$79,440
	19-24"	$170	0	$0	556	$94,520	0	$0	0	$0	0	$0	$94,520
	25-30"	$225	472	$106,200	0	$0	0	$0	0	$0	0	$0	$106,200
	31-36"	$305	329	$100,345	0	$0	0	$0	0	$0	0	$0	$100,345
	37-42"	$380	180	$68,400	0	$0	0	$0	0	$0	0	$0	$68,400
	43"+	$590	121	$71,390	0	$0	0	$0	0	$0	0	$0	$71,390
Activity Total(s)			1,102	$346,335	2,601	$263,820	0	$0	0	$0	0	$0	$610,155
Priority 2 Re-inspection	Per tree	$6	526	$3,156	0	$0	0	$0	0	$0	0	$0	$3,156
Activity Total(s)			526	$3,156	0	$0	0	$0	0	$0	0	$0	$3,156

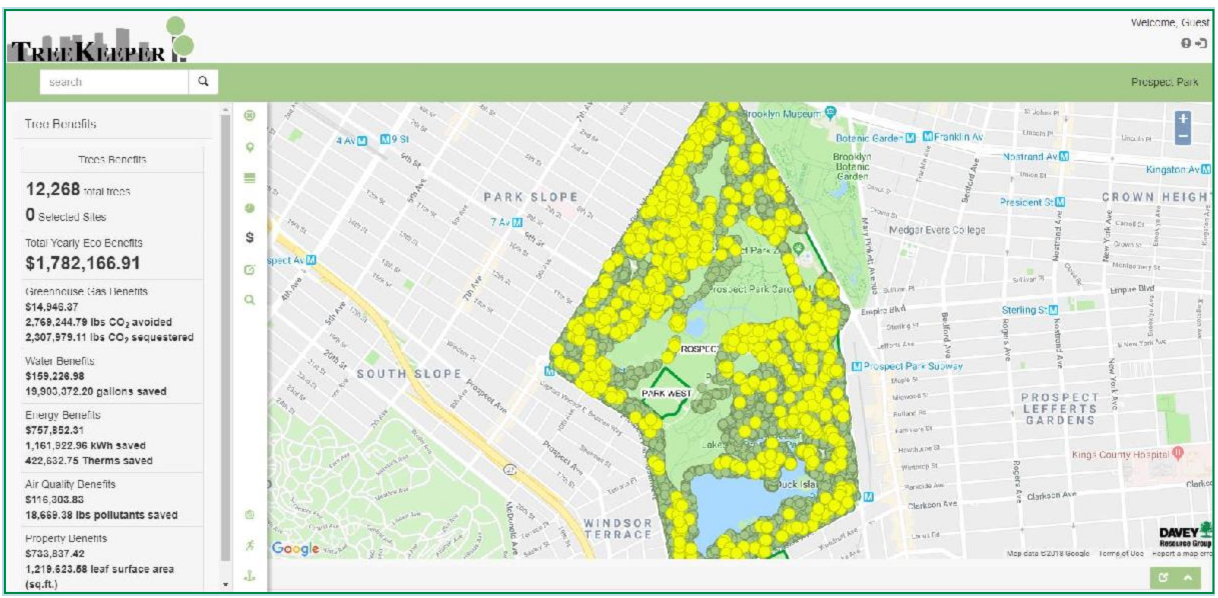
Estimated Costs for Each Activity			Year 1		Year 2		Year 3		Year 4		Year 5		Five-Year Cost
Activity	Diameter	Cost/Tree	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	
Priority 2 Maintenance	1-3"	$25	0	$0	0	$0	3	$75	0	$0	0	$0	$75
	4-6"	$33	0	$0	0	$0	25	$825	0	$0	0	$0	$825
	7-12"	$78	0	$0	0	$0	99	$7,722	0	$0	0	$0	$7,722
	13-18"	$120	0	$0	0	$0	53	$6,360	0	$0	0	$0	$6,360
	19-24"	$185	0	$0	0	$0	28	$5,180	0	$0	0	$0	$5,180
	25-30"	$238	0	$0	0	$0	12	$2,856	0	$0	0	$0	$2,856
	31-36"	$313	0	$0	0	$0	11	$3,443	0	$0	0	$0	$3,443
	37-42"	$395	0	$0	0	$0	1	$395	0	$0	0	$0	$395
	43"+	$603	0	$0	0	$0	4	$2,412	0	$0	0	$0	$2,412
Activity Total(s)			0	$0	0	$0	236	$29,268	0	$0	0	$0	$29,268
Routine Maintenance (5-year cycle)	1-3"	$20	0	$0	0	$0	153	$3,060	153	$3,060	153	$3,060	$9,180
	4-6"	$30	0	$0	0	$0	167	$5,010	167	$5,010	167	$5,010	$15,030
	7-12"	$75	0	$0	0	$0	413	$30,975	413	$30,975	413	$30,975	$92,925
	13-18"	$120	0	$0	0	$0	130	$15,600	130	$15,600	130	$15,600	$46,800
	19-24"	$170	0	$0	0	$0	79	$13,430	79	$13,430	79	$13,430	$40,290
	25-30"	$225	0	$0	0	$0	45	$10,125	45	$10,125	45	$10,125	$30,375
	31-36"	$305	0	$0	0	$0	30	$9,150	30	$9,150	30	$9,150	$27,450
	37-42"	$380	0	$0	0	$0	16	$6,080	16	$6,080	16	$6,080	$18,240
	43"+	$590	0	$0	0	$0	11	$6,490	11	$6,490	11	$6,490	$19,470
Activity Total(s)			0	$0	0	$0	1,044	$99,920	1,044	$99,920	1,044	$99,920	$299,760
Replacement Tree Planting	Purchasing	$170	121	$20,570	121	$20,570	121	$20,570	121	$20,570	121	$20,570	$102,850
	Planting	$110	121	$13,310	121	$13,310	121	$13,310	121	$13,310	121	$13,310	$66,550
Activity Total(s)			242	$33,880	242	$33,880	242	$33,880	242	$33,880	242	$33,880	$169,400
Replacement Young Tree Maintenance	Mulching	$100	121	$12,100	121	$12,100	121	$12,100	121	$12,100	121	$12,100	$60,500
	Watering	$100	121	$12,100	121	$12,100	121	$12,100	121	$12,100	121	$12,100	$60,500
Activity Total(s)			242	$24,200	242	$24,200	242	$24,200	242	$24,200	242	$24,200	$121,000
Annual Mortality (1%) Removals	Average Tree	$260	67	$17,420	67	$17,420	67	$17,420	67	$17,420	67	$17,420	$87,100
Activity Total(s)			67	$17,420	67	$17,420	67	$17,420	67	$17,420	67	$17,420	$87,100
Annual Mortality (1%) Stump Removals	Average Tree	$68	67	$4,556	67	$4,556	67	$4,556	67	$4,556	67	$4,556	$22,780
Activity Total(s)			67	$4,556	67	$4,556	67	$4,556	67	$4,556	67	$4,556	$22,780
Annual Mortality (1%) Planting and Maintenance	Average Tree	$480	67	$32,160	67	$32,160	67	$32,160	67	$32,160	67	$32,160	$160,800
Activity Total(s)			67	$32,160	67	$32,160	67	$32,160	67	$32,160	67	$32,160	$160,800
Activity Grand Total			2,487		3,420		2,489		1,811		1,874		
Cost Grand Total				$518,015		$491,916		$378,312		$241,913		$234,476	$1,864,632

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 gypsy moth and ALB).

There are various avenues for outreach. Maps can be created and posted on websites, in the park, or in business areas near the park. Public service announcements can be developed. Articles can be written and programs about trees and the benefits they provide can be developed. Signs can be hung from trees to highlight the contributions trees make to the community. Contests can even 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. Prospect Park Alliance's data are instrumental in helping to provide tangible and meaningful outreach about the urban forest.



Davey Resource Group's TreeKeeper® **calculates the ecosystem benefits of individual trees, groups of trees, or an entire urban forest using inventory data and highlights gold medal, most beneficial 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 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. Use appropriate computer management software such as TreeKeeper™ to update inventory data and work records. In addition to locating potential new hazards, inspections are an opportunity to look for signs and symptoms of pests and diseases. Prospect Park has a large population of trees that are susceptible to pests and diseases, such as ash, oak, and maple.

Inventory and Plan Updates

DRG recommends that the inventory and management plan be updated using an appropriate computer software program, such as TreeKeeper 8, so that Prospect Park Alliance 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 Prospect Park Alliance 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/update all data fields in five years or a portion of the population (1/5) every year over the course of five years.
- Revise the *Tree Management Plan* after five years when the re-inventory has been completed.

CONCLUSIONS

Every hour of every day, trees in Prospect Park are supporting and improving the quality of life. The park's trees provide an annual benefit of $1,596,472. 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. Prospect Park Alliance should prepare and implement an EAB mitigation plan as soon as possible.

Prospect Park Alliance 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 park's trees, Prospect Park Alliance is well positioned to thrive. If the management program is successfully implemented, the health and safety of Prospect Park's trees and Brooklyn citizens will be maintained for years to come.

GLOSSARY

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.

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.

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: Good, Fair, Poor, Dead.

crown spread (data field): Estimates the width of a tree's canopy in 5-foot increments.

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.

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.

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.

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.

maintenance notes (data field): Describes additional pertinent information.

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

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 (Primary Maintenance Need): Used to show that no secondary maintenance is recommended for the tree.

ordinance: See **tree ordinance**.

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.

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

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

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

Primary Maintenance Need (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.

Raise (Primary Maintenance Need): Signifies a maintenance need for a tree. Raising the crown is characterized by pruning to remove low branches that interfere with sight and/or traffic. It is based on *ANSI A300 (Part 1)*.

Re-inspection (Primary Maintenance Need): 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.

Reduce (Primary Maintenance Need): Signifies a maintenance need for a tree. Reducing the crown is characterized by selective pruning to decrease height and/or spread of the crown in order to provide clearance for electric utilities and lighting.

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.

Restore (Primary Maintenance Need): Signifies a maintenance need for a tree. Restoring is selective pruning to improve the structure, form, and appearance of trees that have been severely headed, vandalized, or damaged.

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

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

Secondary Maintenance Need (data field): Recommended maintenance for a tree generally was geared toward improving the health and structure of the tree and enhancing aesthetics.

Site Type (data field): Best identifies the type of location where a tree is growing.

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 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.

Thin (Primary Maintenance Need): Signifies a maintenance need for a tree. Thinning the crown is the selective removal of water sprouts, epicormic branches, and live branches to reduce density.

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

tree size (data field): A tree's diameter measured to the nearest inch in 1-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.

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

Structural (Primary Maintenance Need): Data field based on *ANSI A300* standards, this maintenance activity is characterized by pruning of trees to correct or eliminate weak, interfering, or objectionable branches to improve structure.

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APPENDIX A
DATA COLLECTION AND SITE LOCATION METHODS

Data Collection Methods

DRG collected tree inventory data using a system that utilizes a customized data collection 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 DRG'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	• Park zone
• Condition	• Pit size (width and length)
• Crown spread	• Secondary maintenance needs
• Inspection type	• Site type
• IPED data fields	• Species
• Primary maintenance needs	• Stems
• Mapping coordinates	• Structure
• Notes	• 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 *Best Management Practices: Tree Risk Assessment* (International Society of Arboriculture [ISA] 2011).

The data collected were provided in DRG's TreeKeeper® software and an ESRI® shapefile, Access™ database, Microsoft Excel™ spreadsheet, and iTree Streets data file on a CD-ROM that accompanies this plan.

Site Location Methods

Equipment and Base Maps

Inventory arborists use FZ-G1 Panasonic Toughpad® unit(s) with internal GPS receiver(s).

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

Base Map Layers Utilized for Inventory

Imagery/Data Source	Date	Projection
NYS GIS Data Clearinghouse http://gis.ny.gov/gisdata/inventories/details.cfm?DSID=1015#contact	2016-2018	NAD 1983 State Plane New York Long Island; Feet

APPENDIX B
RECOMMENDED SPECIES FOR FUTURE PLANTING

Proper landscaping and tree planting are critical components of the atmosphere, livability, and ecological quality of a community's urban forest. The tree species listed below have been evaluated for factors such as size, disease and pest resistance, seed or fruit set, and availability. The following list is offered to assist all relevant community personnel in selecting appropriate tree species. These trees have been selected because of their aesthetic and functional characteristics and their ability to thrive in the soil and climate conditions throughout Zone 7 on the USDA Plant Hardiness Zone Map.

Deciduous Trees

Large Trees: Greater than 45 Feet in Height at Maturity

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

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

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

Medium Trees: 31 to 45 Feet in Height at Maturity

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

Small Trees: 15 to 30 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer buergerianum	**trident maple**	**Streetwise®**
Acer campestre	**hedge maple**	**Queen Elizabeth™**
Acer cappadocicum	**coliseum maple**	'Aureum'
Acer ginnala	**amur maple**	**Red Rhapsody™**
Acer griseum	**paperbark maple**	
Acer nigrum	**black maple**	
Acer pensylvanicum*	**striped maple**	
Acer triflorum	**three-flower maple**	
Aesculus pavia*	**red buckeye**	
Amelanchier arborea	**downy serviceberry**	**(Numerous exist)**
Amelanchier laevis	**Allegheny serviceberry**	
Carpinus caroliniana*	**American hornbeam**	
Cercis canadensis	**eastern redbud**	'Forest Pansy'
Cercis chinensis	**Chinese redbud**	
Chionanthus virginicus	**white fringetree**	
Chionanthus retusus	**Chinese fringetree**	
Cornus alternifolia	**pagoda dogwood**	
Cornus florida	**flowering dogwood**	**(Numerous exist)**
Cornus kousa	**Kousa dogwood**	**(Numerous exist)**
Cornus mas	**corneliancherry dogwood**	'Spring Sun'
Cornus officinalis	**Japanese dogwood**	
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'
Hamamelis virginiana	**witchhazel**	**(Numerous exist)**
Lagerstroemia indica	**common crapemyrtle**	'Muskogee', 'Natchez'
Lagerstroemia fauriei	**Japanese crapemyrtle**	'Townhouse', 'Fantasy'
Laburnum × watereri	**goldenchain tree**	
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)**
Myrica cerifera*	**southern waxmyrtle**	
Oxydendrum arboreum	**sourwood**	'Mt. Charm'
Prunus subhirtella	**Higan cherry**	'Pendula'
Prunus × incamp	**Okame cherry**	'Okame'
Staphylea trifolia*	**American bladdernut**	
Stewartia ovata	**mountain stewartia**	
Styrax japonicus*	**Japanese snowbell**	'Emerald Pagoda'
Syringa reticulata	**Japanese tree lilac**	'Ivory Silk'
Vitex agnus-castus	**chastetree**	
Vitex negundo	**cutleaf chastetree**	'Heterophylla'

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

Coniferous and Evergreen Trees

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Abies concolor	white fir	'Violacea'
Cedrus deodara*	Deodar cedar	
Cedrus libani	cedar-of-Lebanon	
Chamaecyparis nootkatensis	Nootka falsecypress	'Pendula'
Cryptomeria japonica	Japanese cryptomeria	'Sekkan-sugi'
× Cupressocyparis leylandii	Leyland cypress	
Ilex opaca	American holly	
Magnolia grandiflora*	southern magnolia	
Picea omorika	Serbian spruce	
Picea orientalis	Oriental spruce	
Pinus densiflora	Japanese red pine	
Pinus palustris*	longleaf pine	
Pinus strobus	eastern white pine	
Pinus sylvestris	Scotch pine	
Pinus taeda	loblolly pine	
Pinus virginiana	Virginia pine	
Quercus myrsinifolia	Chinese evergreen oak	
Thuja plicata	western arborvitae	(Numerous exist)
Tsuga canadensis	eastern hemlock	

Medium Trees: 31 to 45 Feet in Height at Maturity

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

Small Trees: 15 to 30 Feet in Height at Maturity

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

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 C
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.

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.

Prospect Park is located in USDA Hardiness Zone 7b, which is identified as a climatic region with average annual minimum temperatures between 5°F and 10°F. Tree species selected for planting in Prospect Park 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.

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

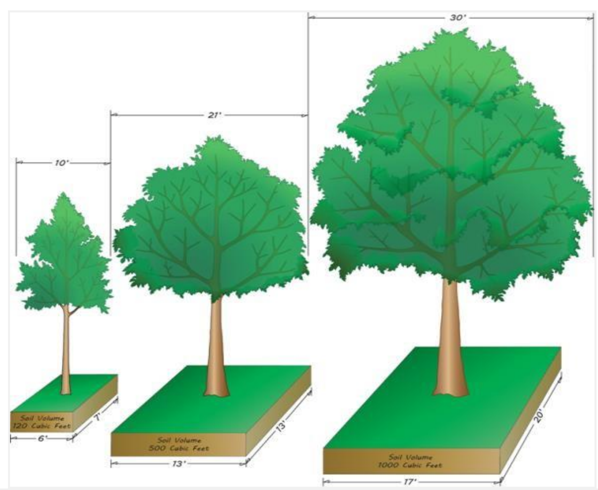
After the tree is established, it will require routine tree care, which includes inspections, routine pruning, watering, plant health care, and integrated pest management as needed.

Prospect Park 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 park'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 park's trees are properly diagnosed and that a beneficial and realistic action plan is developed.



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

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 park's urban forestry program and encourage tree planting on private property. The Prospect Park Alliance should encourage citizens to reach out if they notice any changes in the park trees, such as signs or symptoms of pests, early fall foliage, or new mechanical or vehicle damage.

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

Once they arrive, 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.

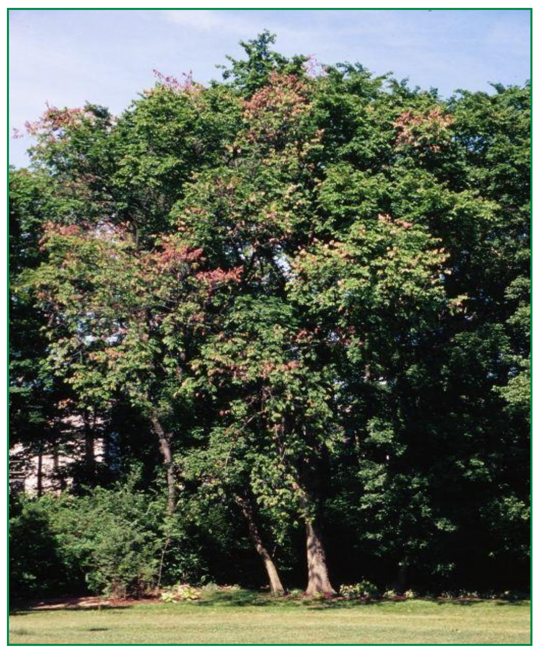
Adult Asian longhorned beetle

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.



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

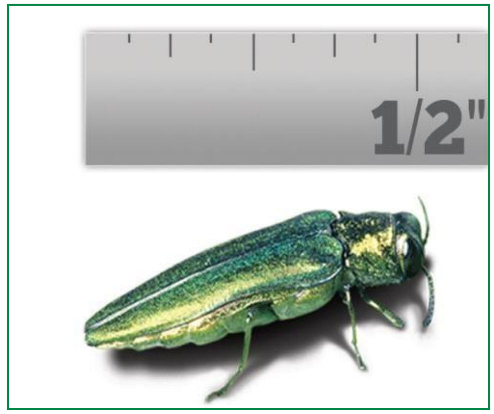
Photograph courtesy of Steven Katovich, USDA Forest Service, Bugwood.org (2011)

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*).

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).

European Oak Borer

The European oak borer (*Agrilus sulcicollis*) is native to Europe. It was first found in North America in Ontario, followed by Michigan and then New York. Adults range in size from 5 to 9 mm long and various metallic shades of bronze, green, violet, and blue. In their native Europe, they are found to have a 1-year lifespan, tend to fly between the months of May and July, and infest stressed Oaks. There is limited evidence of what impact the European oak borer may have on North American forests.

Close-up of blue adult European oak borer

Photograph courtesy of Joshua P. Basham (2009) from BugGuide

Gypsy Moth

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

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

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

Oak Splendor Beetle (Agrilus biguttatus)

The oak splendour beetle (*Agrilus biguttatus*) is a native of Europe, Africa, and Asia. It is a close relative to the emerald ash borer, though unlike emerald ash borer, it has not yet been found in North America. As the name suggests, oaks are the main host of this beetle, though chestnut (Castanea) and beech (Fagus) trees are also vulnerable. Adults are 8 to 13mm in length and metallic green in color with a pair of white spots on the inside of their wings. Females feed on oak leaves and lay their eggs in cracks in the bark. The larvae then feed on the cambium and leave behind zig-zag galleries. Between May and June, adults emerge via D-shaped holes.

Close-up of blue adult oak splendor beetle Photograph from France courtesy of Wikipedia

Oak Wilt

Oak wilt symptoms on red and white oak leaves

Photograph courtesy of USDA Forest Service (2011a)

Oak wilt was first identified in 1944 and is caused by the fungus *Ceratocystis fagacearum*. While considered an invasive and aggressive disease, its status as an exotic pest is debated since the fungus has not been reported in any other part of the world. This disease affects the oak genus and is most devastating to those in the red oak subgenus, such as *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.

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.

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

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 southern pine beetles

Photograph courtesy of Forest Encyclopedia Network (2012)

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.

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APPENDIX E
PRIORITY AND PROACTIVE MAINTENANCE

Priority Maintenance

Identifying and ranking the maintenance needs of a tree population enables tree work to be assigned priority based on condition, location, and size. 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.

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.